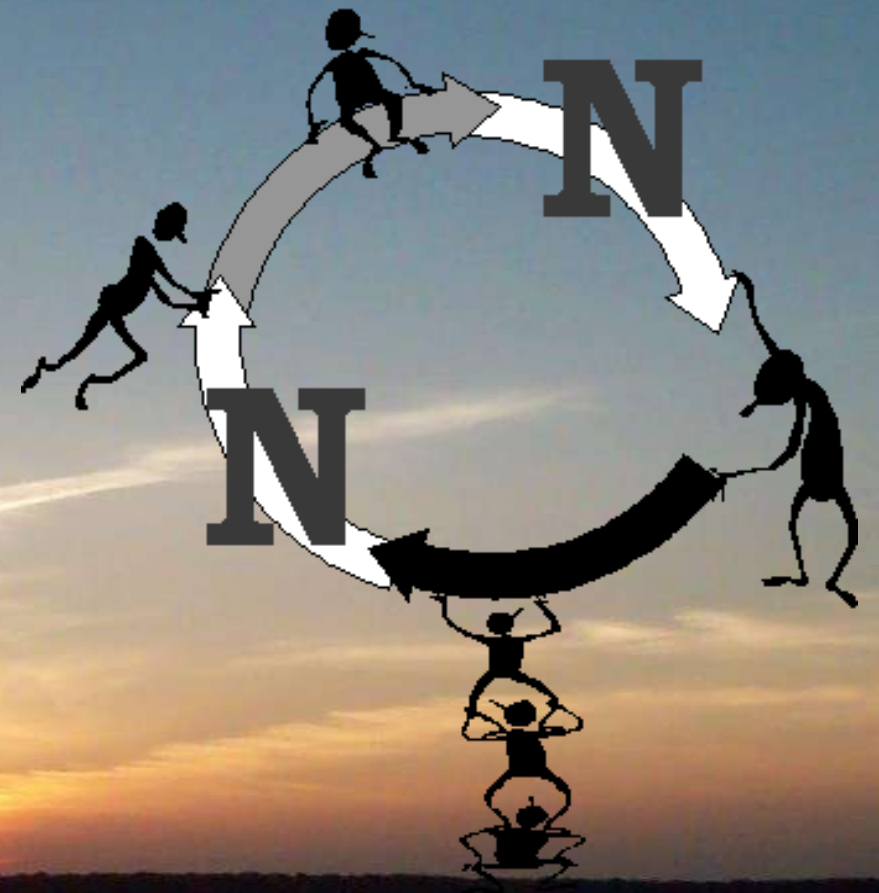


Nitrogen Treatment in onsite septic systems

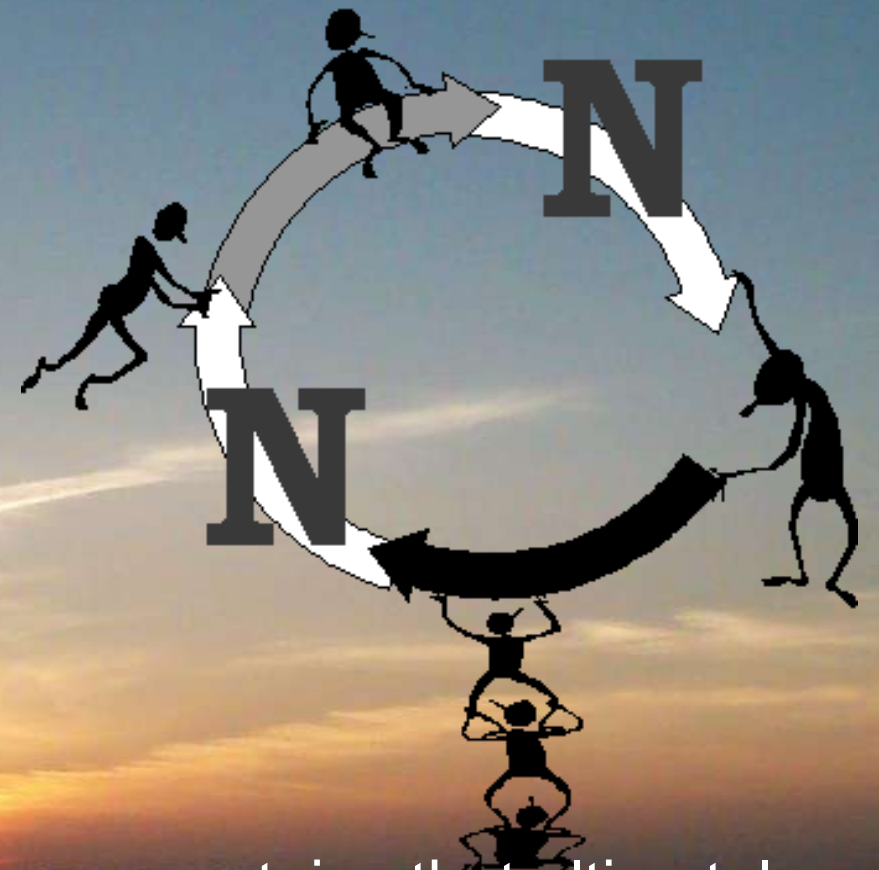
The Big Picture



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Barnstable County Department of Health and Environment
Massachusetts Alternative Septic System Test Center
gheufelder@barnstablecounty.org

Nitrogen Treatment in onsite septic systems

The Big Picture



WE are part of the nitrogen cycle. We take in nitrogenous proteins that ultimately came from organisms that fixed atmospheric nitrogen gas. We excrete what we don't need, primarily as urea, into our septic tanks. Bacteria in the septic tank anaerobically ammonify the nitrogen. Other bacteria aerobically nitrify the ammonia in the soil as wastes pass through the leachfield. If we introduce nitrified waste to the right anoxic setting, we can denitrify the wastewater or turn the nitrate into nitrogen gas. And the cycle continues.....

