Chesapeake Bay STAC and NAHB Workshop

In My Backyard: An Innovative Look at the Advances of Onsite Decentralized Wastewater Treatment Systems

NAHB Headquarters
Washington, D.C.
December 17-18, 2013

Florida Onsite Sewage Nitrogen Reduction Strategies (FOSNRS) Study: Project Overview and Preliminary Results

Presentation by:

Damann L. Anderson, P.E.

HAZEN AND SAWYER
Environmental Engineers & Scientists

Acknowledgements

Many thanks to co-authors on this work:

- Josefin Edeback-Hirst, P.E., Hazen and Sawyer
- Daniel Smith, Ph.D., Applied Environmental Technology

Many thanks to colleagues on this work:

- Eberhard Roeder, Ph.D., Florida Dept. of Health
- Elke Ursin, Envir. Health Program Consultant, Florida Dept. of Health
- UF Gulf Coast Research and Education Center
  - Craig Stanley, Ph.D.
  - Gurpal Toor, Ph.D.

Presentation overview

- FOSNRS Project background
- FOSNRS Task A: Nitrogen treatment and reduction options for Florida
- Pilot test results
- FOSNRS Task B: Full-scale testing of PNRS systems
- Summary
- Questions and answers

Florida Onsite Sewage Nitrogen Reduction Strategies Study (FOSNRS) Background

HAZEN AND SAWYER
Environmental Engineers & Scientists

FOSNRS project initiated by Florida legislature

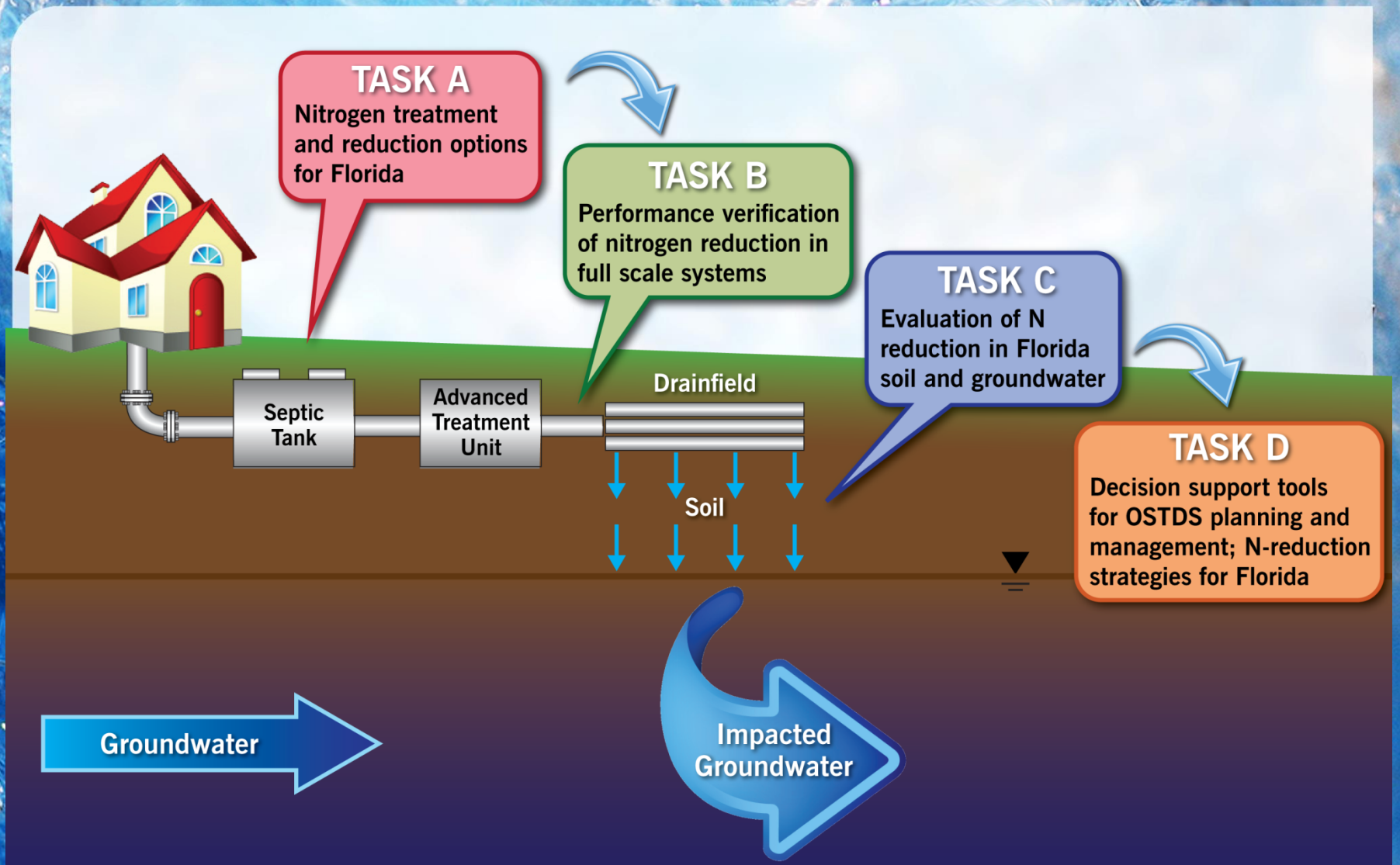
- Laws of Florida, 2008-152, directed FDOH to conduct a study to further develop more “passive” & cost-effective nitrogen reduction strategies for onsite sewage treatment and disposal systems (OSTDS)
- Initiated the Florida Onsite Sewage Nitrogen Reduction Strategies (FOSNRS) Project in 2009
- RFP identified four primary study areas

FOSNRS Study Overview

Four Primary Study Areas

- **Task Series A:** Technology evaluation for field testing, Test facility design & construction, Pilot testing of passive nitrogen reduction systems (PNRS)
- **Task Series B:** Field testing of full-scale treatment technologies, Performance & cost documentation
- **Task Series C:** Evaluation of nitrogen reduction provided by Florida soils & shallow groundwater
- **Task Series D:** Nitrogen fate and transport modeling, Development of decision support tools for OSTDS planning & management

How do tasks relate to N-reduction strategies?



FOSNRS Task A: Nitrogen treatment and reduction options for Florida

HAZEN AND SAWYER
Environmental Engineers & Scientists

Review of biological nitrogen reduction for onsite wastewater treatment

Primary Treatment

Mineralization of most organic N to ammonia (ammonia – NH_4)

Nitrification

TKN (Ammonia and organic N) oxidized to nitrate (NO_3) by nitrifying bacteria, requires oxygen

Denitrification

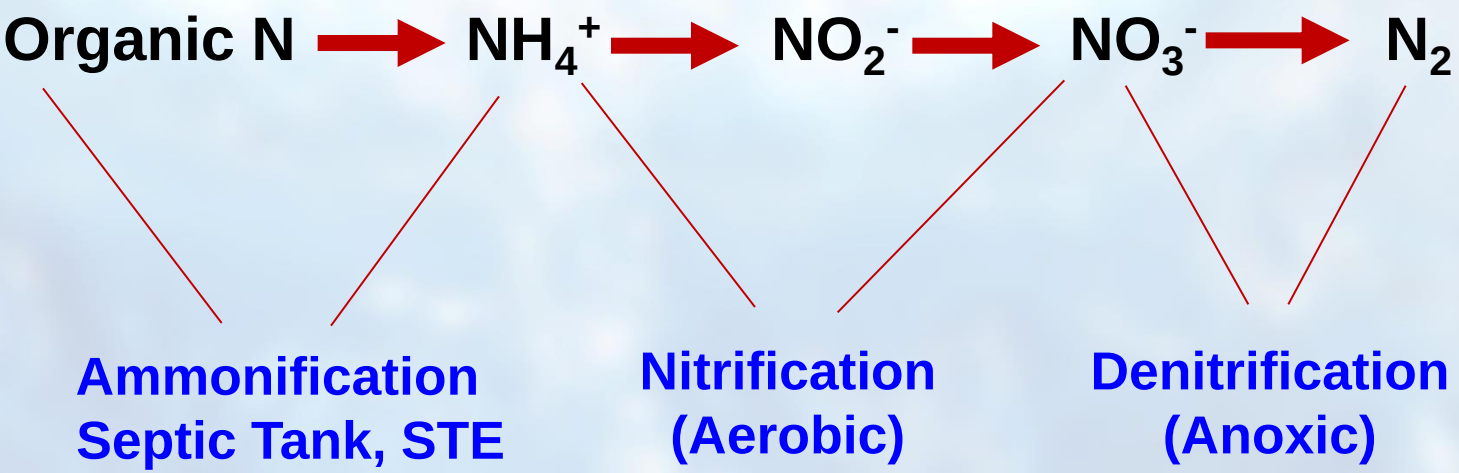
Nitrate converted to N_2 in anoxic environment; requires supply of electron donor

