Are There Alternative Methods for Treating Wastewater in the Rural Southeast?

Virginia Tech — Invent the Future

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Problem Statement:

The treatment of municipal wastewater is widely considered one of the greatest environmental health achievements of the 20th century; however, insufficient household wastewater disposal systems – such as piping raw sewage into streams – still persist in rural regions of the southeastern United States (aka "straight pipes"). These systems are commonly found in isolated residential areas where it is technically and financially difficult to extend municipal waste treatment technology.

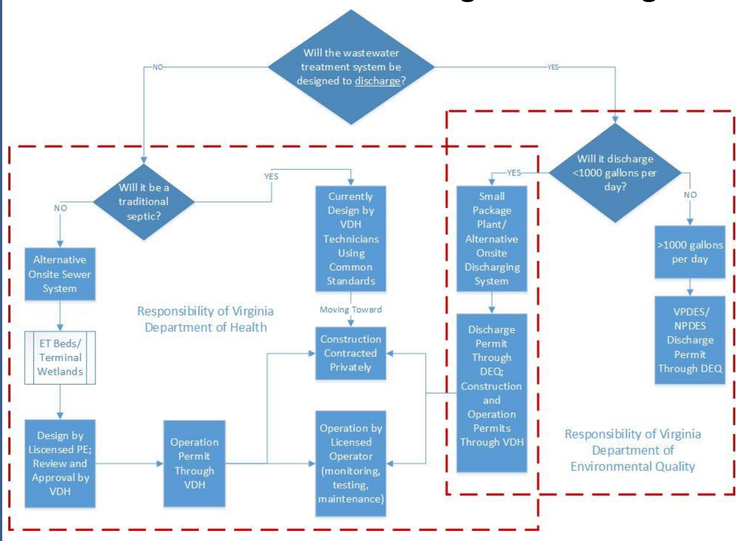
As constructed wetland technology improves, subsurface, lateral-flow wetlands are increasingly valid alternatives to traditional septic drain fields, and could be successfully implemented to replace straight pipes in the rural Southeast.



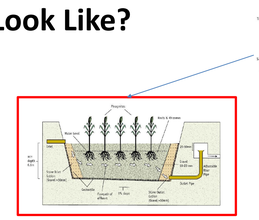
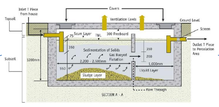
Research Objectives:

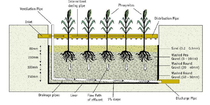
1) Raise awareness of current wastewater treatment challenges in rural communities.
2) Explore the use of constructed wetlands for use in on-site treatment of wastewater
3) Seek out current design methods and standards for commonly used alternative wetland treatment systems
4) Understand policy requirements and regulatory jurisdiction for alternative onsite wastewater systems in Virginia

How is Wastewater Treatment Regulated in Virginia?



What Does an Alternative Wetland Treatment System Look Like?

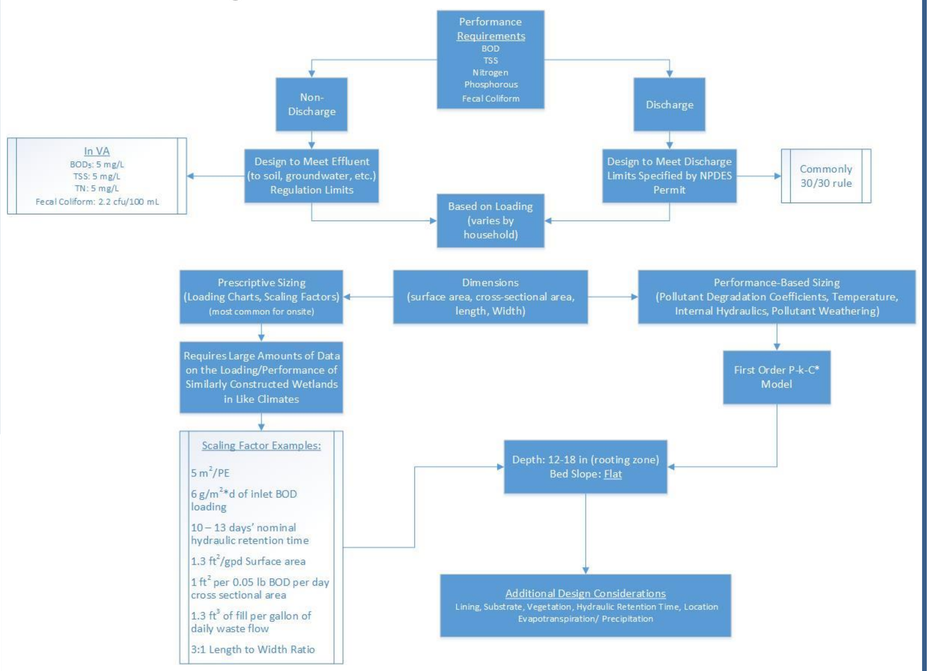


Septic Tank


Vertical Flow (VF)

Horizontal Subsurface Flow (HSSF)
(AKA Vegetated Submerged Bed, ET Bed, and more)
(No pumping, no exposed waste, no mosquitos)

Figures from: Ireland. 2010. Code of Practice for Wastewater Treatment Systems for Single Houses.

