On-Site Wastewater Treatment Systems Nitrogen Reduction Technology Expert Review Panel

Drip Irrigation and Peat Treatment System BMP Review

May 1, 2018

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Agenda

- OWTS Expert Panel charge and membership
- Drip Irrigation BMP
- Peat Treatment System BMP
- Summary

OWTS Panel Charge

- Convened in July 2015
- Review available science on the nitrogen removal performance of two proposed best management practices:
  - (1) a peat treatment system with dispersal to a pad or a trench (not currently covered by an existing BMP and therefore represents a potentially new BMP for the sector) and
  - (2) shallow placed (≤ 12”) drip dispersal (currently covered by the BMP of Shallow Placed, Pressure-Dosed Dispersal which combines low pressure distribution and drip dispersal into the same category with a net 38 percent TN reduction)
- Provide concise definitions, qualifying conditions, and percent reductions for nitrogen load reduction practices

List of Panelists

Panelist	Organization
Jason Baumgartner	Delaware Department of Natural Resources and Environmental Control
Steven Berkowitz	North Carolina Department of Health and Human Services
Tom Boekeloo	New York State Department of Environmental Conservation
John Buchanan	University of Tennessee
Jay Conta	Virginia Department of Health
Marcia Degen	Virginia Department of Health
John Diehl	Pennsylvania Department of Environmental Protection
Scott Eichholz	Delaware Department of Natural Resources and Environmental Control
Robert Goo	US Environmental Protection Agency
Jack Hayes	Delaware Department of Natural Resources and Environmental Control
Sara Heger	University of Minnesota, On-site Sewage Treatment Program
Larry Hepner	Retired, Delaware Valley University
David Lindbo	USDA-NRCS, Soil Science Division
Kathryn Lowe	Colorado School of Mines
Jay Prager	Maryland Department of Environment
Eberhard Roeder	Florida Department of Health
Erik Severson	Virginia Department of Health

