Operated by

Barnstable County Department of Health and the Environment

In cooperation with

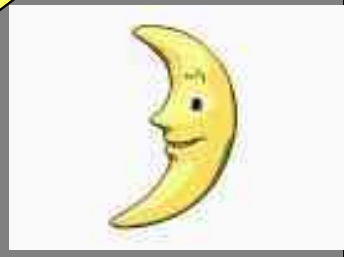
Massachusetts DEP

New England Region EPA

TEST CENTER

The opinions expressed herein are not necessarily those of the Massachusetts Department of Environmental Protection, the United States Environmental Protection Agency or the Barnstable County Department of Health and the Environment, neither does the mention of any product or procedure constitute an endorsement of such by those agencies.

The challenge, in our geological setting is to Remove Nitrogen from Wastewater



O_2 O_2 O_2 O_2 O_2 O_2 O_2

DAYTIME –Oxygen Production

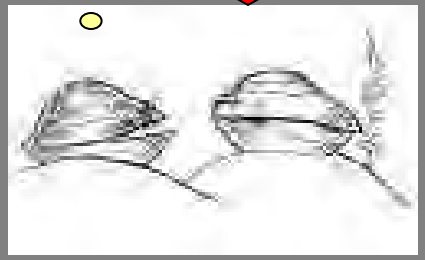
NIGHT -Oxygen Depletion

It's gonna be a long night.

