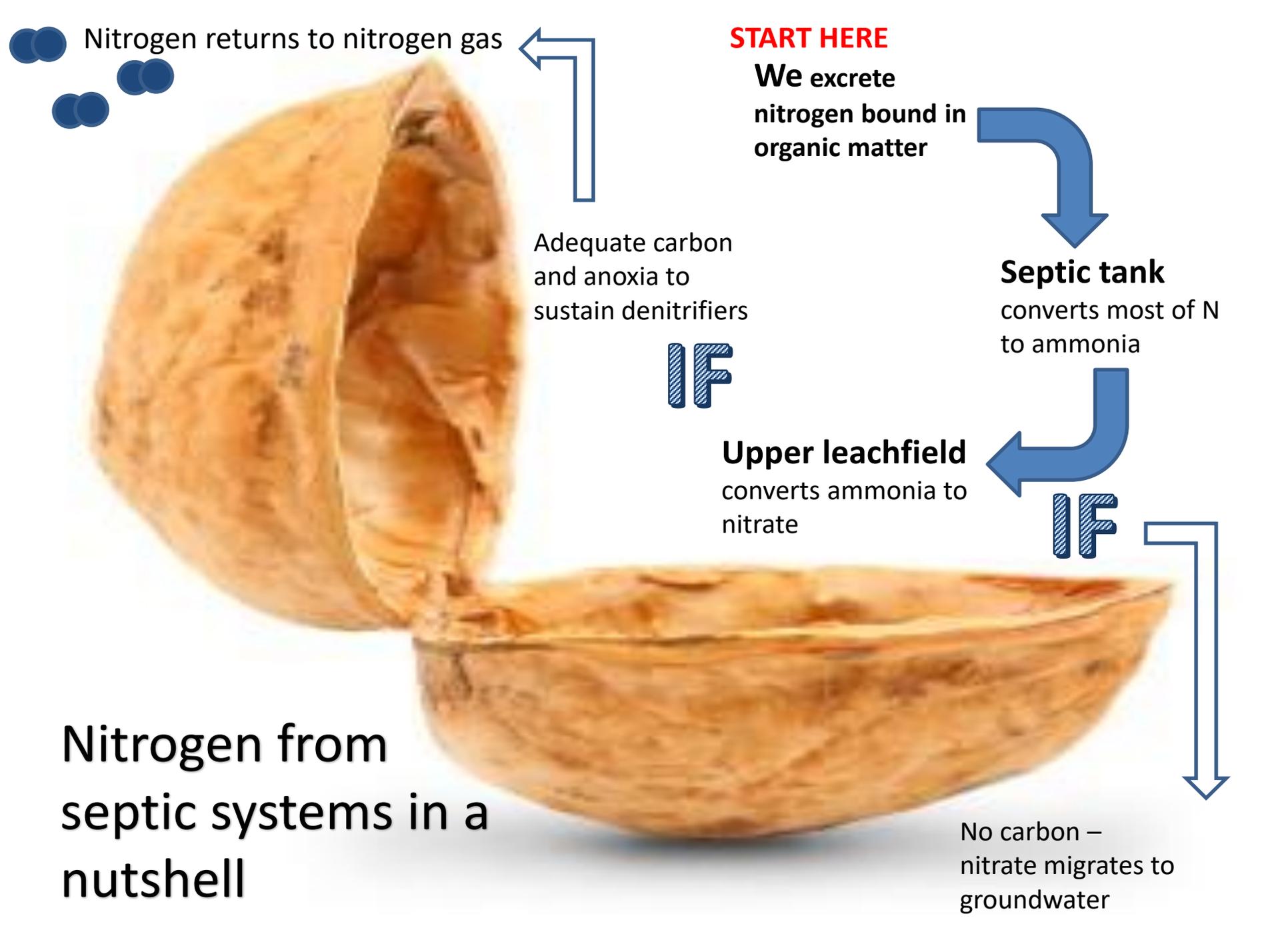


Of Sawdust and Septic Systems -

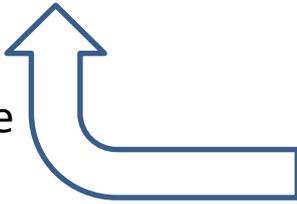
George Heufelder
Barnstable County Department of Health and
Environment
Massachusetts Alternative Septic System Test
Center

**Nitrogen in Wastewater
from Onsite Septic Systems
- a review in a nutshell-**

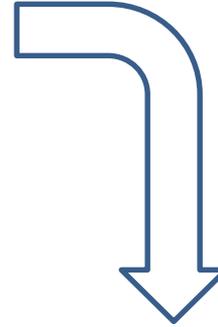




To
atmosphere
as gas



**Fixed
Nitrogen**

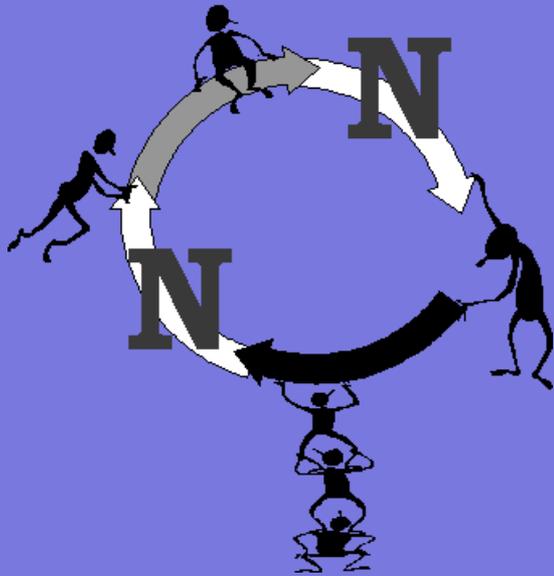


To groundwater as
nitrate

infant methemoglobinemia



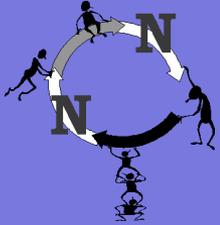
Manipulating the nitrogen cycle



The majority of
denitrifying systems work
on the same principle
....you must first nitrify
to denitrify

Types or broad classes of
alternative onsite septic
systems that remove
nitrogen. *to name a few...*

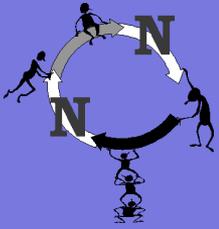
- **Trickling filters (various media)**
- **Mixed liquor systems with some fixed film growth**
- **Sequencing Batch Reactors**
- **Membrane bioreactors**
- **Woodchip Bioreactors**



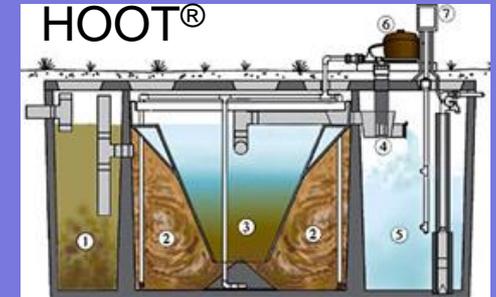
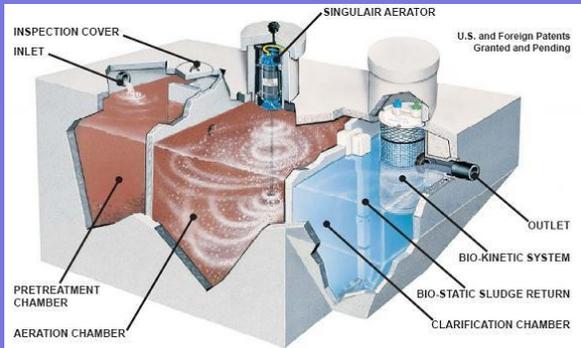
Media Filters

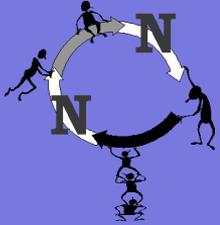
with recirculation





Mixed Liquor and fixed film some with recirculation

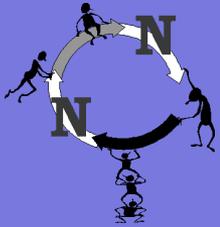




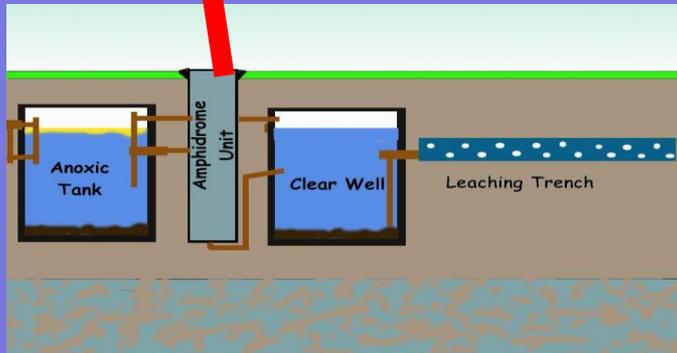
Membrane Bioreactors

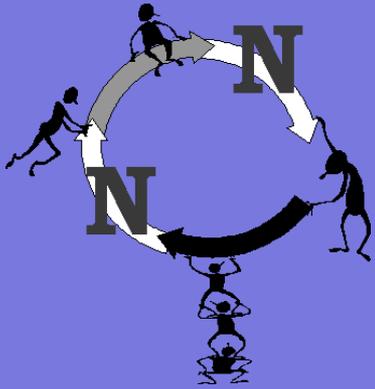
some with recirculation





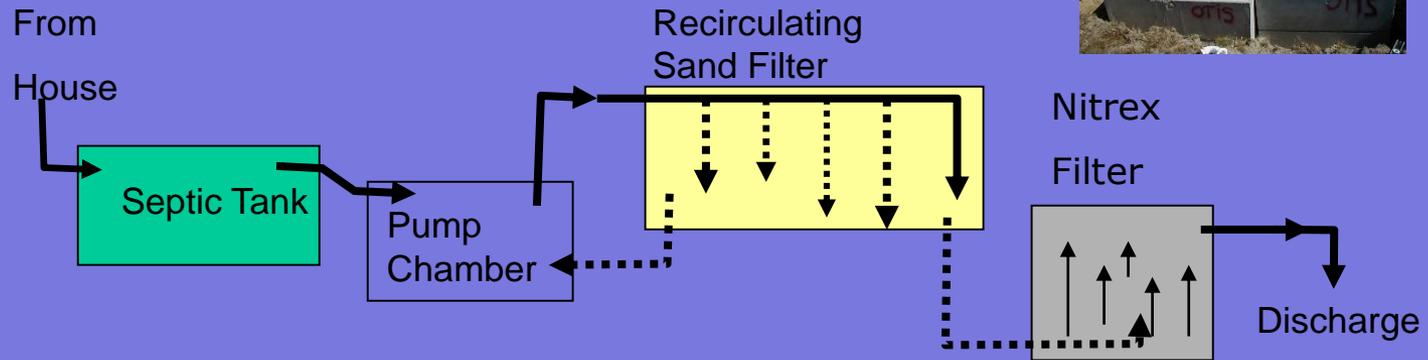
Sequencing Batch Reactor





Woodchip Bioreactors

Nitrex®



How do they all work?



