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FLORIDA DEPARTMENT OF
HEALTH

**EFFECTIVE, USER-FRIENDLY
NITROGEN REDUCING ONSITE
WASTEWATER SYSTEMS**

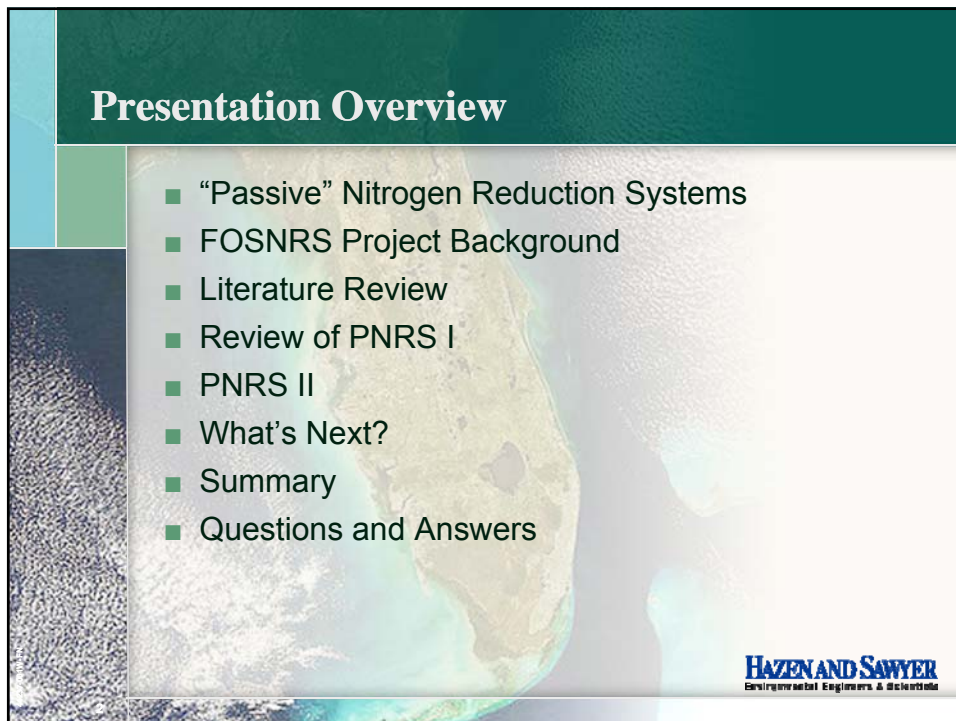
by
**Josefin E. Hirst, P.E. and
Damann L. Anderson, P.E.**

**NEHA 2011 AEC – OWS Summit
June 18th, 2011**

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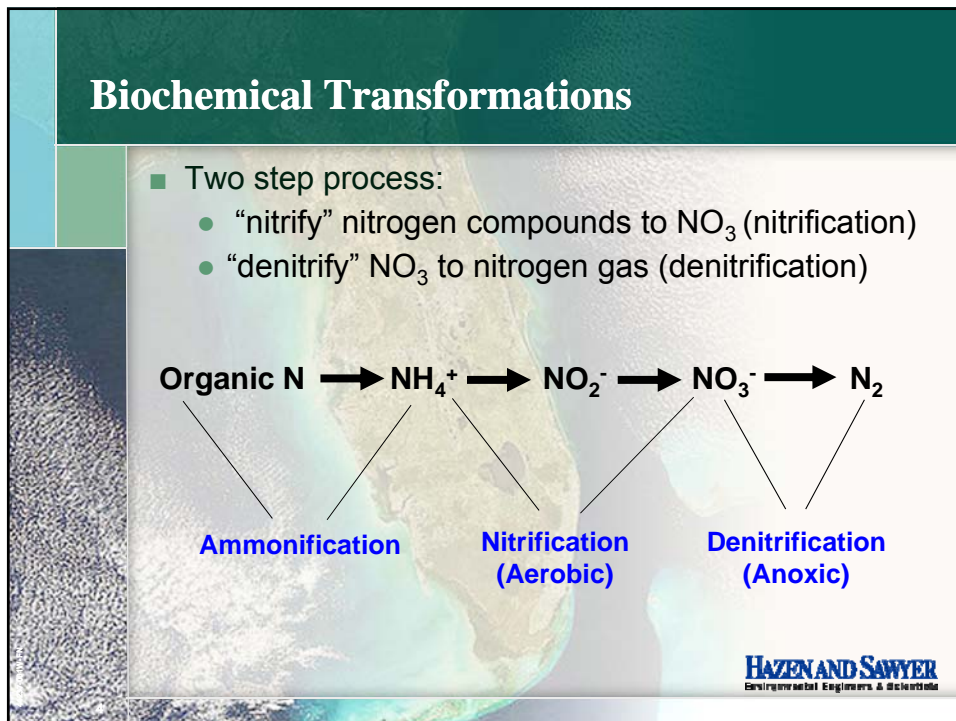
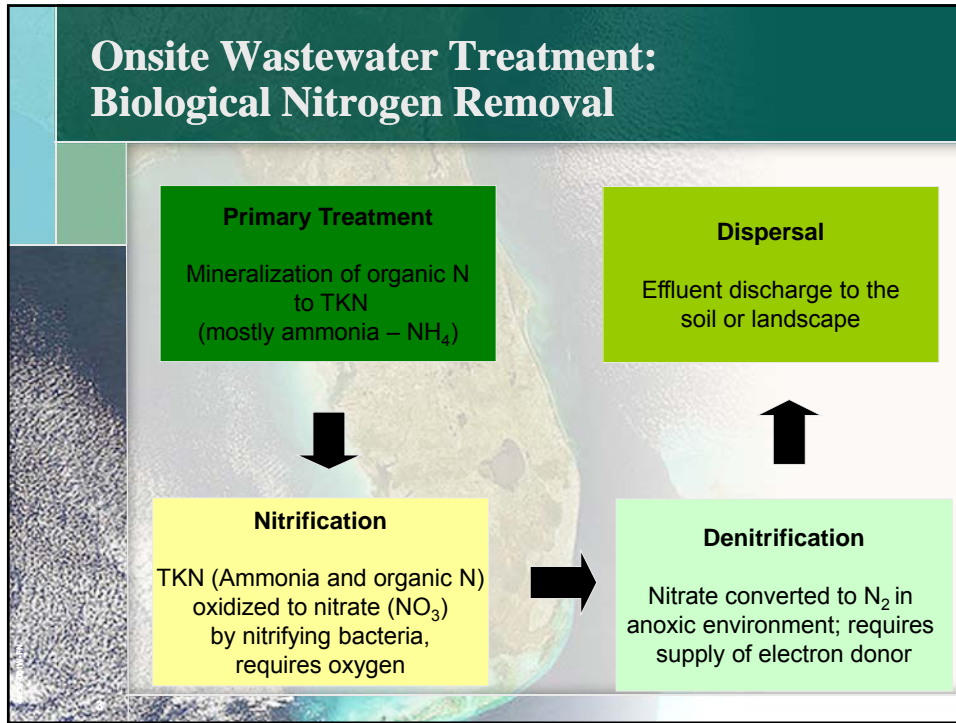
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Presentation Overview