Dispersal

Effluent discharge to the soil or landscape

Bio-N removal is a two-stage process

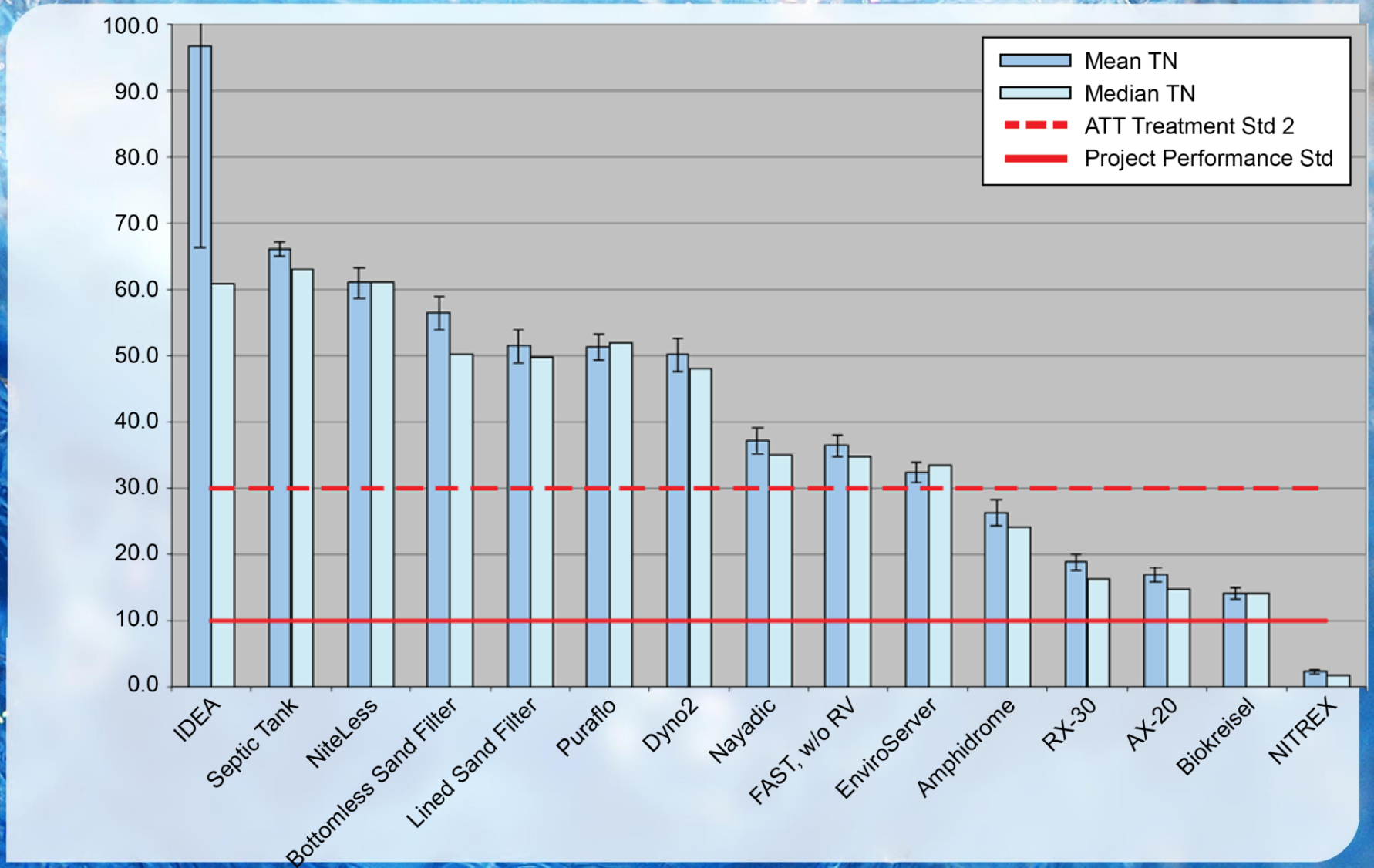
1. "nitrify" nitrogen compounds to NO_3 (nitrification)
2. "denitrify" NO_3 to nitrogen gas (denitrification)



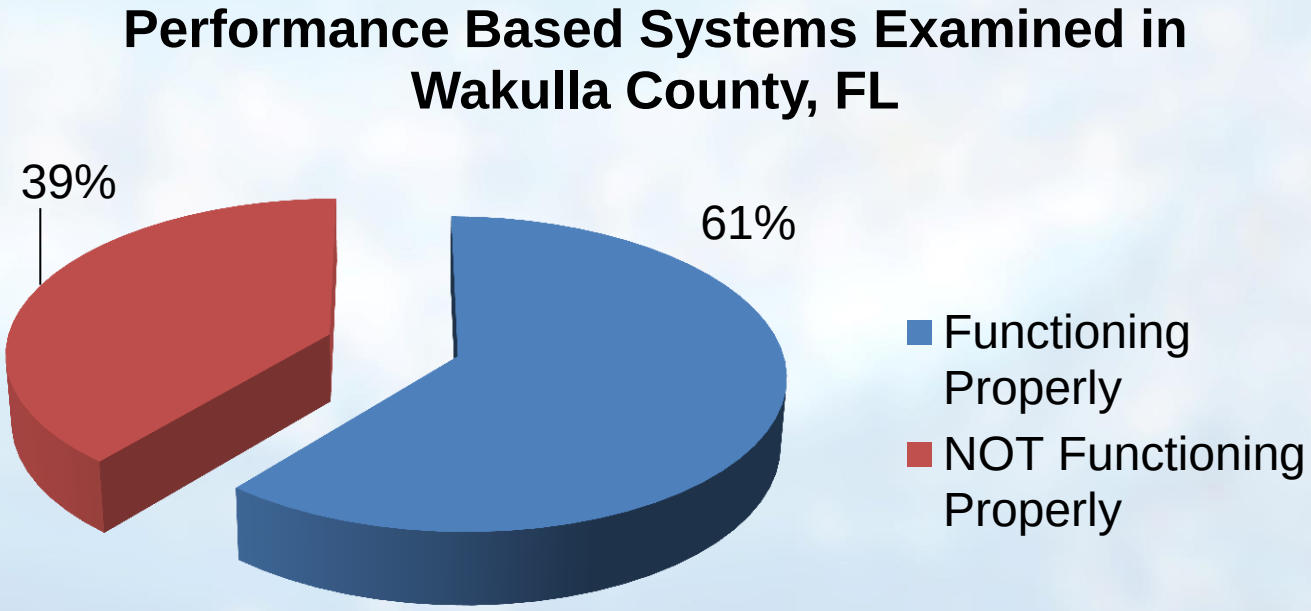
What are “Passive” nitrogen reduction systems?

- Most current N-reducing onsite systems are mechanical treatment units
- “Passive” nitrogen reducing OSTDS are more similar to conventional onsite systems in their operation and maintenance
- Passive nitrogen reduction system (PNRS): OSTDS that reduces effluent N using reactive media for denitrification and a single liquid pump, if necessary.

La Pine national demonstration project showed the performance of mechanical systems…

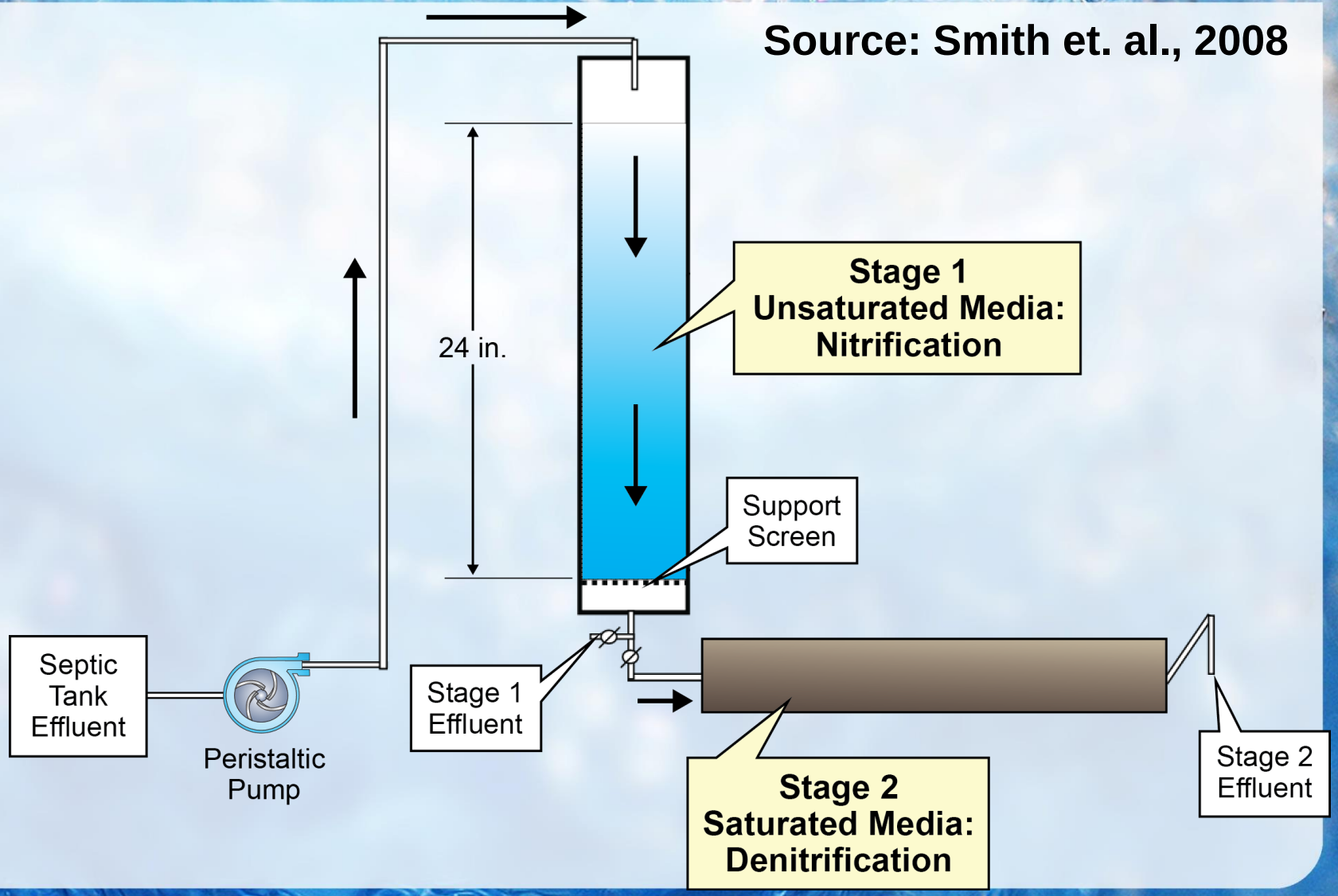


Recent evaluation in Florida had similar findings for mechanical systems…



"Of a total of 59 performance based treatment systems (PBTS) inspected in Wakulla County, 23 (39%) of these systems were not functioning properly at the time of inspection" Harden et al. (2010)

Earlier work by FDOH showed bench-scale "passive" two stage biofiltration concepts



Bench-scale “passive” two stage biofiltration performance (Smith et. al., 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

AET
Applied Environmental Technology

Task A was designed to further the concepts developed in previous work

- Follow up with larger, pilot scale units and various media combinations
- Developed detailed performance data for passive biofiltration designs
- Produce scalable design criteria from pilot scale biofilters for subsequent full-scale testing
- We also evaluated single pass vs recirculating stage 1 biofilters
- Twenty-two biofilters consisted of nine unsaturated Stage 1 biofilters, nine saturated Stage 2 biofilters, and four vertically stacked biofilter designs.