Failed Septic System?
Repairs Too Expensive? **WE CAN HELP!**

Barnstable County Community Septic Management Loan Program

JUST ONE BITE.  **TRAVEL VACCINES AVAILABLE**
CALL 508-375-6617

HOME HEALTH TOPICS PROGRAMS & SERVICES BCDHE IN MY TOWN RESOURCES OTHER TOPICS ABOUT enter search terms

Innovative/Alternative Septic System Tracking

[Go Back to Programs and Services](#)



DEPARTMENT CONTACT INFORMATION

- 508-375-6613
- bch.info@barnstablecounty.org
- P.O. Box 427, Barnstable, MA 02630

ONE BITE
CAN RUIN YOUR VACATION



TRAVEL VACCINES AVAILABLE

BCDHE MAKE AN APPOINTMENT
CALL 508-375-6617

You can find
out for
yourself

<https://www.barnstablecountyhealth.org/programs-and-services/ia-septic-system-tracking>

With the exception of the woodchip bioreactor, generally mechanical systems are considered to remove 50-60% of the nitrogen

In general the standard septic system gets half the job done – it can nitrify but runs it out of carbon to denitrify.





So where
does wood
come in?

Cellulose > Glucose

6

C

Carbon
12.0107

Wood in various forms represents a slow release form of carbon for use by the bacteria involved in denitrification



There are organisms in the soil beneath your septic system leachfield that can change wood into a soluble food and remove nitrogen as they do.



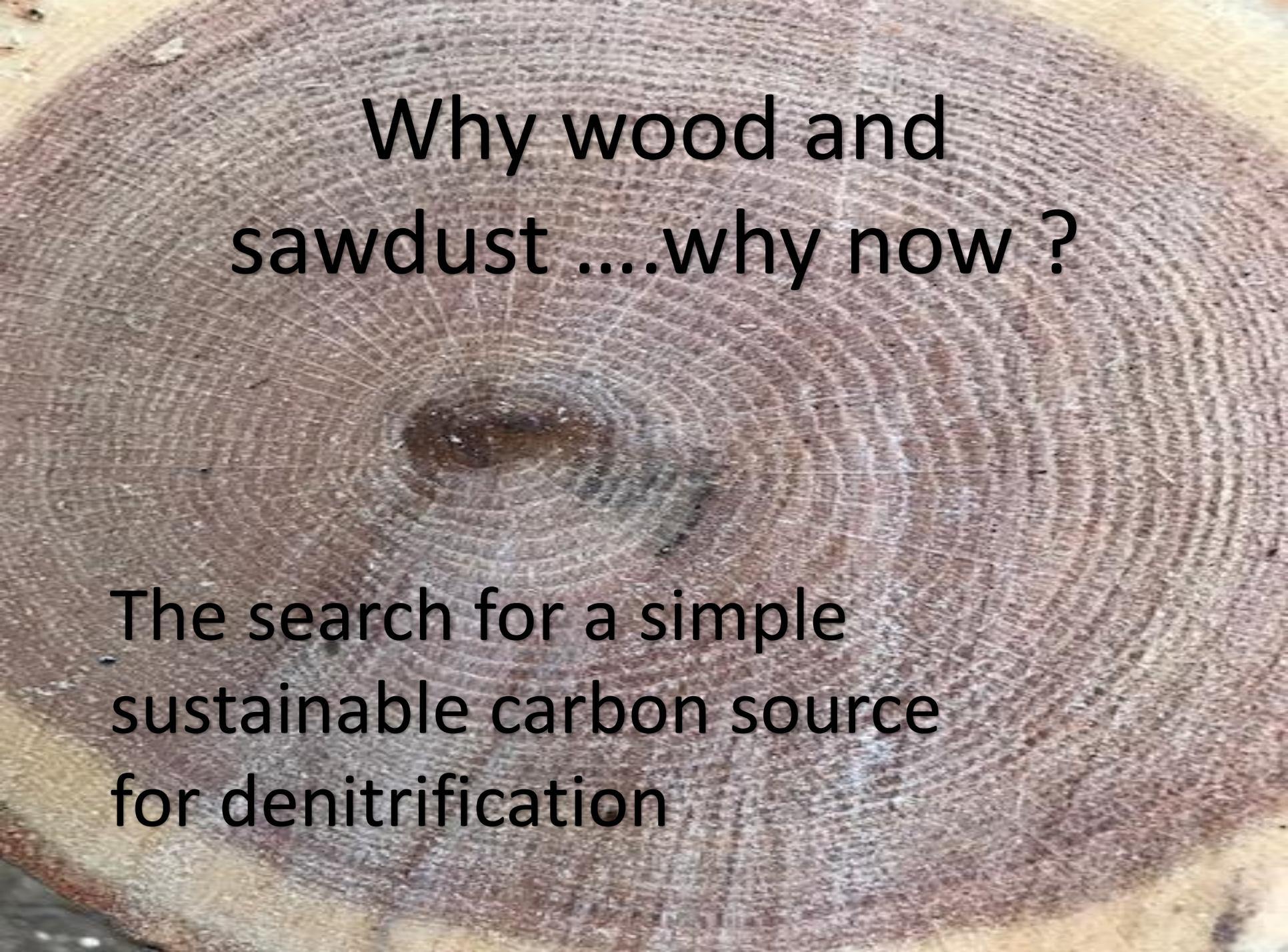
Cellulose > Glucose

6

C

Carbon
12.0107





Why wood and sawdust ...why now ?

The search for a simple
sustainable carbon source
for denitrification

This is not new !

NITREX™

Permeable Reactive Barriers (PRB)

1995

Woodchip barriers widely used in agricultural settings

Denitrification Activity, Wood Loss, and N₂O Emissions over 9 Years from a Wood Chip Bioreactor

Long-Term Performance of In Situ Reactive Barriers for Nitrate Remediation

by W.D. Robertson^a, D.W. Blowes^b, C.J. Ptacek^b, and J.A. Cherry^a

Comparing Carbon Substrates for Denitrification of Subsurface Drainage Water

Article in Journal of Environmental Quality - May 2006

Journal of Environmental Quality

SPECIAL SECTION

MOVING DENITRIFYING BIOREACTORS BEYOND PROOF OF CONCEPT

Temperature and Substrate Control Woodchip Bioreactor Performance in Reducing Tile Nitrate Loads in East-Central Illinois

Mark B. David,* Lowell E. Gentry, Richard A. Cooke, and Stephanie M. Herbrtritt

Integrate the use of wood into septic system design that is...



- Simple
- Inexpensive
- Sustainable
- Constructible
- Permittable
- Oh yeah.....works



Design 1

- Easiest to install
- Overall 75%+ removal
- Uncertain media life



Design 2

- Liner required
- Overall 75%+ removal
- Final disposal required
- More certain media life



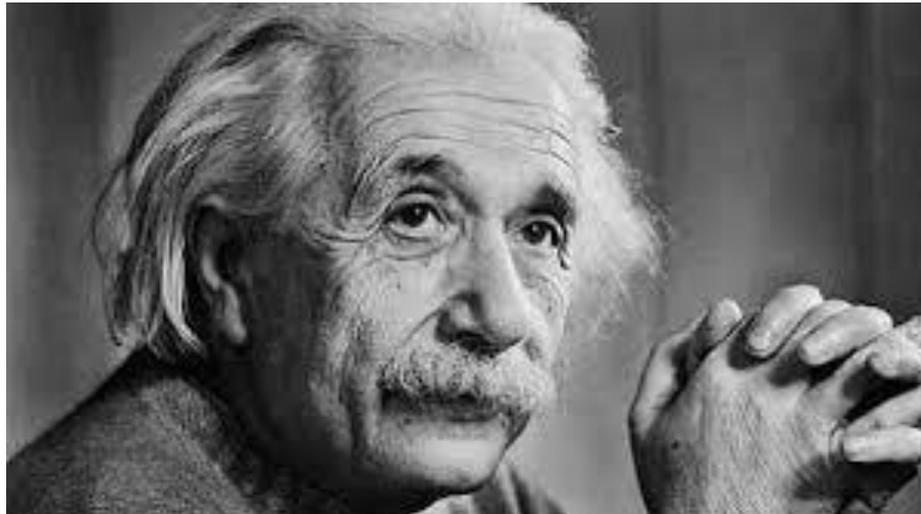
Design 3

- Overall 85-90% removal
- Final disposal required
- More certain media life
- Easy access for media replacement

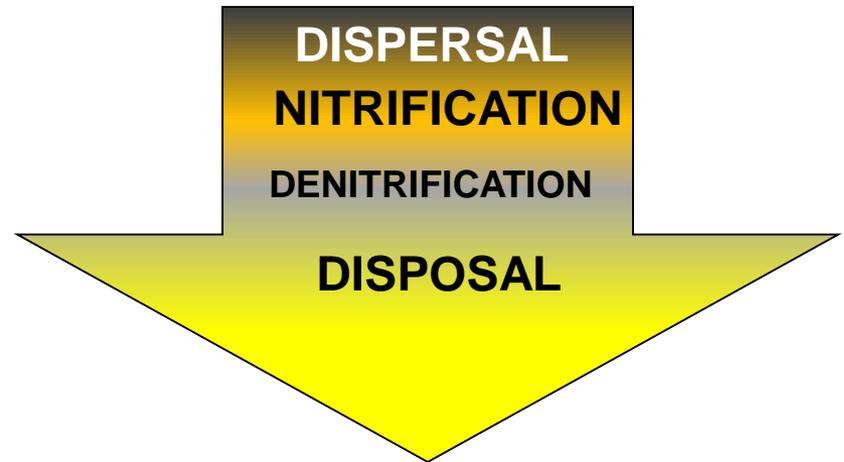


Guiding principle for present efforts

“Everything should be made as simple as possible, but not simpler”

