Santa Fe Springs Protection Forum

Onsite Sewage Nitrogen Study

Update October 22, 2015

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Nitrogen Reduction Options for Septic Systems

History

Nitrogen levels in springs have increased, harming our environment and economy. Septic systems are one of several sources of nitrogen. We have conducted research looking at how much nitrogen comes from septic systems and ways to reduce that contribution. The results of our research provide options that can be used at the local level to address nitrogen from septic systems.

Dock and diving platform on Santa Fe River O'Leno State Park, Florida, 1940

Photo Credit: State Archives of Florida, *Florida Memory*, https://floridamemory.com/items/show/152931

Primary Study Areas

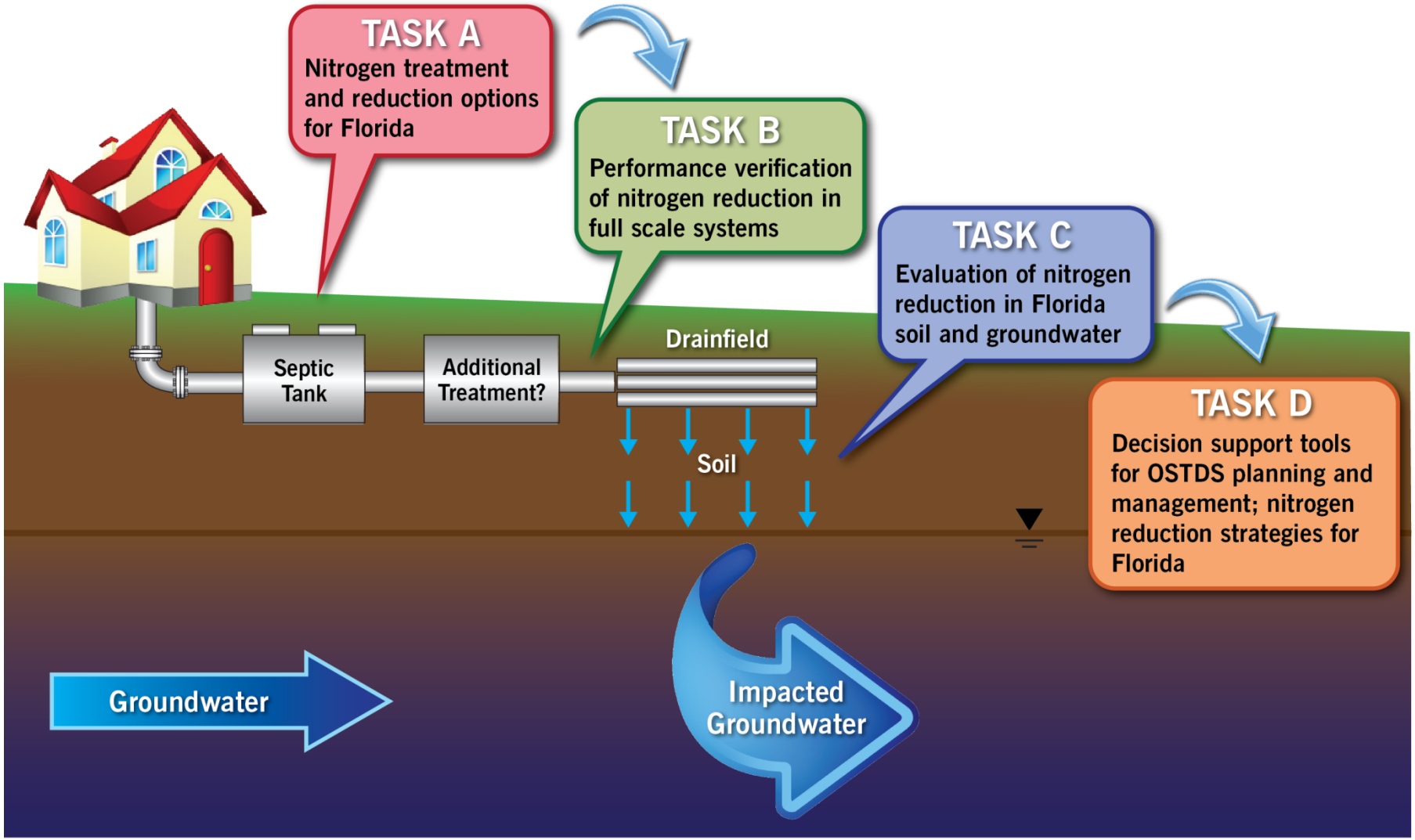


Image Credit: Hazen and Sawyer

Biological Nitrogen Removal (BNR)
Two-stage Biofiltration

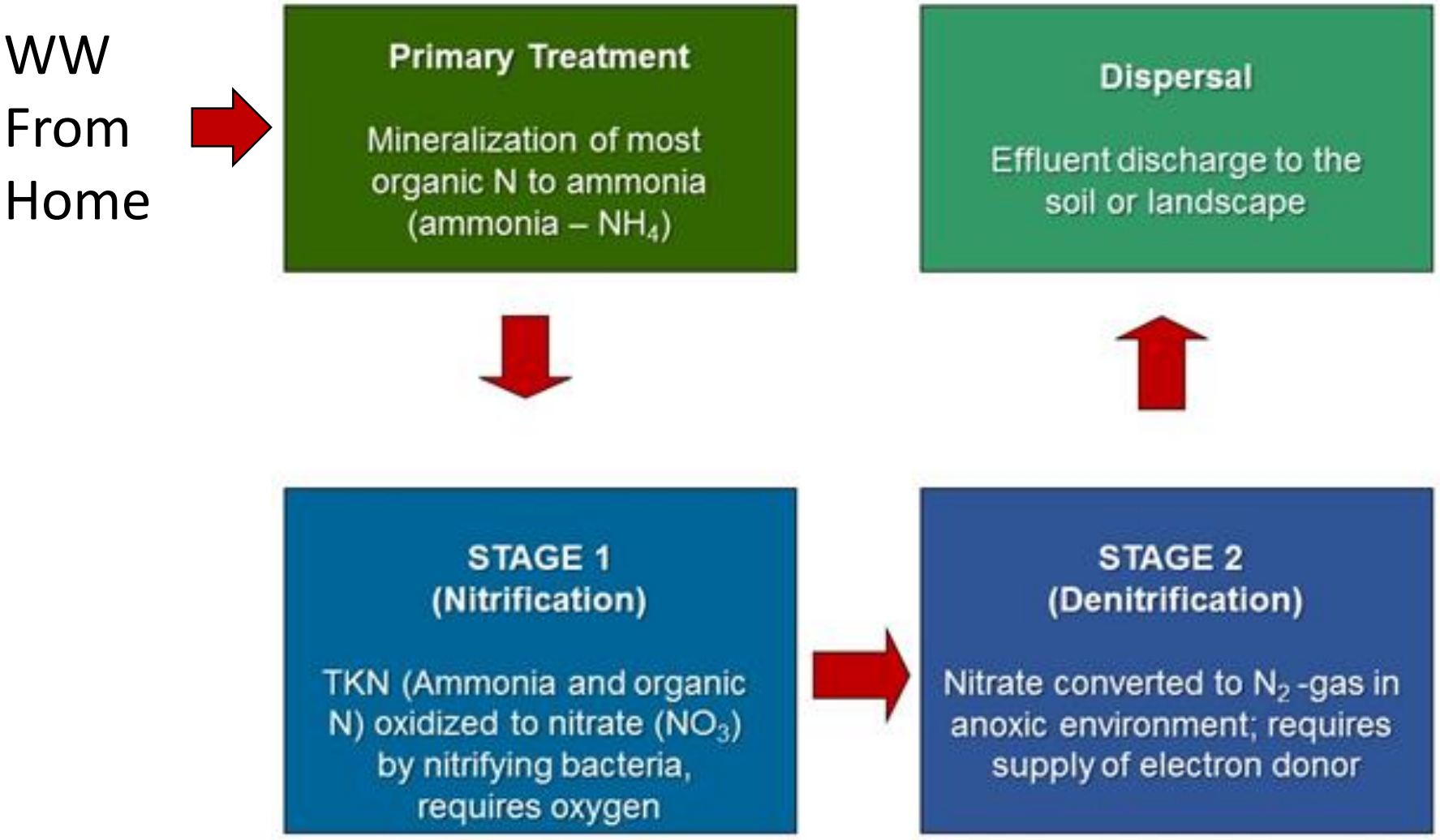


Image Credit: Hazen and Sawyer

What are “Passive” Nitrogen Reduction Systems?

They are onsite wastewater systems that reduce effluent N using reactive media for denitrification and a single liquid pump, if necessary.

Two stage process:

Stage 1

“nitrify” nitrogen compounds to NO_3 (nitrification)

nitrification media: sand & expanded clay

Stage 2

“denitrify” NO_3 to nitrogen gas (denitrification)