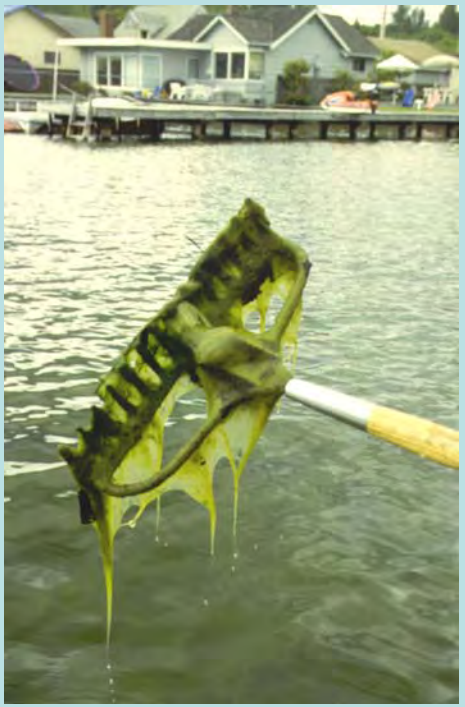
O_2 Respiration O_2

Decomposition

O_2



The Impacts of Nitrogen in Marine Settings



Mission of the Massachusetts Alternative Septic System Test Center

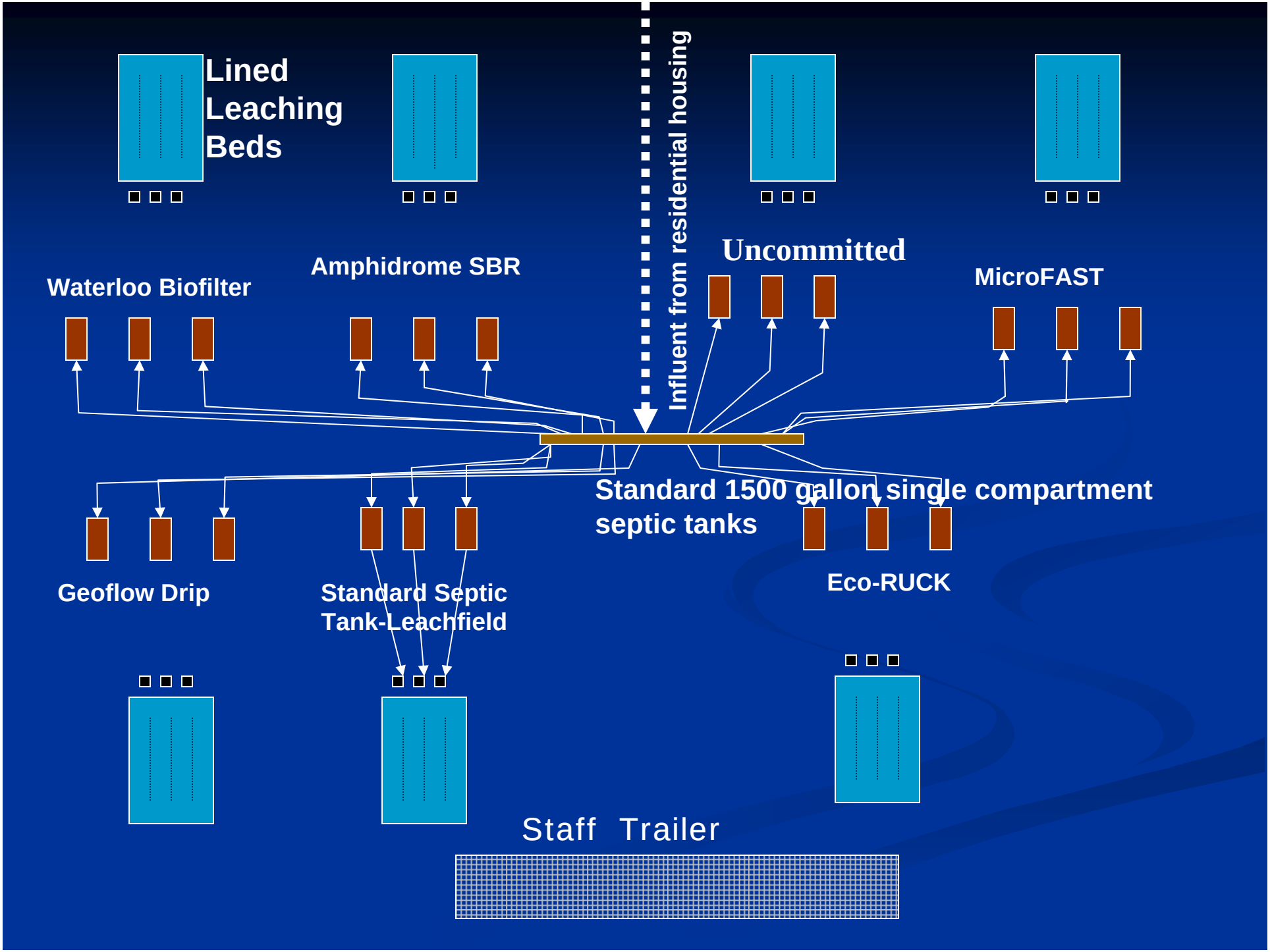
- **To provide a facility where research, development and testing of advanced onsite septic systems can be conducted.**
- **Provide information to boards of health and other environmental decision makers regarding the efficacy of advanced treatment units (in our area particularly for nitrogen).**

Massachusetts Alternative Septic System Test Center
Wastewater Source

Coast Guard residential housing and a county jail

Test Center from Space (circa. 2003)

Test Center from Space (circa. 2003)


Lined
Leaching
Beds
Influent from residential housing
Uncommitted
Amphidrome SBR
Waterloo Biofilter
MicroFAST
Standard 1500 gallon single compartment
septic tanks
Geoflow Drip
Standard Septic
Tank-Leachfield
Eco-RUCK
Staff Trailer