**Where does nitrogen fit in as a
difficulty for treatment?**



Challenges for onsite septic system treatment

?

Contaminants
of emerging concern

Nutrient
Phosphorus

Nutrient
Nitrogen

Pathogens
(bacteria and viruses)

Wastewater “Stabilization”
(removal of oxygen demand
oxidation of ammonia)

Dispose of volume



Challenges for onsite septic system treatment

?

Contaminants
of emerging concern

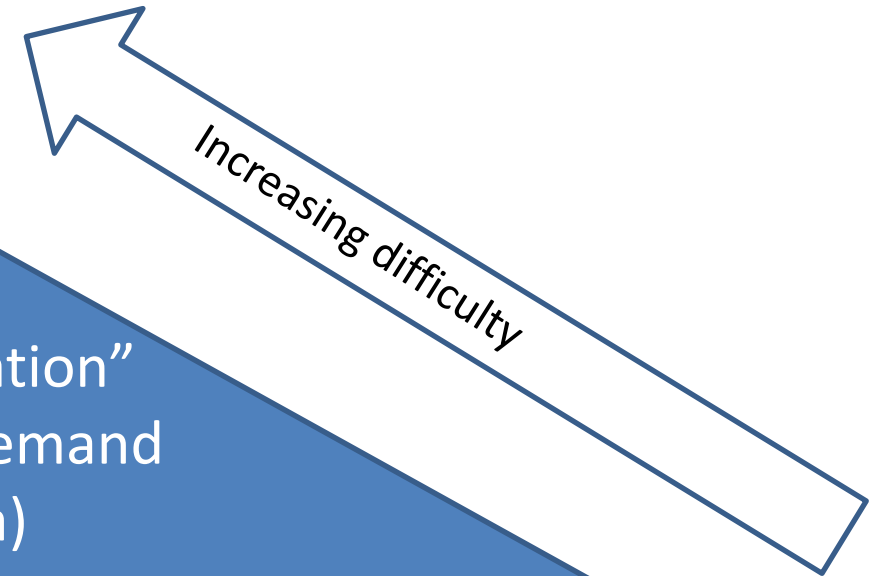
Nutrient
Phosphorus

Nutrient
Nitrogen

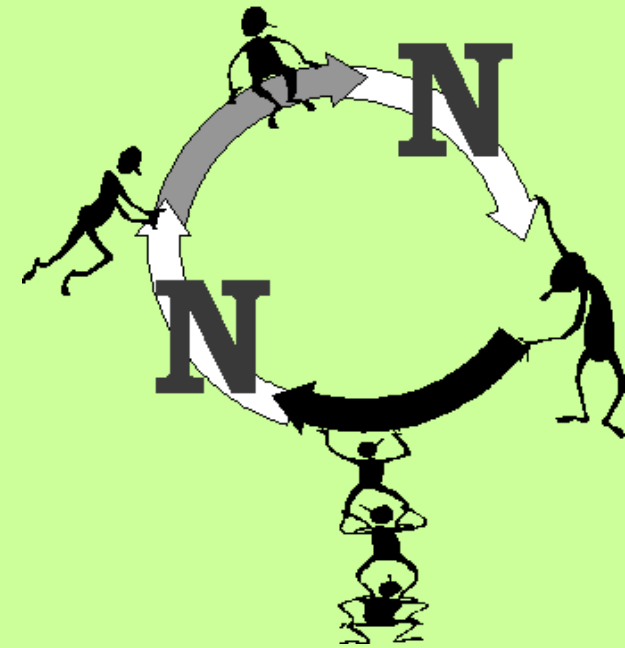
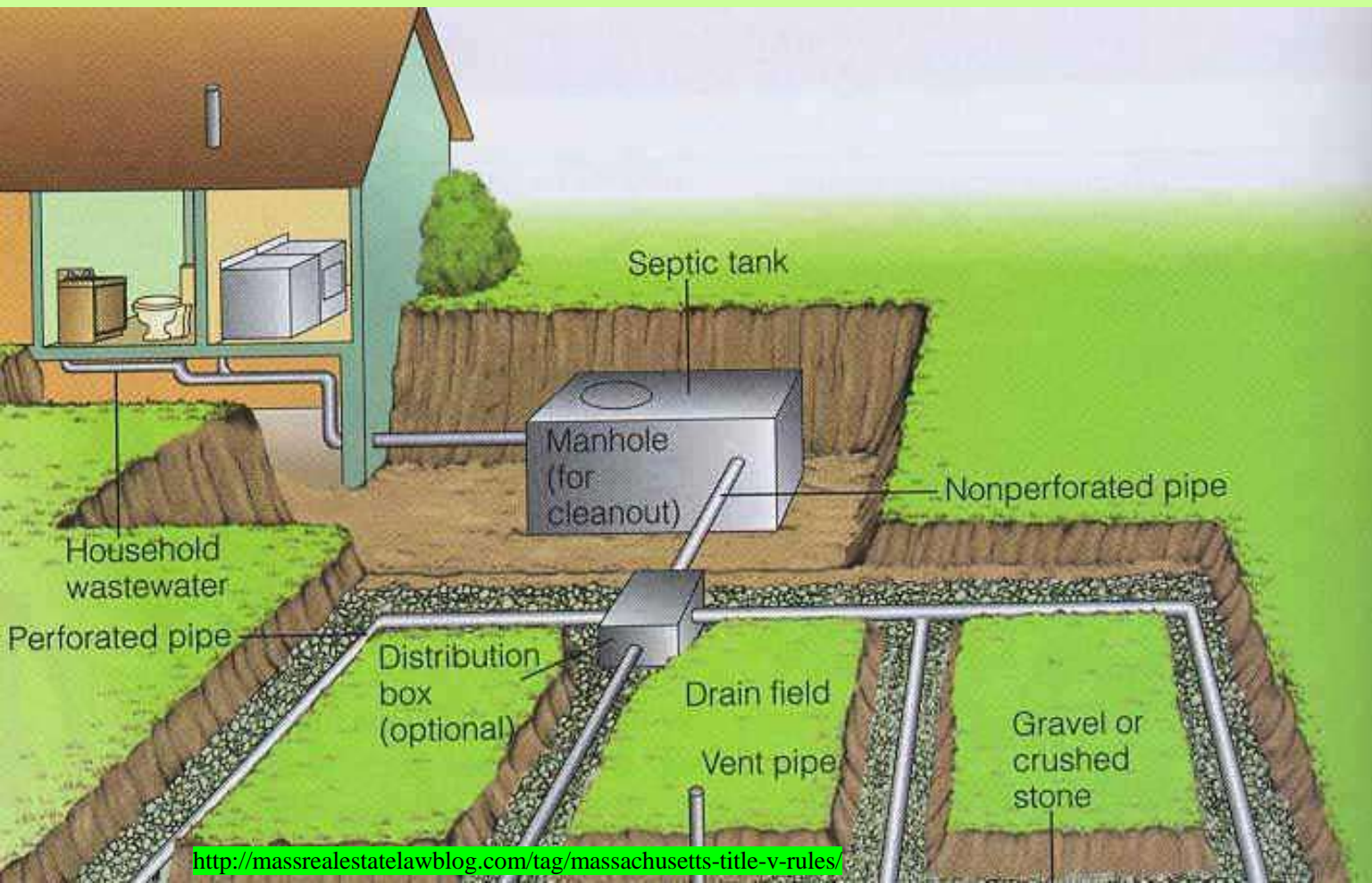
Pathogens
(bacteria and viruses)