denitrification media: lignocellulosics & elemental sulfur

Test Facility

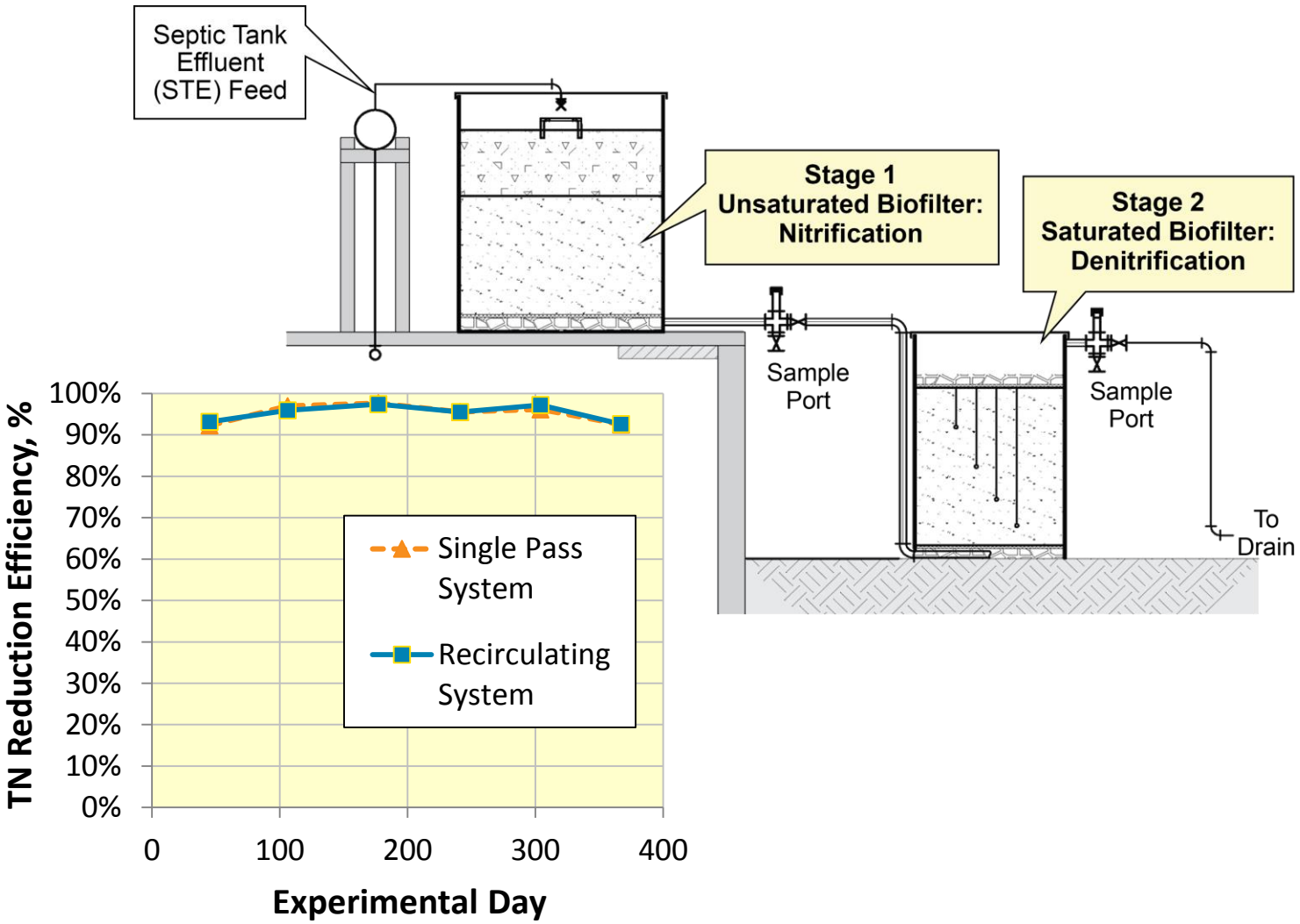
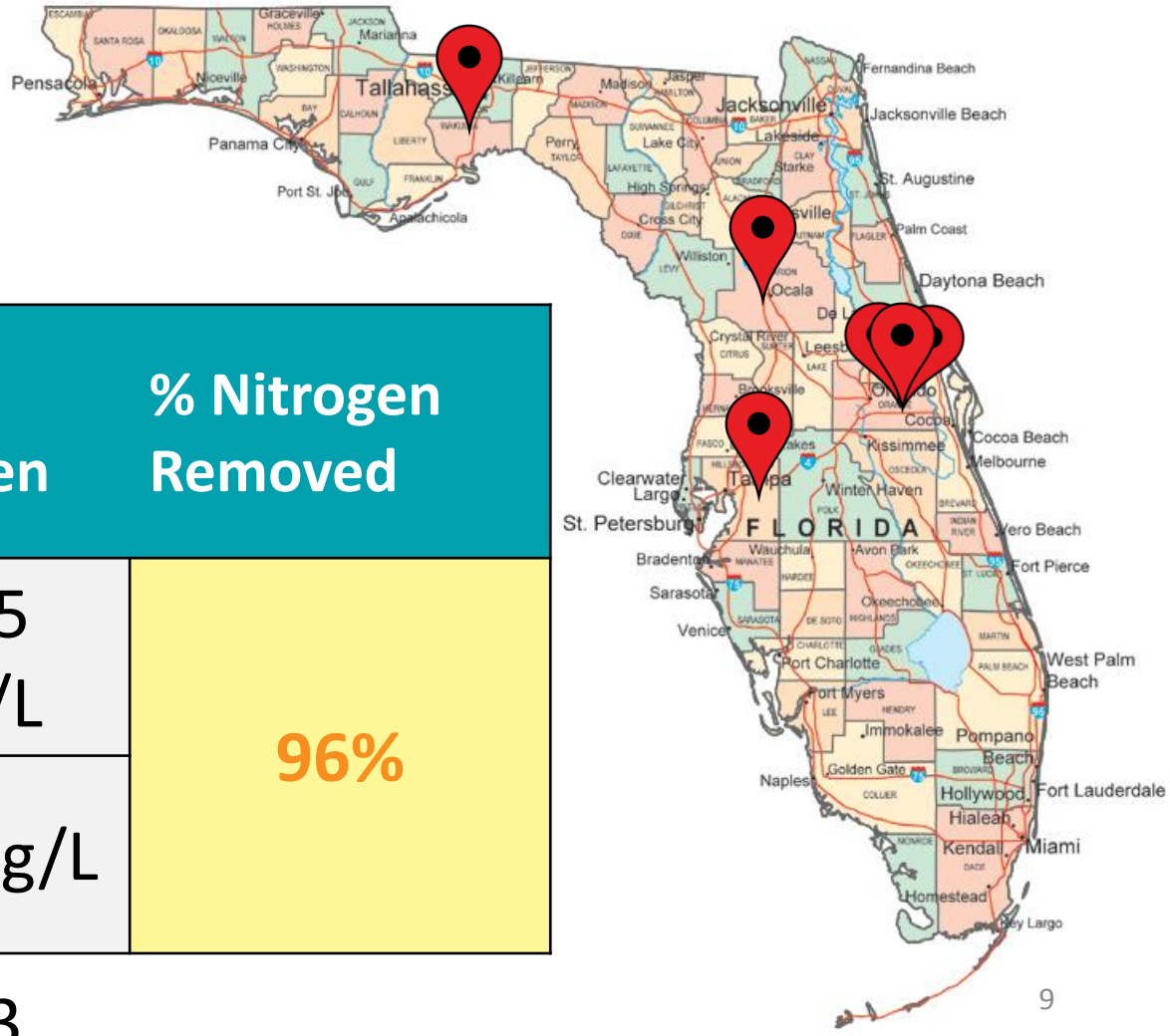


