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

Presentation of Final Report to Watershed Technical Workgroup

March 6, 2014

Marcia J. Degen, Ph.D., PE
VA Department of Health

Agenda

- OWTS Expert Panel charge and membership
- Baseline loadings from on-site systems
- BMP definitions and qualifying conditions
  - Proprietary and non-proprietary technologies
  - *Exsitu* (pretreatment) and *insitu* (soil treatment) technologies
- Future research and management recommendations

OWTS Panel Charge

- Initially convened in January 2012
- Review available science on the nitrogen removal performance of treatment practices
- Provide concise definitions and percent reductions for nitrogen load reduction practices
- Provide a definition for each treatment practice and the qualifying conditions under which credits can be received
- Only address TN reduction in treatment technologies, not in the soil between edge-of-system and edge-of-stream ("attenuation")

List of Panelists

Panelist	Organization
Jim Anderson	University of Minnesota
Eric Aschenbach	Virginia Department of Health
Jason Baumgartner	Delaware Department of Natural Resources and Environmental Control
Derrick Caruthers	Delaware Department of Natural Resources and Environmental Control
Marcia Degen	Virginia Department of Health
Kitt Farrell-Poe	University of Arizona
Joshua Flatley	Maryland Department of the Environment
Robert Goo	U.S. Environmental Protection Agency
Rick Hertges	West Virginia Health and Human Services
Mike Hoover	North Carolina State University
Joyce Hudson	U.S. Environmental Protection Agency
Randy Miles	University of Missouri
Jeff Moeller	Water Environment Research Foundation
Dave Montali	West Virginia Department of Environmental Protection
Sushama Pradhan	North Carolina State University
Jay Prager	Maryland Department of the Environment

Other Authors and Contributors

- Robert Adler – *EPA Region 1*
- Jay Conta – *Virginia Tech*
- Rich Piluk – *Anne Arundel County Health Department*

Staff/Contractor Support

- Ning Zhou – *Virginia Tech*
- Jeremy Hanson – *Chesapeake Research Consortium*
- Victor D'Amato, Jim Kreissl, Mark Sievers – *Tetra Tech*