Wastewater “Stabilization”
(removal of oxygen demand
oxidation of ammonia)

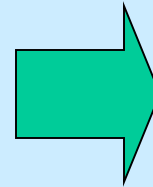
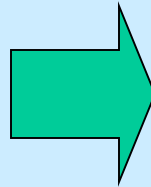
Dispose of volume



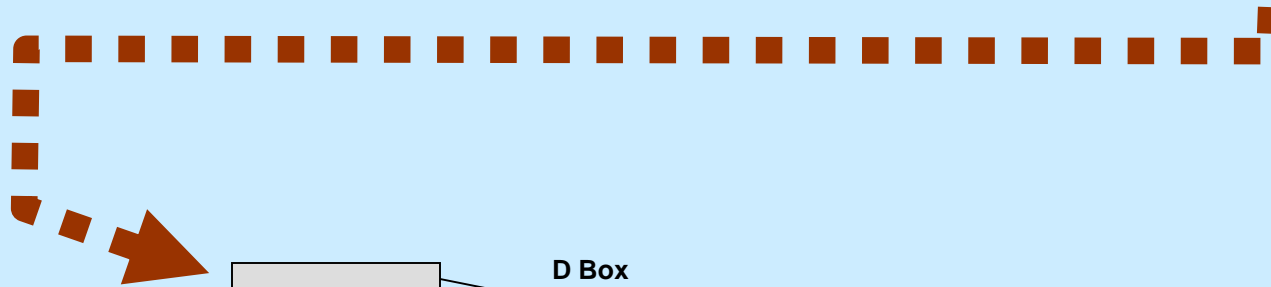
The standard “Title 5” Septic System – How much nitrogen is removed and how is it removed?