- “Passive” Nitrogen Reduction Systems
- FOSNRS Project Background
- Literature Review
- Review of PNRS I
- PNRS II
- What’s Next?
- Summary
- Questions and Answers

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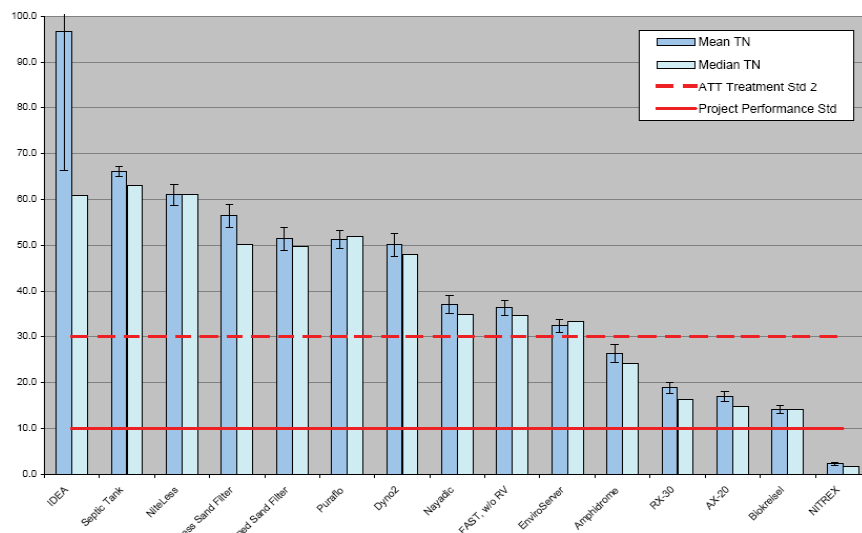


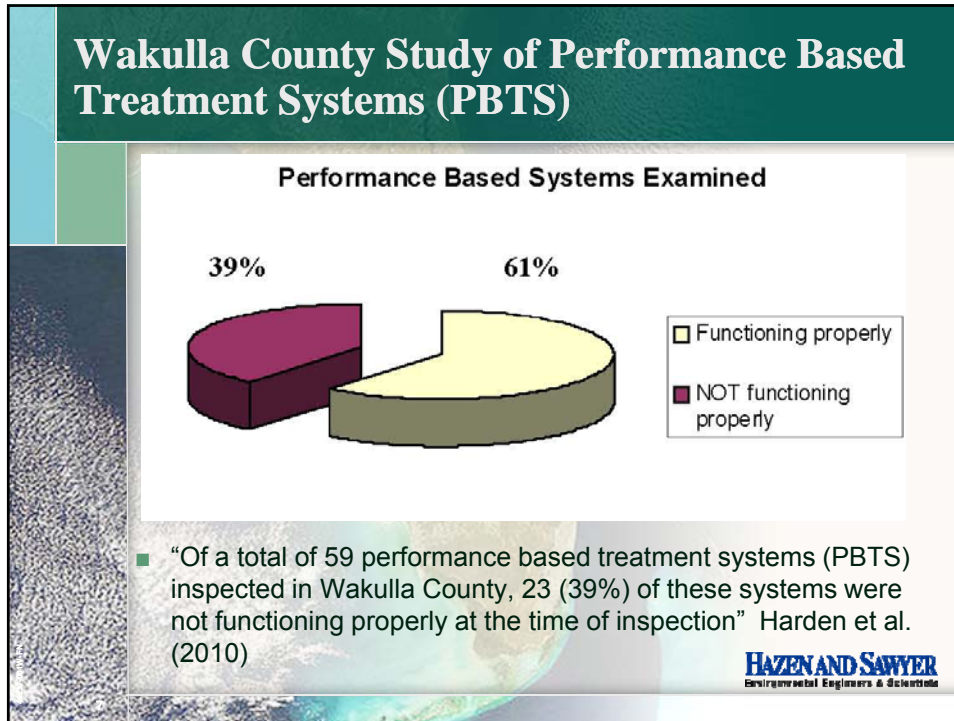
What are “Passive” nitrogen reduction systems?

- Most N-removing onsite systems currently used in FL are mechanical treatment units utilizing an activated sludge biological process, typically utilizing pumps, blowers and other controls.
- “Passive” nitrogen removal is intended to describe nitrogen reducing OSTDS that are more similar to conventional onsite systems in their operation and maintenance.
- Passive nitrogen removal systems are those that achieve TN concentrations of ≤ 10 mg/L using a “reactive media” for denitrification, and no more than 1 pump, if necessary.

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Performance of N-Reduction Systems (La Pine National Demonstration Project)



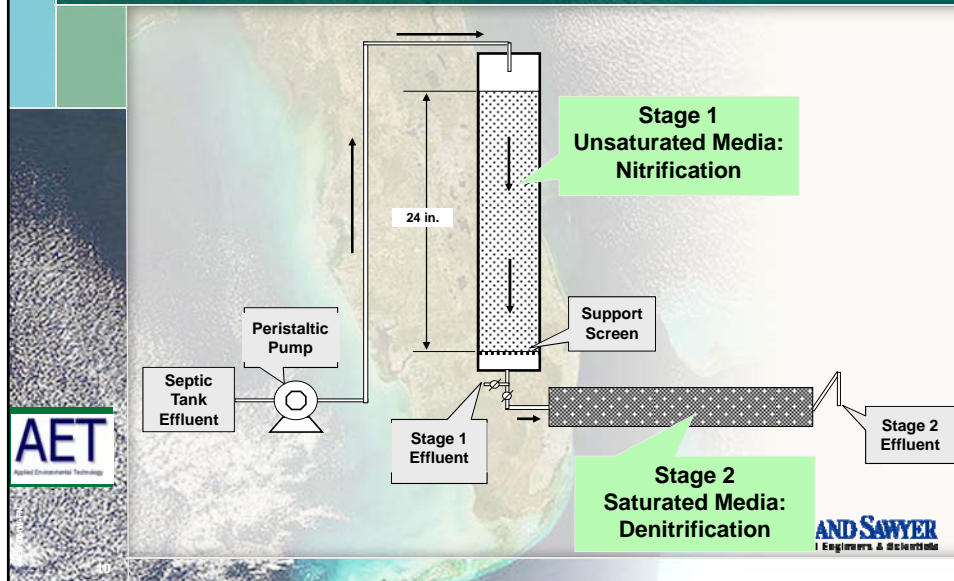


- ### Florida Project Background
- Laws of Florida, 2008-152, directed FDOH to conduct a study to further develop more “*passive*” & cost-effective nitrogen reduction strategies for OSTDS
 - Initiated the Florida Onsite Sewage Nitrogen Reduction Strategies (FOSNRS) Project in 2009
 - This presentation focuses on preliminary project results from passive biofilters with sulphur-based denitrification processes
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Previous Studies of Sulphur-based Denitrification