What is the Design Process?



Suggested Parameters?

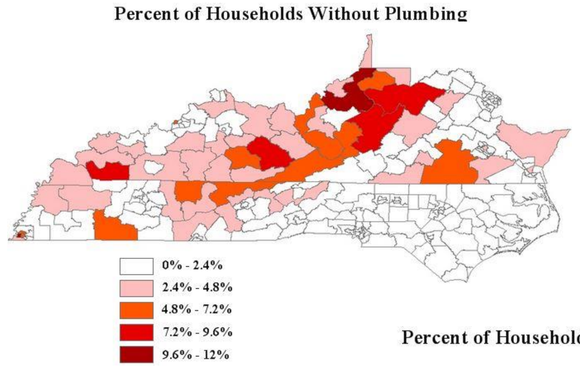
	Danish Guidelines	Ireland Code of Practice (Part 1)	TVA Wetland Manual	USEPA Design Manuel	IOWA Onsite Waste Treatment and Disposal Systems Regulations
Lining	0.5mm tight membrane	Synthetic geotextile clay/ natural clay liner	Not Specified	Not Specified	Synthetic PVC or PE plastic liner (20 – 30 mils)
Substrate	Uniform sand	Gravel 10 – 20 mm	Sized, washed gravel (A.H.D. sizes 8-9)	Porous media: Rock or gravel	Washed River Gravel (diameter 0.75 – 2.5in)
Vegetation	*Phragmites australis*	Emergent macrophytes	Typhaceae Cyperaceae Graminear and Juncaceae Families	*Typha* (cattail) *Scirpus (bulrush) Phragmites (reed)*	• *Typha latifolia* • *Typha angustifolia* • *Scirpus spp.* • *Phragmites communis*

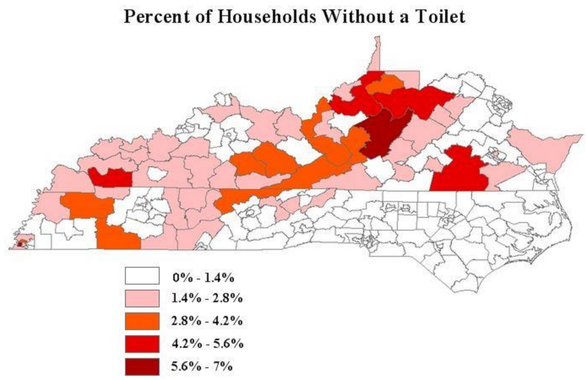
How Well Do Wetlands Perform?

Values taken from: Kadlec, R. & S. D. Wallace. 2009. Treatment wetlands 2nd Edition.

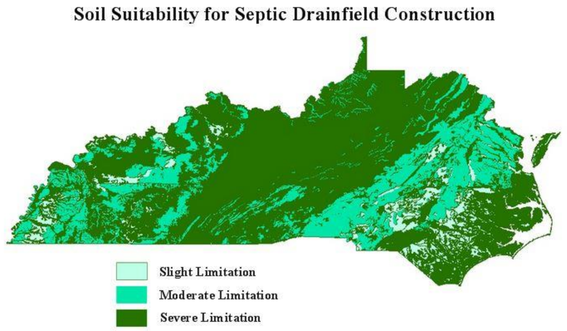
BOD	TSS	Nitrogen	Phosphorous	Fecal Coliform
Influent Load Range: 1-1000 kg/ha*d Effluent conc. range: 1 – 100 mg/L	Influent Load Range: 0.01-100 g/m^2*d Avg: Effluent Conc.: 22.5 mg/L	Influent Load Range: 200-5000 gN/m^2*yr Effluent conc. range: 2-100 mg/L	Influent Load Range: 0.01-10 g/m^2*yr Effluent conc. range: 1-20 mg/L	Influent Range: 2 Log10 - 8 Log10 FC Effluent conc. range: 0.2 Log10 – 7 Log10 FC
✓	✓	–	–	✓

Where is Implementation of Sewage Infrastructure a Problem?





The data used to create these maps were taken from the American Community Survey (ACS) Public Use Microdata Sample (pums), which is a subset of the census intended for the publication of information about individuals and households for planning purposes. Each Public Use Microdata Area (puma) contains a population of approximately 100,000 individuals.



Data for this map were taken from the STATSGO2 database through the USGS Web Soil Survey

Conclusions:

- Subsurface, lateral-flow constructed wetlands could be a viable alternative to septic drain fields in the rural Southeast, but are currently uncommonly used because of the lack of established standards and regulations, due to limited regional performance data for this application, particularly for nitrogen removal.
- According to current knowledge, additional mechanisms such as aerobic suspended growth units, or further filtration may have to be utilized in order to meet nitrogen effluent requirements.
- To develop viable solutions to meet this public health need, the following are needed: the collection of performance data from existing wastewater wetlands treating septic effluent, the advancement of innovative designs which increase nitrogen removal, and the development of design standards for general permitting.

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