Complex Organic Compounds



Rearranged Complex Organic Compounds
+urea



SEPTIC TANK

D Box

SOIL ABSORPTION SYSTEM

Many Different Microbes

Organic N Broken
Down to Simpler
Compounds and
Ammonium



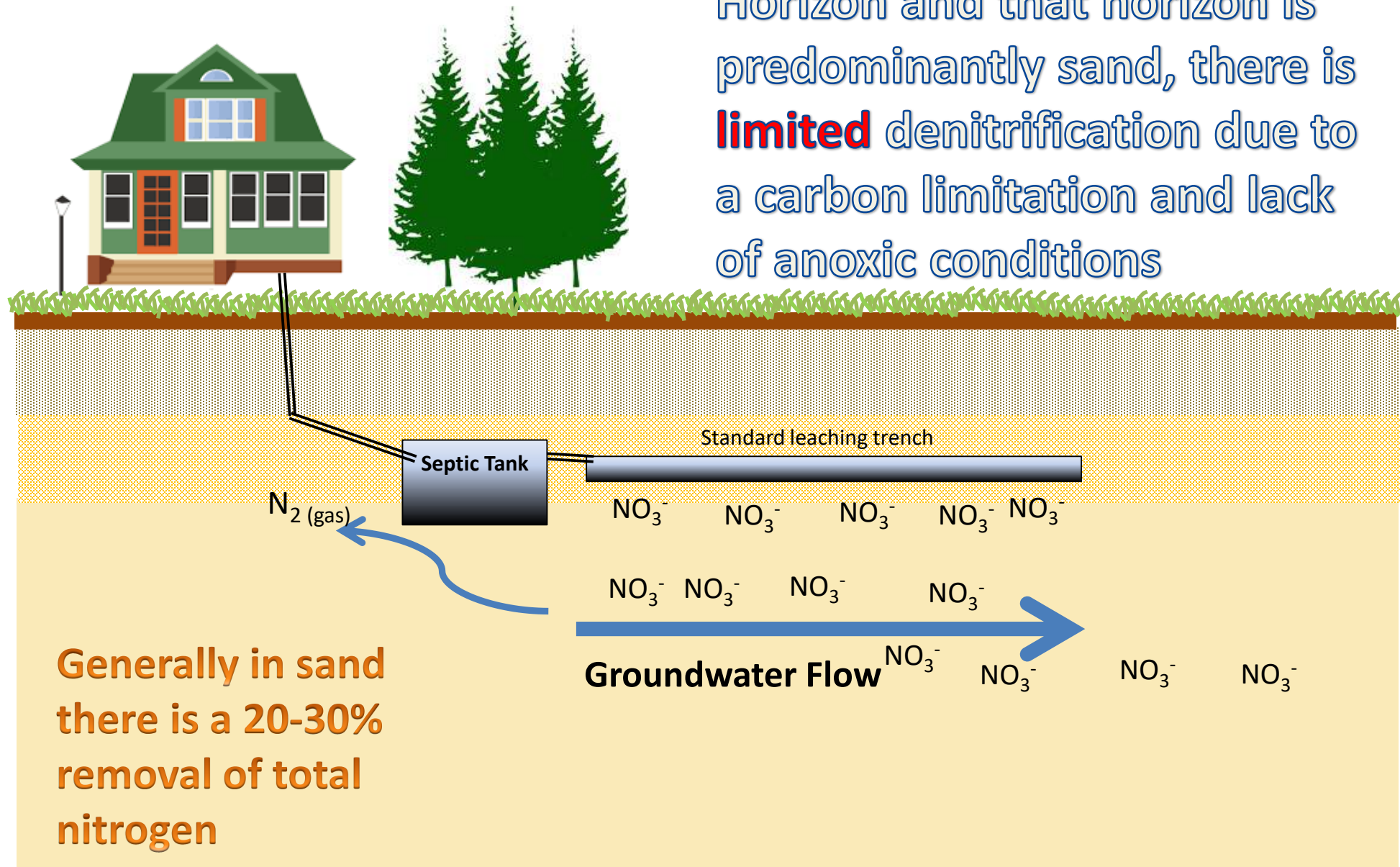
Some denitrification



Nitrosomonas

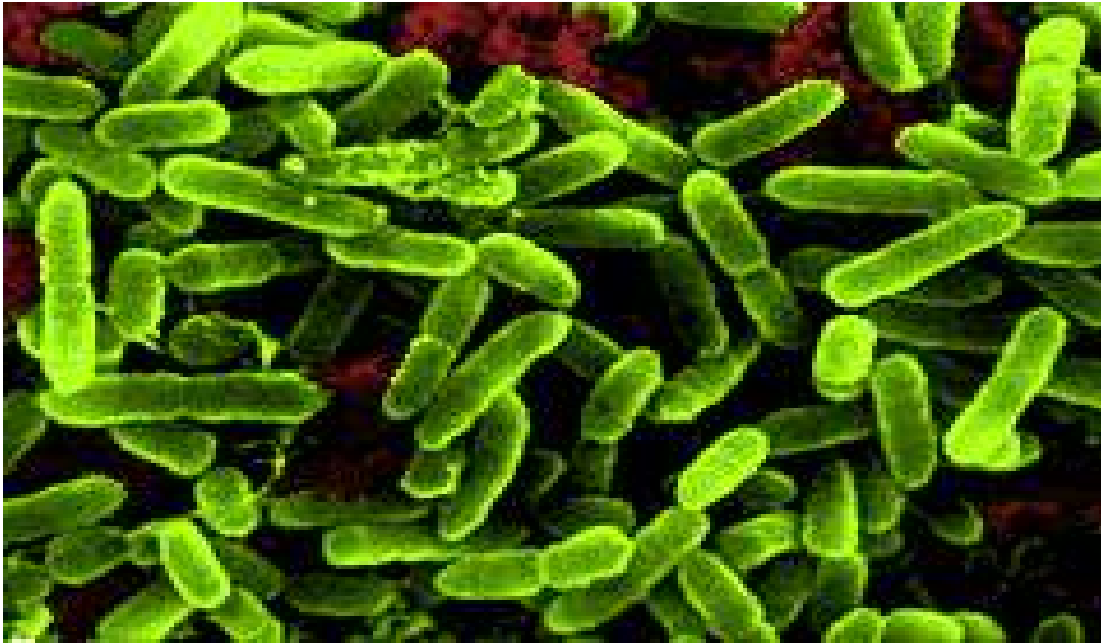
Nitrobacter

When a soil absorption system is placed in the C Horizon and that horizon is predominantly sand, there is **limited** denitrification due to a carbon limitation and lack of anoxic conditions



Important
Important
to
Remember!
Remember!

NITROGEN TRANSFORMATIONS IN WASTEWATER ARE MEDIATED PRIMARILY BY BACTERIA

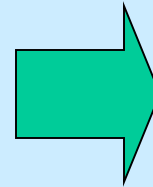
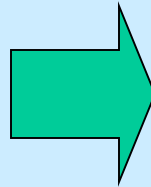


* Subject to a number of variables such as soil type, moisture, organic matter, temperature, hydraulic loading rate and what color clothes the contractor had on while he/she was installing the system.