Other Authors and Contributors

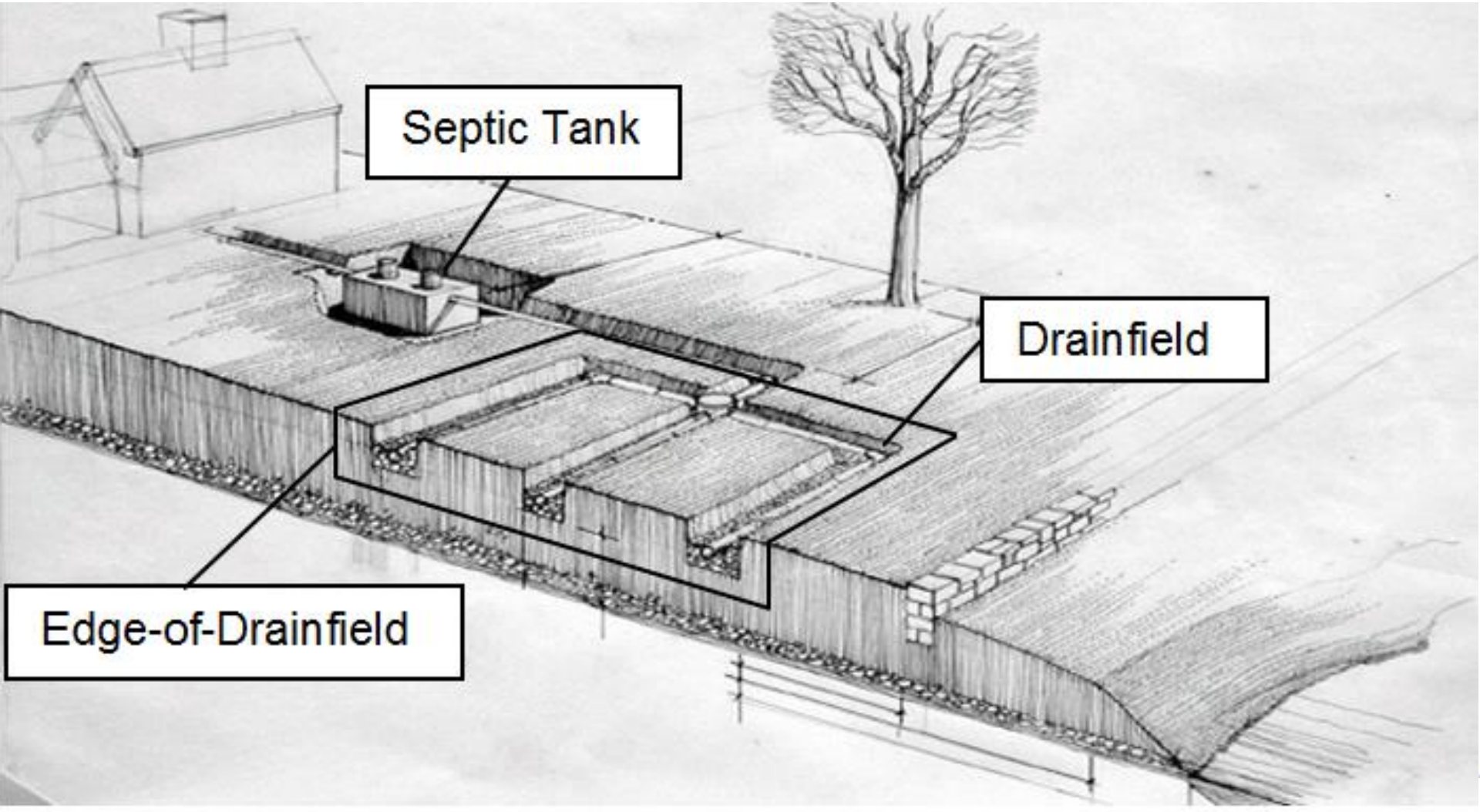
Staff/Contractor Support

- Ning Zhou – *Virginia Tech*
- Victor D'Amato– *Tetra Tech*

Current Baseline Load

- 5 kg TN/person/year in raw wastewater and STE
  - Assumed flow of 60 gpcpd
  - TN concentration of 60 mg/L in septic tank effluent (STE)
- 4 kg TN/person/year at edge-of-drainfield
  - 20 percent reduction in drainfield, average
  - 48 mg/l TN at edge of drainfield
- 50% reduction = 24 mg/l TN or 2 kg TN/person/yr at edge of drainfield

Baseline System



Source: Joubert et al. (2005)