Reference	Denitrification Media	Results
Kanter, Tyler and Converse (1998)	Sulphur/Dolomite Sulphur: <2.5 mm	TN Removal: 87.9% Nitrified Influent: 23.5 mg-N/L Effluent: 3.0 mg-N/L
Sengupta and Ergas (2006)	Sulphur/Oyster Shell (75/25% by volume) Sulphur: 4.7 mm	NO ₃ -N Removal: 80% Influent: 2-32 mg NO ₃ -N/L Effluent: 4.2 mg NO ₃ -N/L
Brighton (2007)	Sulphur/Oyster Shell (75/25% by volume) Sulphur: 2 - 5 mm	TN Removal: 81.7% Nitrified Influent: 23 mg-N/L Effluent: 4.2 mg-N/L
Smith et al. (2008)	Sulphur/Oyster Shell (75/25% by volume) Sulphur: 2 - 5 mm	TN Removal: 93.8% Nitrified Influent: 35.2 mg-N/L Effluent: 2.2 mg-N/L

Bench-Scale Passive Two Stage Biofiltration (Smith et al., 2008)





Bench-Scale Passive Nitrogen Removal Study (Smith et. al., 2008)

- 8 months operation of bench-scale units at Flatwoods Park, Hillsborough County
- Elemental sulphur as electron donor for denitrification
- 97% nitrogen reduction from septic tank effluent



Stage 1
vertical
unsaturated

Stage 2
horizontal
saturated





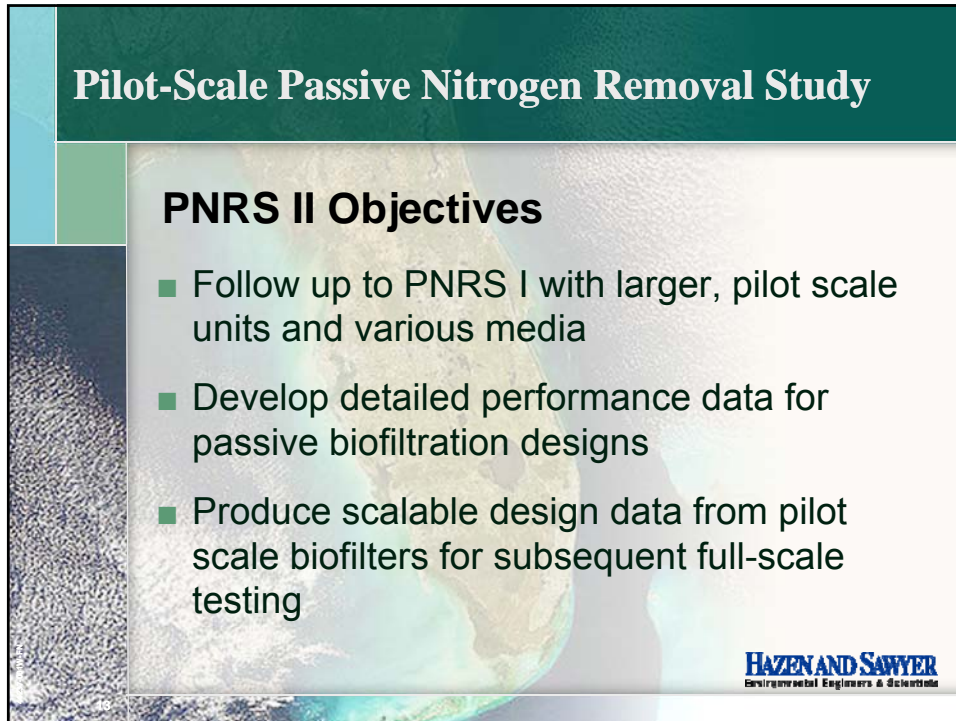
Bench Scale Passive Nitrogen Removal Study

PNRS I Results (Smith, 2008)

- Showed feasibility of passive two stage biofiltration
- One pump, no aerators, reactive media
- Continuous 24/7 operation for 8 months
- Proof of passive 2-stage biofiltration concept provided

Treatment Media	Effluent TN (mg/L)	TN Reduction (%)
Zeolite & Sulphur Media	2.2	97
Expanded Clay & Sulphur	2.6	96.2





Pilot-Scale Passive Nitrogen Removal Study

PNRS II Objectives

- Follow up to PNRS I with larger, pilot scale units and various media
- Develop detailed performance data for passive biofiltration designs
- Produce scalable design data from pilot scale biofilters for subsequent full-scale testing

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Passive Nitrogen Removal Study II

PNRS II Approach

- Establish test facility at Gulf Coast Education and Research Center (University of Florida IFAS)
- Test program for in-vessel and in-situ pilot systems
- Operate on septic tank effluent for 12 months
- Various nitrification and denitrification biofilters to be tested

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Unique Pilot Facility Constructed at UF Center



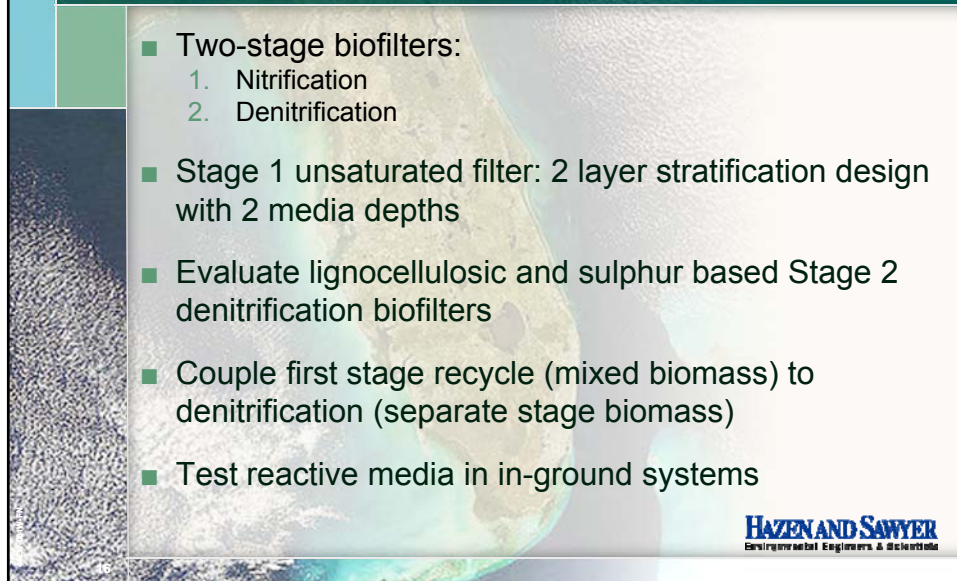
Source: <http://gcrec.ifas.ufl.edu/>

Gulf Coast Research and Education Center

- University of Florida, Institute for Food & Agricultural Sciences (IFAS)
- 475 acres of land in SE Hillsborough County
- Facility conducts agricultural research & trials for vegetables, fruit and ornamental plants
- 16 laboratories housed onsite (1 water quality lab)