Image Credit: Hazen and Sawyer

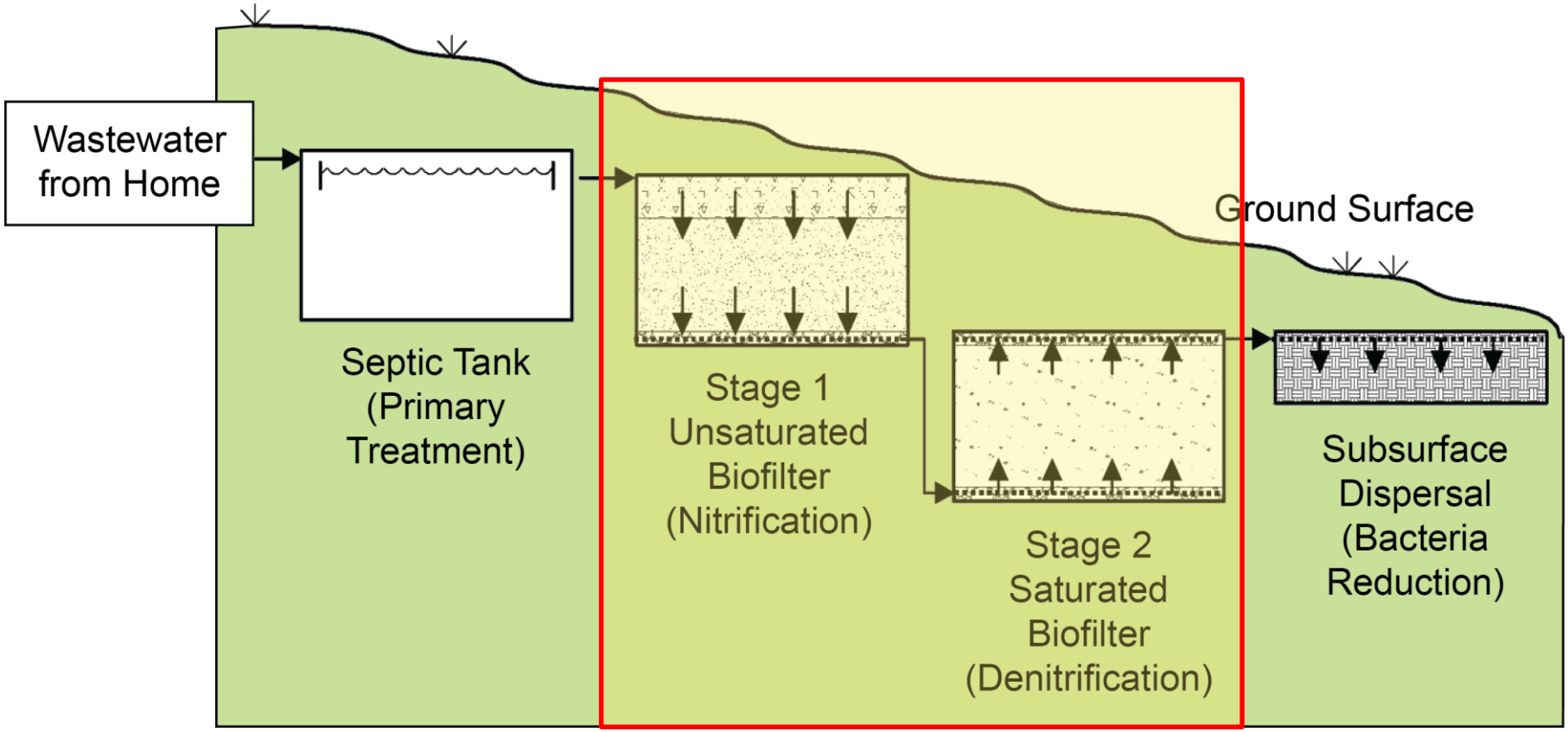
Nitrogen Reduction at Field Sites



Results from Seminole County field site:	Total Nitrogen	% Nitrogen Removed
Wastewater **Before**	50.5 mg/L	**96%**
Wastewater **After**	1.9 mg/L	

n = 13

Full Scale Concepts Complement Existing Septic Systems



Summary of Full Scale Prototype PNRS Nitrogen Results

System	Design	System Description	Mean Influent TN, mg/L	Mean Effluent TN, mg/L	Mean TN Removal %
1	Proprietary	Stage 1 Aerocell™, Stage 2 Nitrex™	82.7	7.1	91
2	PNRS In-tank	Stage 1 with R, dual-media Stage 2	54.7	2.5	95
3	PNRS In-ground	Stacked Stage 1 over Stage 2a ligno with supplemental Stage 2b sulfur	50.5	1.9	96
4	PNRS In-tank	Gravity Stage 1, dual-media Stage 2	70.1	7.4	89
5	PNRS In-tank	Stage 1 SP and with R, dual-media Stage 2	72.1	2.1	97
6	PNRS In-tank	Stacked Stage 1 over Stage 2a ligno with supplemental Stage 2b sulfur	66.3	12.4	81[a]
7	PNRS In-ground	In-ground stacked SP Stage 1 over Stage 2 ligno	54.9	19.1	65[a]

[a] Performance of systems 6 and 7 may have been significantly improved with design and construction revisions based on lessons learned in this study.

Table Credit: Hazen and Sawyer

Lignocellulosic Media Life Estimates

System	% Reactive Media	Media Volume, ft^3	Calculated Longevity[1], years	Longevity with factor of safety[2], years
1	100%	194.8	83.8	64.5
2	100%	126.0	107.5	82.7
3	50%	136.5	80.8	62.2
4	100%	126.0	21.6	16.6
5	100%	126.0	43.6	33.5
6	100%	67.0	39.1	30.1
7	100%	362.0	176.2	135.5

[1] Assumptions regarding lignocellulosic media included: dry bulk density of 20 lb./ft^3; 50% carbon content by weight with available carbon being approximately 50% of carbon content

[2] Factor of safety used was 1.3

Table Credit: Hazen and Sawyer

Sulfur Media Life Estimates

System	% Reactive Media	Media Volume, ft³	Study Conditions			If lignocellulosic depleted		
			Mean influent NOx-N	Calculated Longevity[1], years	Longevity with factor of safety[2], years	Stage 1 mean influent NOx-N	Calculated Longevity[1], years	Longevity with factor of safety[2], years
2	90%	32.4	0.02	N/A	N/A	16.7	194.0	149.2
3	90%	34.7	5.8	461.2	354.8	23.9	112.2	86.3
4	90%	24.3	3.2	348.5	268.0	33.6	27.2	20.9
5	90%	24.3	4.1	520.5	400.4	43.4	53.5	41.1
6	90%	18.0	24.9	57.2	44.0	42.3	34.0	26.1

[1]Assumptions regarding sulfur media included: dry bulk density of 76 lb./ft^3 and influent NOx concentrations from the preceding process. In systems where lignocellulosic denitrification preceded the sulfur, low influent NO_x concentrations resulted in very long estimates of longevity.