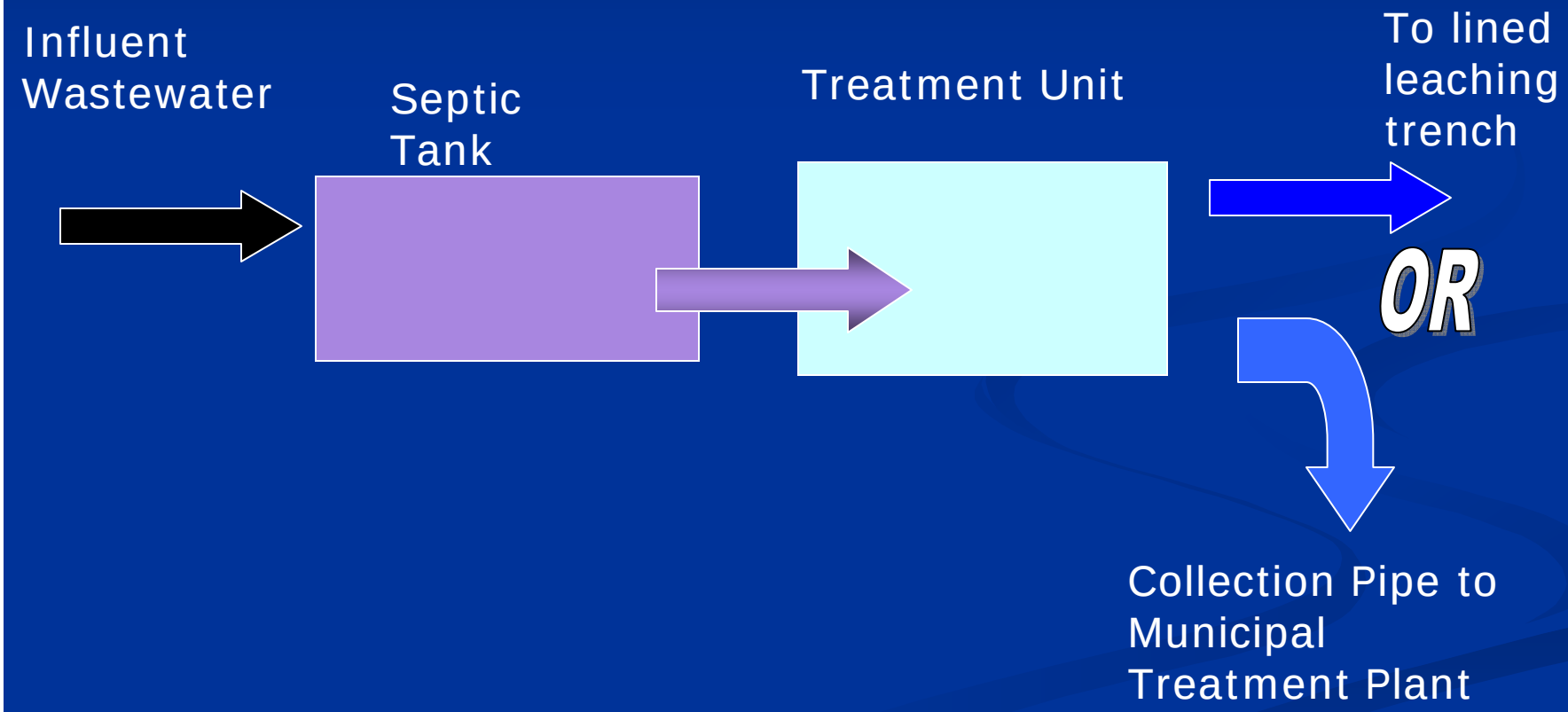
Concept 1

Test systems in triplicate over two years. Issue open invitation.