A unique pilot facility was constructed at UF research 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
- Experts in soil and water science onsite

Various nitrification media were evaluated

Examples of Stage 1 Media

Zeo-Pure clinoptilolite

Expanded polystyrene

Torpedo sand

Expanded clay

Several denitrification media were also evaluated

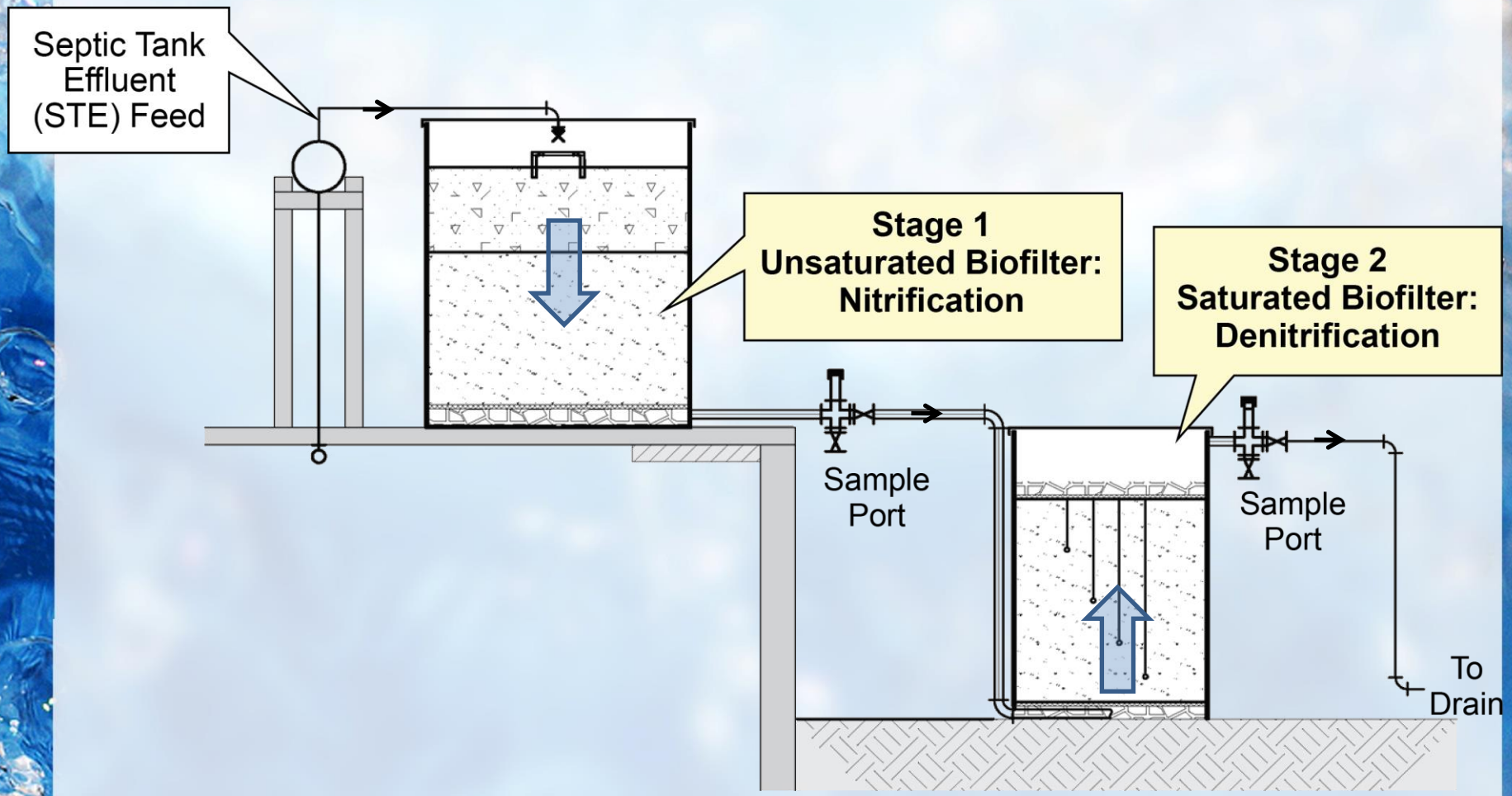
Examples of Stage 2 Media

Lignocellulosics

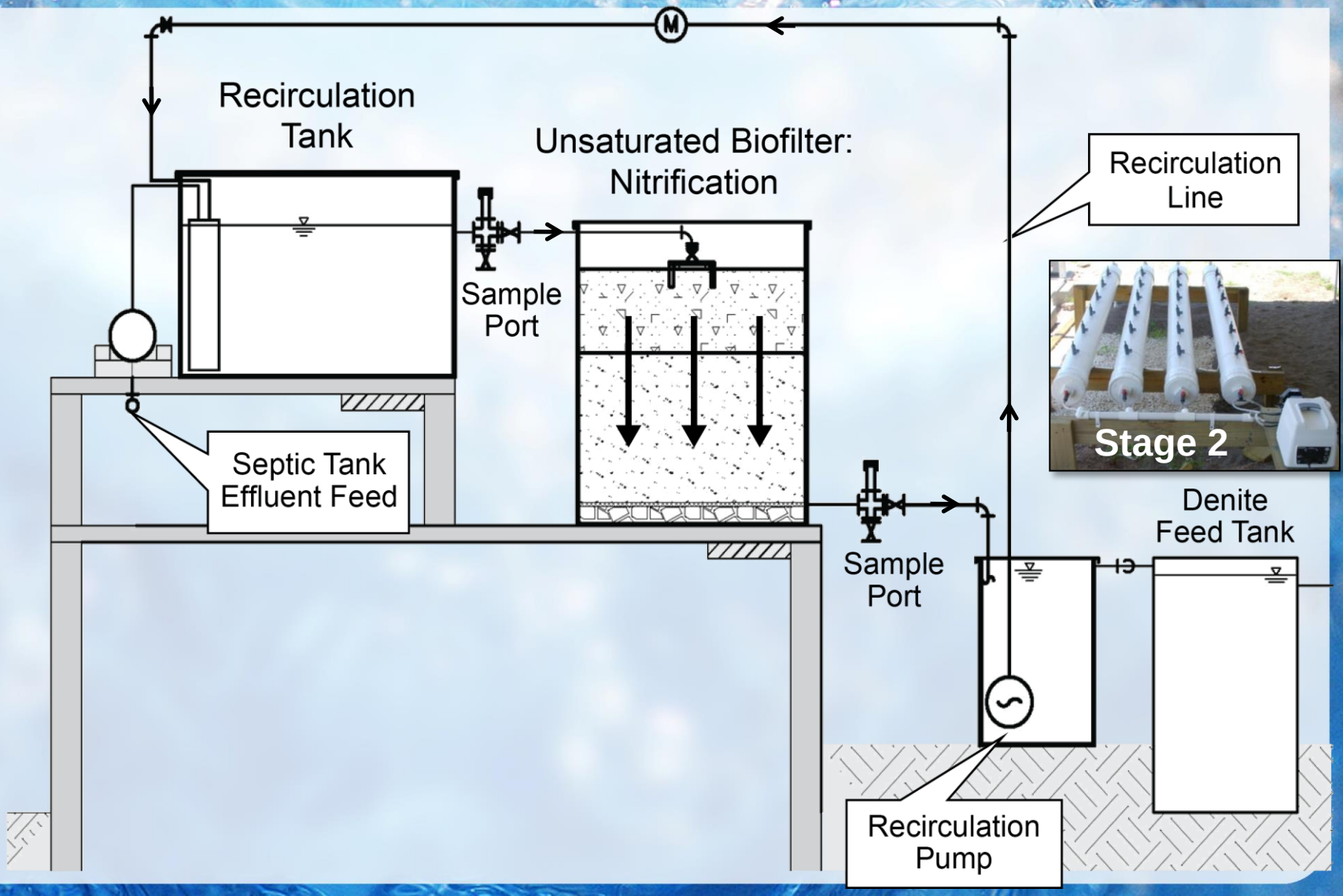
Elemental Sulphur

Expanded Clay

Two stage single pass biofilters



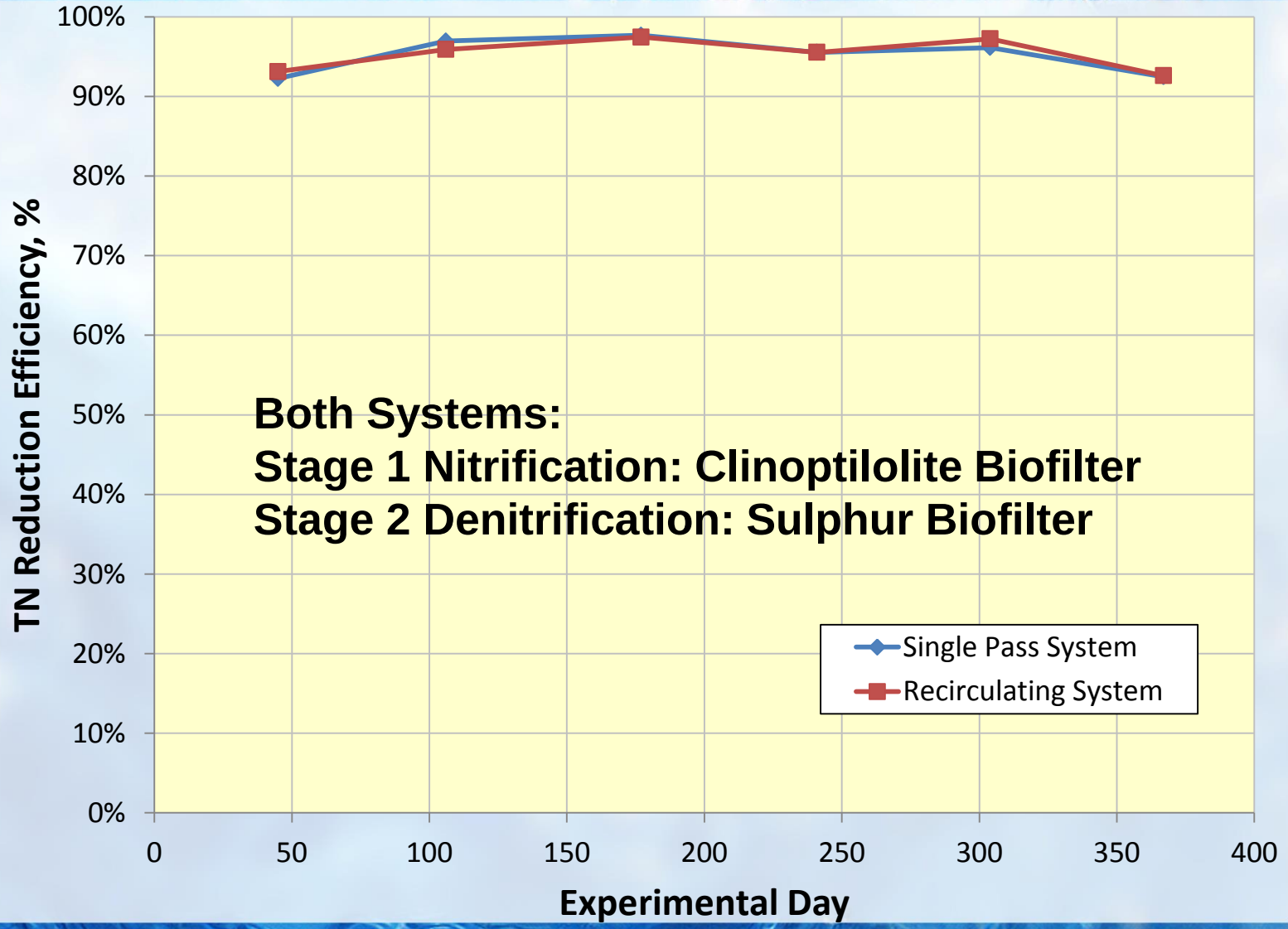