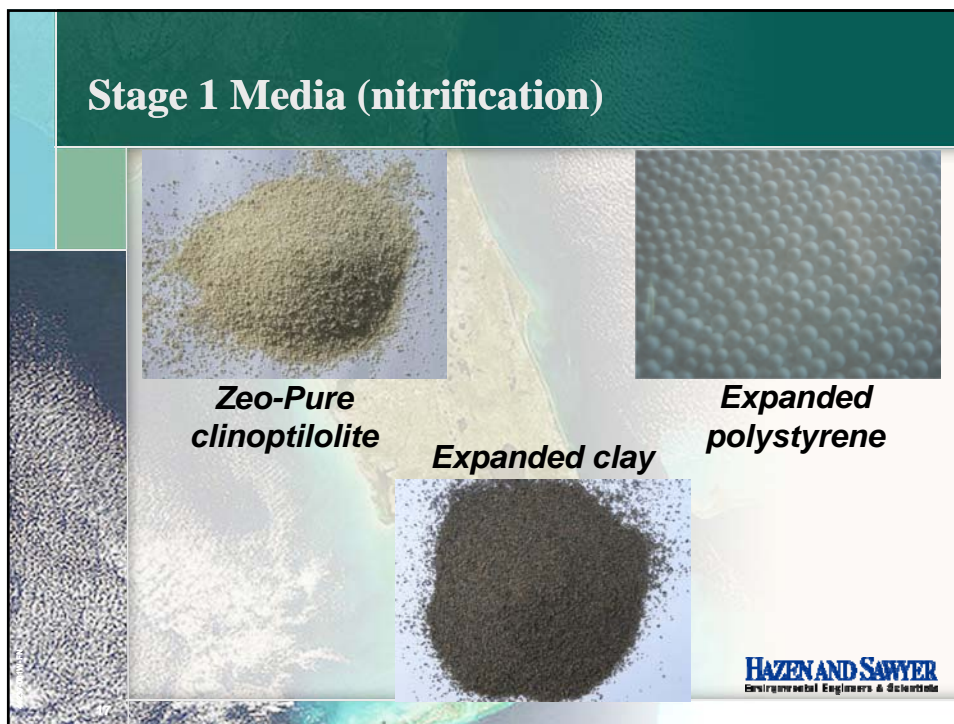
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Significant Features

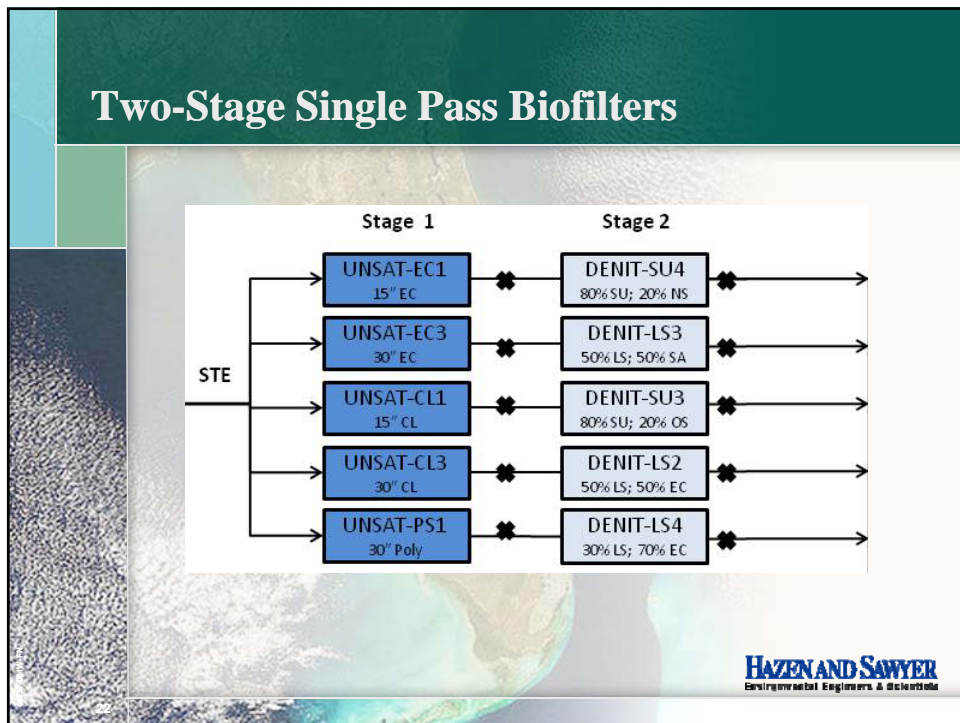
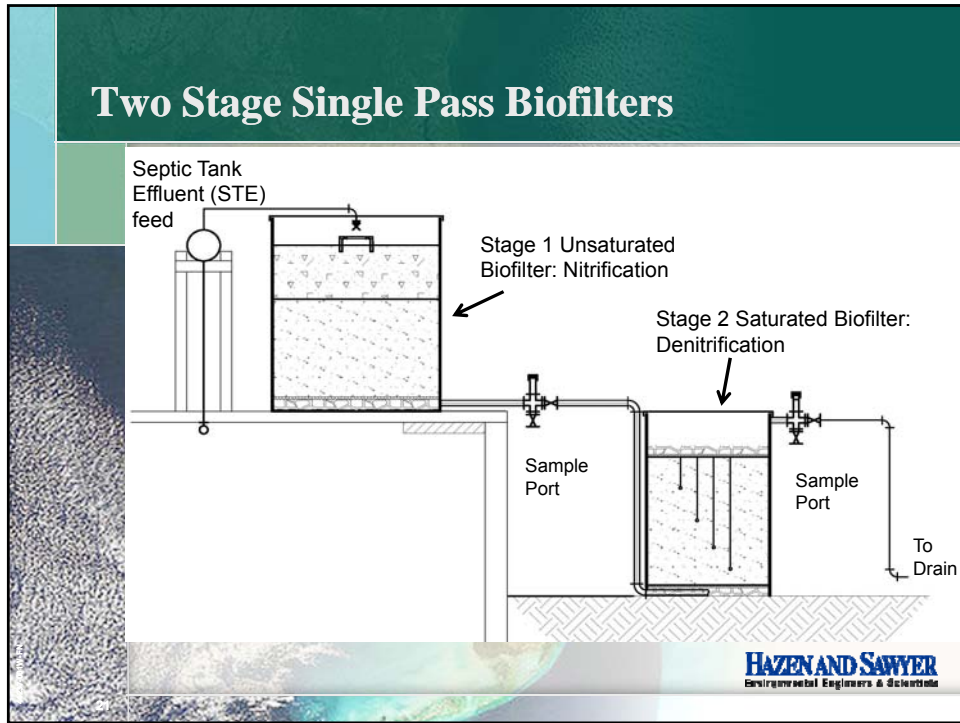