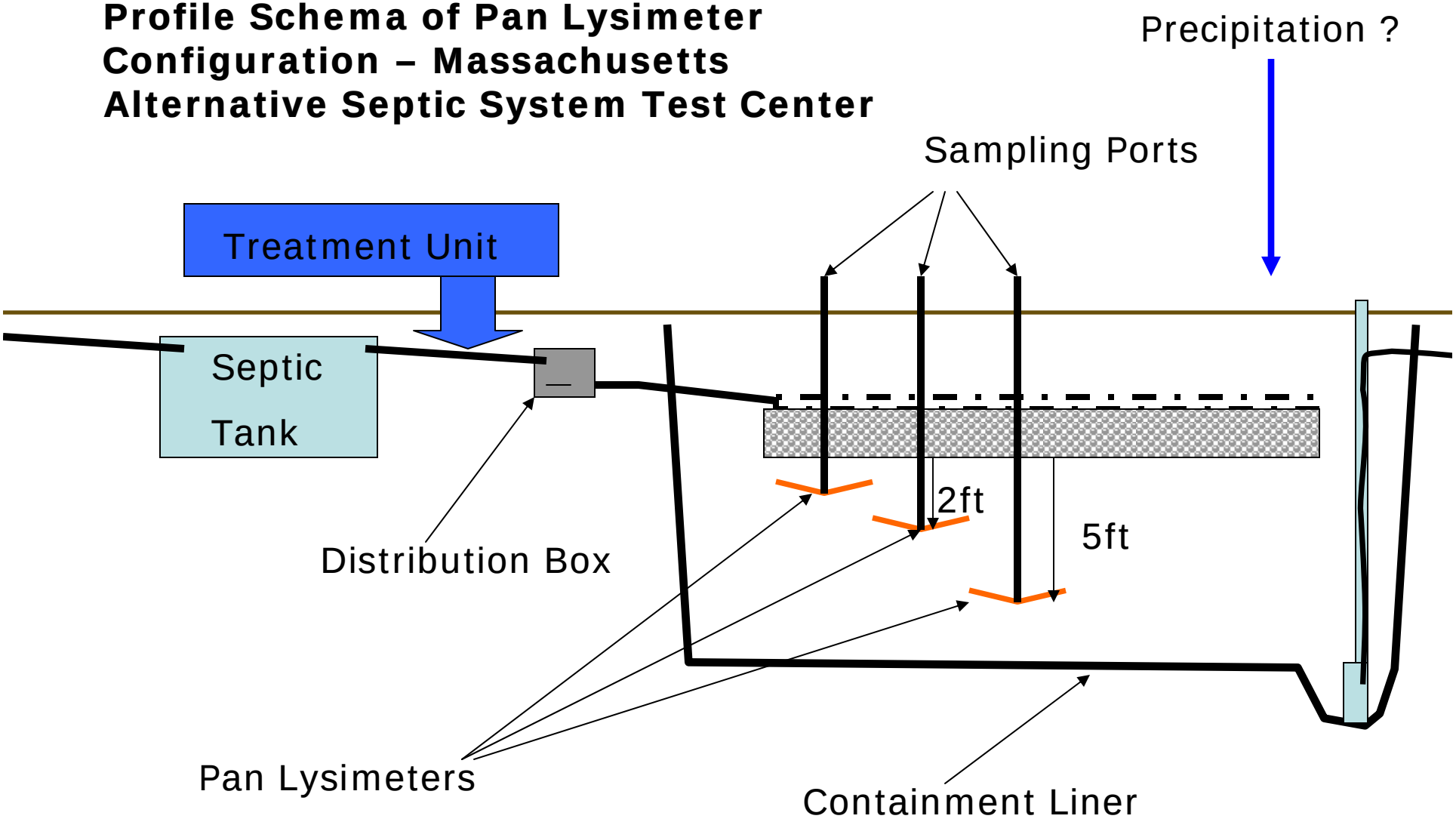
FIVE "TAKERS"