Stage 1 recirculating biofilters



Pilot test results

HAZEN AND SAWYER
Environmental Engineers & Scientists

Results for several systems were encouraging



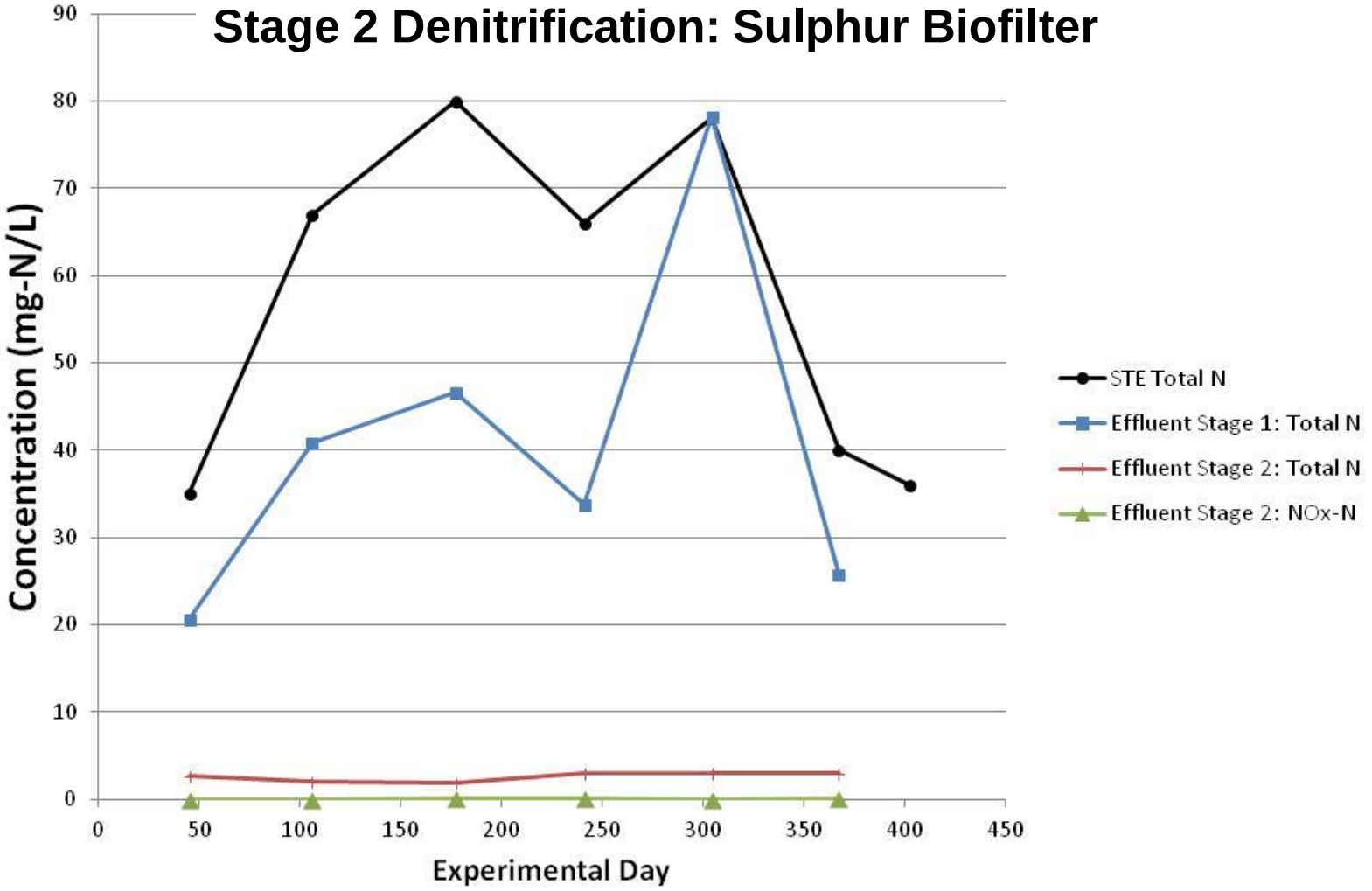
Detailed results show consistent treatment

	Stage 1 Treatment Media	Stage 2 Treatment Media	Effluent TN[1] (mg N/L)		TN Reduction (%)
STE	NA	NA	MEAN	61.04	NA
			STD DEV	19.12	
			MIN	35.02	
			MAX	80.01	
Single Pass	Clinoptilolite	Sulphur	MEAN	2.60	95.2
			STD DEV	0.52	
			MIN	1.85	
			MAX	3.02	
Recirculation	Clinoptilolite	Sulphur	MEAN	2.54	95.3
			STD DEV	0.40	
			MIN	2.04	
			MAX	2.96	