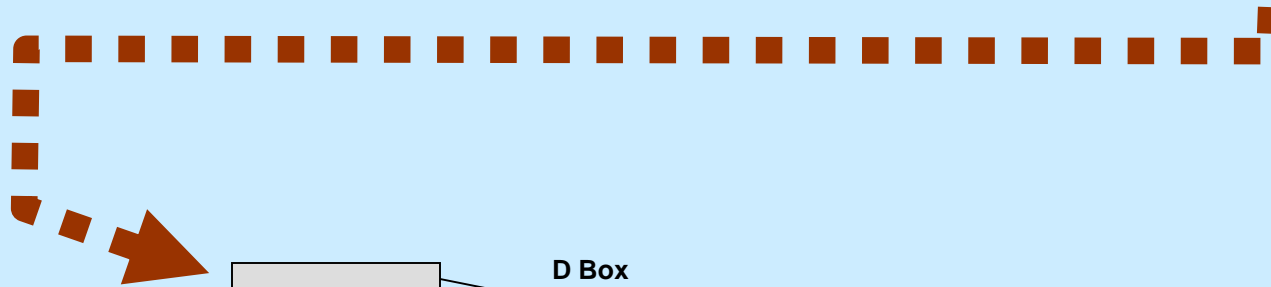
20 – 30 %*

The amount of influent organic nitrogen that is cycled back up to nitrogen gas as it passes through the standard septic system placed in sandy soil.

Complex Organic Compounds



Rearranged Complex Organic Compounds + urea

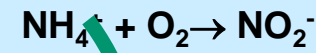


SEPTIC TANK

Many Different Microbes

D Box

SOIL ABSORPTION SYSTEM



Nitrosomonas



Nitrobacter

Some denitrification
 NO_2^- or $\text{NO}_3^- \rightarrow \text{N}_2$ gas

DENITRIFICATION

Organic N Broken Down to Simpler Compounds and Ammonium

Alternative Onsite Septic Systems

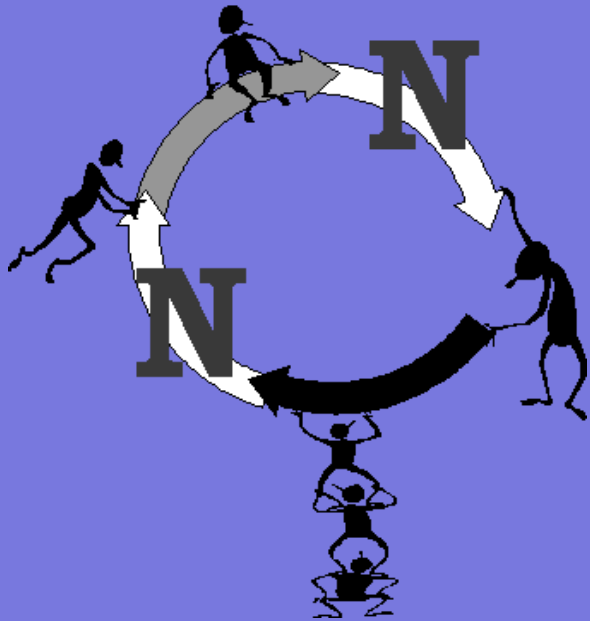
How much better can it get?



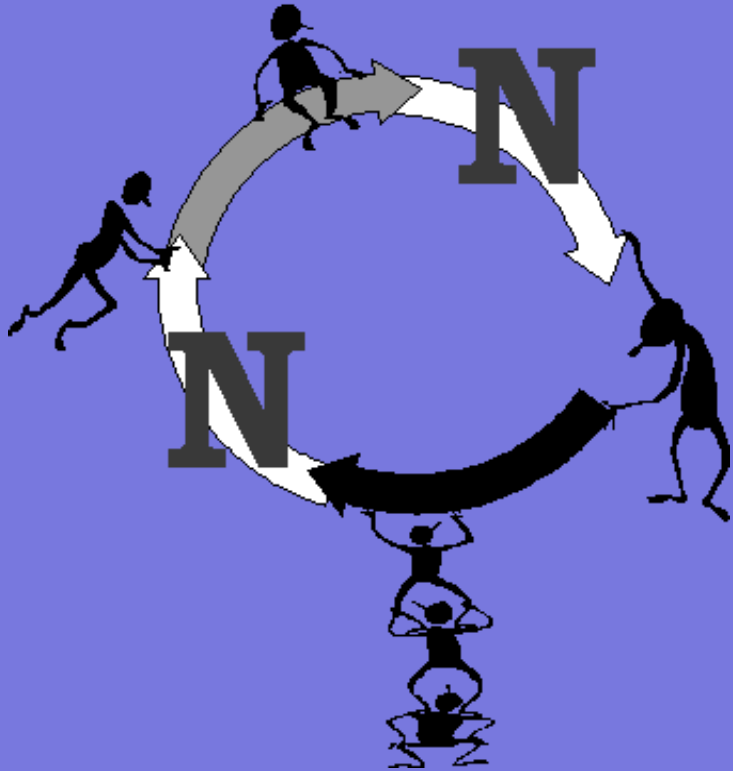
NOTICE

The mention of any product in the following slides does not constitute an endorsement and the omission of any product does not constitute an opinion as to their efficacy.