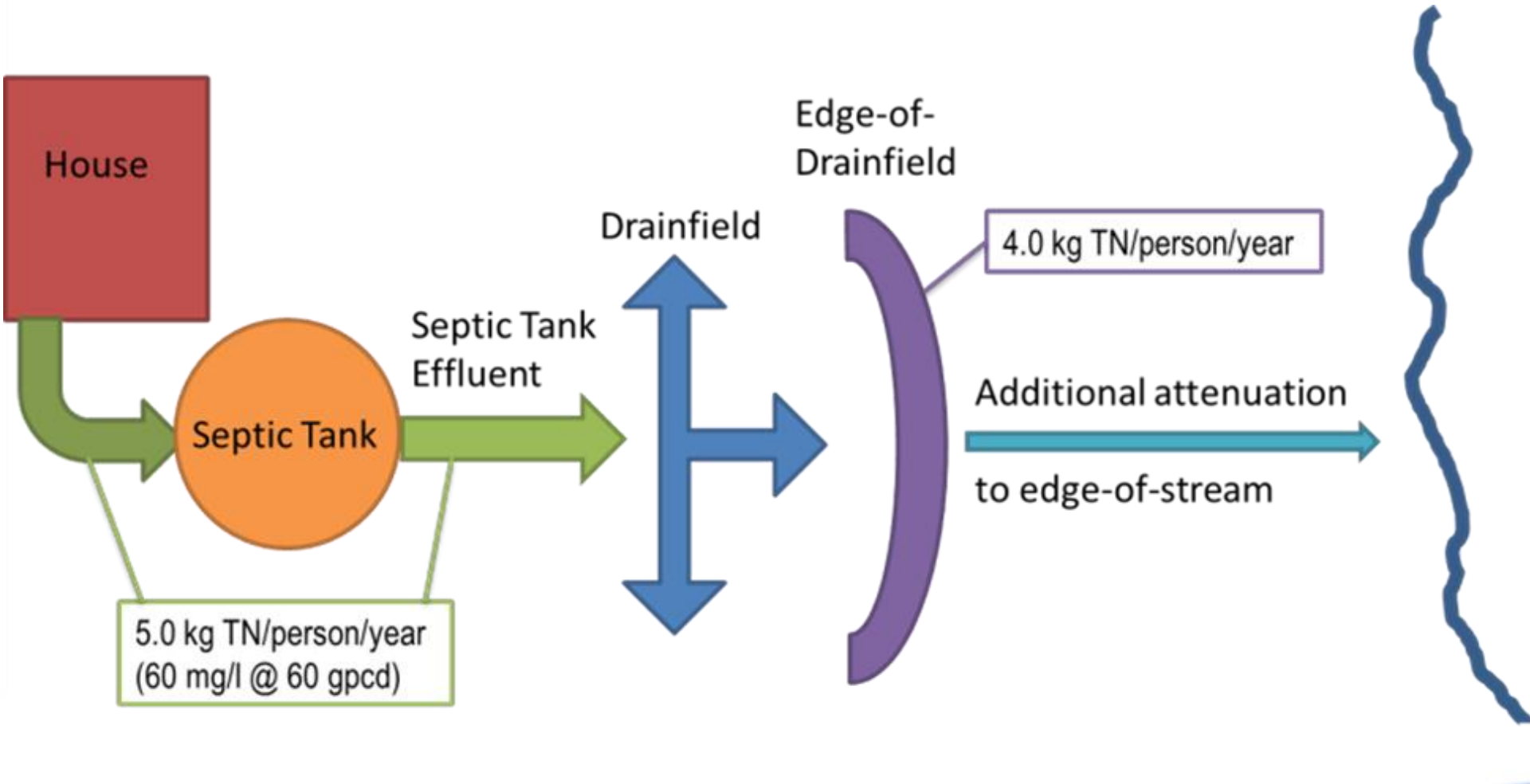
Current Model Assumptions for Onsite

- Baseline condition
  - Conventional septic tank and drainfield
  - 4 kg TN/person/year at edge-of-drainfield
  - Assumed flow of 75 gpcpd + TN concentration of 39 mg/l
- 60 percent attenuation between drainfield and edge-of-stream
- Three BMPs
  - Connection to central sewer (100 percent reduction from on-site sector)
  - 50 percent denitrification system (50 percent reduction)
  - Routine septic tank pump-out (5 percent reduction)

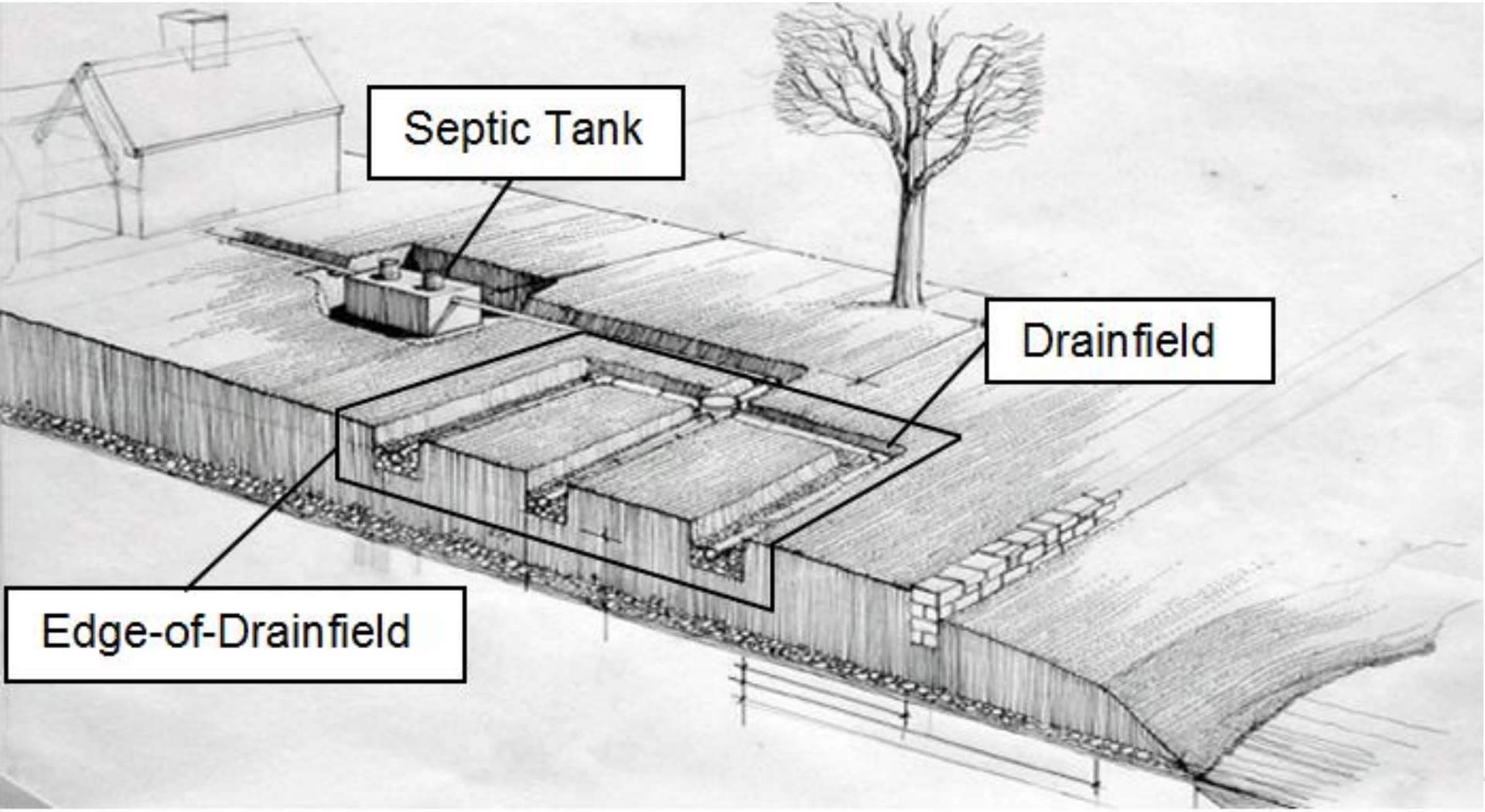
Baseline Load Recommendations

- 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
- No attenuation recommendation