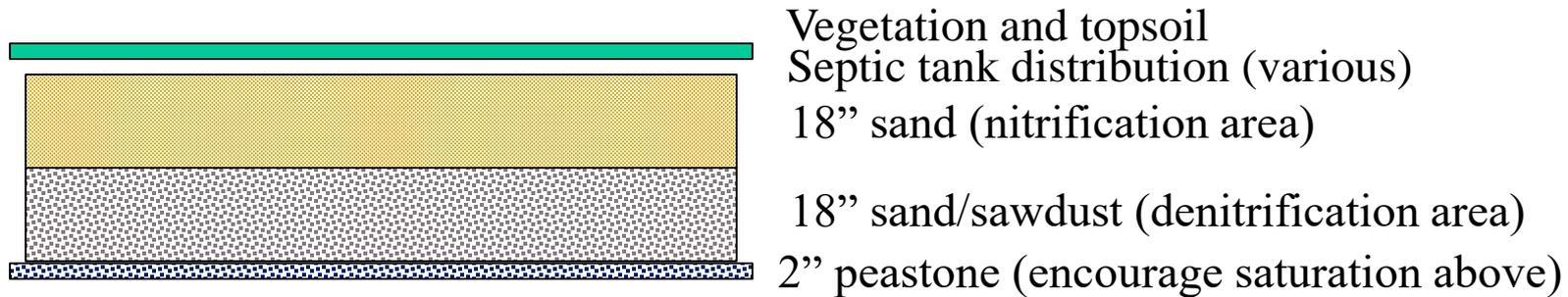


keeping it Simple

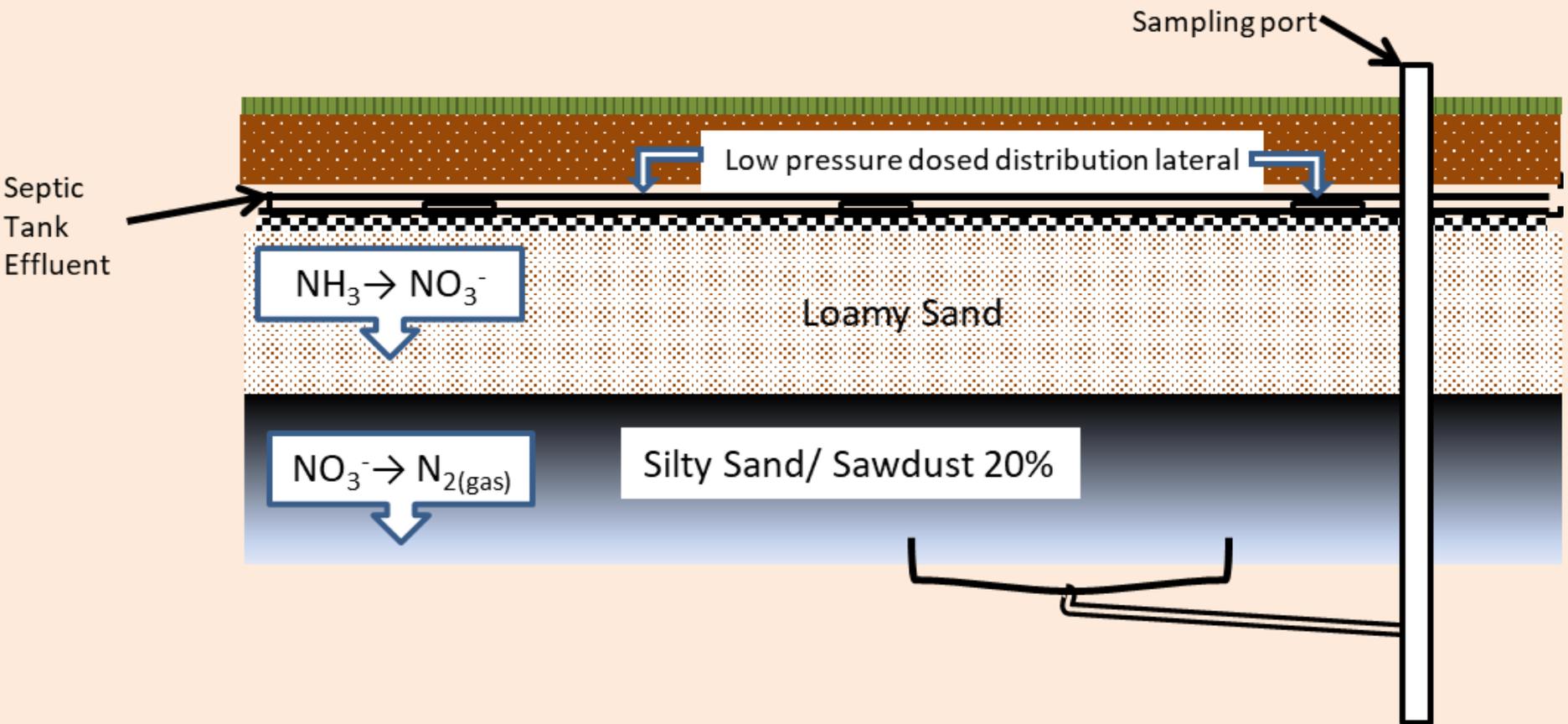


Layered System (aka. “layer cake”, “pancake system”, “that system the guys from Barnstable County plays with”).

- A soil absorption system in which a layer of sandy material mixed with sawdust, mulch or woodchips is positioned beneath a layer of clean fill sand for the purpose of achieving denitrification of percolating septic tank effluent.



Simple layered system (no liner)



Full-scale layered system



Sawdust sand-silt
mix

**Place denitrification layer
material (sawdust-sand-silt
mix)**

Design 1

Simple layered system (no liner)



“Marry” denitrification layer material to nitrification material layer

Design 1

Simple layered system (no liner)



Design 1

Simple layered system (no liner)

Field area
levelled and
made ready for
distribution
piping

Low-pressure
distribution
piping placed



Design 1

Simple layered system (no liner)



Final grade over soil treatment area

Grass planted over soil treatment area



Design 1

Simple layered system (no liner)