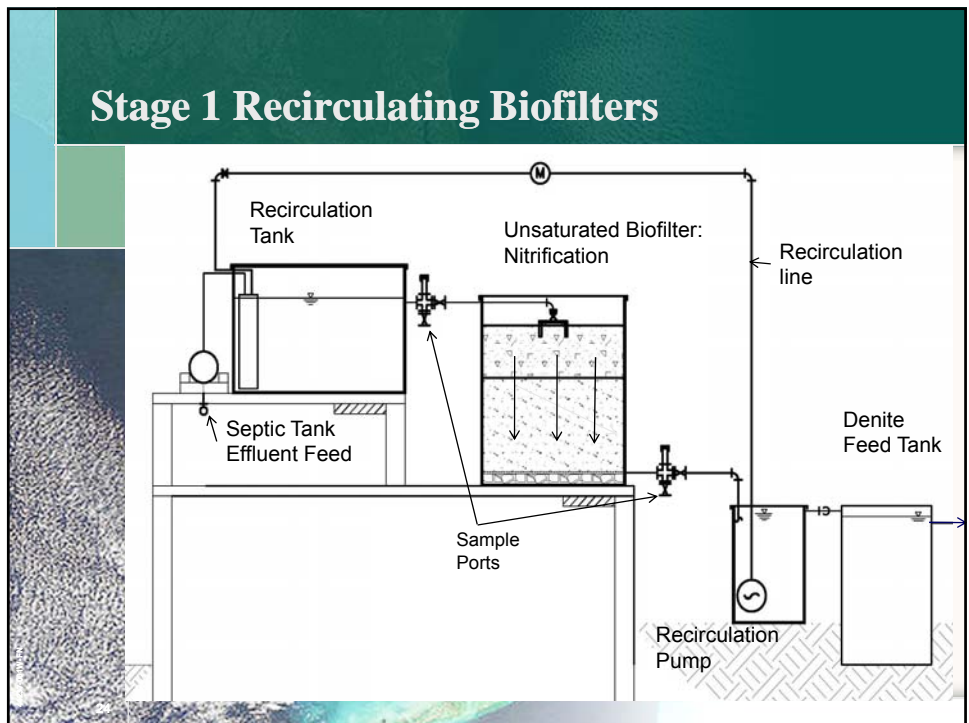
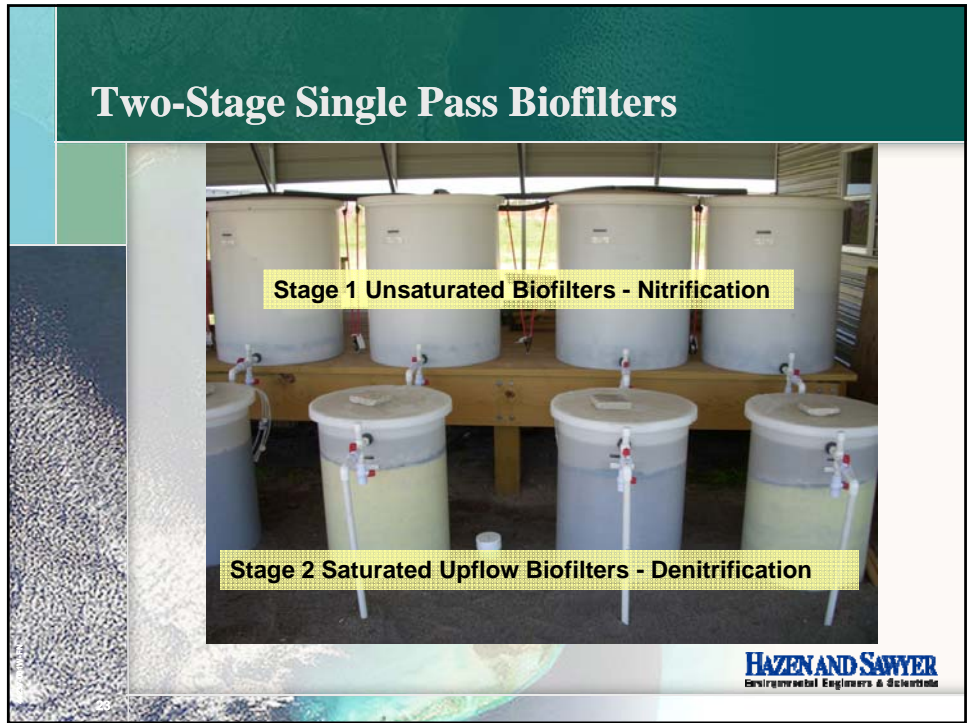
- Two-stage biofilters:
 1. Nitrification
 2. Denitrification
- Stage 1 unsaturated filter: 2 layer stratification design with 2 media depths
- Evaluate lignocellulosic and sulphur based Stage 2 denitrification biofilters
- Couple first stage recycle (mixed biomass) to denitrification (separate stage biomass)
- Test reactive media in in-ground systems