[1]Continuous operation for 367 days

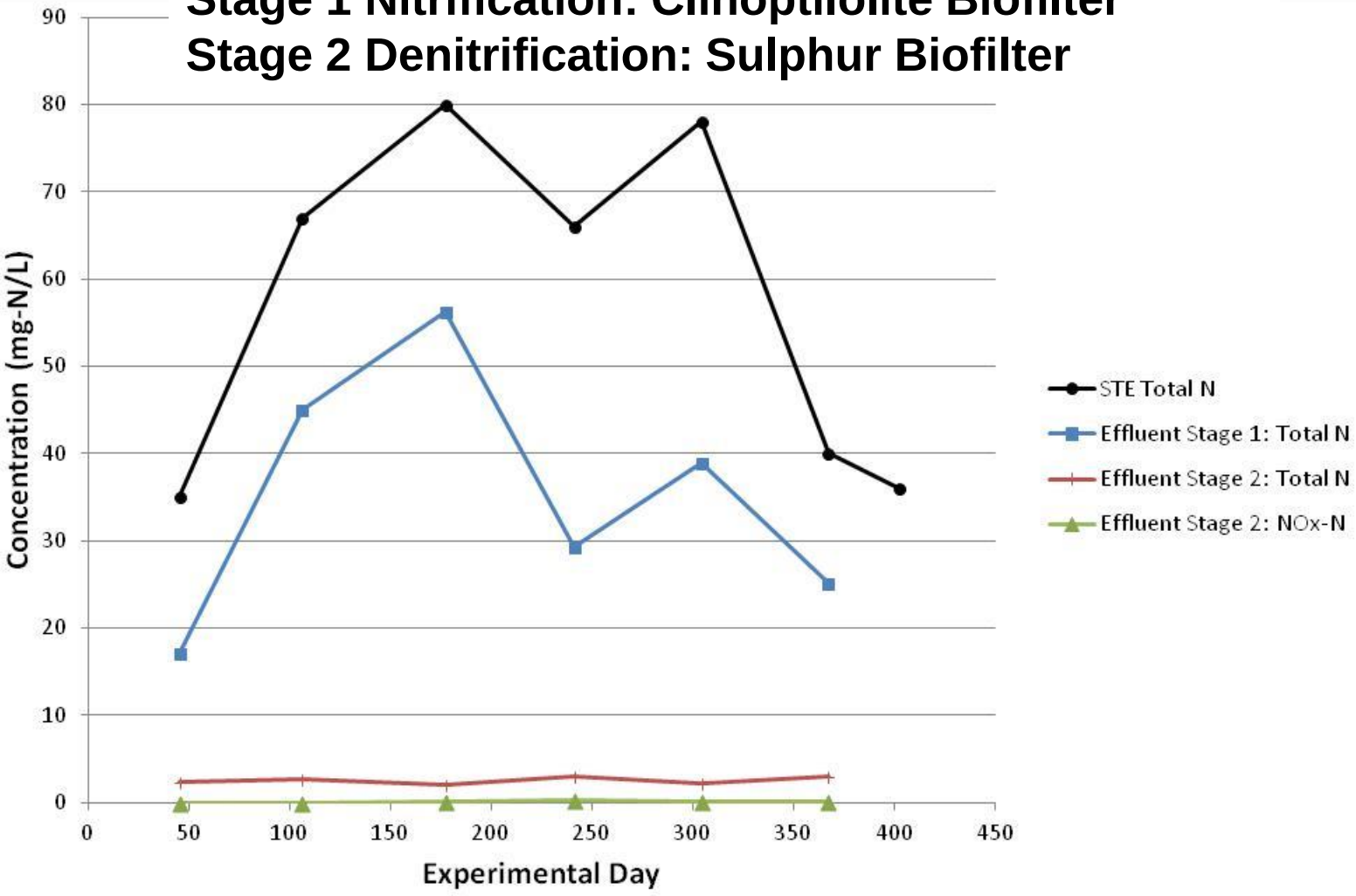
Single Pass System

Stage 1 Nitrification: Clinoptilolite Biofilter
Stage 2 Denitrification: Sulphur Biofilter

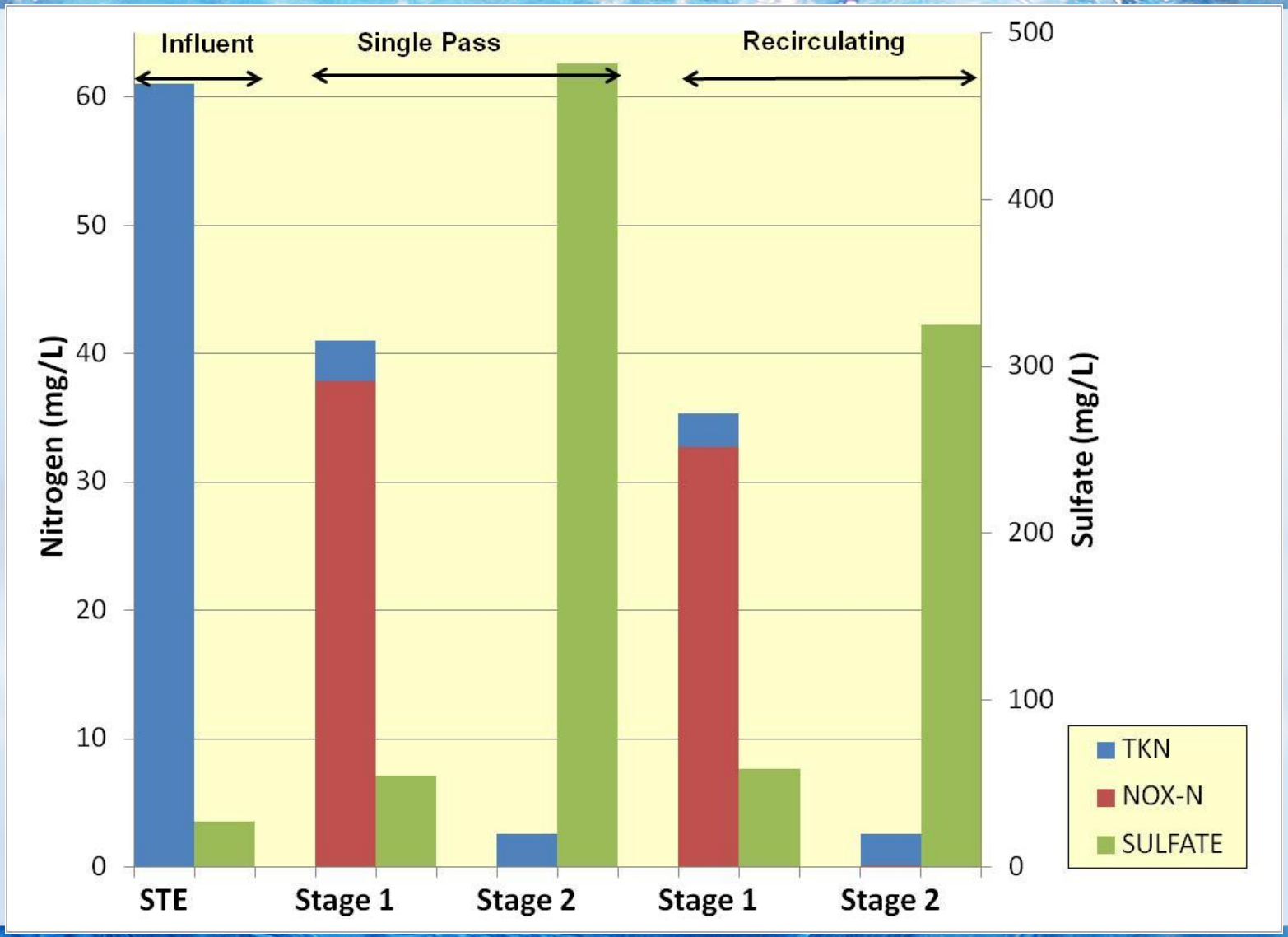


Recirculating System

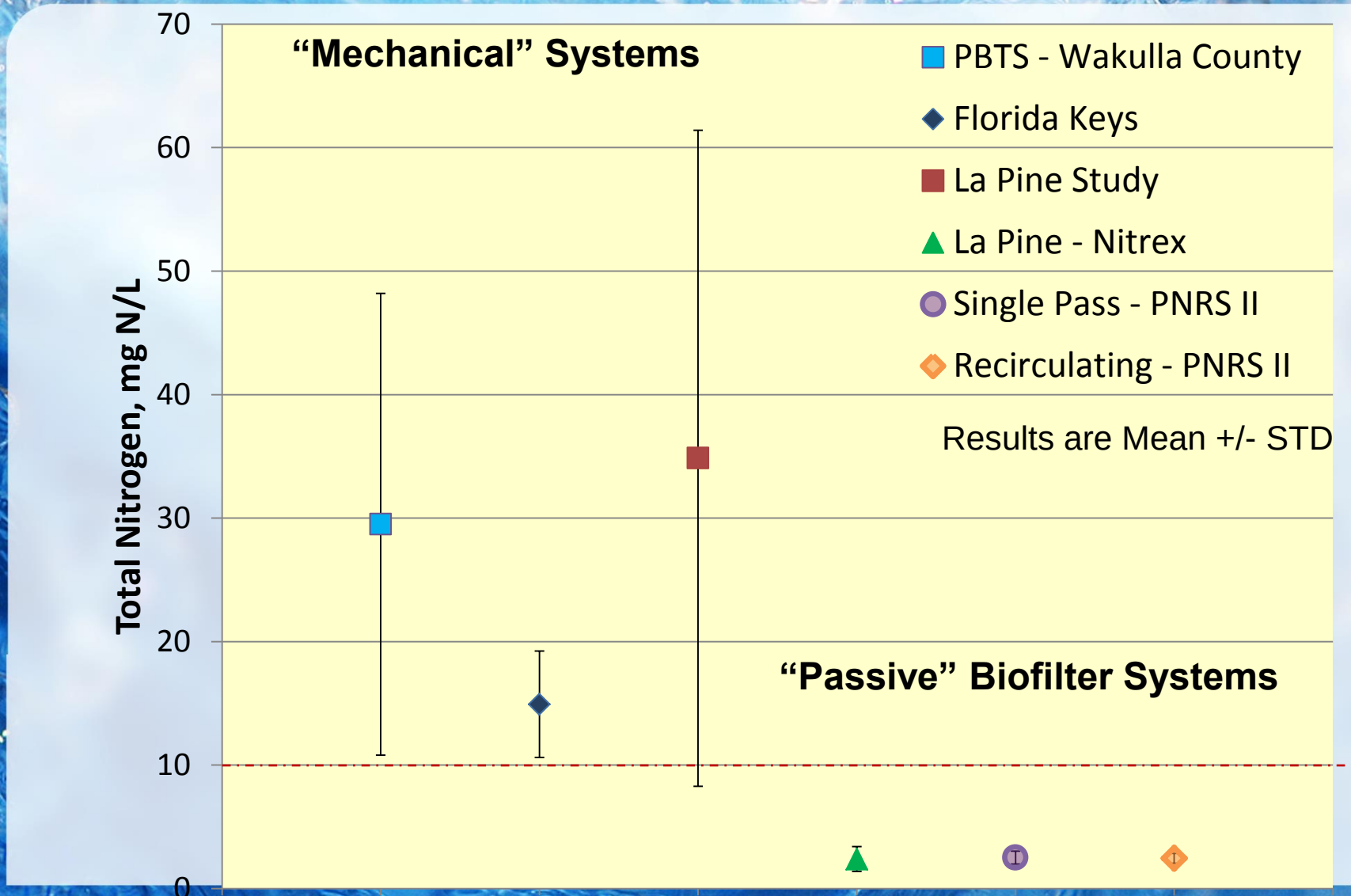
Stage 1 Nitrification: Clinoptilolite Biofilter
Stage 2 Denitrification: Sulphur Biofilter