Grass over soil treatment area – Season 2

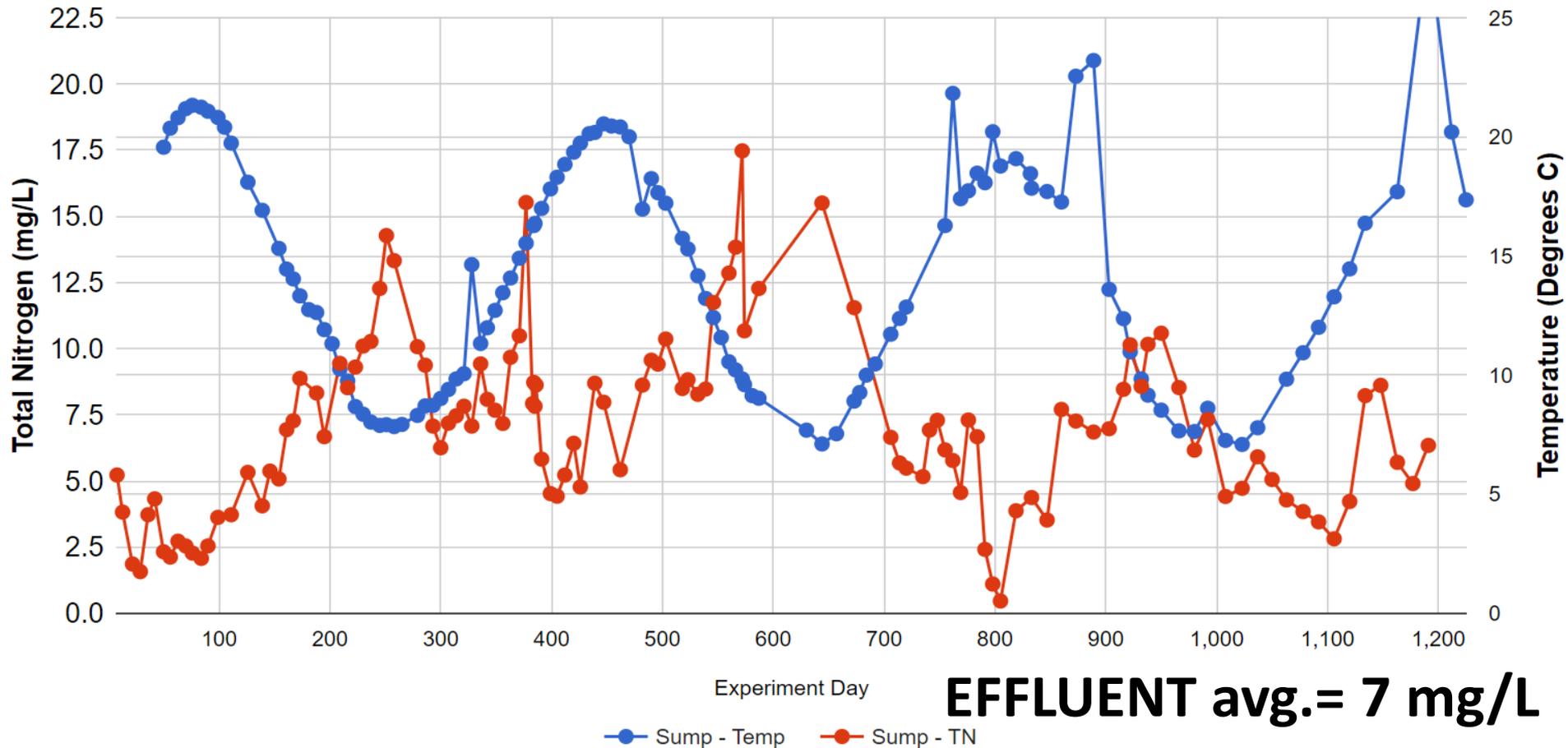
Brief Summary

Studies at

MASSTC

Test Center System

INFLUENT avg.= 44 mg/L



EFFLUENT avg.= 7 mg/L

84% removal

PRESENT

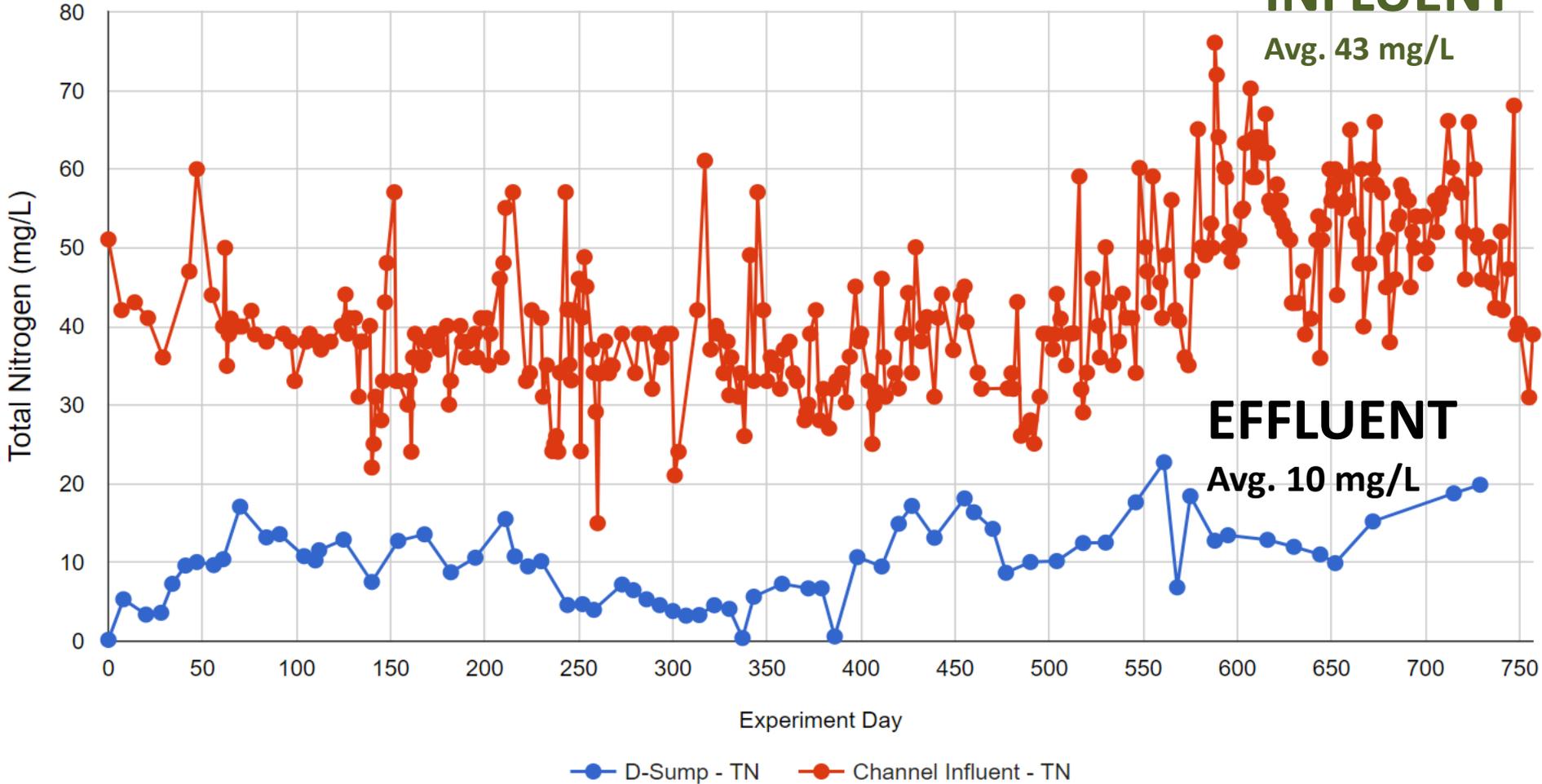
Simple layered system (no liner)

INFLUENT

Avg. 43 mg/L

EFFLUENT

Avg. 10 mg/L



77% removal

**What about
the
Real World ?**

vs. Test Center Studies



Configurations installed generally were installed with a control portion for comparison.

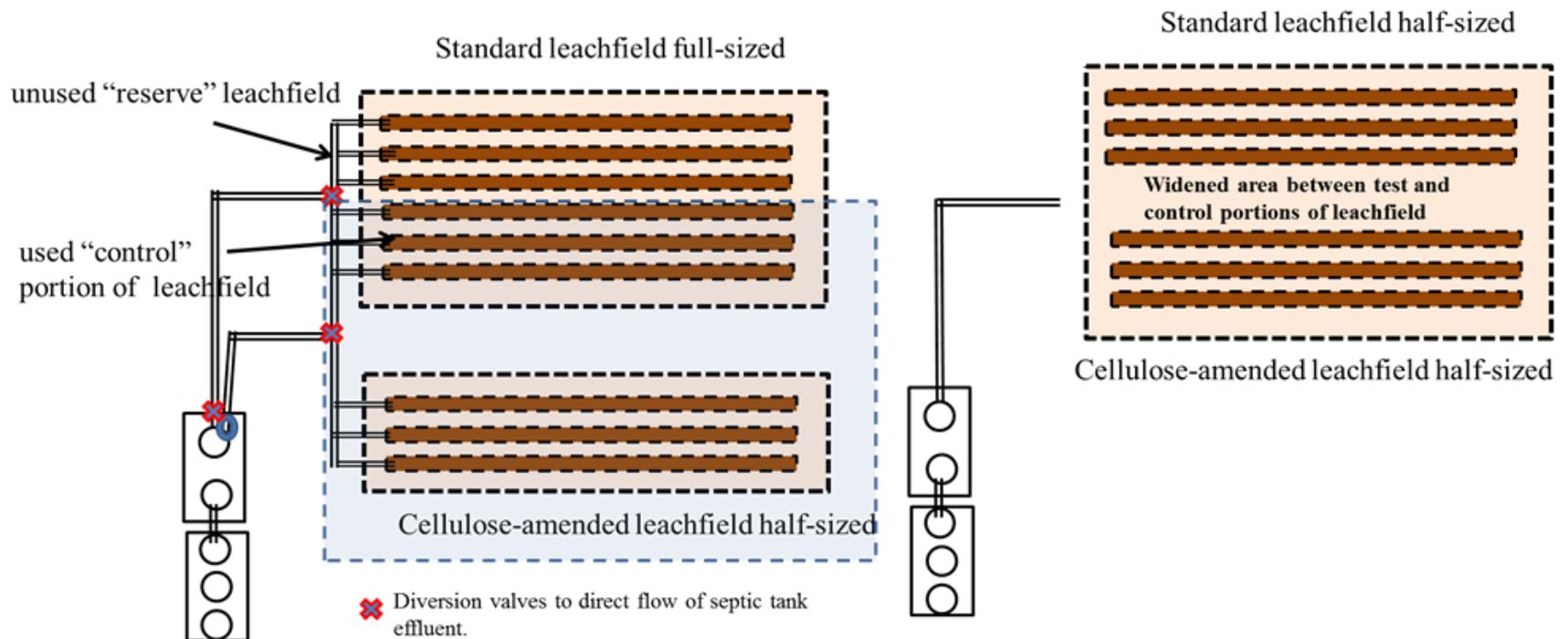
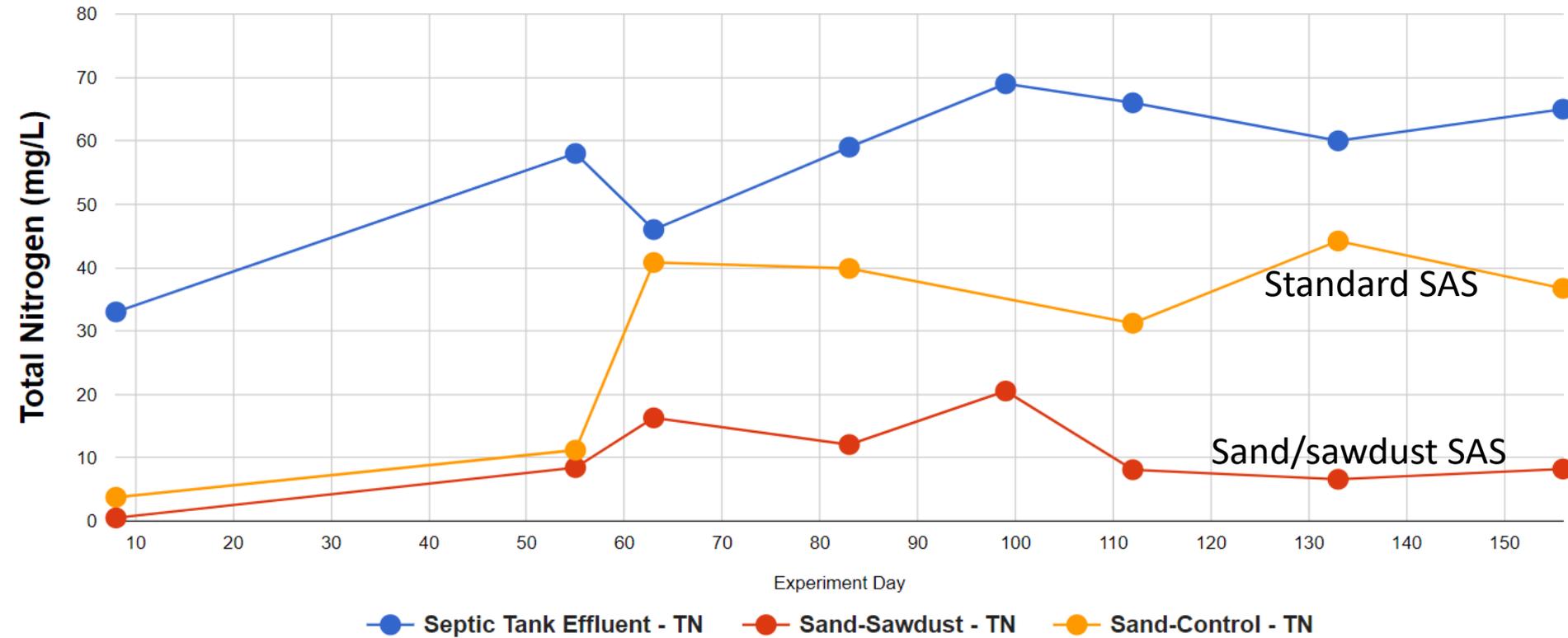