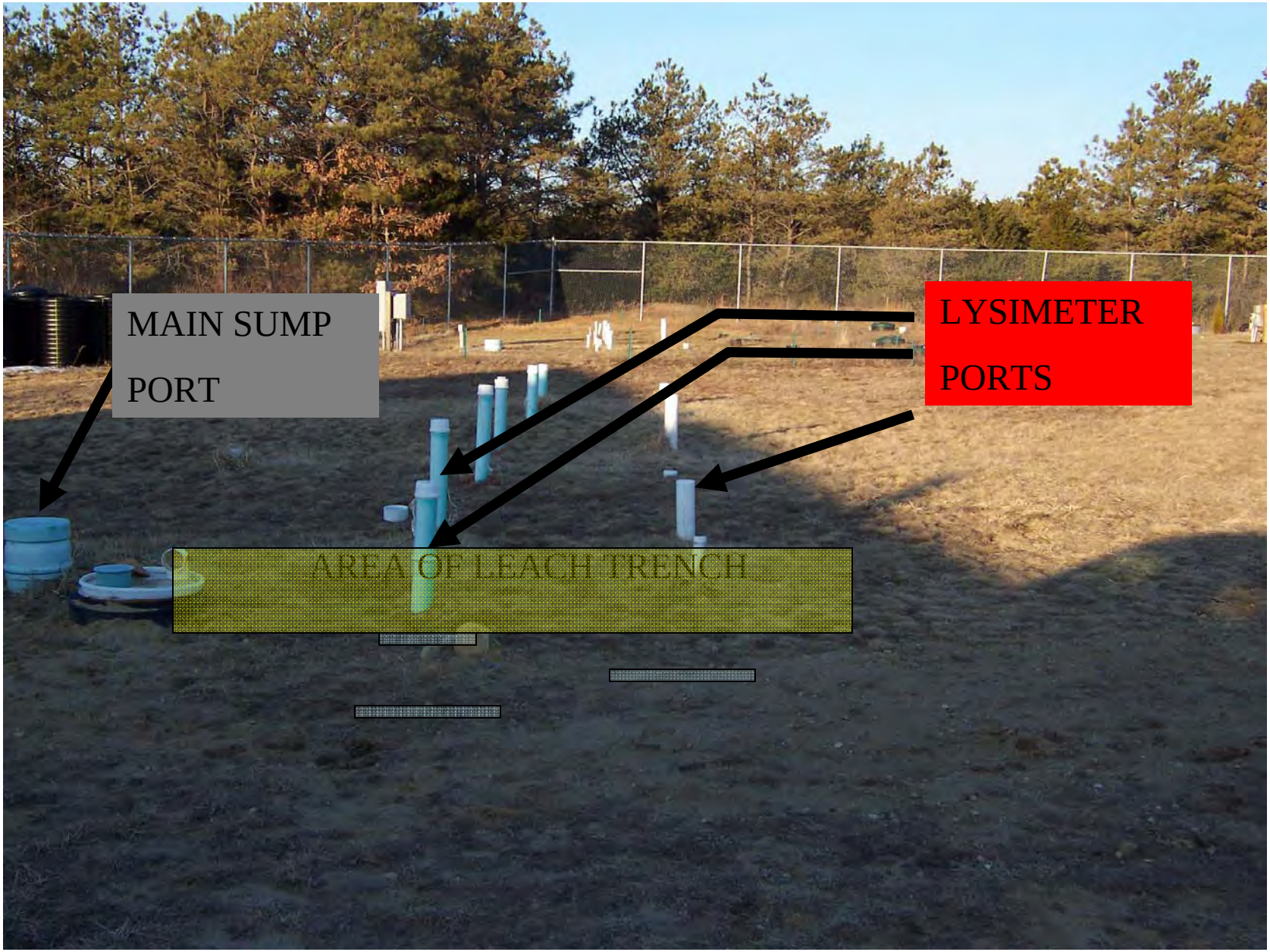
Construction 1998-1999

General Schema of Septic Systems Installed at the Massachusetts Alternative Septic System Test Center