Baseline Load Recommendations

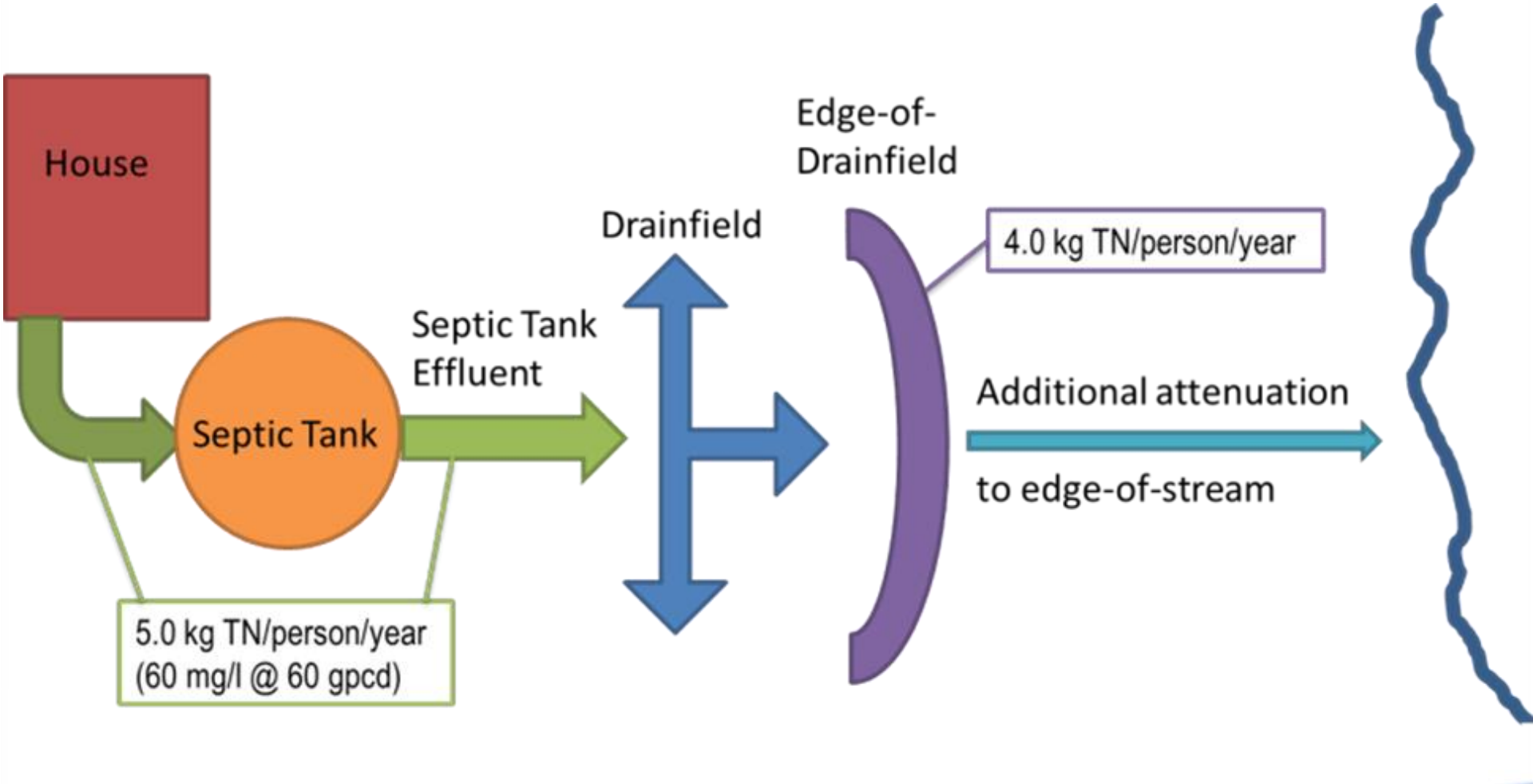


Table 1. Summary of Net TN Load Reductions for Combined *In situ* and *Ex situ* Systems.

Ex Situ Practice \ *In Situ* 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%)
NSF 40 Class I Secondary Systems	3.2 kg/p/yr (20%)	2.0 kg/p/yr (50%)	2.0 kg/p/yr (50%)
Intermittent Media Filter	3.2 kg/p/yr (20%)	2.0 kg/p/yr (50%)	2.0 kg/p/yr (50%)
Vegetated Submerged Bed	3.2 kg/p/yr (20%)	2.0 kg/p/yr (50%)	2.0 kg/p/yr (50%)
Anne Arundel Co. IFAS	2.0 kg/p/yr (50%)	1.25 kg/p/yr (69%)	1.25 kg/p/yr (69%)
Recirculating Media Filter	2.0 kg/p/yr (50%)	1.25 kg/p/yr (69%)	1.25 kg/p/yr (69%)
Proprietary (e.g., NSF 245 certified) Systems	Varies depending on technology and testing results		

Note: Percent reductions in table entries represent net reduction from baseline of 4 kg/person/year at edge-of-drainfield.

OWTS Panel Charge

- Review available science on the nitrogen removal performance of two proposed best management practices:
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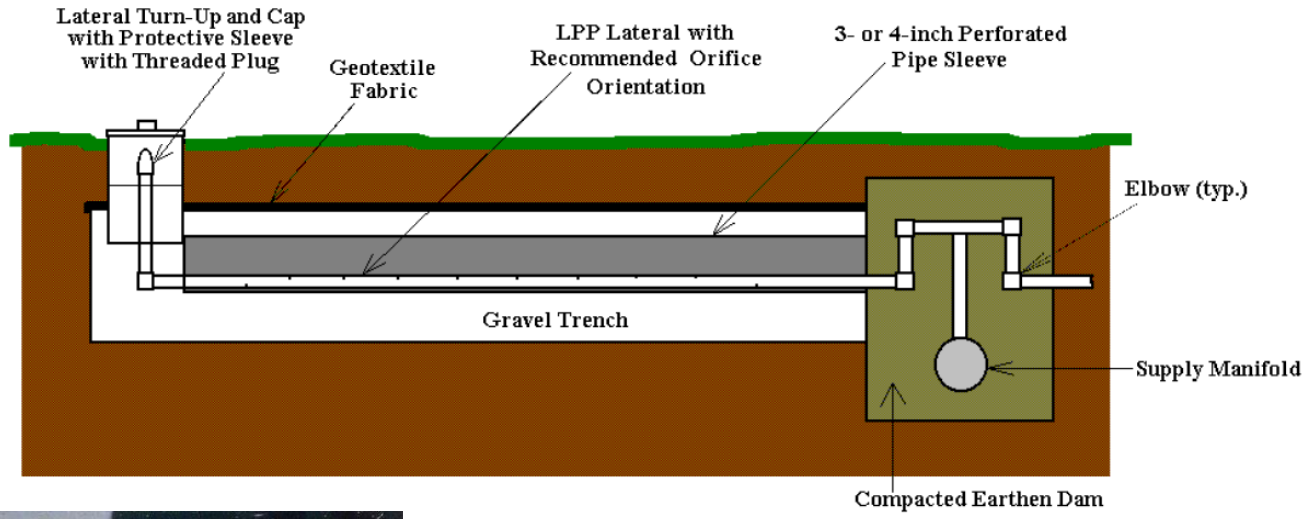
  - (2) shallow placed (≤ 12”) drip dispersal (currently covered by the BMP of Shallow Placed, Pressure-Dosed Dispersal which combines low pressure distribution and drip dispersal into the same category with a net 38 percent TN reduction)
- Provide concise definitions and percent reductions for nitrogen load reduction practices
- Provide the qualifying conditions under which credits can be received