Single pass vs recirculating biofilters: sulfate



Comparison with other N-reduction studies



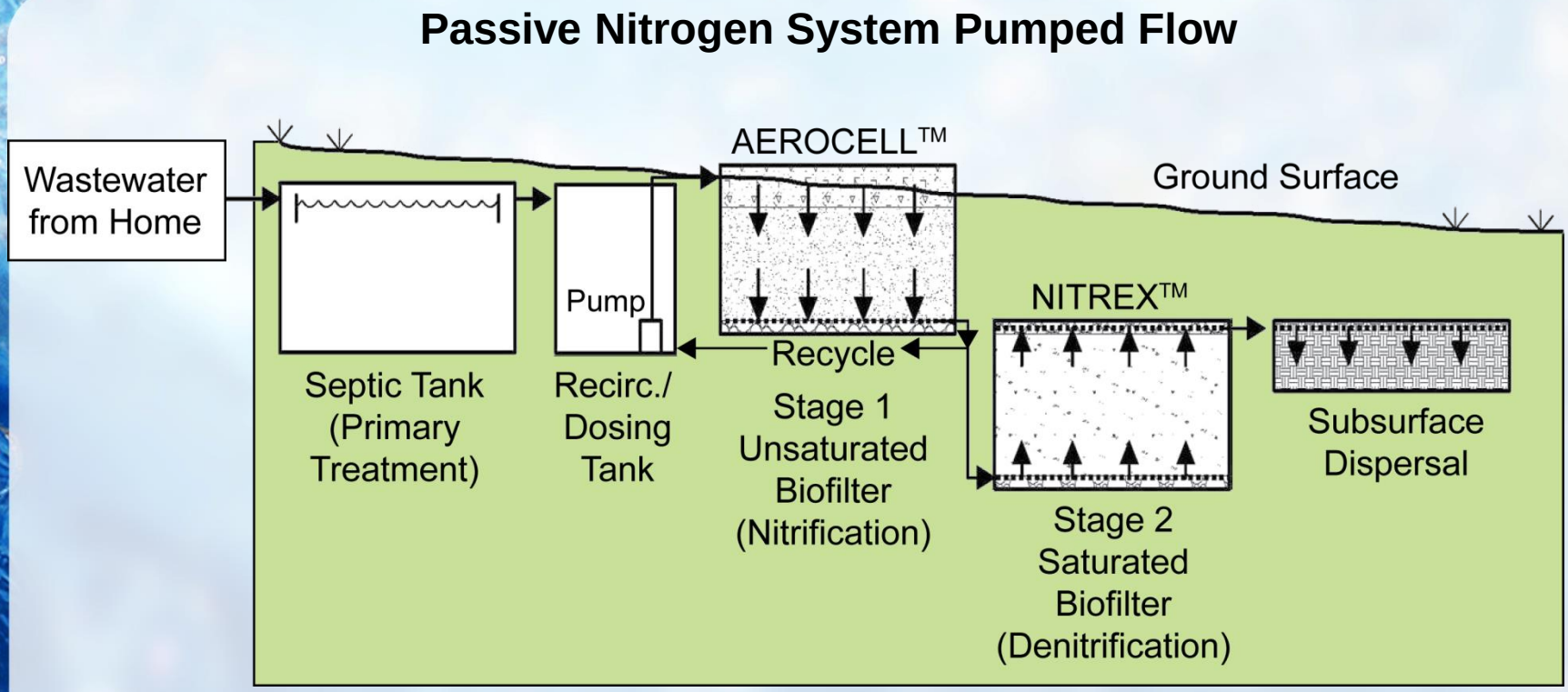
Lessons learned from pilot test

- Encouraging results from pilot PNRS
- Sulfate production vs nitrate reduction
- Highly reactive elemental sulfur media
- Lignocellulosic retention time
- Evaluation of combination lignocellulosic and elemental sulfur denitrification systems

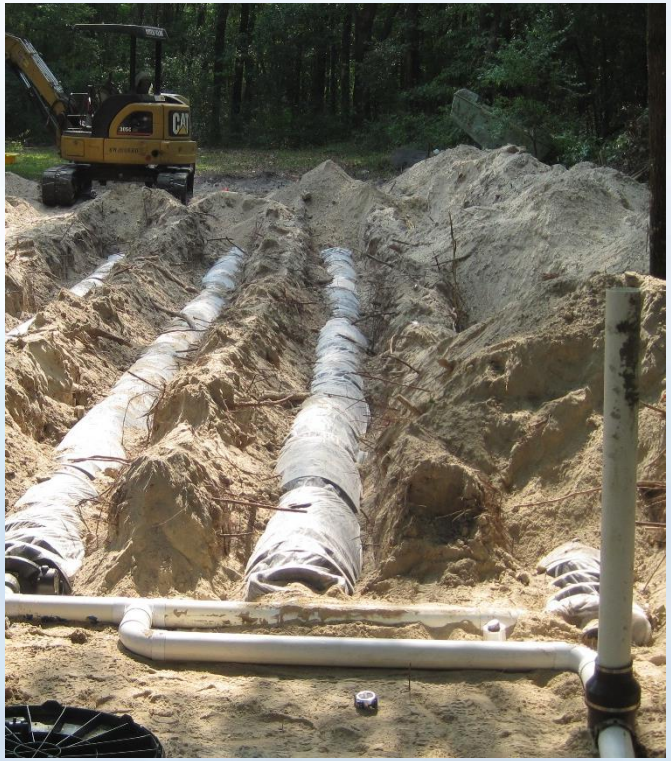
FOSNRS Task B: Full-scale testing of passive nitrogen reduction systems

HAZEN AND SAWYER
Environmental Engineers & Scientists

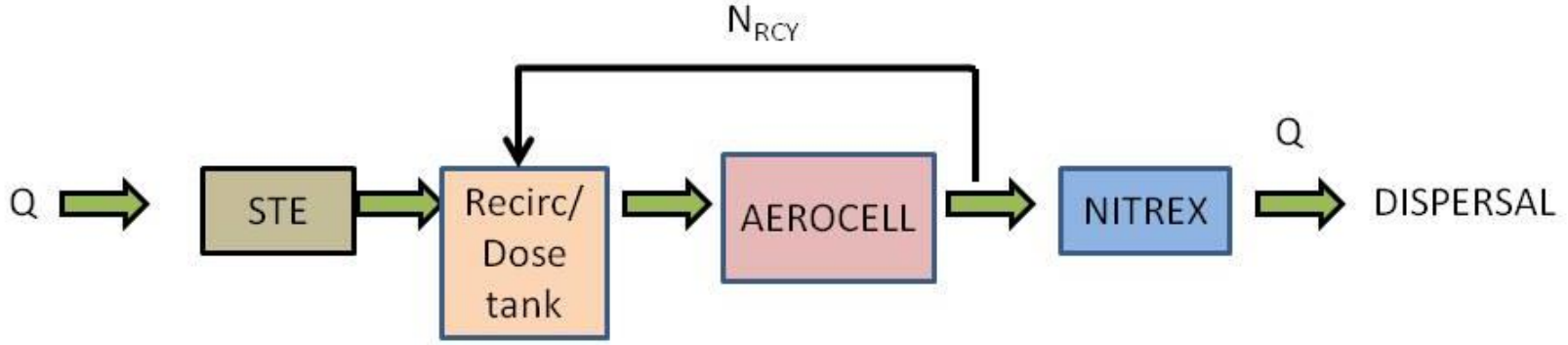
Wakulla County PNRS, proprietary systems



Wakulla County PNRS, proprietary systems



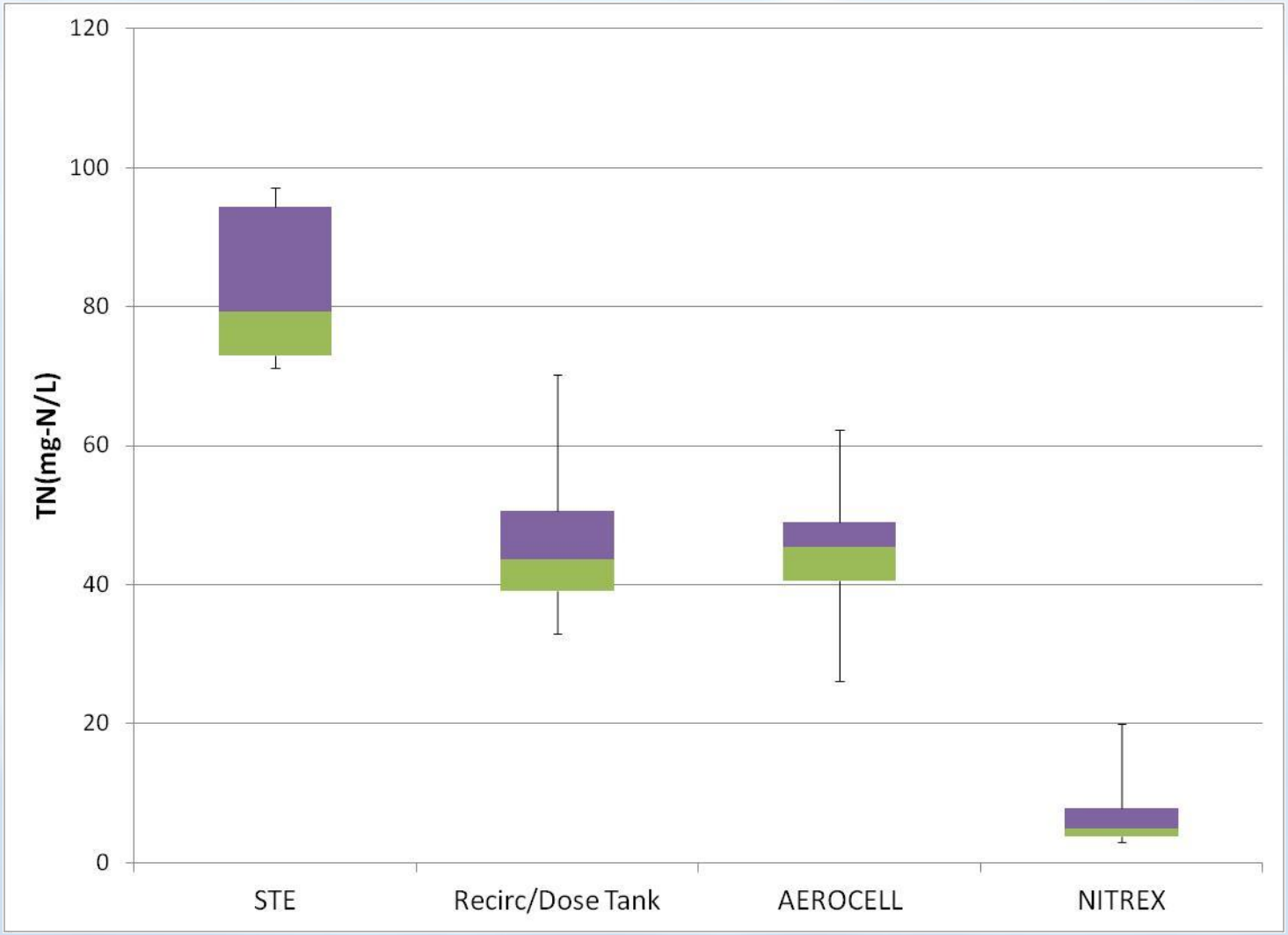
Results over 8 sample events
1 year operation