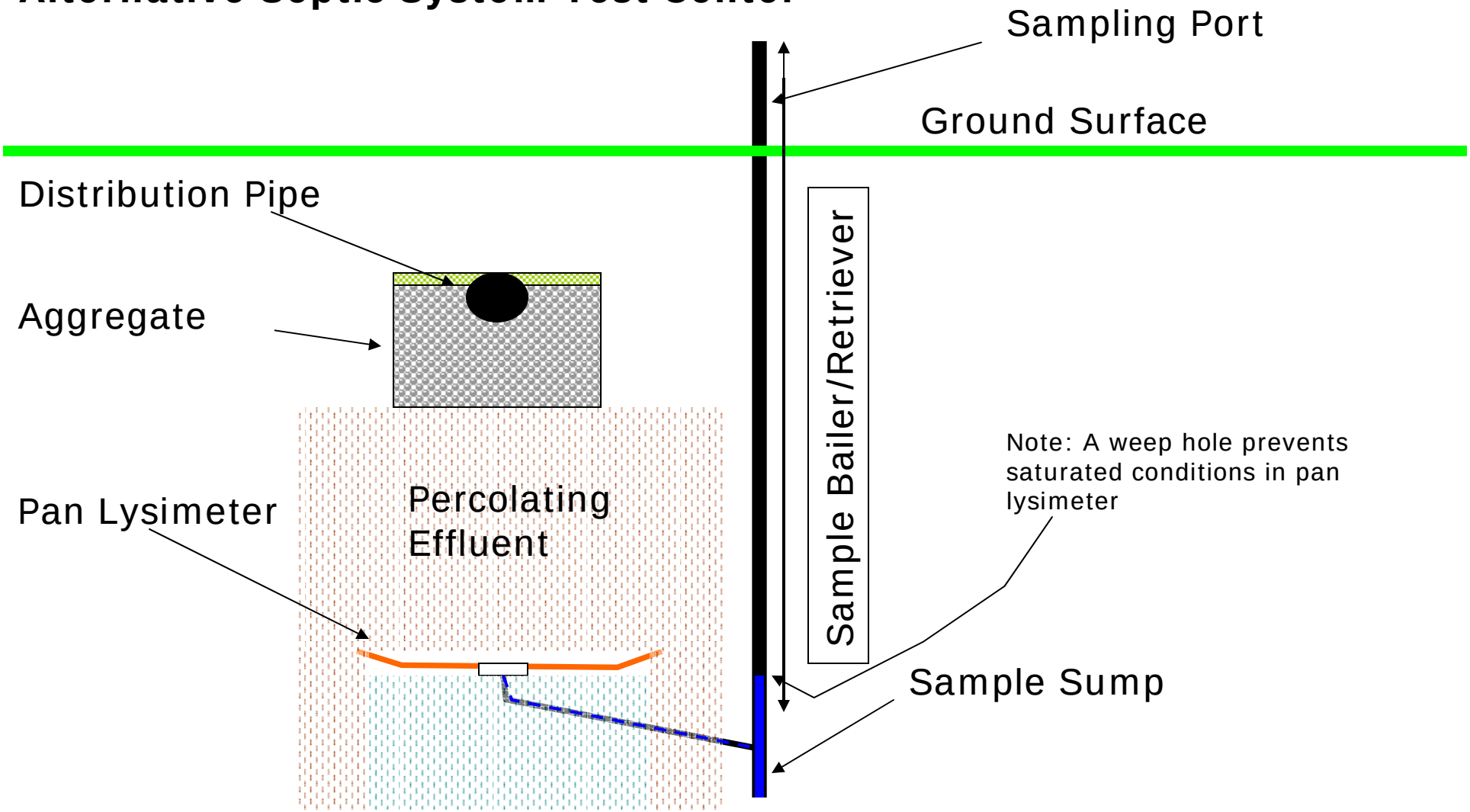


Profile Schema of Pan Lysimeter Configuration – Massachusetts Alternative Septic System Test Center




MAIN SUMP
PORT
LYSIMETER
PORTS
AREA OF LEACH TRENCH

End View Schema of Pan Lysimeter Configuration – Massachusetts Alternative Septic System Test Center



AutoSamplers

- Composite Sample
- Set for 24 hrs.
- Synchronized with discharge


F
C
B
B
E
D
D
A
A
I
G
H

Average Daily Electric Consumption

Kilowatts per Day

9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00

SeptiTech (G2)
Fast(Ds)
Bioclere (H1)
Amphidrome (B1)
GeoFlow (Es)
Waterloo (A3)