Figure A

Figure B

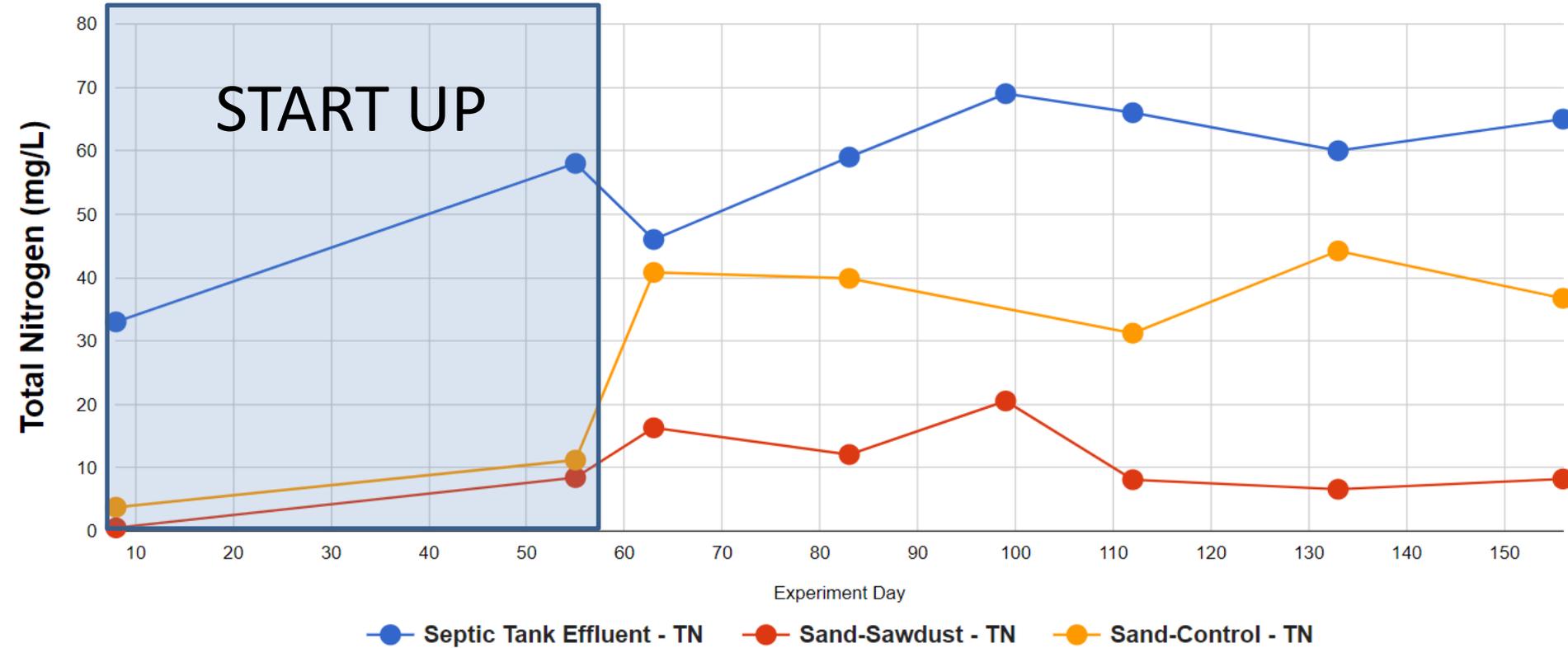
System 1

Acushnet Residential - 3 person year-round - 212 gal/day



System 1

Acushnet Residential - 3 person year-round - 212 gal/day

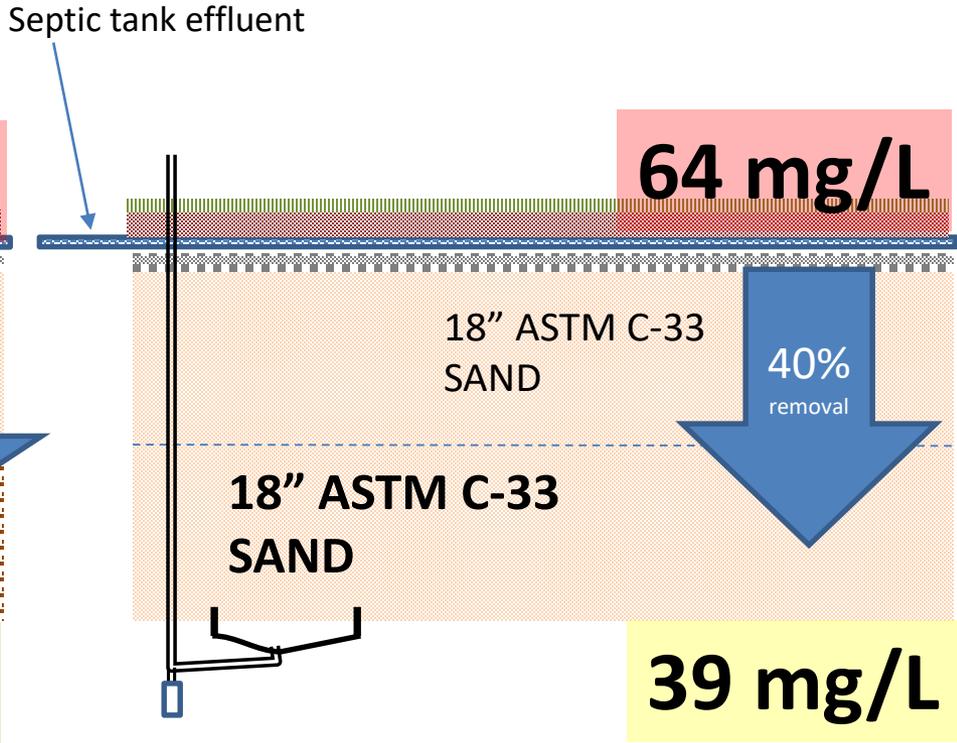
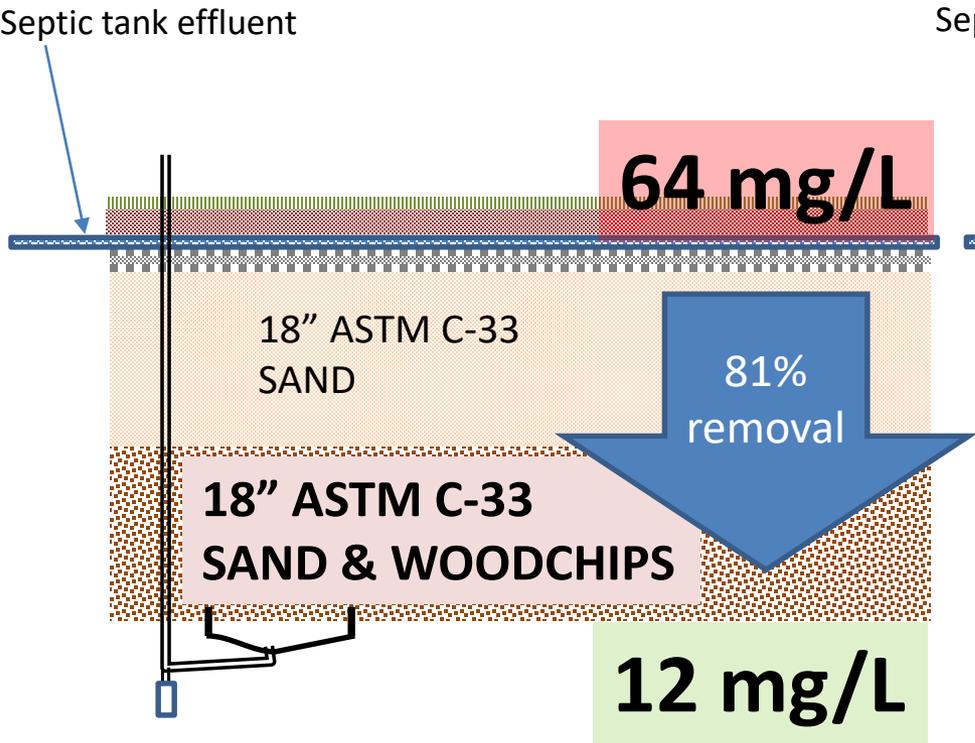


System 1

Acushnet Residence

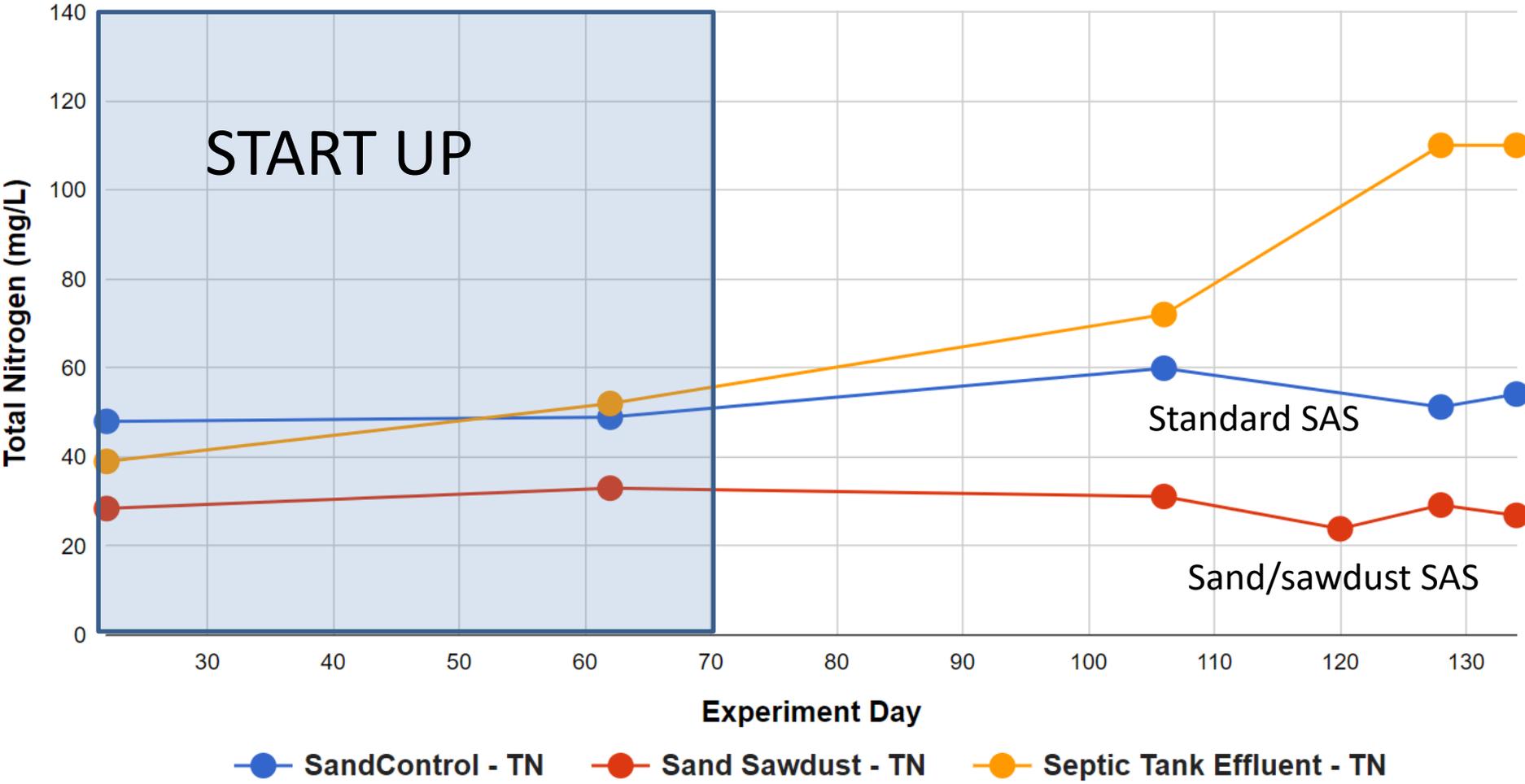
Treated Portion of Soil Absorption System