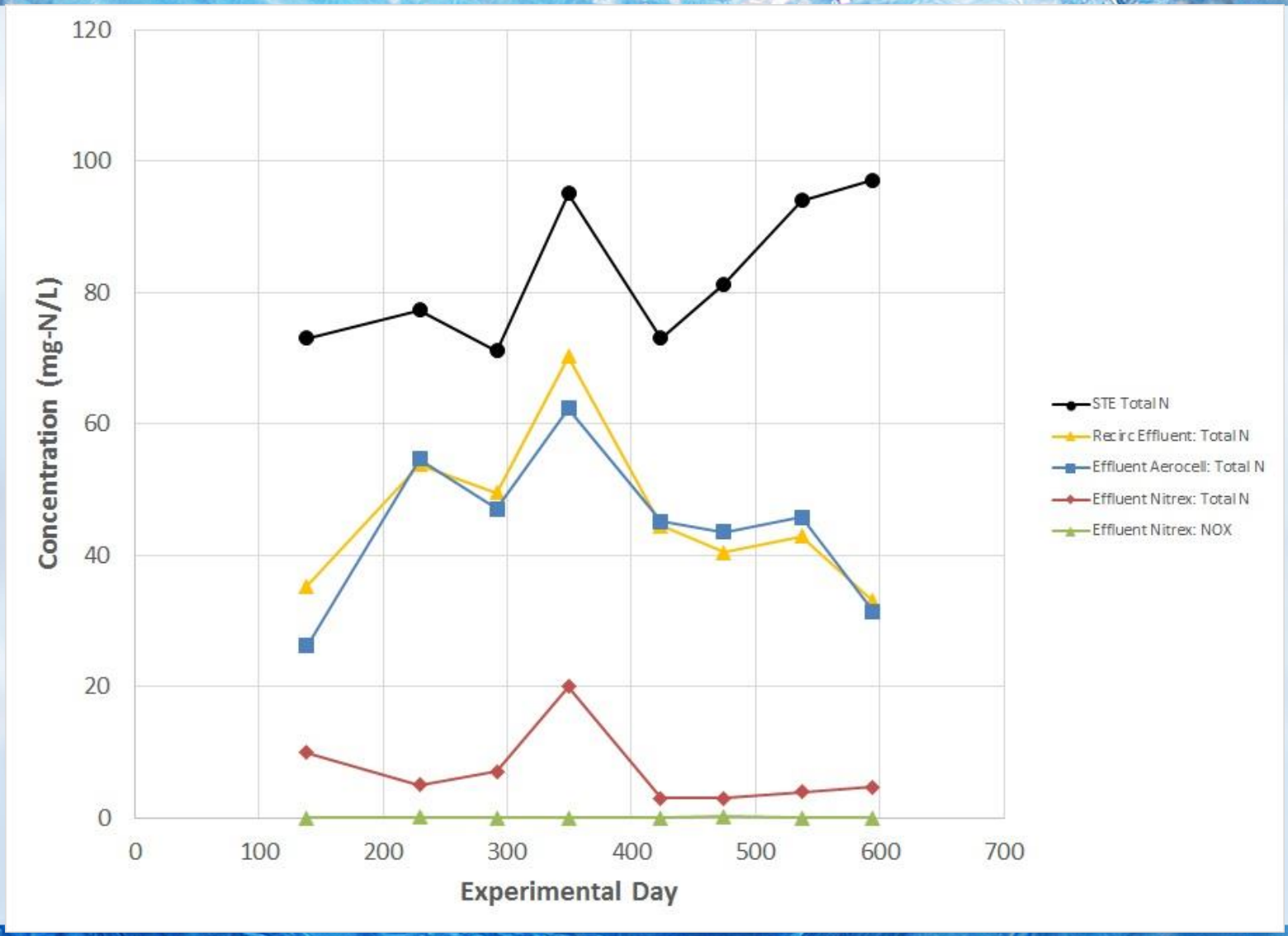
n		8	8	8	8
$CBOD_5$ mg/L	mean	108.0	12.9	26.5	27.3
TKN mg N/L	mean	82.6	18.1	12.1	7.0
NH_3 mg N/L	mean	64.1	14.2	8.3	4.5
NO_x mg N/L	mean	0.1	28.1	32.4	0.1
TN mg N/L	mean	82.7	46.2	44.5	7.1
Fecal Coliform (Ct/100 Ml)	geomean	151,088	2,703	436	5.9