[2] Factor of safety used was 1.3

Table Credit: Hazen and Sawyer

Case Study: Groundwater Monitoring

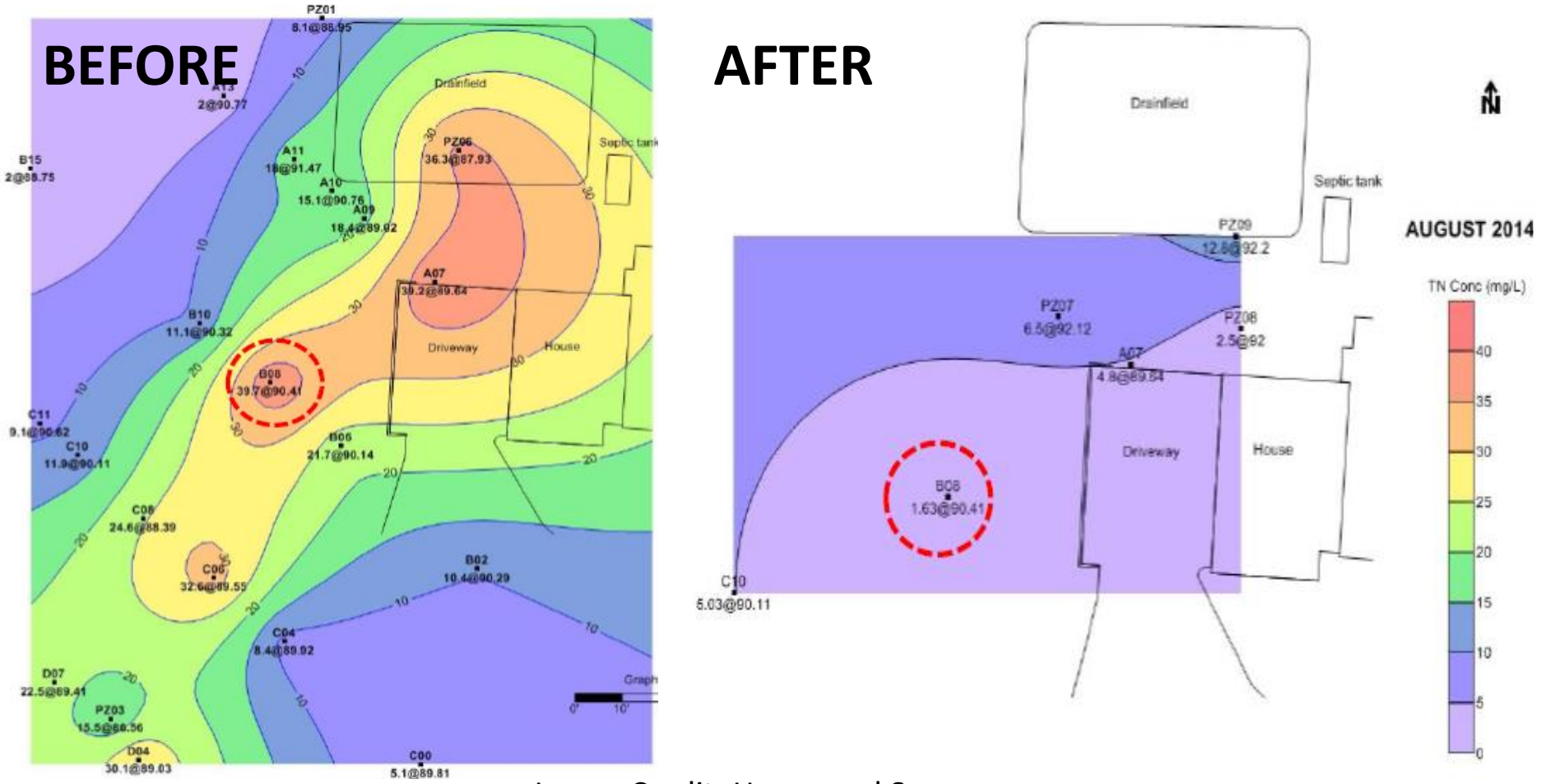


Image Credit: Hazen and Sawyer

Lined Drainfield

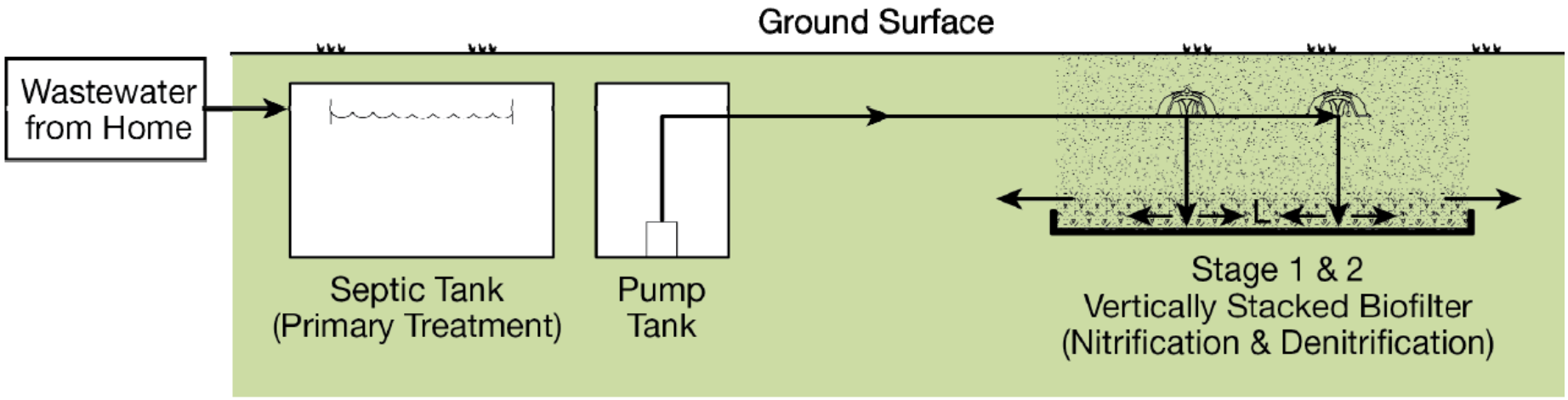


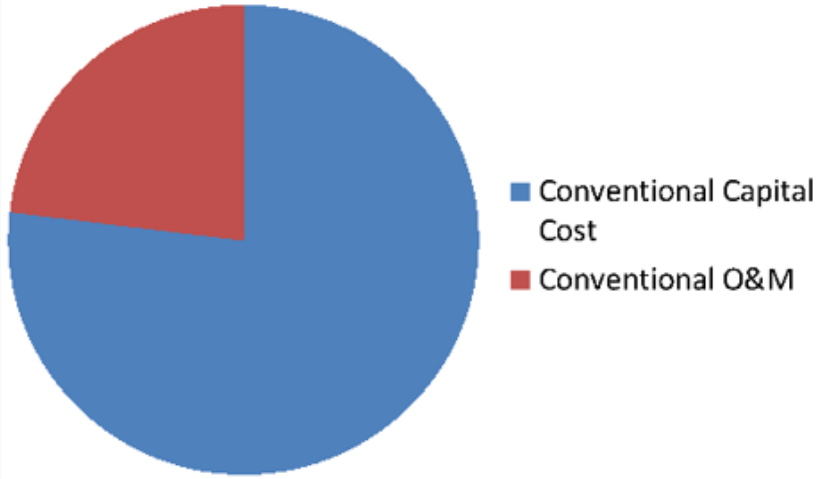