Un-Treated (Control) Portion of Soil Absorption System



System 2

Residence - Woods Hole 1-3 residents

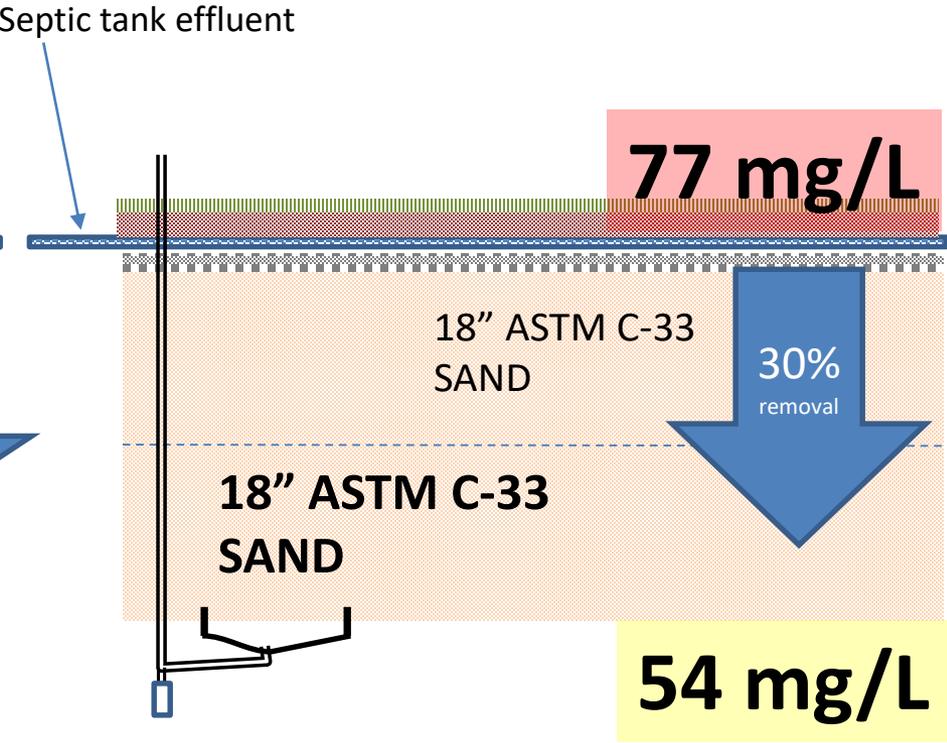
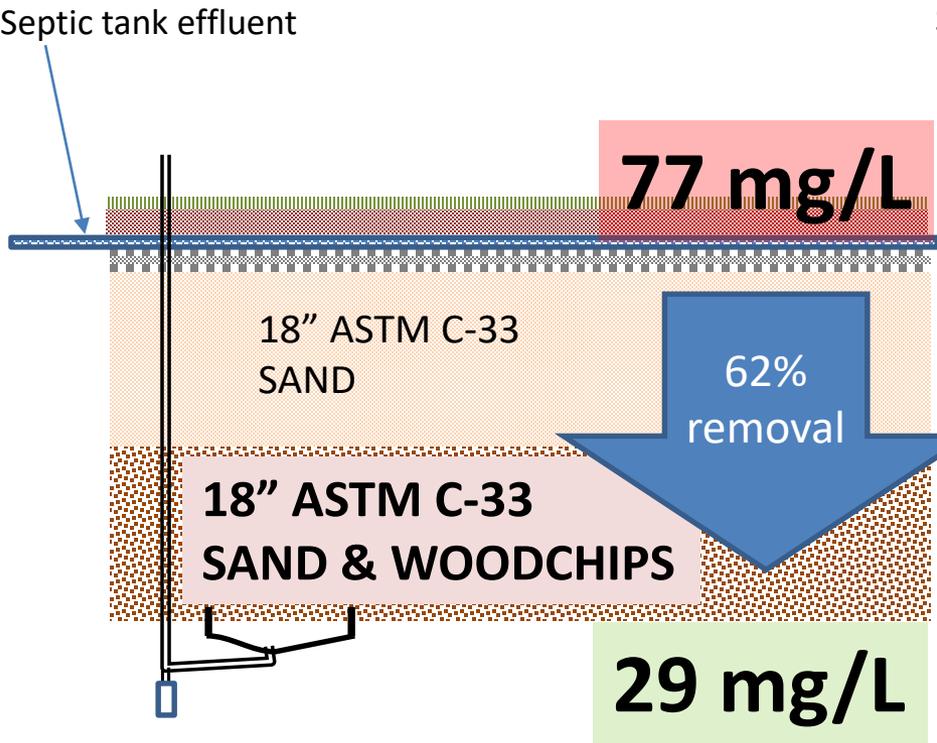


System 2

Woods Hole Residence

Treated Portion of Soil Absorption System

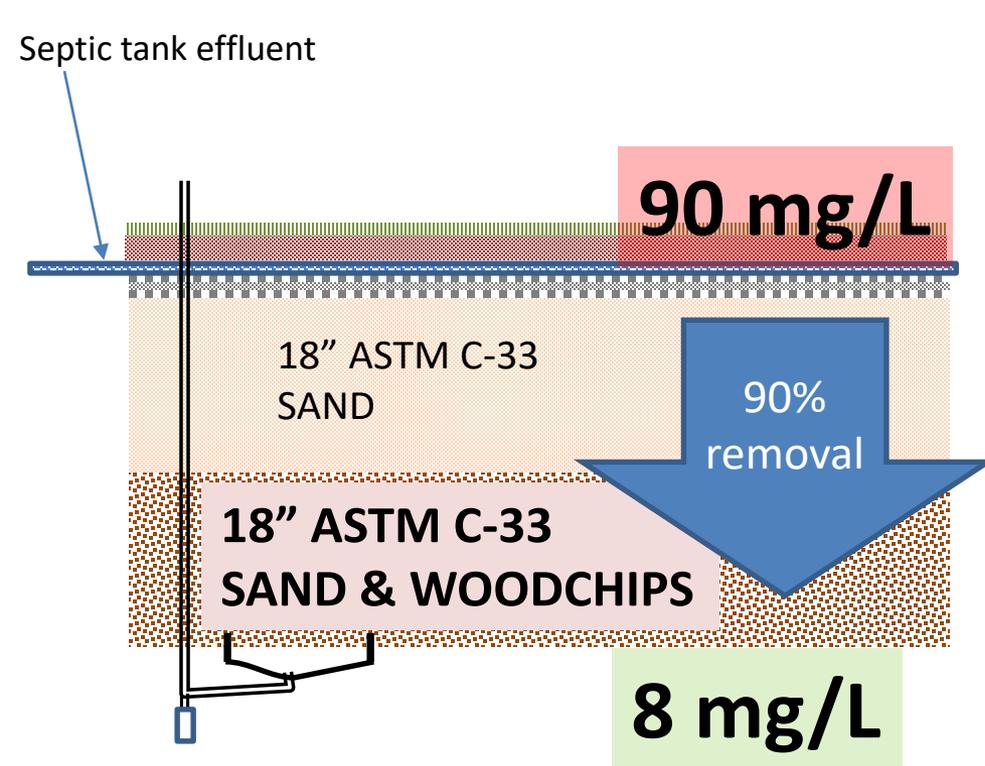
Un-Treated (Control) Portion of Soil Absorption System



System 3

West Falmouth Harbor (seasonal)

Treated Portion of Soil Absorption System



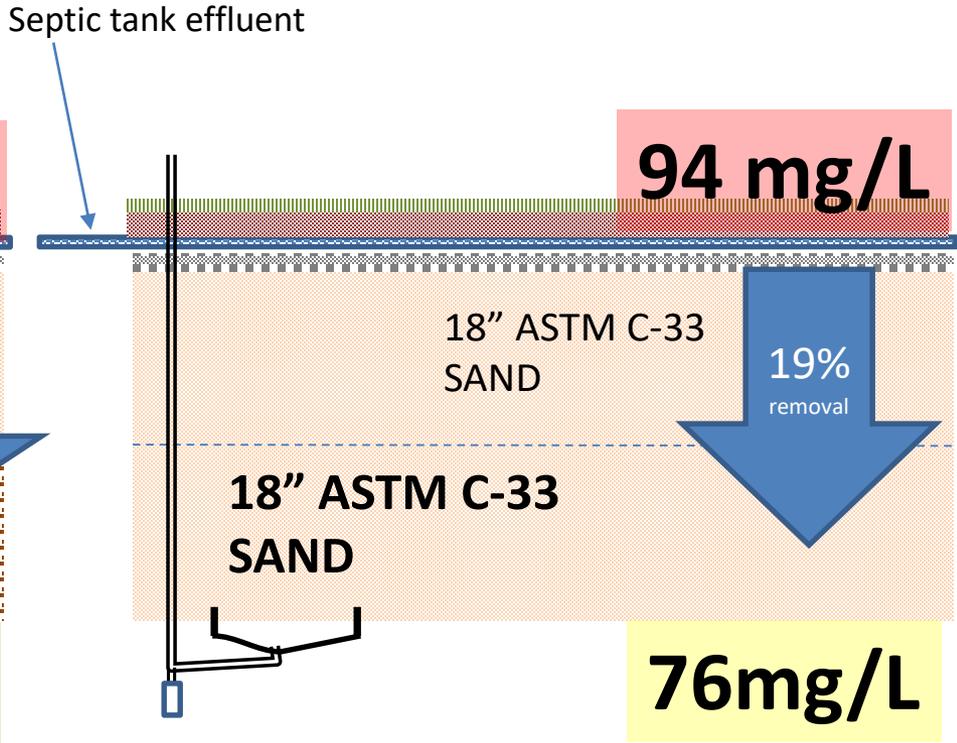
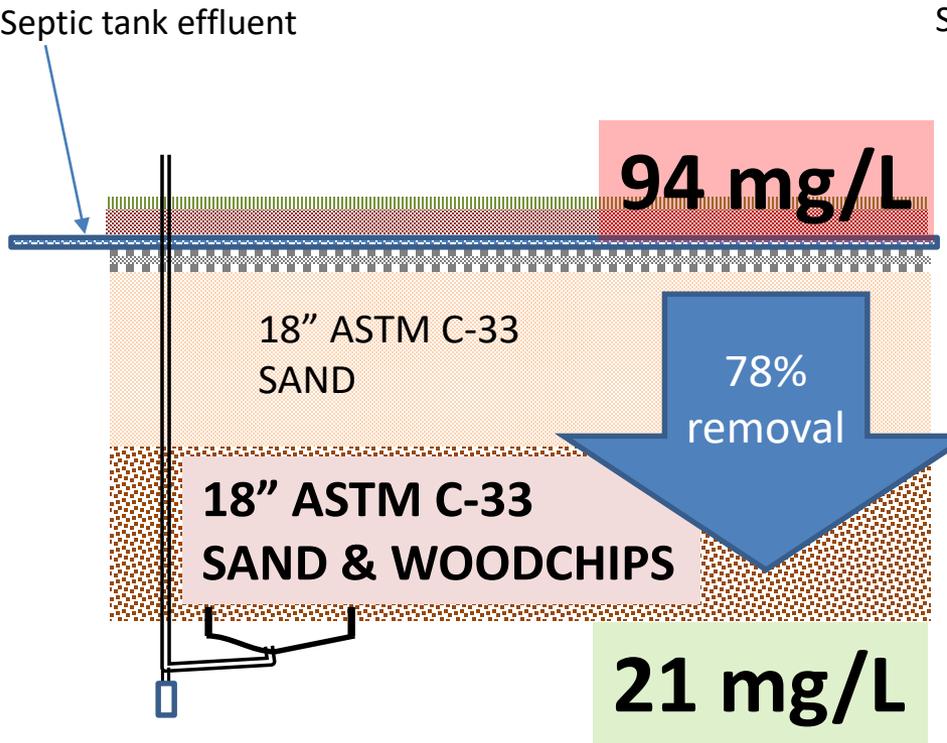
Un-Treated (Control) Portion of Soil Absorption System not installed at this location