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



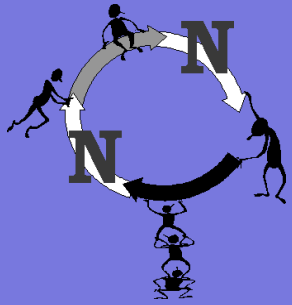
Manipulating the nitrogen cycle



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

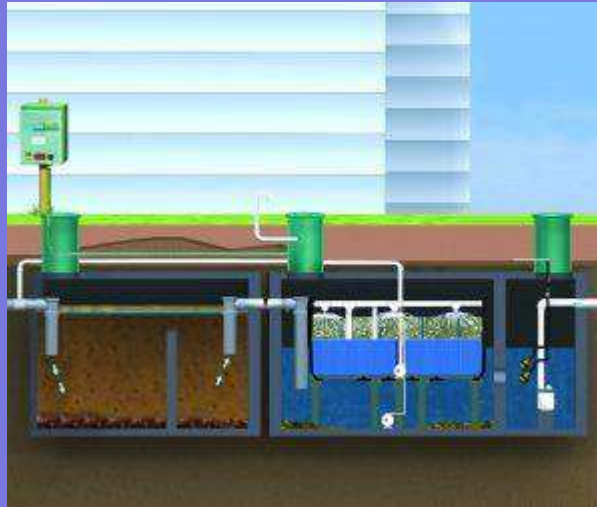
Types or broad classes of
alternative onsite septic
systems that remove
nitrogen. *to name a few...*

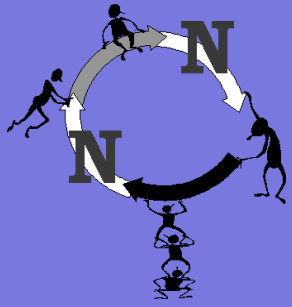
- **Trickling filters (various media)**
- **Mixed liquor systems with some fixed film growth**
- **Sequencing Batch Reactors**
- **Membrane bioreactors**
- **Woodchip Bioreactors**



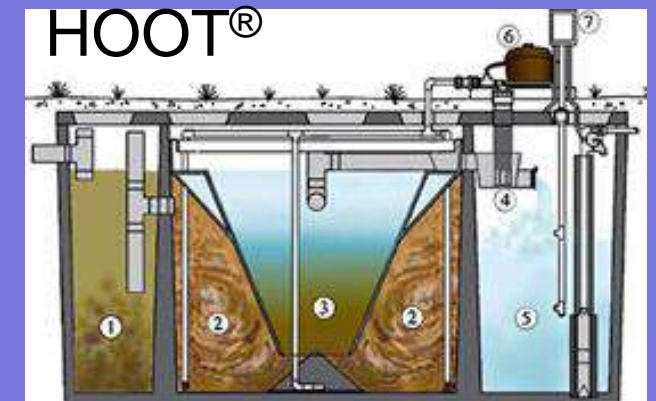
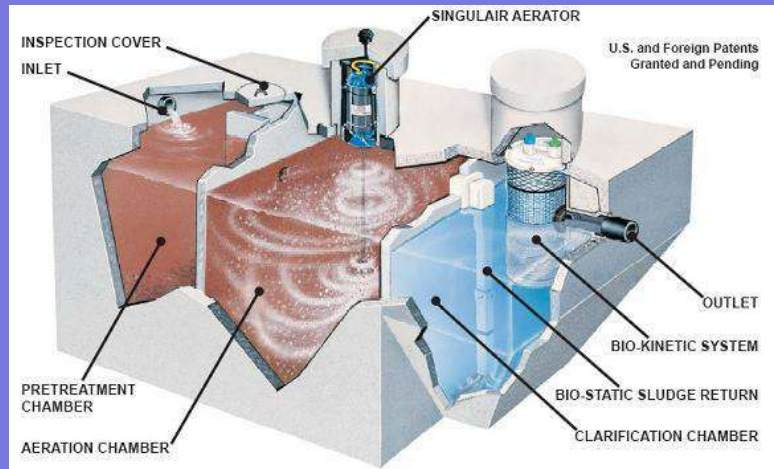
Media Filters

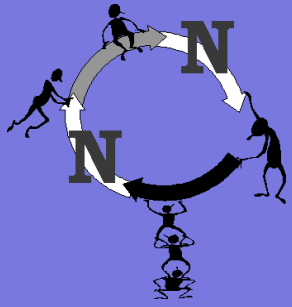
with recirculation





Mixed Liquor and fixed film some with recirculation

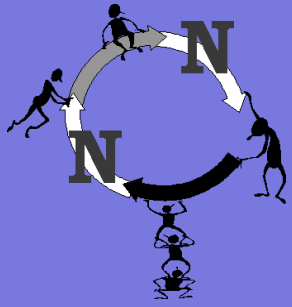




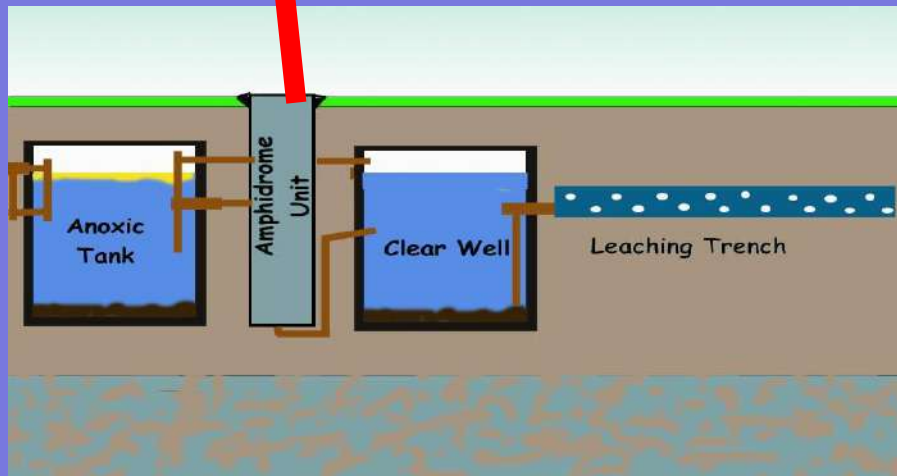
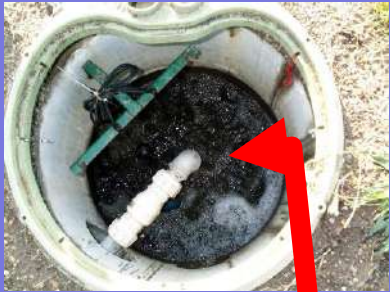
Membrane Bioreactors