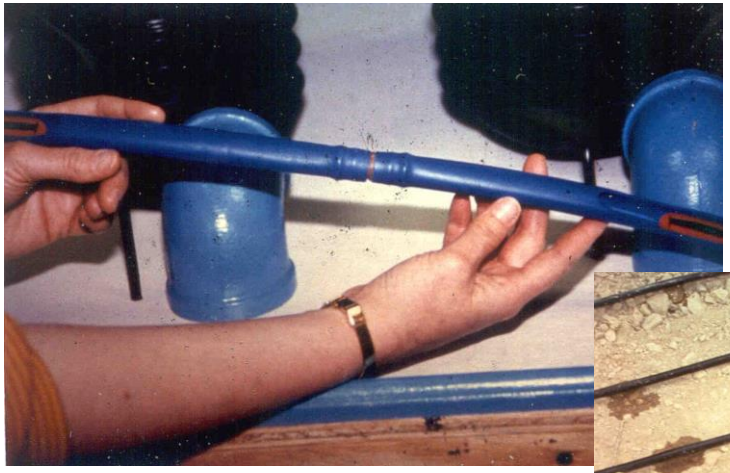
Drip Irrigation

- Currently addressed in “Shallow-Placed, Pressure-Dosed Dispersal” nitrogen reduction BMP
- BMP includes Drip and Low Pressure Dispersal (LPD) systems
- Current net TN reduction 38%

- Request: Consider drip irrigation data separately, using lower application rates for septic tank effluent, and reassess the TN reduction credits.

Shallow-Placed, Pressure-Dosed BMP





Dispersal Mat Technology

- A manufacturer of a dispersal mat technology requested to be considered with the drip review
- Panel considered and determined:
  - The product was not similar to drip irrigation to warrant extrapolating the drip data to the mat technology
  - The limited product specific data did not support a higher TN reduction
  - The product could be considered under the existing “Shallow-Placed, Pressure-Dosed Dispersal” BMP

Literature Review

- Table 4. List of Primary References and Data Sources for Drip Dispersal Evaluation
  - 3 studies ranked high
  - 4 studies ranked medium
  - 10 studies ranked low
- Table 5. Summary of Primary References and Data Sources for Drip Dispersal Evaluation
  - Data generally support the net 50% reduction in all but sandy soils (Anderson et al)

STUMOD

- developed at the Colorado School of Mines
- spreadsheet-based model to simulate nitrogen transport in the unsaturated zone below an on-site wastewater treatment system.
- The model is based on fundamental principles of water movement and contaminant transport using an analytical solution to calculate pressure and moisture content profiles in the vadose zone and a simplification of the general advection dispersion equation (Geza et al., 2010).
- The model requires some simplifying assumptions (e.g., one dimensional vertical flow, continuous steady state dosing) but can be calibrated to site-specific data if available.

Why STUMOD?