Baseline Load Recommendations



Baseline System

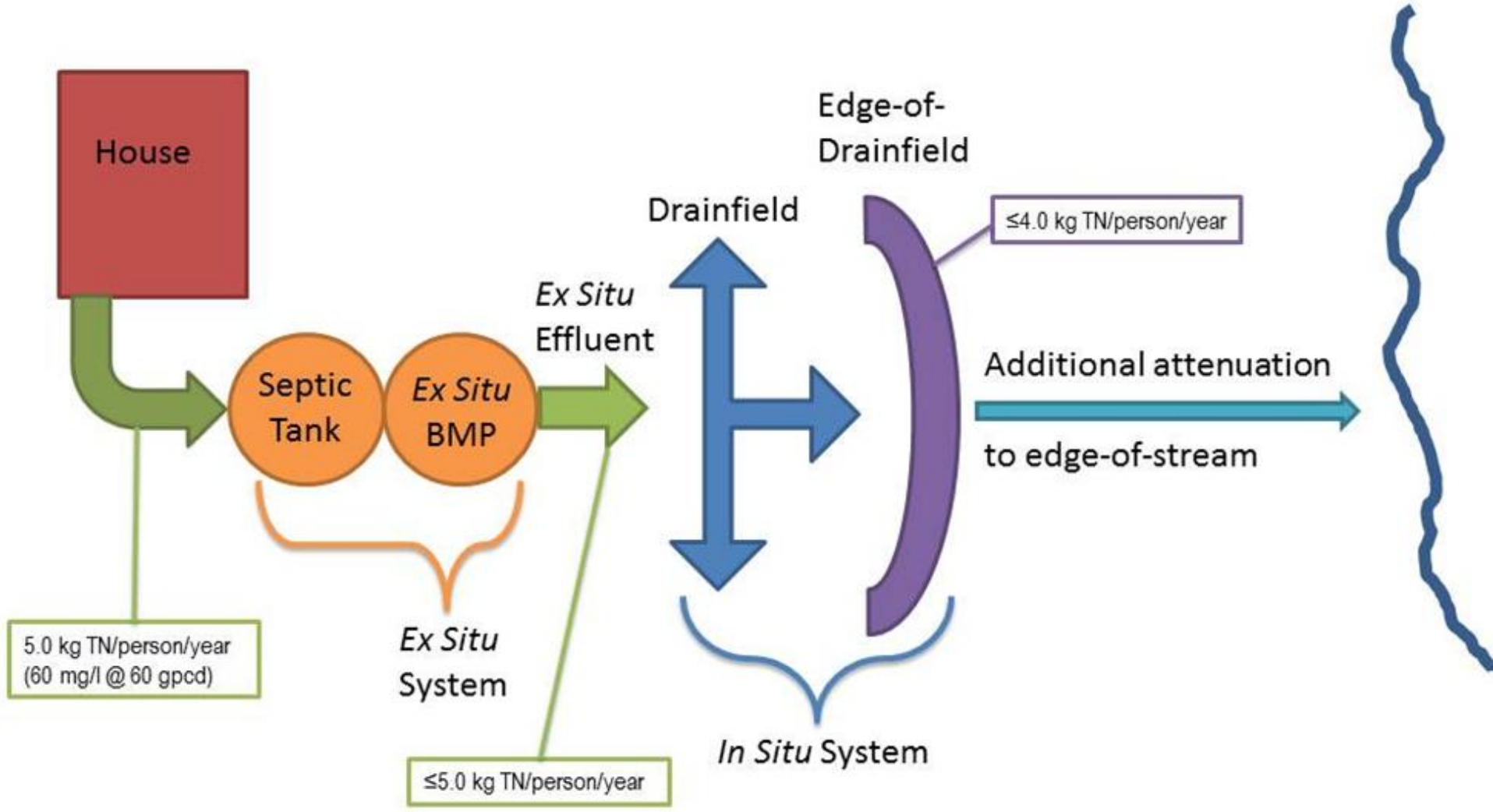


Source: Joubert et al. (2005)

Onsite BMP Categories

- *Exsitu* BMP or Treatment BMP
  - BMP efficiency assessed at end of process prior to soil application
  - Reduction based on baseline effluent TN of 5 kg/person/year
- *Insitu* BMP or Soil BMP
  - Reduction based on TN removal beyond baseline 20 percent reduction or 4 kg/person/year at edge-of-drainfield
- Combined *Exsitu* with *Insitu* BMPs
  - Reduction based on TN of 4 kg/person/year at edge-of-drainfield
  - Assume consistent TN reduction across the soil treatment system, regardless of *exsitu* effluent characteristics

Onsite System with BMP



Best Management Practices

- Performance of recommended BMPs is well-supported by science and verifiable data
  - Ongoing sampling and analysis for each system is not recommended for verification
- Recommendations intended to complement existing state regulations and policies
  - Design and management criteria, beyond minimum standards
  - Initial set of BMPs suggested by states
- Recognition that biological nitrogen removal performance can be variable
  - Require minimum USEPA Level 2 management model (operators, permits)
  - Suggestions for overarching management activities to promote effective BNR