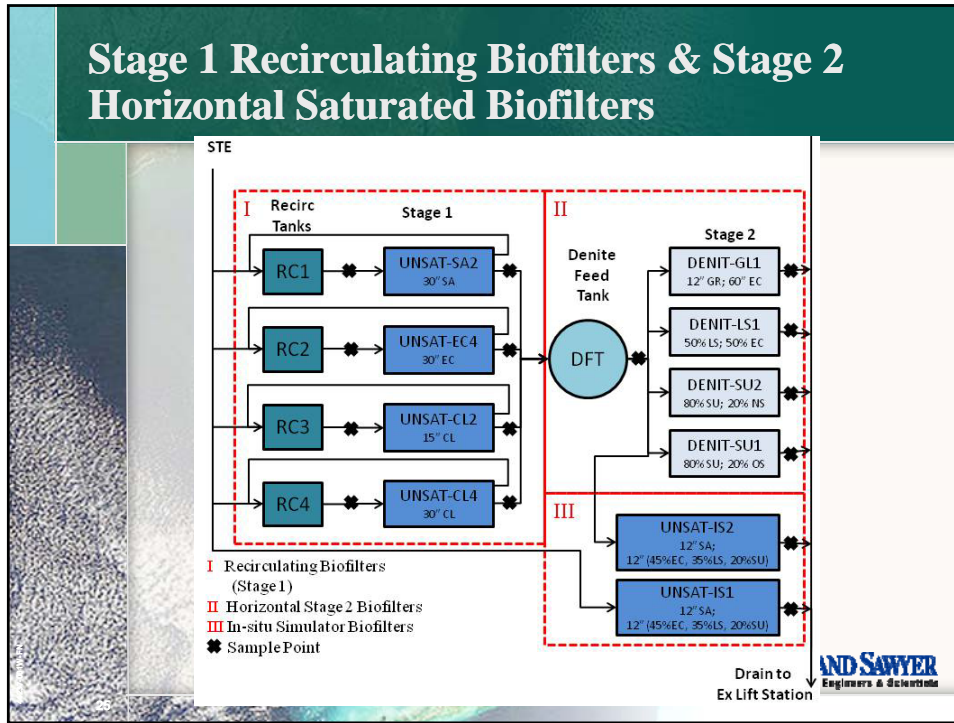
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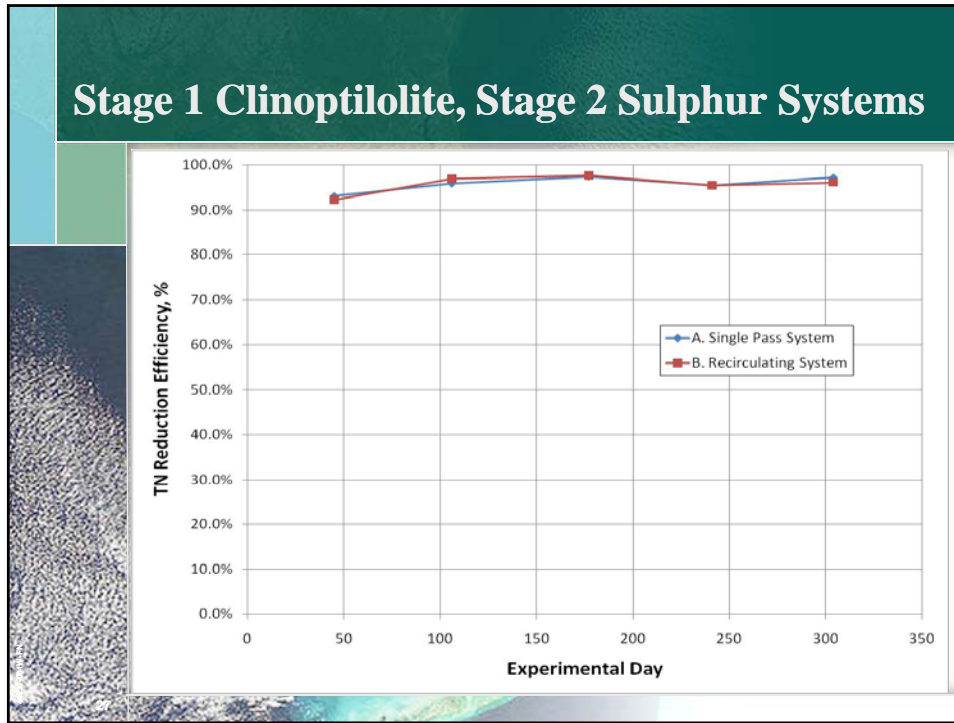










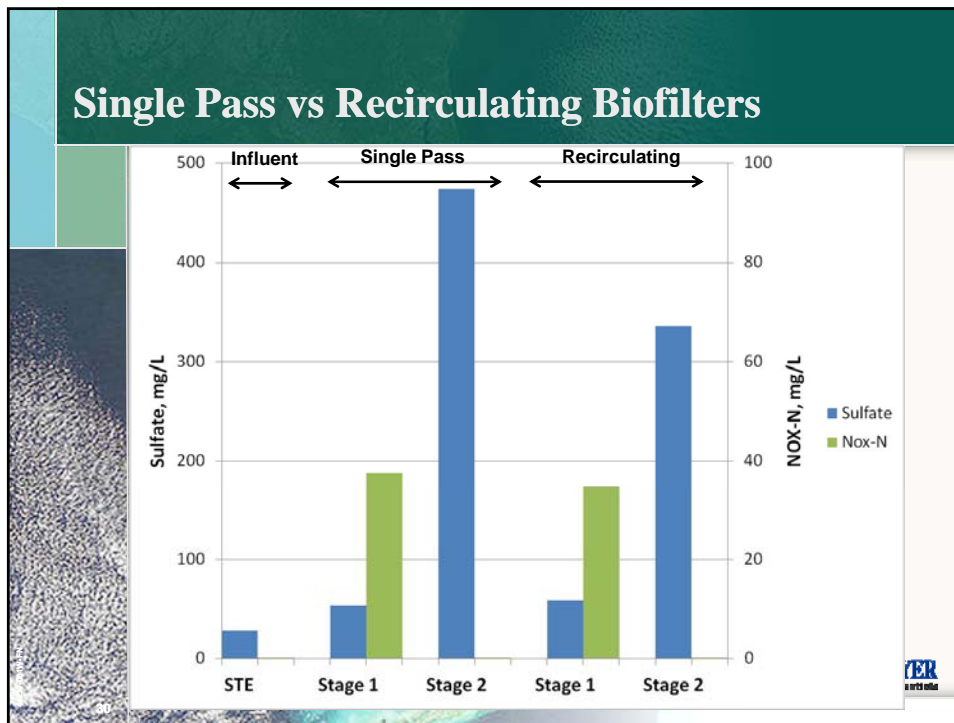
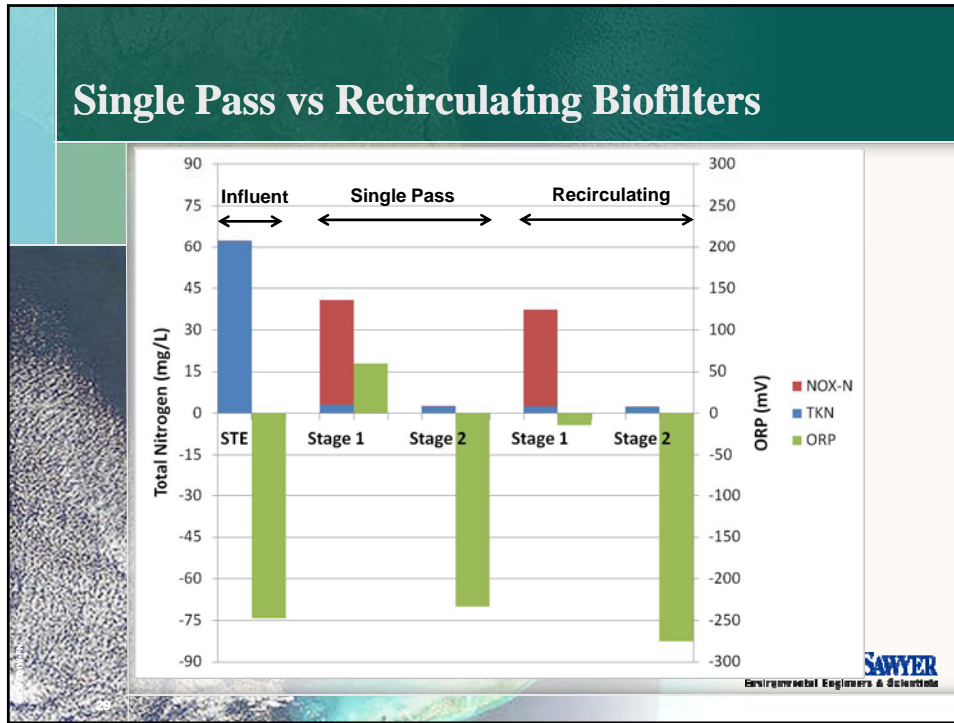