91.4% TN Reduction

Total nitrogen results

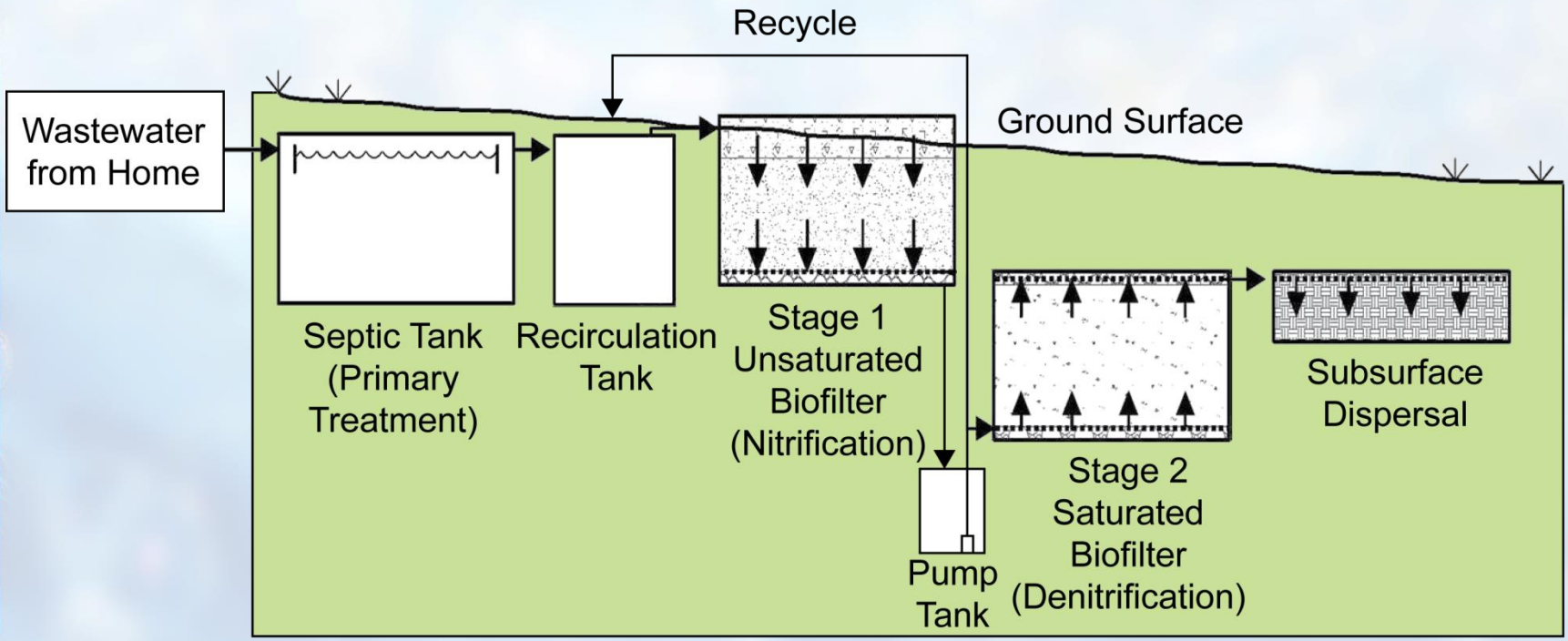


Total nitrogen results



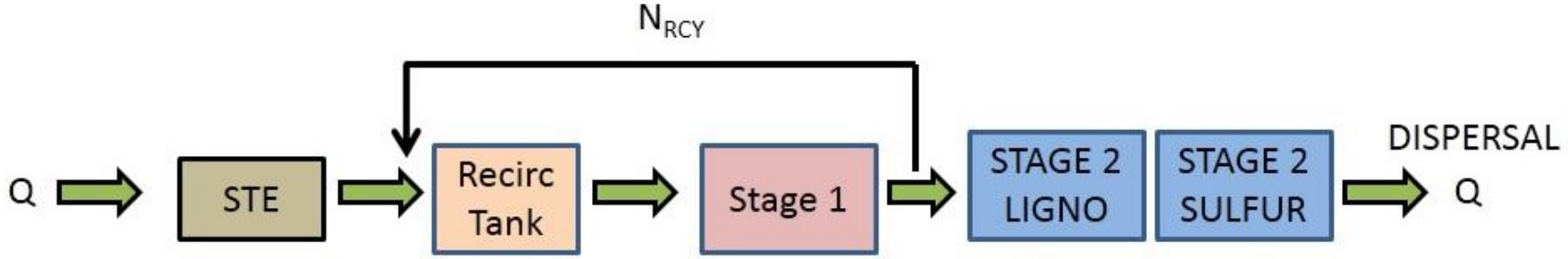
Hillsborough County PNRS

Passive Nitrogen System Pumped Flow



Hillsborough County PNRS

Preliminary results over 6 sample events 12 months operation

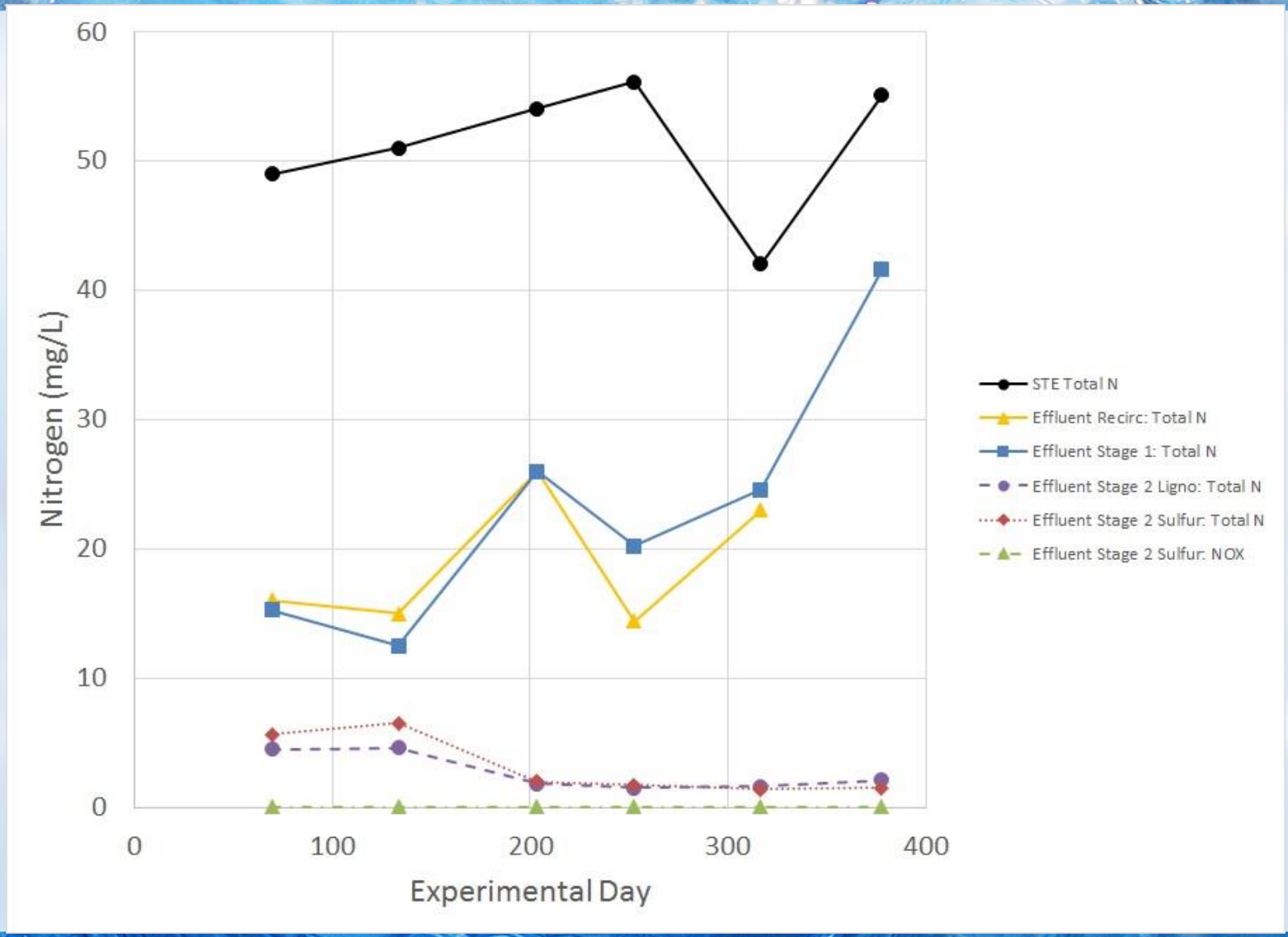


n		6	5	6	6	6
$CBOD_5$ mg/L	mean	104.7	25.2	13.7	45.7	74.7
TKN mg N/L	mean	51.2	12.8	3.2	2.6	3.1
NH_3 mg N/L	mean	43.5	9.0	0.8	1.4	1.9
NO_x mg N/L	mean	0.06	6.1	20.2	0.09	0.02
TN mg N/L	mean	51.2	18.9	23.4	2.7	3.1
Fecal Coliform (Ct/100 Ml)	geomean	112,691	38,350	153	30.7	39.9

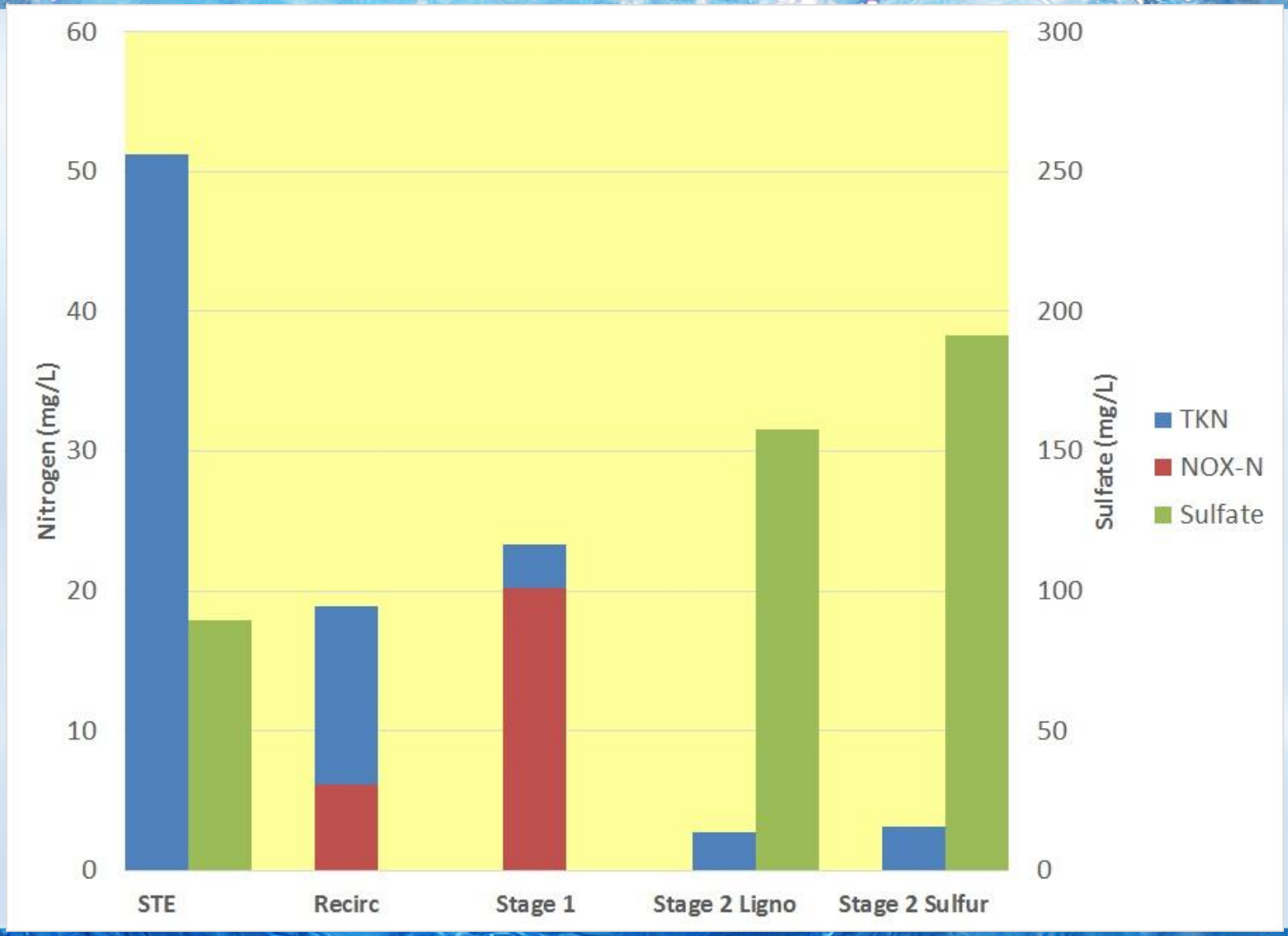
93.9% TN Reduction

Total nitrogen results

Total nitrogen results



Nitrogen and sulfate results



Summary

HAZEN AND SAWYER
Environmental Engineers & Scientists

FOSNRS Summary

- Multi-prong project underway to reduce nitrogen from Florida's Onsite Sewage Treatment and Disposal Systems
- Integrated tasks of:
  - Treatment technology evaluation including new passive systems
  - Full-scale field testing of treatment technologies
  - Monitoring of nitrogen fate and transport in subsurface
  - Modeling and planning tools to support regulatory decision making
- Successful results would allow OSTDS to achieve nutrient removal similar to wastewater treatment plants and play a role in nitrogen reduction in sensitive watersheds.

Questions?

Damann L. Anderson, P.E.
Josefin Edeback-Hirst, P.E.

Hazen and Sawyer, P.C.
10002 Princess Palm Avenue, Suite 200
Tampa, FL 33619

danderson@hazenandsawyer.com
jhirst@hazenandsawyer.com

HAZEN AND SAWYER
Environmental Engineers & Scientists