Best Management Practices

Exsitu (treatment) system components

- NSF Standard 40 Class I secondary systems or equivalent
- Intermittent (single-pass) media filters
- Constructed wetlands (vegetated submerged beds)
- Recirculating media filters (RMFs)
- Anne Arundel County Integrated Fixed-Film Activated Sludge (IFAS)
- Proprietary *ex situ* treatment systems

Insitu (soil treatment) system components

- Shallow-placed, pressure-dosed dispersal
- Elevated sand mounds
- Permeable reactive barriers

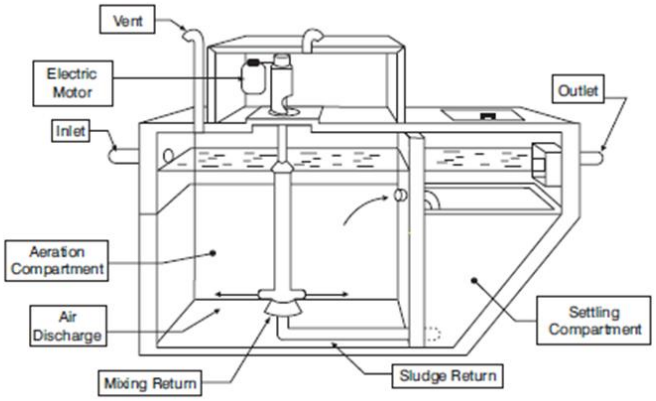
Example BMP Outline

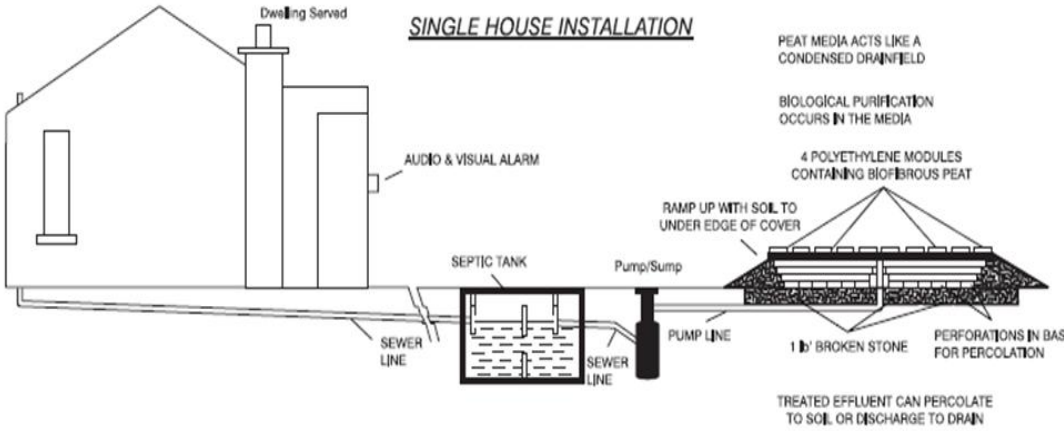
Exsitu (Treatment) BMP Summary

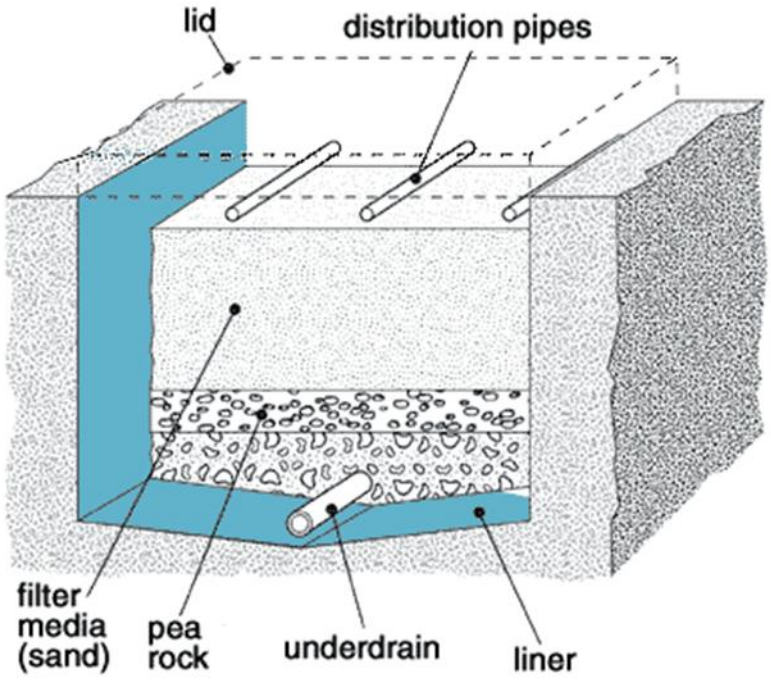
Table ES-1. Summary of BMP Recommendations for *Ex Situ* Unit Processes.