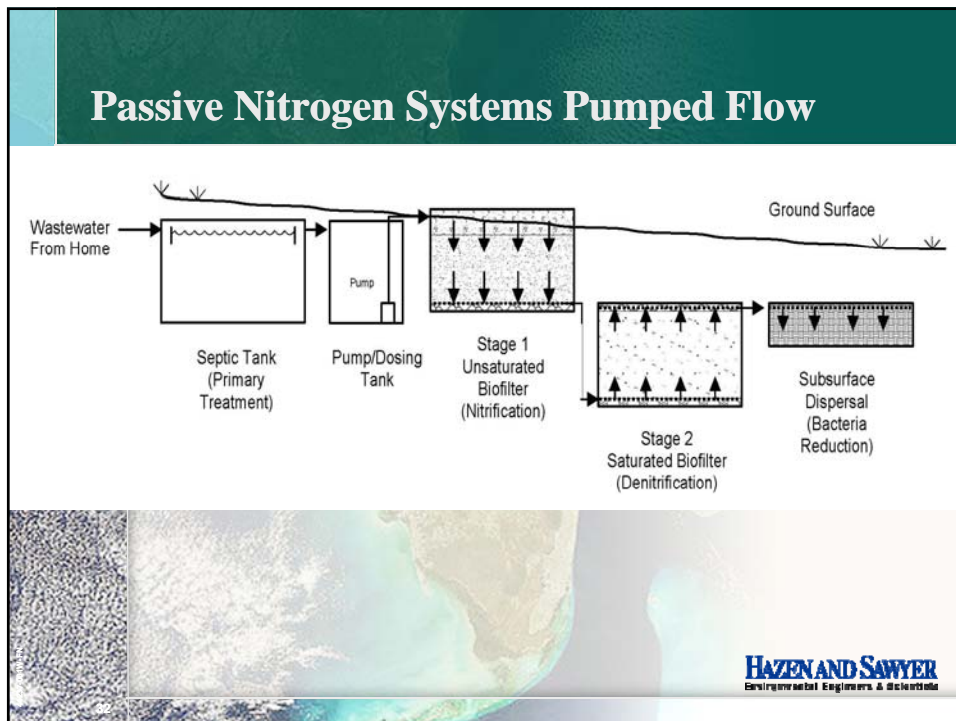
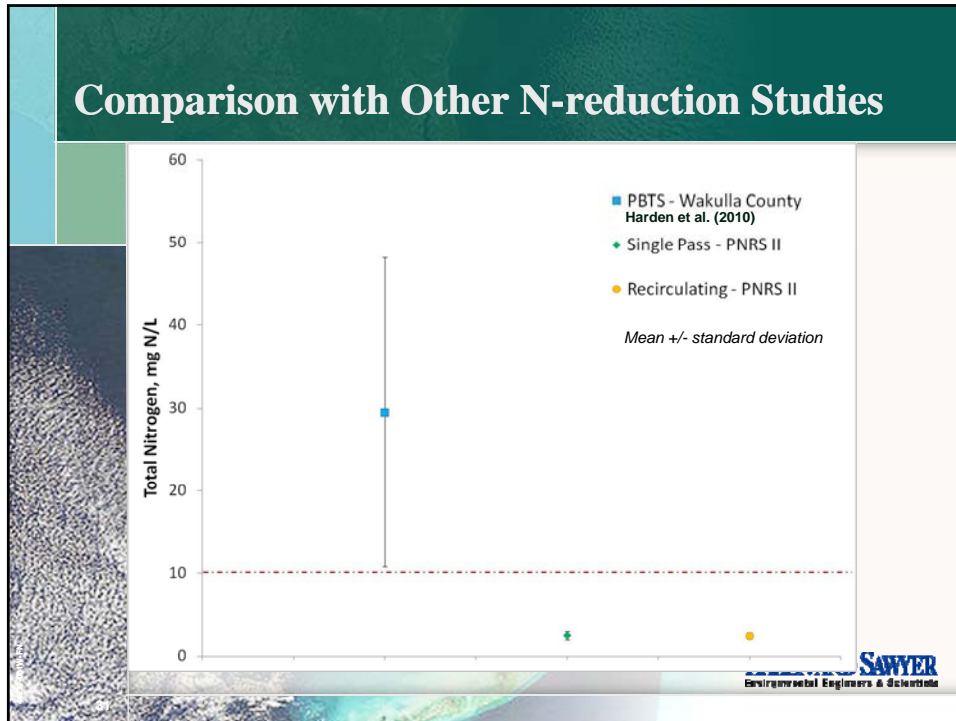
Preliminary Results