Image Credit: Hazen and Sawyer

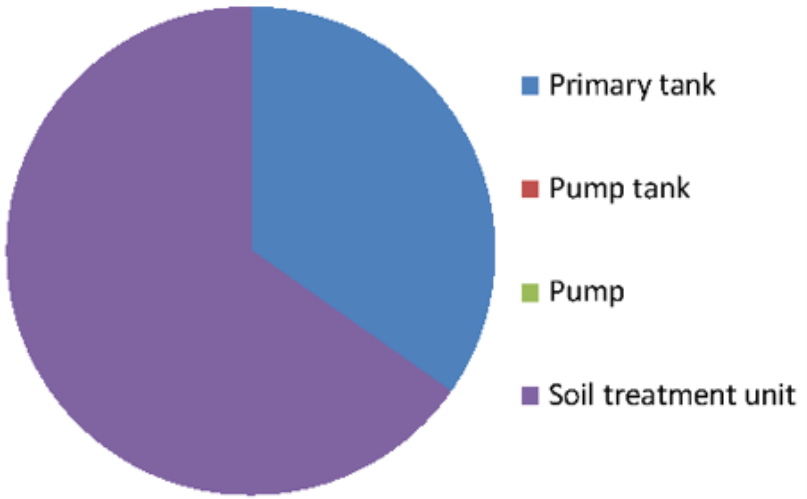
Description: Engineer-designed nitrogen-reducing liner beneath a conventional drainfield.

Benefit: Low-cost alternative to other performance-based nitrogen-reduction systems. Requires no operating permit or maintenance contract.