some with recirculation





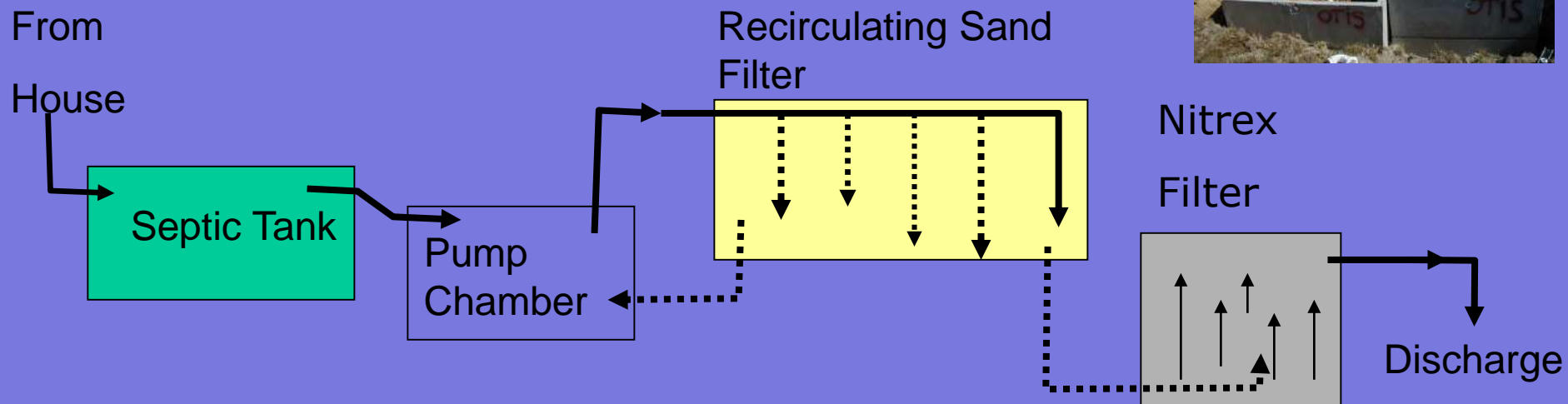
Sequencing Batch Reactor





Woodchip Bioreactors

Nitrex



How do they all work?



You can find
out for
yourself



Innovative/Alternative Septic System Tracking

[Go Back to Programs and Services](#)



DEPARTMENT CONTACT INFORMATION

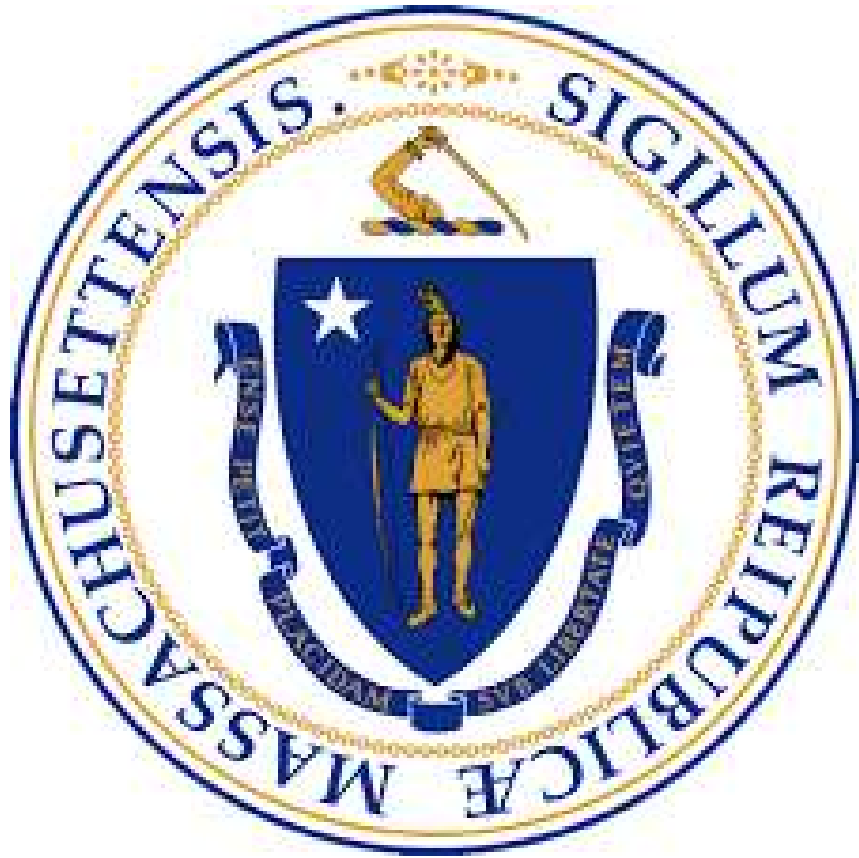
508-375-6613
bch.info@barnstablecounty.org
P.O. Box 427, Barnstable, MA 02630



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

What is the state of the art ?