System 4

West Falmouth Harbor (seasonal)

Treated Portion of Soil Absorption System

Un-Treated (Control) Portion of Soil Absorption System



The Connecticut Experiment

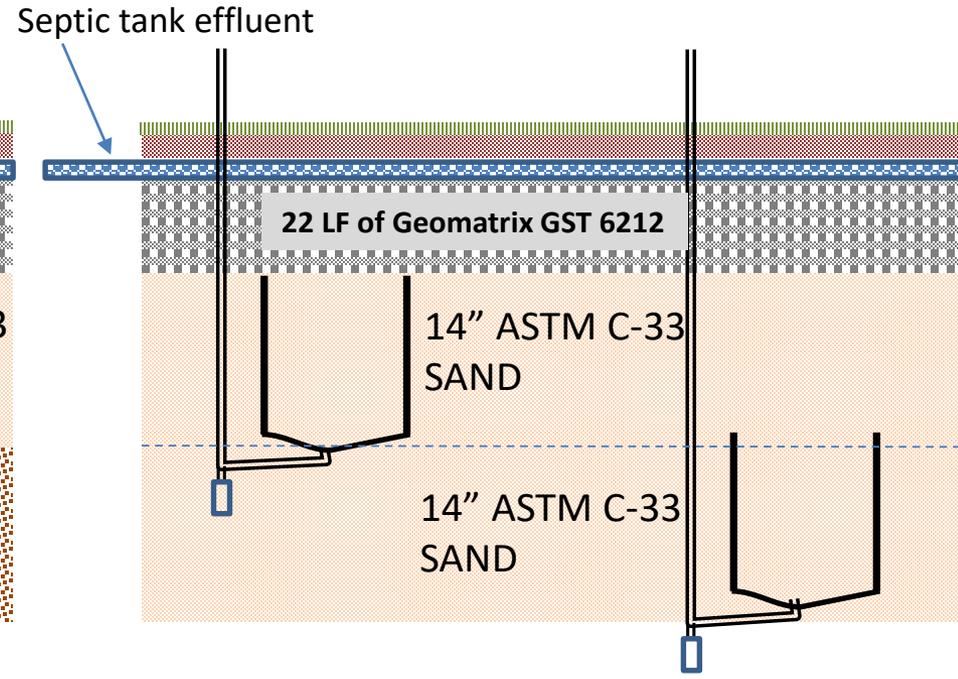
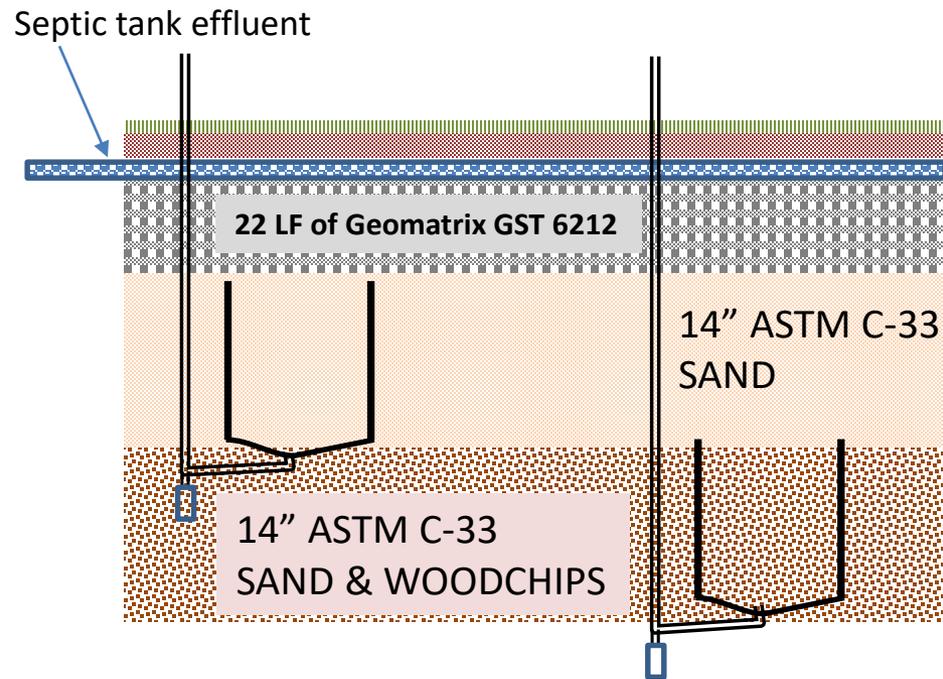


- DPW Garage
- Expected high nitrogen concentration
- Close to seasonal high groundwater