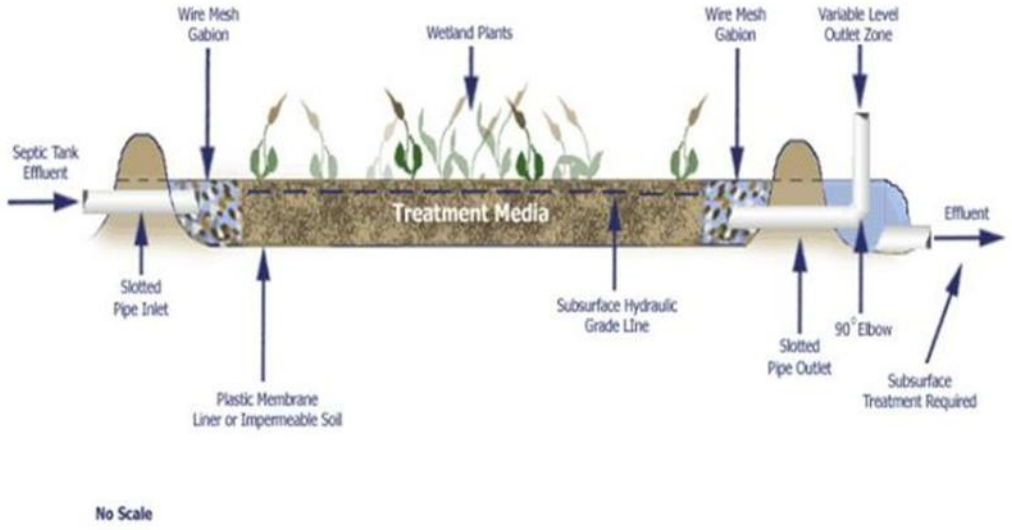
Best Management Practice	Qualifying Conditions	*Ex Situ* Reduction Credit[1]
Septic tank (baseline practice)	N/A	0
NSF 40 Class I Equivalent Secondary Systems	• Certified as Class I under NSF International Standard 40 or similar (e.g., CAN/BNQ 3680-600, CEN Standard 12566-3) • Design, installation, and operation in accordance with manufacturer recommendations and state or local regulation	20%
Intermittent media filters	• Timer-based flow equalization with 12–24 doses/day • 2' depth (sand) media ES = 0.5–1.0 mm; UC ≤ 4.0; < 0.5% passing #200 sieve • HLR ≤ 2 gpd/sf • OLR ≤ 5 lb BOD/1,000 sf • Uniform, pressurized distribution ≤ 6 sf/orifice	20%
Constructed wetlands	• ≤2' depth media ES = 40–80 mm inlet/outlet; ES = 20–30 mm treatment zone, extending 0.1 m above water level • Length-to-Width ratio < 10:1 • Surface Area ≥ 54 sf/PE • Width between 0.56 and 1.31 feet/PE • Outlet structure allows for variable flooding depth • 6" top layer of planting media	20%

Exsitu BMPs


Vent
Electric Motor
Inlet
Outlet
Aeration Compartment
Air Discharge
Settling Compartment
Mixing Return
Sludge Return


Dwelling Served
SINGLE HOUSE INSTALLATION
PEAT MEDIA ACTS LIKE A CONDENSED DRAINFIELD
BIOLOGICAL PURIFICATION OCCURS IN THE MEDIA
AUDIO & VISUAL ALARM
4 POLYETHYLENE MODULES CONTAINING BIOFIBROUS PEAT
RAMP UP WITH SOIL TO UNDER EDGE OF COVER
SEPTIC TANK
Pump/Sump
SEWER LINE
SEWER LINE
PUMP LINE
1 lb' BROKEN STONE
PERFORATIONS IN BAS FOR PERCOLATION
TREATED EFFLUENT CAN PERCOLATE TO SOIL OR DISCHARGE TO DRAIN