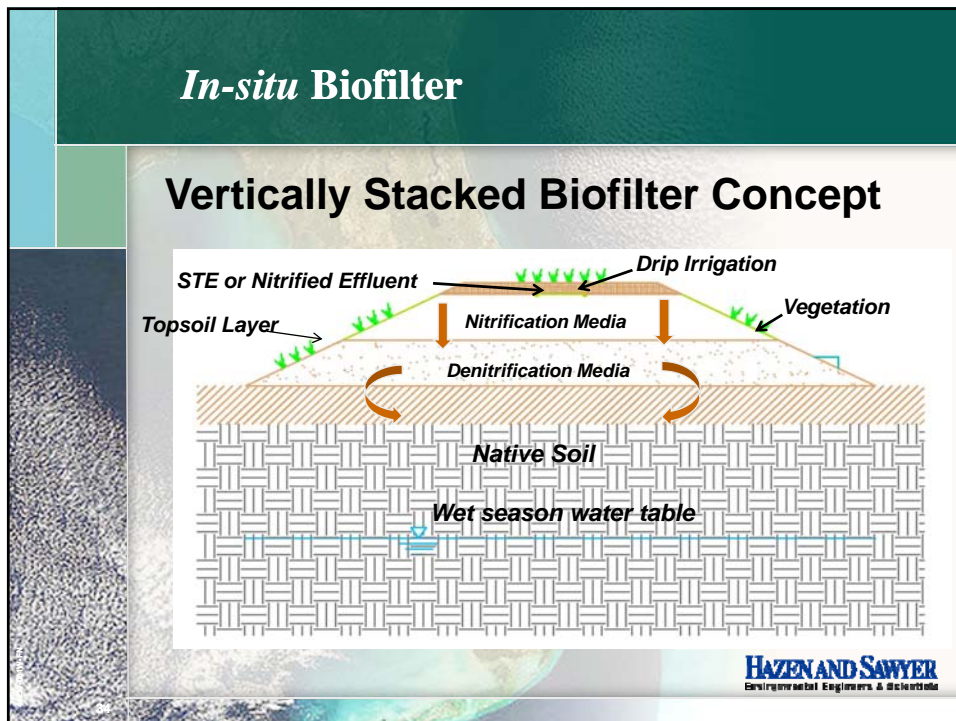
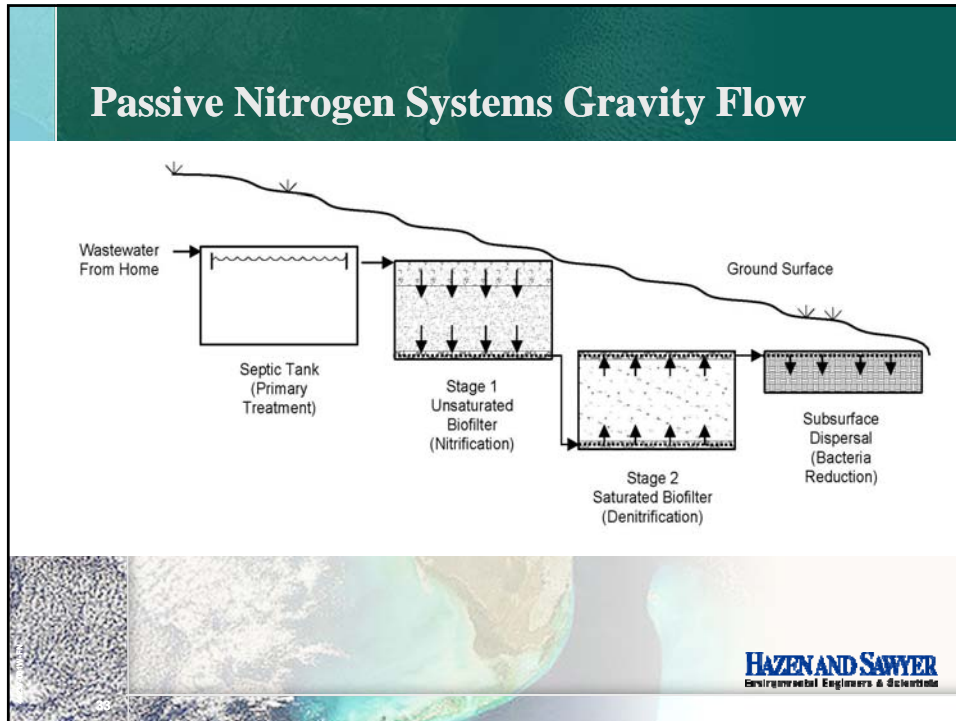
	Stage 1 Treatment Media	Stage 2 Treatment Media	Effluent TN ¹ (mg N/L)		TN Reduction (%)
STE			MEAN	65.24	
			STD DEV	18.02	
			MIN	35.02	
			MAX	80.01	
Single Pass	Clinoptilolite	Sulphur	MEAN	2.51	96.1
			STD DEV	0.54	
			MIN	1.85	
			MAX	3.02	
Recirculation	Clinoptilolite	Sulphur	MEAN	2.46	96.2
			STD DEV	0.38	
			MIN	2.04	
			MAX	2.95	

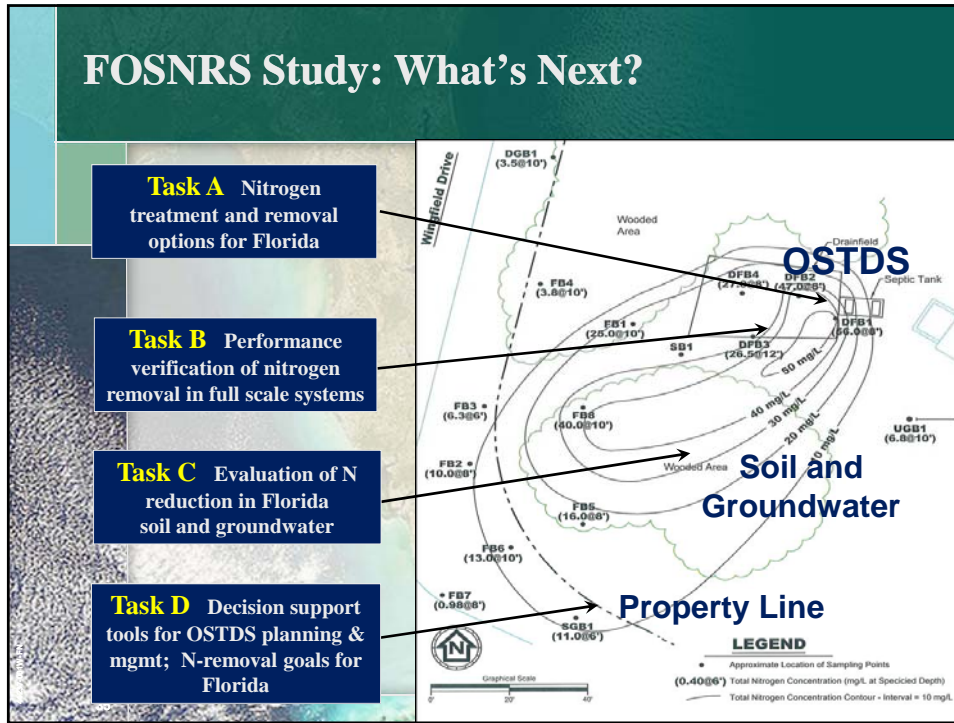
¹Continuous operation for 304 days

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- Task A** Nitrogen treatment and removal options for Florida
- Task B** Performance verification of nitrogen removal in full scale systems
- Task C** Evaluation of N reduction in Florida soil and groundwater
- Task D** Decision support tools for OSTDS planning & mgmt; N-removal goals for Florida

Summary

- The pilot-scale systems are functioning as intended:
 - STE quality supplied to PNRS II systems is reasonably characteristic of typical household STE quality
 - Stage 1 unsaturated biofilters are nitrifying
 - Stage 2 saturated biofilters are denitrifying
 - Sulphur-based Single Pass and Recirculating systems are achieving TN reduction of 96%
- Successful results would allow OSTDS to achieve nutrient removal similar to wastewater treatment plants in an effective and user-friendly manner playing a role in nitrogen reduction in sensitive watersheds.

<http://www.doh.state.fl.us/Environment/ostds/research/Nitrogen.html>

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