- Fill in data gaps
- Mimics known processes especially ET and plant uptake

Model Setup

- 9 inch installation (23 cm)
- Roots extending to 15 inches (37 cm) (6 inches below emitter)
- Shallow water table at 18 inches below emitter (27 inches)
- TN of 60 mg-N/l applied as ammonium

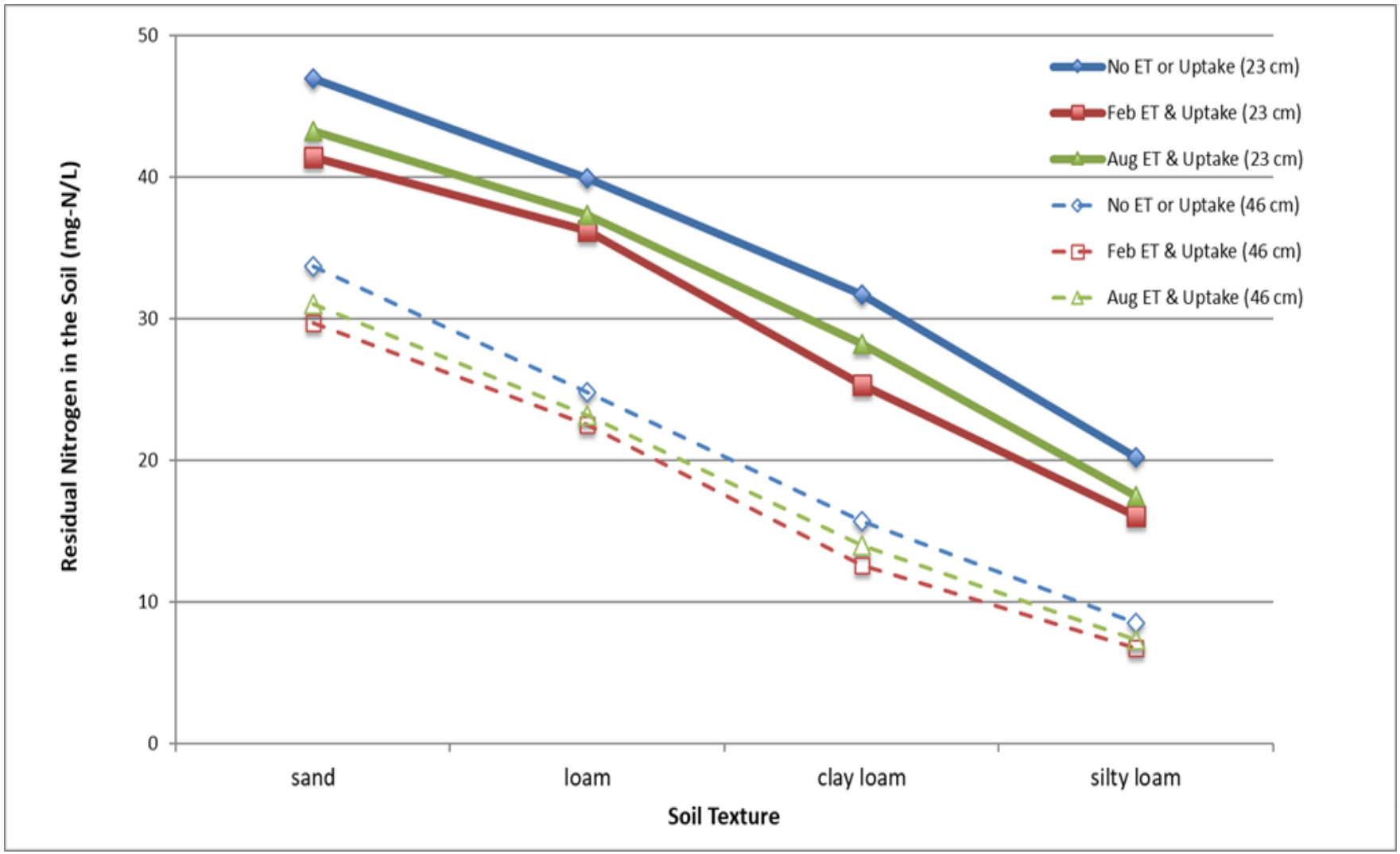
Model Setup

- To evaluate ET and plant uptake
  - Ran February (none) and August (default of 0.35 kg/ha/d)
- Chesapeake Bay Latitude
  - 37.5214 ^{o}N
- Mean soil temperature 18.5°C

Model Setup

- 4 soil textures and loading rates:
  - Sand (0.27 gpd/ft^2)
  - Loam (0.20 gpd/ft^2)
  - Clay Loam (0.14 gpd/ft^2)
  - Silty Clay (0.09 gpd/ft^2)

MODEL Results



Conclusion

Drip irrigation should be recognized as a BMP achieving a net 50% TN reduction when either septic tank effluent or treated effluent is applied to a drip irrigation system designed under the following design criteria.