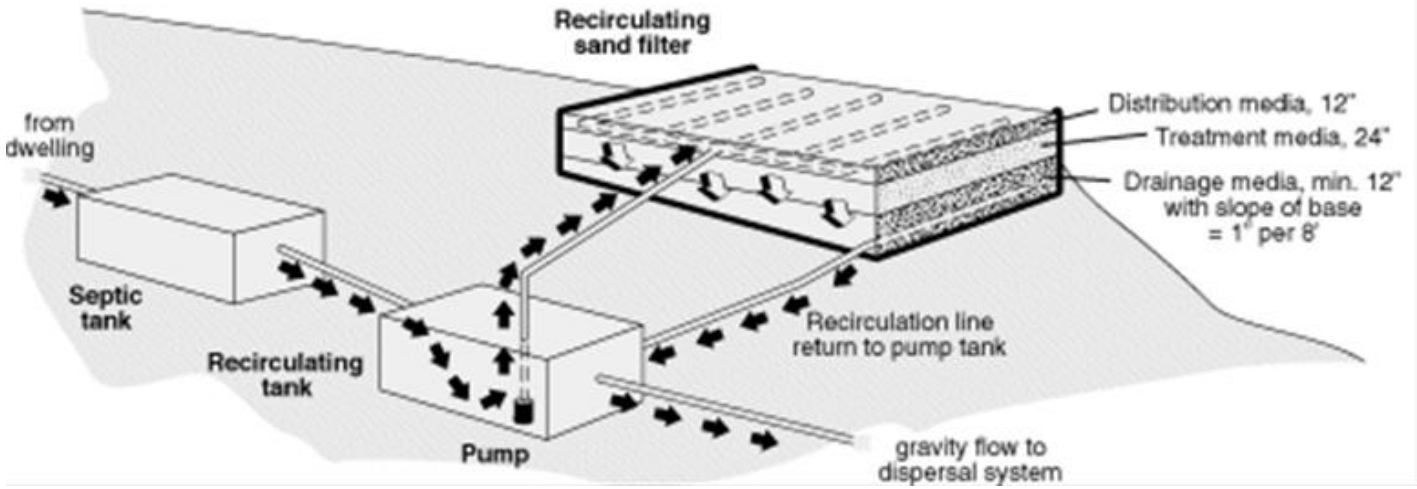

lid
distribution pipes
filter media (sand)
pea rock
underdrain
liner

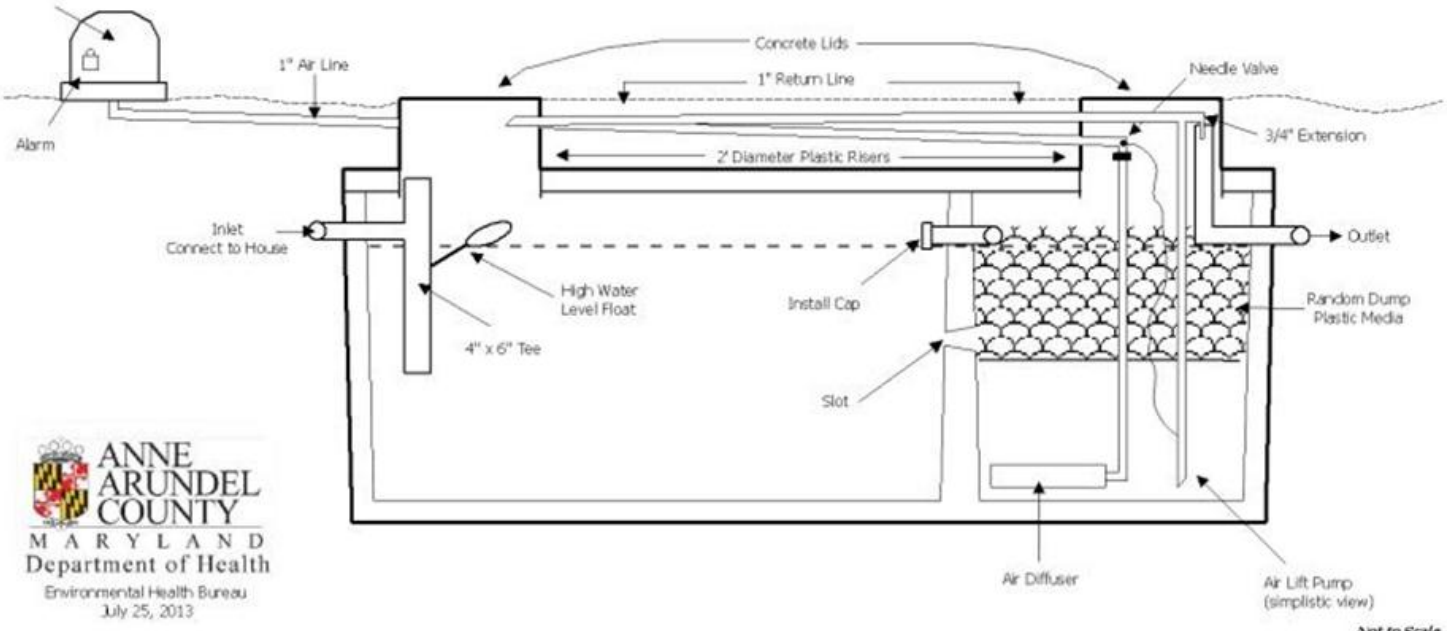

Wire Mesh Gabion
Wetland Plants
Wire Mesh Gabion
Variable Level Outlet Zone
Septic Tank Effluent
Treatment Media
Effluent
Slotted Pipe Inlet
Subsurface Hydraulic Grade LIne
Slotted Pipe Outlet
90° Elbow
Plastic Membrane Liner or Impermeable Soil
Subsurface Treatment Required
No Scale

Exsitu BMP Summary

Best Management Practice	Qualifying Conditions	*Ex Situ* Reduction Credit[1]
Recirculating media filters	• Timer-based flow equalization with 24–48 doses/day • 2' depth media • Sand media: ES = 1.0–5.0 mm; UC ≤ 2.5; < 0.5% passing #200 sieve; HLR ≤ 5 gpd/sf; OLR ≤ 5 lb BOD/1,000 sf • Gravel media: ES = 5.0–20 mm; UC ≤ 2.5; < 0.5% passing #200 sieve; HLR ≤ 15 gpd/sf; OLR ≤ 15 lb BOD/1000 sf • Uniform, pressurized distribution ≤ 6 sf/orifice • Device capable of recirculating 3–5 times forward flow back to anoxic zone	50%
Anne Arundel County IFAS	• 2-day HRT anoxic chamber • 1-day HRT aerobic chamber with ≥ 600 sf surface area fixed-film media • Aeration device capable of maintaining 3.0 mg/L DO • Device capable of recirculating 3–5 times forward flow back to anoxic zone • Alarm for aeration device fault	50%
Proprietary treatment systems	• NSF 245 certification or similar • Technology-specific • Percent removal based on qualifying third-party field testing	≥ 50%