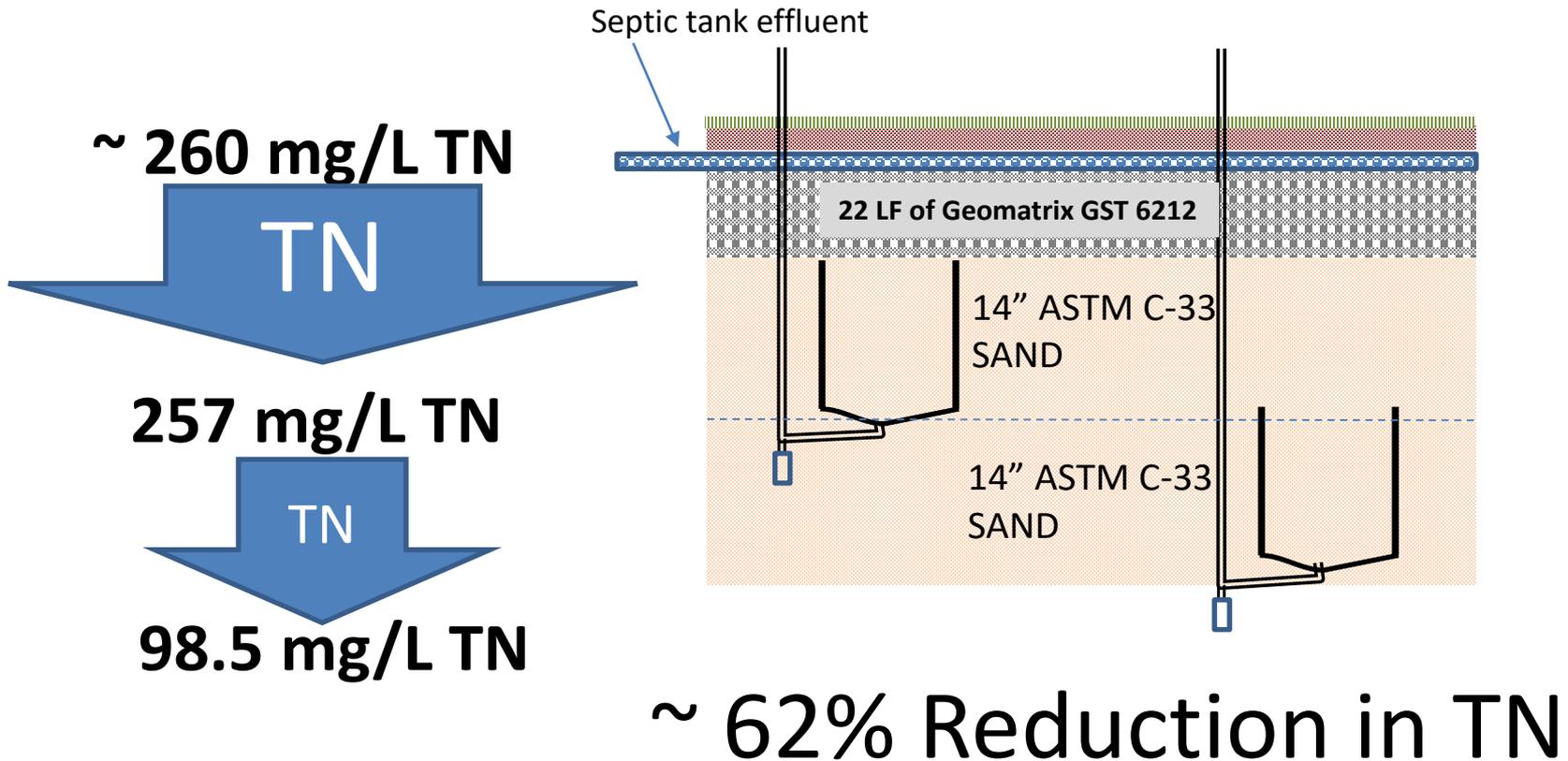
Town DPW Garage

Treated Portion of Soil Absorption System

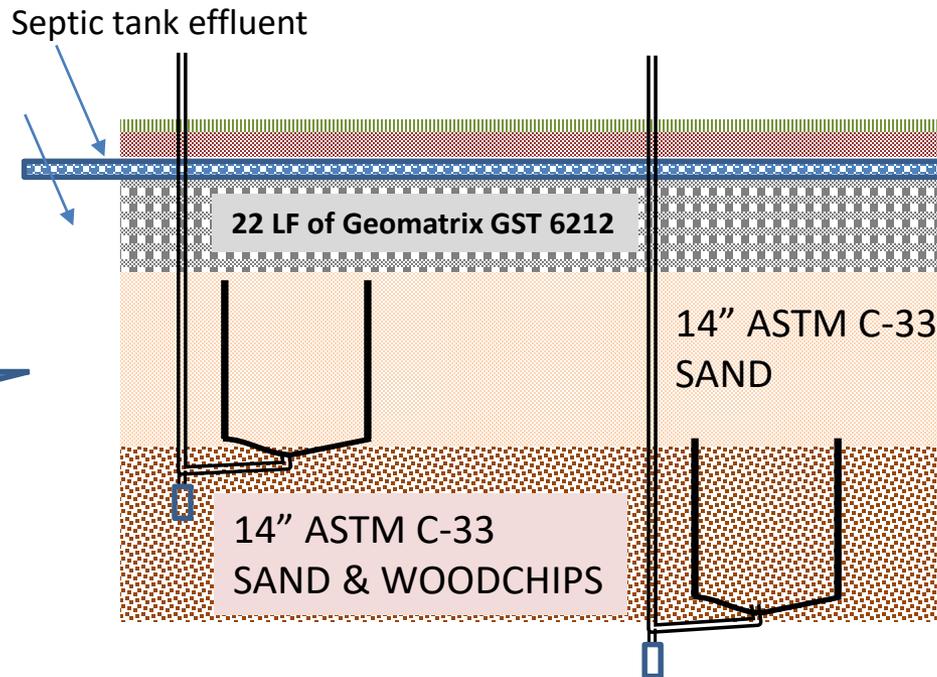
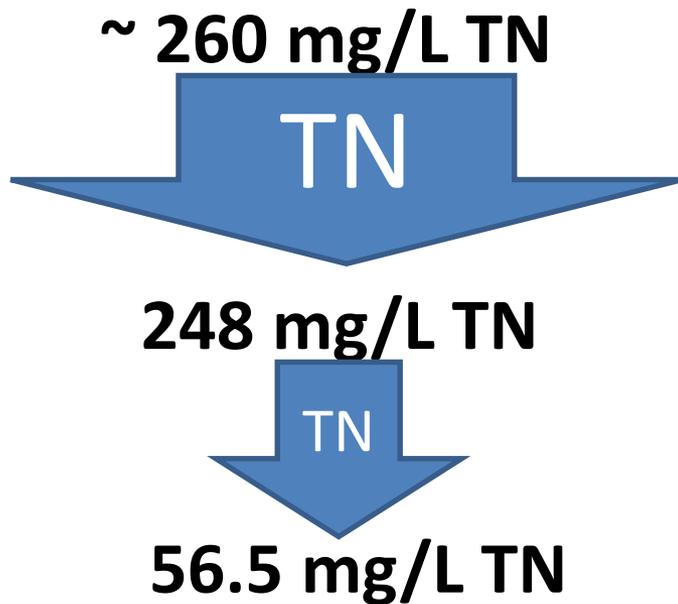
Un-Treated (Control) Portion of Soil Absorption System



Un-Treated (Control) Portion of Soil Absorption System

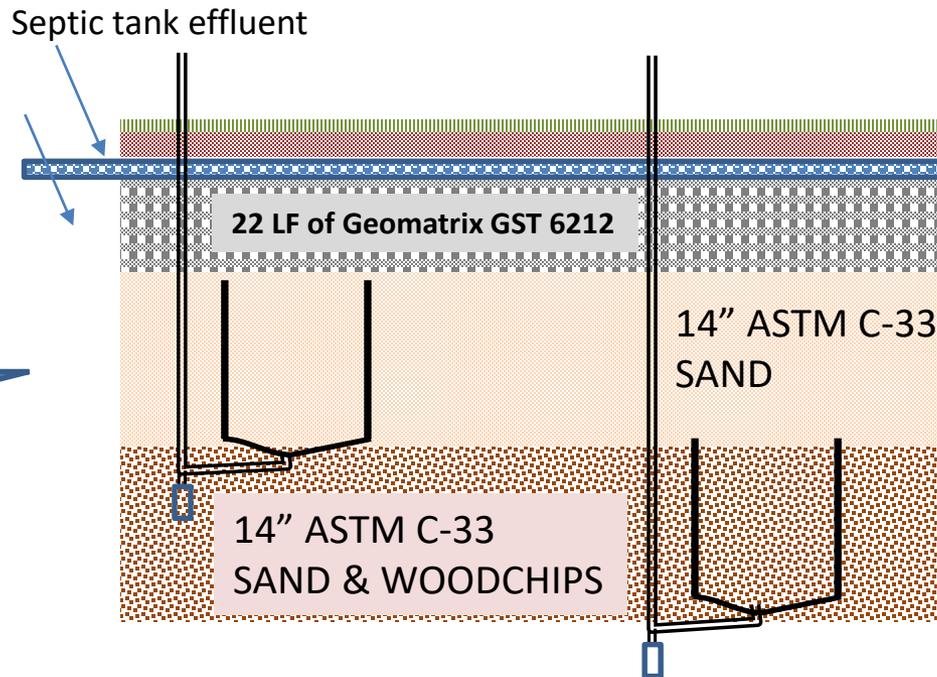
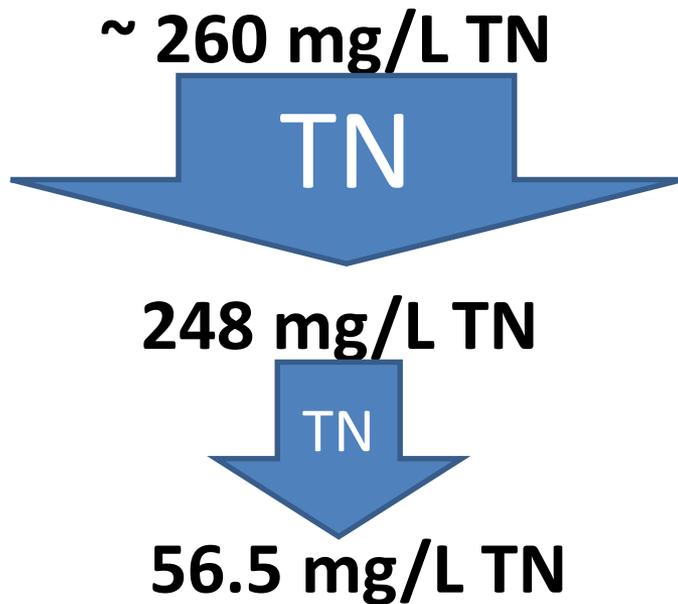


Treated Portion of Soil Absorption System

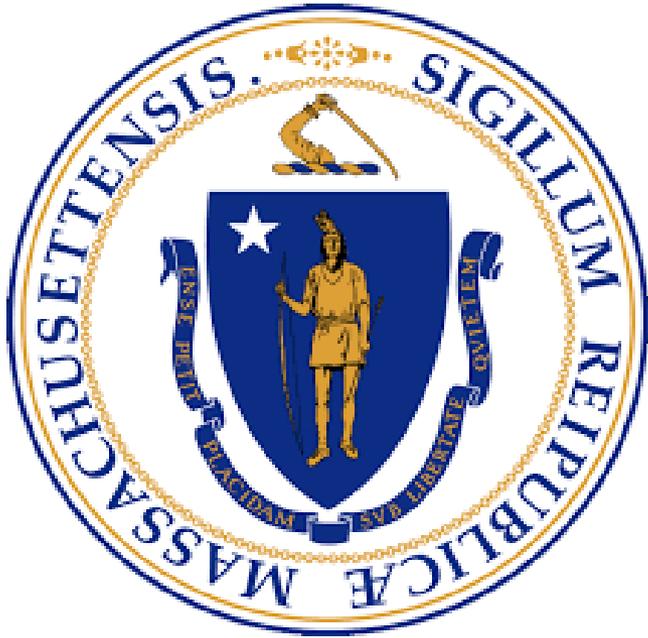


~ 78% Reduction in TN

Treated Portion of Soil Absorption System



~ 78% Reduction in TN



Systems with Site-Specific Pilot Approval



Under
Development



REMEMBER

Nitrex back in early 2000s

Many manufacturers are coming to realize the benefits of wood-based carbon sources and are integrating them into their products

New Company

Nitroe[®]

Wood-based
denitrification following
nitrification





**Layered System
(sand/sawdust layer)**



Conclusions

- Simple layering of an organic material like cellulose may offer a simple, sustainable and relatively inexpensive way to achieve nitrogen removal from onsite septic systems.
- Research in this area should continue to determine all the factors controlling the performance of the systems.

Remaining Questions

- Is it worth it \$\$\$\$?
- How long will the carbon last?
- What are all the possible negative impacts?
- Do they outweigh the positive impacts?

Some final thoughts

- Shallow drainfields used in these systems enhance removal of contaminants of emerging concern.
- Recent research suggests that wood-based denitrification may also reduce endocrine disrupting compounds.

Ligninolytic enzymes: Versatile biocatalysts for the elimination of endocrine-disrupting chemicals in wastewater.

Ayodeji O. Falade Leonard V. Mabinya Anthony I. Okoh Uchechukwu U. Nwodo

First published: 17 October 2018 <https://doi.org/10.1002/mbo3.722>

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Acknowledgement of the Collaborative Effort

- Massachusetts Alternative Septic System Test Center
- Damann L. Anderson, P.E., a researcher of passive nitrogen removal systems for the State of Florida Onsite Sewage Nitrogen Reduction Study (FOSNRS);
- George Loomis, an onsite septic system specialist and published author from the University of Rhode Island;
- Dr. Will Robertson of the University of Waterloo;
- Jose Amador, a soil scientist at the University of Rhode Island;
- John Eliasson with the Wastewater Management Section of Washington State Department of Health's Division of Environmental Public Health
- More recently, researchers at Stony Brook University, NY

Questions?