Detailed Definition of Practice – Key Points

- Install in a natural surface horizon no deeper than 12 inches.
- No credit where TG 1 soils predominate within 12 inches below
- 18 inches unsaturated zone beneath
- Either septic tank effluent or treated effluent

Detailed Definition of Practice

- Filtration system on effluent
- Automatic flush cycle
- Equalize and time dosing over 24 hours
- Dose volume minimum 3.5 times drip network, 5X recommended

Detailed Definition of Practice

- A/V release valves at high points
- Max emitter spacing 2 ft : normal tube spacing 2 ft
- Minimum drip tube length = ½ dispersal area
- Maximum loading rates per Texture Group
  - TG II 0.27 gpd/sf
  - TG III 0.17 gpd/sf
  - TG IV 0.12 gpd/sf

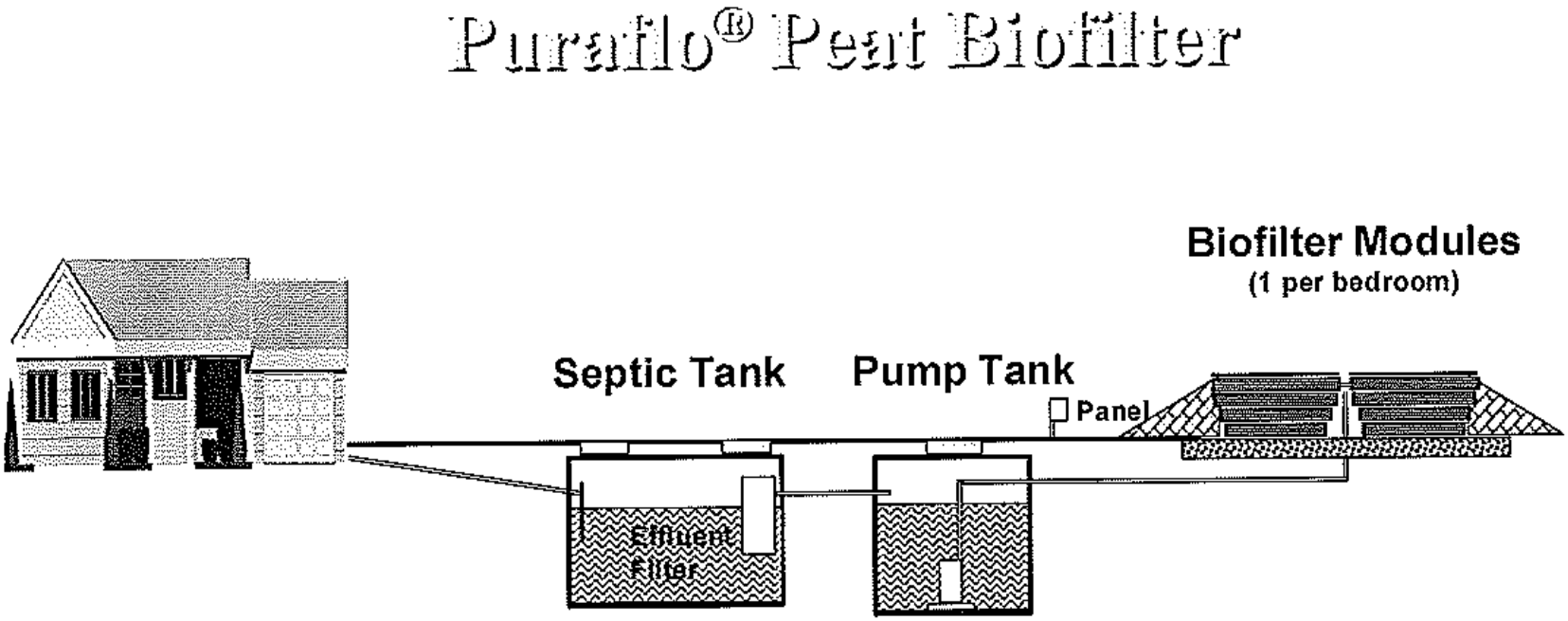
PEAT TREATMENT WITH PAD/TRENCH DISPERSAL

THE PROPOSAL

- ***Peat treatment units in combination with a soil dispersal trench or pad installed no deeper than 18 inches in original soil and with at least 12 inches of separation to a limiting feature such as rock or water table result in a net > 50 percent total nitrogen reduction when applied to soil at specified loading rates.***