Exsitu BMPs



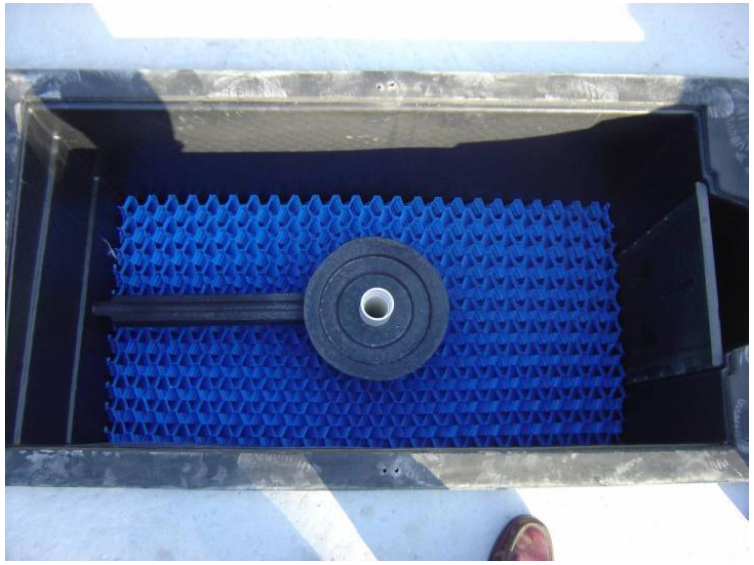


ANNE ARUNDEL COUNTY
MARYLAND
Department of Health
Environmental Health Bureau
July 25, 2013

Best Management Practices

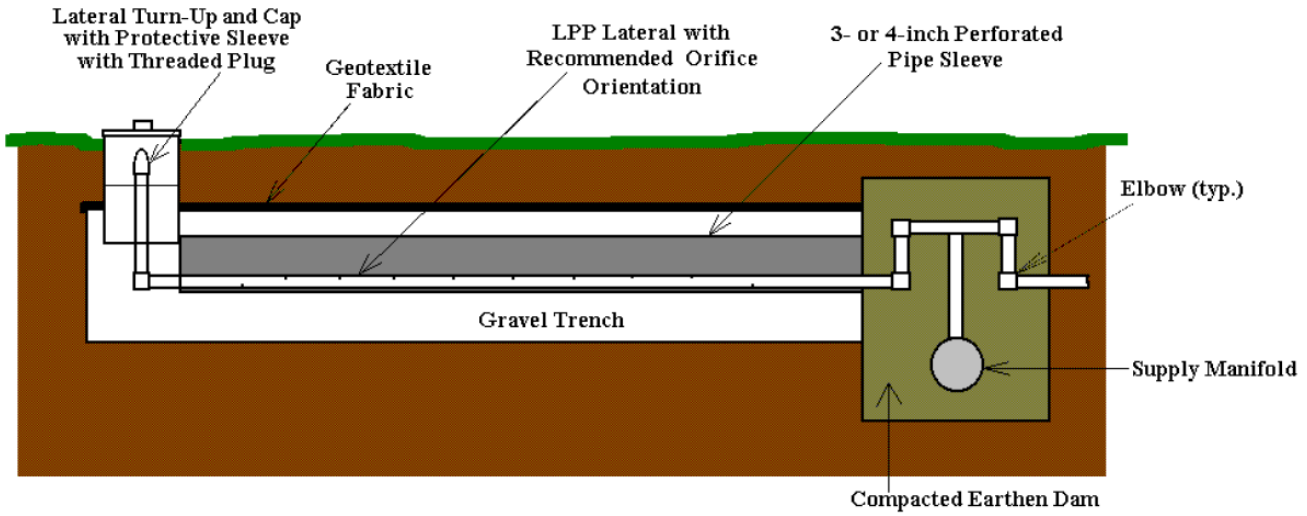
- Proprietary Exsitu Treatment BMPs
  - Developed, marketed, and constructed by a manufacturer
  - Manufacturer responsibility for system design, installation, and ongoing management
  - Standardized design and construction and little variability between the same model
  - Recommend two-step credit assignment protocol: **provisional testing** (e.g., NSF Standard 245) followed by third-party **field testing**
  - TN reduction credit of 50 percent, unless managed according to min. EPA Level 3
- Nonproprietary Exsitu Treatment BMPs
  - Designed on case-by-case basis for each site using nonspecific and readily available materials and mechanical equipment
  - Local design and material variations common
  - Two-step protocol for design and verification of individual BMP