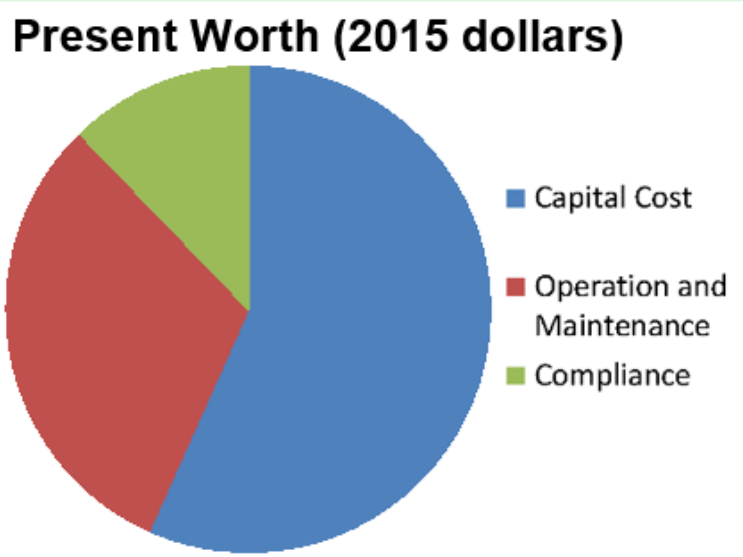
LIFE CYCLE COSTS

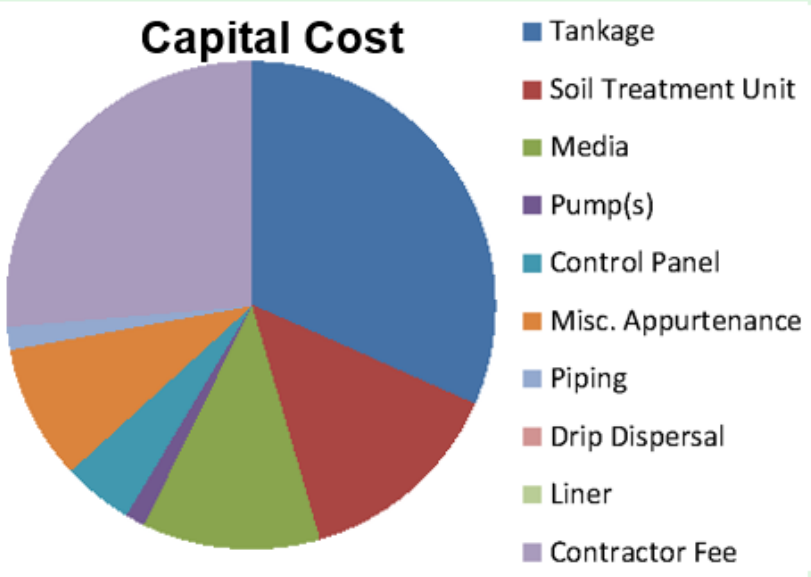
CONVENTIONAL





PASSIVE NITROGEN





STUMOD

Vadose zone inputs | Vadose zone outputs | Sat. zone inputs | Sat. zone outputs | STUMOD-HPS | Multi-sites I | Multi-sites II | Sensit | CFD I | CFD II

Nitrogen Model

Choose soil type ? Help Caution! Default values ?

Effluent concentration ?

Hydraulic loading rate ?

Treatment depth ?

Soil temperature ?

ET & plant uptake ?

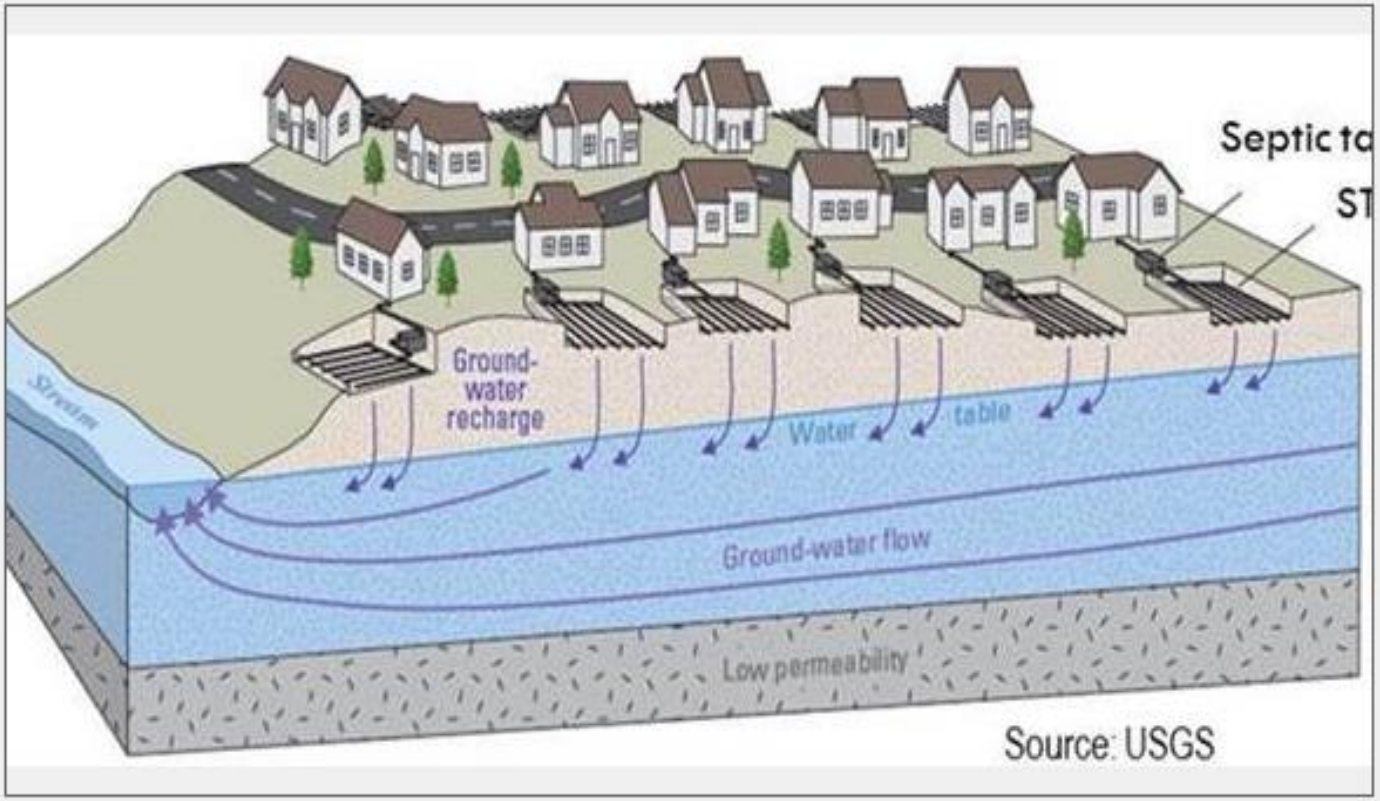
Carbon content functi ?

Select # of soil Layers

No. of Layers ?