- Four technologies with General Use Approval (for nitrogen removal) in the Commonwealth
- Many additional technologies available but that have not sought approval
- One soil absorption system modification that can attenuate nitrogen (under site-specific Pilot Approval)
- One diversion technique is approved but not generally accepted




**Systems with
Site-Specific
Pilot Approval**

Nitroe[®]

Wood-based
denitrification following
nitrification

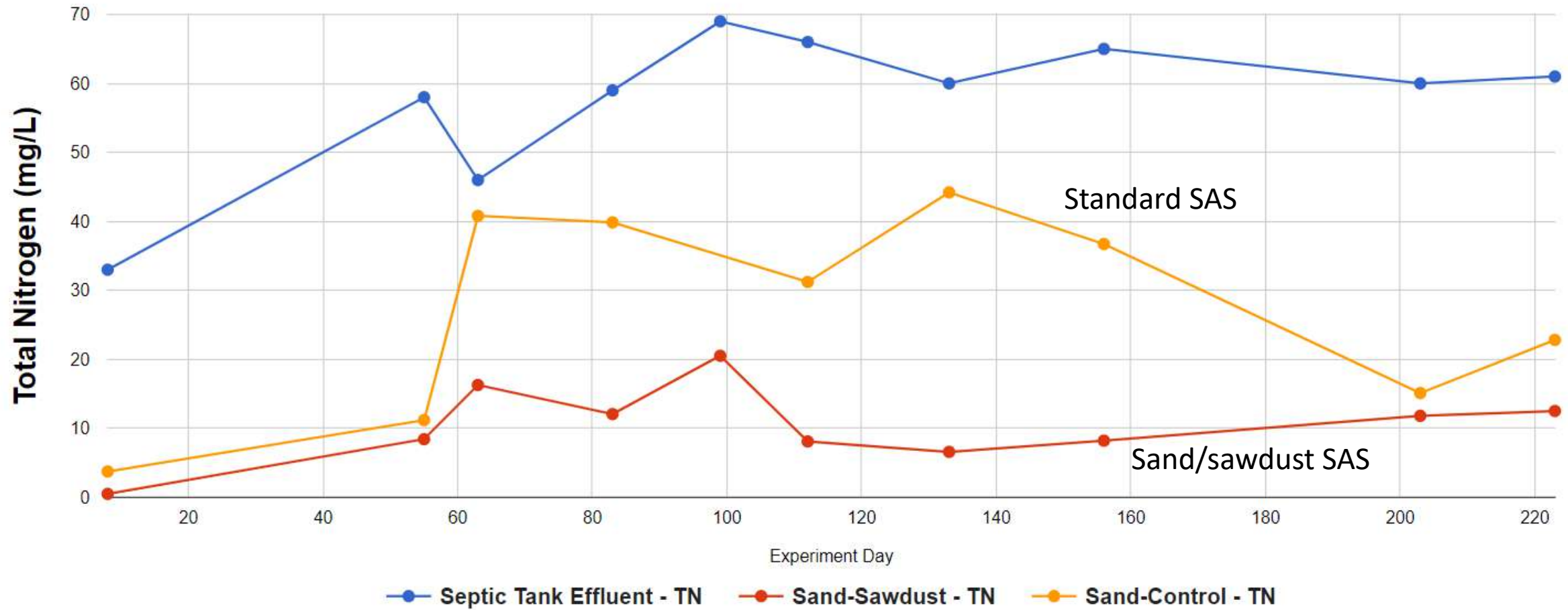




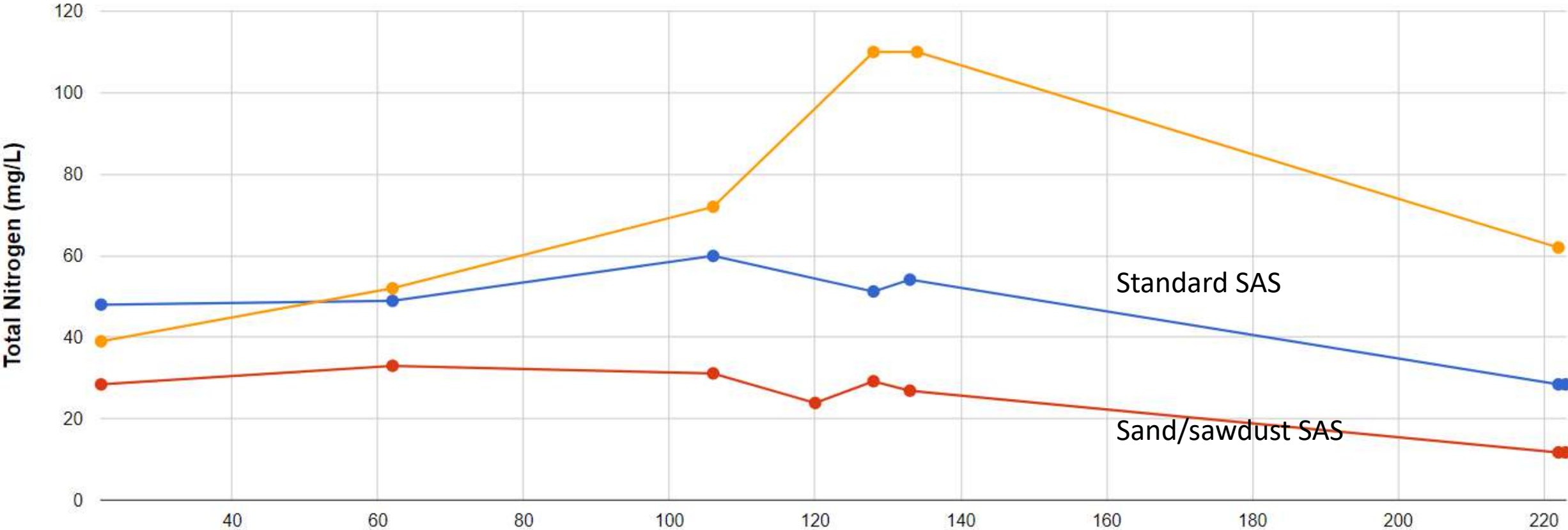
Layered System (sand/sawdust layer)



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



Residence - Woods Hole 1-3 residents



Finally

Lest we forget....



Phoenix R-200

Questions?