Peat Treatment Units

Typical pad layout



Data Review

Two data sets were submitted, one from each manufacturer:

- Bord Na Mona. 1999/2014. VA Demonstration Project Report for PURAFLO Peat Biofilter (VA PURAFLO Study) (23 sites)
- Belanger, M. 2014. VA Monitoring Program Summary for ECOFLO TN Removal (VA ECOFLO Study) (21 sites)

Data Review

- Both studies conducted in VA
- TN samples collected
  - Applied to peat filter
  - Peat filter effluent
  - One foot below pad or trench
- Systems in all 4 soil texture groups

Data Analysis

- Only paired data sets used
- Many sites had water tables within 12 inches of trench/pad bottom
- Chloride samples provided
- Influence of dilution calculated on soil samples

Table 8. TN Reduction through Treatment Unit (paired data sets only)[1]

	Puraflo	Ecoflo
Count	91	68
Minimum	-88.5%	-89.7%
Maximum	99.0%	92.5%
Mean	**22.4%**	**23.8%**
Standard Deviation	38.2%	45.9%

[1] Treatment unit removal = (Septic tank effluent – Treatment unit effluent)/Septic tank effluent. Data with more than a negative 100% reduction dropped.

Texture Group I

	Puraflo		Ecoflo	
	Soil Removal	Overall	Soil Removal	Overall
Count	14	10	1	0
Minimum	-117.3%	-32.2%	0.8%	
Maximum	94.0%	89.1%	0.8%	
Mean	**33.4%**	**23.3%**	**0.8%**	
Standard Deviation	51.9%	45.1%		

Texture Group II

	Puraflo		Ecoflo	
	Soil Removal	Overall	Soil Removal	Overall
Count	23	19	4	4
Minimum	-49.2%	-205.8%	0.0%	46.8%
Maximum	99.2%	99.6%	95.0%	93.5%
Mean	**35.7%**	**43.4%**	**51.9%**	**72.3%**
Standard Deviation	50.8%	71.1%	41.5%	19.9%

Texture Group III

	Puraflo		Ecoflo	
	Soil Removal	Overall	Soil Removal	Overall
Count	18	10	3	3
Minimum	-30.2%	9.1%	27.6%	-45.5%
Maximum	92.0%	90.2%	87.6%	94.1%
Mean	26.1%	50.5%	64.9%	37.3%
Standard Deviation	34.8%	26.2%	32.6%	73.3%

Texture Group IV

	Puraflo		Ecoflo	
	Soil Removal	Overall	Soil Removal	Overall
Count	**No data**	**No data**	**14**	**11**
Minimum			0.0%	-45.5%
Maximum			95.0%	94.1%
Mean			**46.2%**	**51.2%**
Standard Deviation			37.6%	44.4%

Conclusion

- The Panel recommends that single-pass peat treatment systems plus dispersal **NOT** be included as an OWTS sector BMP in the Chesapeake Bay Program at this time.

Conclusion

- The Panel encourages the collection of additional paired, dilution corrected data to strengthen the statistical significance of the dataset and further inform the performance of this technology.
- NSF 40 certified peat treatment units already fall under an ex-situ BMP that assigns a 20 percent TN reduction to the treatment unit alone.

Panel Recommendations Summary

- The Panel recommends that drip irrigation systems that meet the design and installation criteria in Section 2 be approved as a BMP for reducing nitrogen within the drainfield (Zone 1) by 50 percent. This recommendation adds a new BMP to those already approved by the CBP.

Panel Recommendations Summary

- Upon a review of available field data on single-pass peat filtration systems discharging to a pad or trench, the Panel recommends not adding a new creditable BMP.
- The existing data that were reviewed exhibited an extremely high level of variability and thus statistical uncertainty.
- More research is needed.

Panel Recommendations Summary

- Panel recommends tracking the efforts of the nitrogen sensor challenge to determine if they might provide better data.
- The CBP should take a more proactive approach to verifying BMPs and the sensors may help in that effort.

Panel Recommendations Summary

- With regards to *in situ* BMPs, there is scientific uncertainty about the impacts of saturated conditions within the dispersal area on nitrogen.
- More research in fluctuating water table environments would therefore be worthwhile. Future studies should continue to collect chloride data in order to separate the impacts of groundwater dilution from mass removal.
- Future studies should also measure soil carbon as it should be an important characteristic for nitrogen removal.

Questions?

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