Exsitu BMPs



Best Management Practice	Qualifying Conditions	*In Situ* Reduction Credit[1]
Conventional system (baseline practice)	N/A	20%
Shallow-placed, pressure-dosed dispersal	• Drip or LPD installed within 12" of grade in natural surface horizon (e.g. A or A/B) • Credit not provided where sand or loamy sand soils predominate within 12" below effluent dispersal depth • Lines placed on contour • Drip requires prefiltration system, automatic flush cycle, flow equalization, air release valves • LPD requires: working pressure head of 2–5', dosing volume of 7–10 times distribution system piping, lateral flushing provisions, max flow variation of 10% for each lateral	50%
Elevated sand mounds	• Installation on intact natural surface horizon (e.g. A or A/B) • Scarify surface of soil under mound • Uniform, pressurized distribution ≤ 6 sf/orifice • Minimum 0.5' (for secondary treated effluent) or 2' (for STE) layer of sand: ASTM C33; ≤ 20% by weight > 2 mm; D10 = 0.15 to 0.3 mm; UC = 4 to 6 • Max. top of sand ALR = 1 gpd/sf for STE, 2 gpd/sf for secondary • 6–12" loamy cover layer • Credit not provided where sand or loamy sand soils predominate within 12" below mound	50%
Permeable reactive barriers	• Site-specific	Case-by-case

Insitu BMPs


Lateral Turn-Up and Cap with Protective Sleeve with Threaded Plug
Geotextile Fabric
LPP Lateral with Recommended Orifice Orientation
3- or 4-inch Perforated Pipe Sleeve
Elbow (typ.)
Gravel Trench
Supply Manifold
Compacted Earthen Dam

Net N Reduction of Combined BMPs

- All onsite systems consist of some type of treatment and soil dispersal system
- Have to look at the whole system to assess the final N reduction
- Many combinations available
  - Septic tank effluent + drip
  - TL2 + drip
  - 50% N reducing unit + mound
  - etc

Baseline Defined

- BMPs are given credit for N reduction **BEYOND** the *baseline condition*
- The *baseline condition* is a conventional septic tank and drainfield.
- All BMPs have to be compared to the *baseline condition* to determine the **NET N Reduction**
- *Baseline condition* is measured at edge of drainfield
- From model: edge of drainfield = 9 lb/person/yr or 4 kg /person/year

Net N Reduction Example

Proposed: NSF 40 treatment system PLUS shallow drip

5 kg TN → NSF 40 unit

NSF 40 unit reduces the TN by 20%

TN out to drainfield → 4 kg TN

4 kg TN → shallow drip

shallow drip reduces TN by 50%

TN to edge of drainfield → 2 kg TN

NET TN Reduction ((4-2)/4) x 100 = 50%

Net N Reduction Example

Proposed: Septic tank with shallow drip

5 kg TN → Septic Tank

Septic Tank reduces the TN by 0%

TN out to drainfield → 5 kg TN

5 kg TN → shallow drip

shallow drip reduces TN by 50%

TN to edge of drainfield → 2.5 kg TN

NET TN Reduction ((4-2.5)/4) x 100 = 38%

Combined *Exsitu* and *Insitu* BMPs

Net Edge of Drainfield N Load and Percent Reduction

***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%)

Treatment and Soil Based BMP Combinations and Resulting Net TN Reduction		
Treatment Unit Gross TN Reduction	**Soil Dispersal Gross TN Reduction**	**Net TN Reduction of Combined System**
• Septic Tank (0 %)	• Gravity drainfield (20%)	0%
• Septic Tank (0 %)	• Shallow placed pressure dosed(50%) • Elevated Sand Mounds (50%)	38%
• Single Pass Sand filter (20%) • Constructed Wetlands (20%) • NSF 40Treatment Unit (20%)	• Gravity drainfield (20%)	20%
• Single Pass Sand filter (20%) • Constructed Wetlands (20%) • NSF 40 Treatment Unit (20%)	• Shallow placed pressure dosed(50%) • Elevated Sand Mounds (50%)	50%
• Recirculating Sand/Gravel Filter (50%) • Proprietary N Removal Systems (50%) • Anne Arundel IFAS (50%)	• Gravity drainfield (20%)	50%
• Recirculating Sand/Gravel Filter (50%) • Proprietary N Removal Systems (50%) • Anne Arundel IFAS (50%)	• Shallow placed pressure dosed (50%) • Elevated Sand Mounds (50%)	69%

Combined BMPs

Treatment	Soil Dispersal	Net N Reduction
20%	20%	20%
20%	50%	50%
50%	20%	50%
50%	50%	69%

Reevaluation of Septic Tank Pumpout BMP

- The Panel was asked to revisit the existing Septic Tank Pumpout BMP to verify if the reduction of 5% was valid.
- Appendix C contains the evaluation
- A 5% reduction was re-justified with conditions:
  - Good for the year the pumpout occurs
  - Frequency of 1/5 years or greater
  - Conventional systems only to avoid double counting N reductions

Research and Management Recommendations

- Alkalinity control
  - Critical for effective nitrification (50 mg/L recommended in final effluent)
  - R&D for simple, inexpensive alkalinity control would help optimize TN removal and could justify higher credits in future
- BMP sampling
  - Not recommended to be mandatory for verification
  - However, widespread BMP implementation offers opportunity for data collection
- Data sharing and reciprocity
  - EPA-OWM offered to facilitate
  - Also addressed at July 2013 SORA/NEHA conference
- Variable baseline and BMP performance by soil type
  - Consider including soil type as predictor of TN reduction performance
  - Defer to future attenuation expert panel

Questions?

Marcia.Degen@vdh.virginia.gov

www.vdh.virginia.gov