Soil type layer 2

Soil type layer 3



Run STUMOD Close

Image Credit: Colorado School of Mines

floridahealth.gov/FLWMI

GOAL:

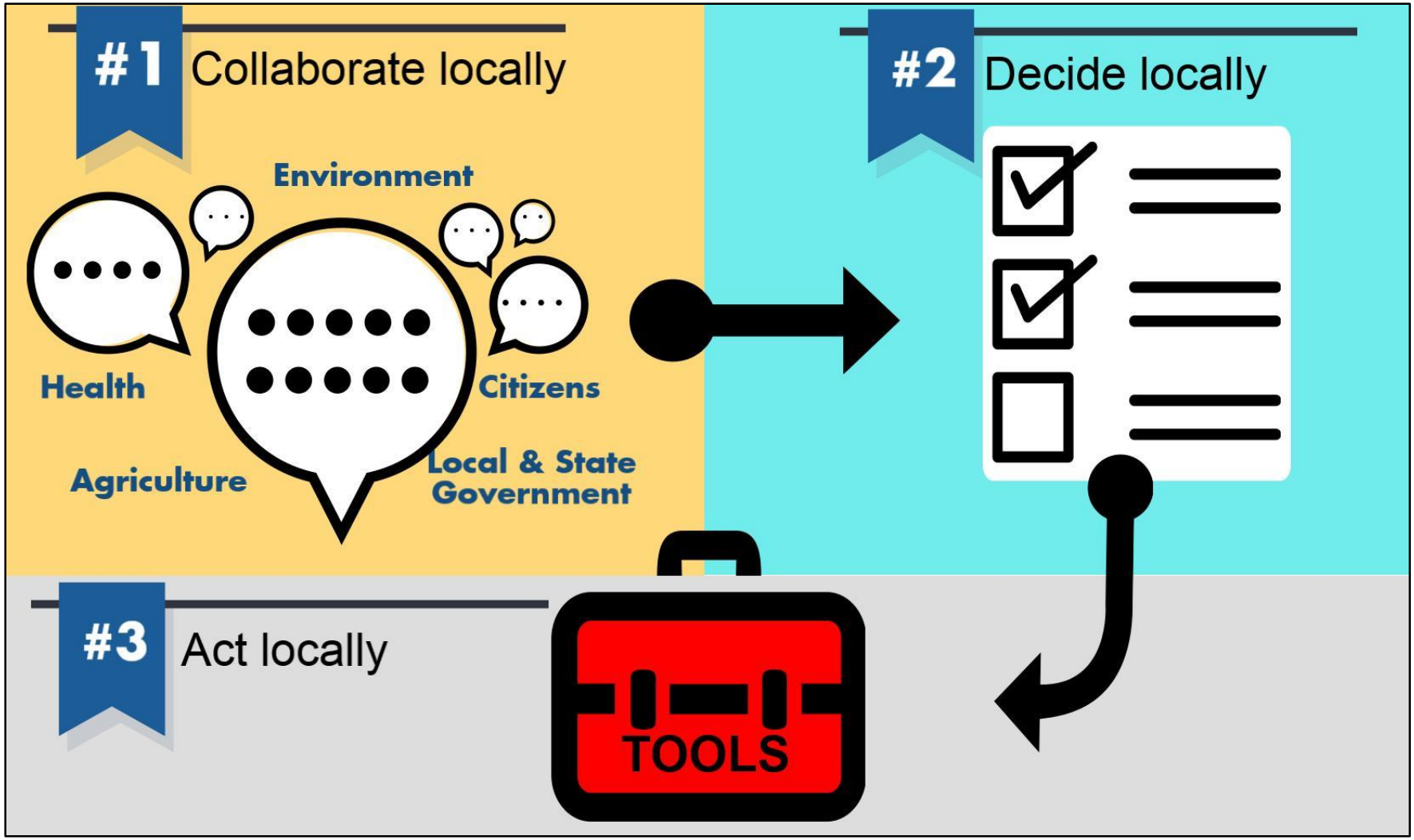
Map the drinking water source and wastewater treatment method for every built property in Florida

Final Department Report Due 12/31/2015 Containing:

1. Analysis of field monitoring of performance and cost of technologies
2. Analysis of soil and groundwater sampling to determine how nitrogen moves
3. Analysis to show how nitrogen is affected by treatment in Florida-specific soils
4. Final reporting on all tasks with recommendations for science-based nitrogen reduction options for septic systems

Implementation Plan:

Goal: Make tools available to reduce nitrogen contributions from septic systems


#1 Collaborate locally
Environment
Health
Citizens
Agriculture
Local & State Government
#2 Decide locally
#3 Act locally
TOOLS

PLAN

Inventory locations

Estimate loading

Determine costs

TEACH

Public meetings

Education campaigns

Train installers & inspectors

BUILD

Conventional systems

Lined drainfield & existing technologies

Nitrogen reduction systems

1

Implementation Plan

Approve baseline conventional septic system enhanced for nitrogen reduction (lined drainfield)

Requires rule change

Status: Evaluation by Technical Review and Advisory Panel on October 22, 2015

2

Implementation Plan

Incorporate nitrogen study systems as approved performance-based systems

Requires development of system specifications

Status: Being developed, with target implementation in December 2015

3

Implementation Plan

Develop new nitrogen reducing systems section in Florida Administrative Code Chapter 64 E-6

Requires rule and possibly statute changes

Status: Requires multiple public meetings, with target implementation in September 2016

4

Implementation Plan

Provide public education and training on nitrogen reduction strategies

Requires training development and message standardization

Status: Ongoing

5

Implementation Plan

Share planning-level tools to assess nitrogen reducing strategies (inventory, model)

Requires coordination with local stakeholders

Status: Ongoing

6

Implementation Plan

Determine funding solutions for nitrogen reduction efforts

Requires coordination with Department of Environmental Protection and local stakeholders

Status: Pending

Basin Management Action Plan (BMAP) Activities

BMAPs with significant septic system contributions are planned to have an advisory committee focused on developing locally appropriate solutions.

Three-pronged approach:

1. Projects
2. Research
3. Education

Seeing Silver Springs in glass bottom boats

Photo Credit: State Archives of Florida, *Florida Memory*, http://floridamemory.com/items/show/161202

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