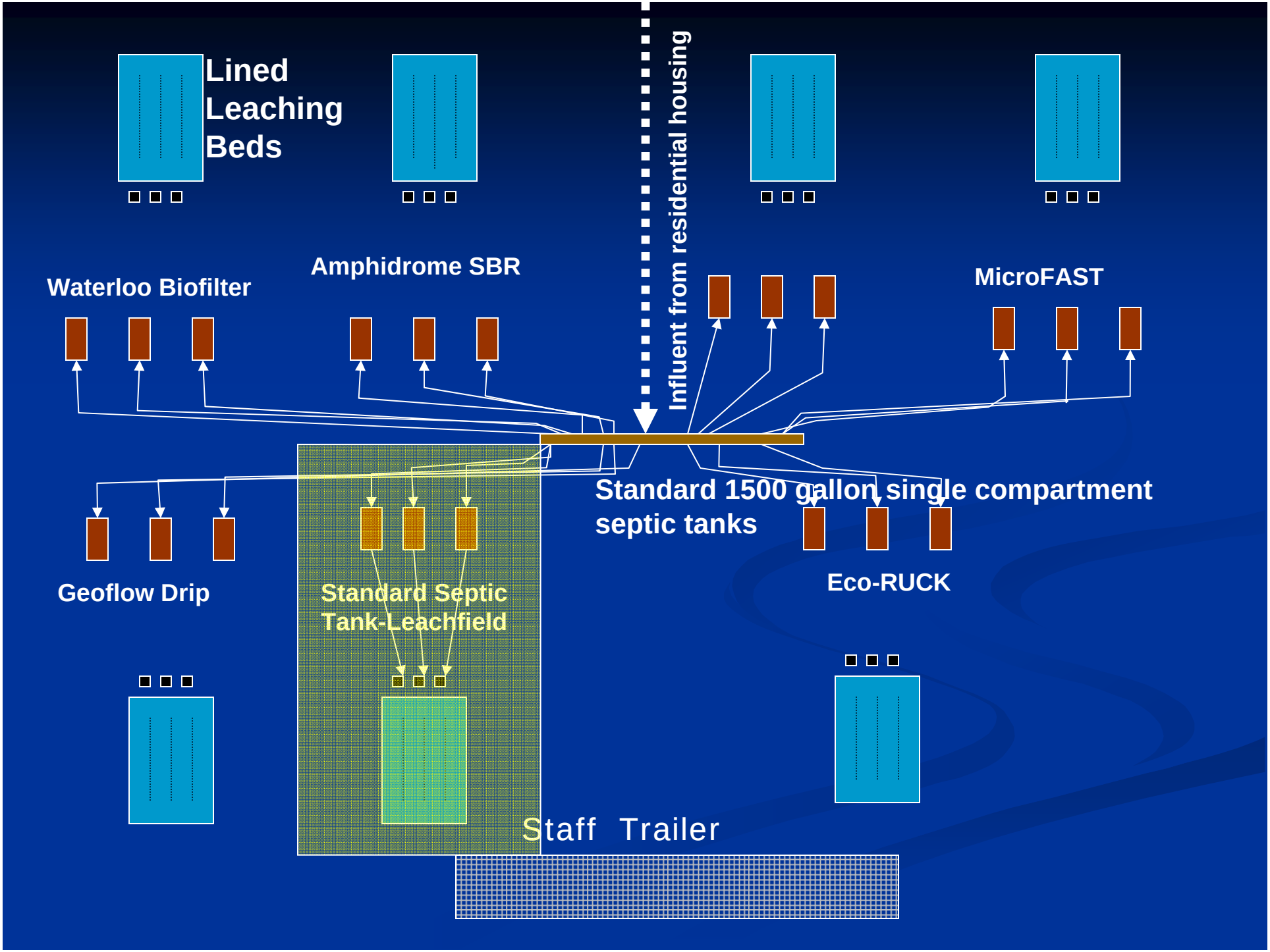
System

ETI – ENVIRONMENTAL TECHNOLOGY INITIATIVE

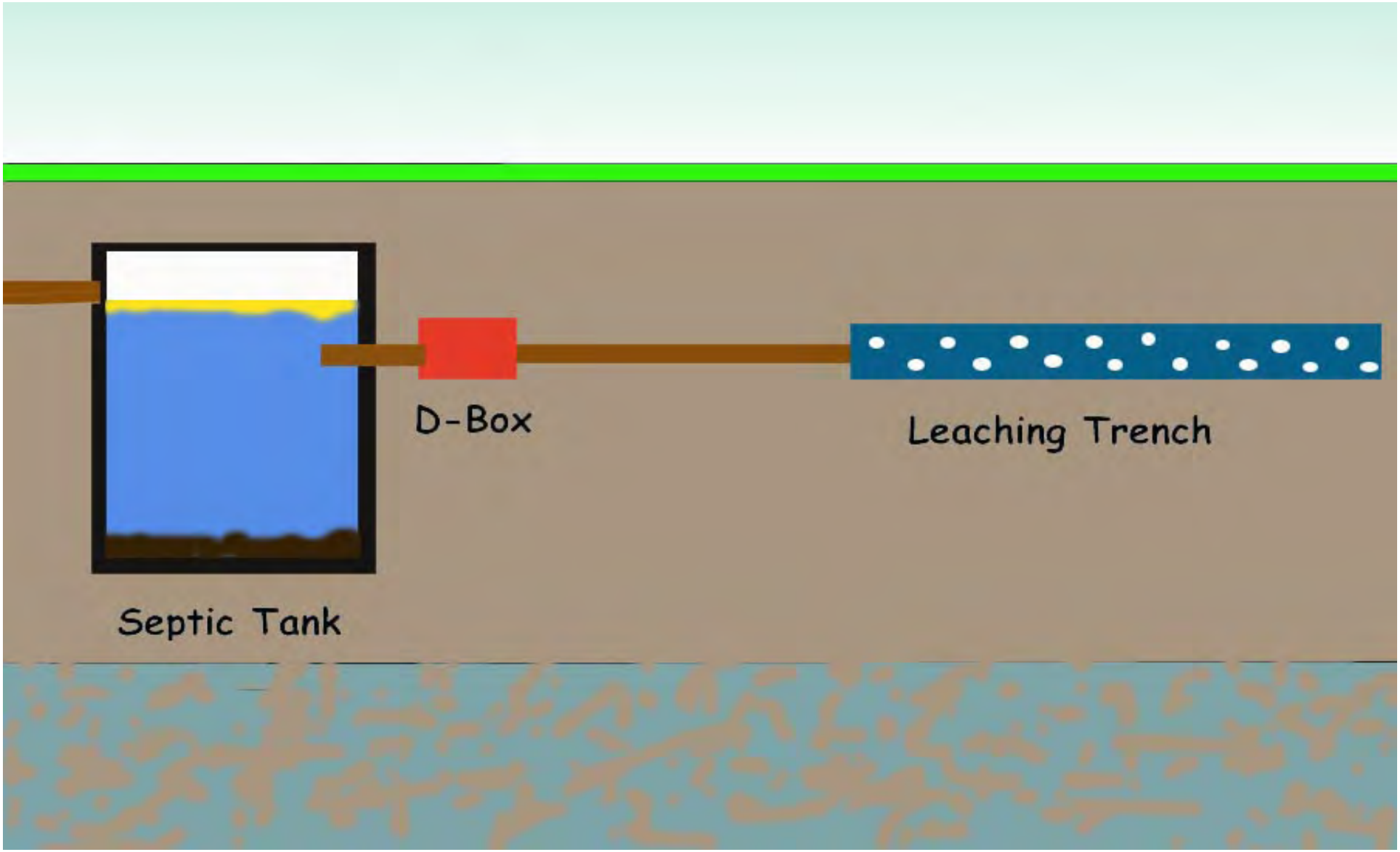
Two Years of Bi-weekly Testing

Five Systems and a Standard Septic Tank Leach Trench System Started

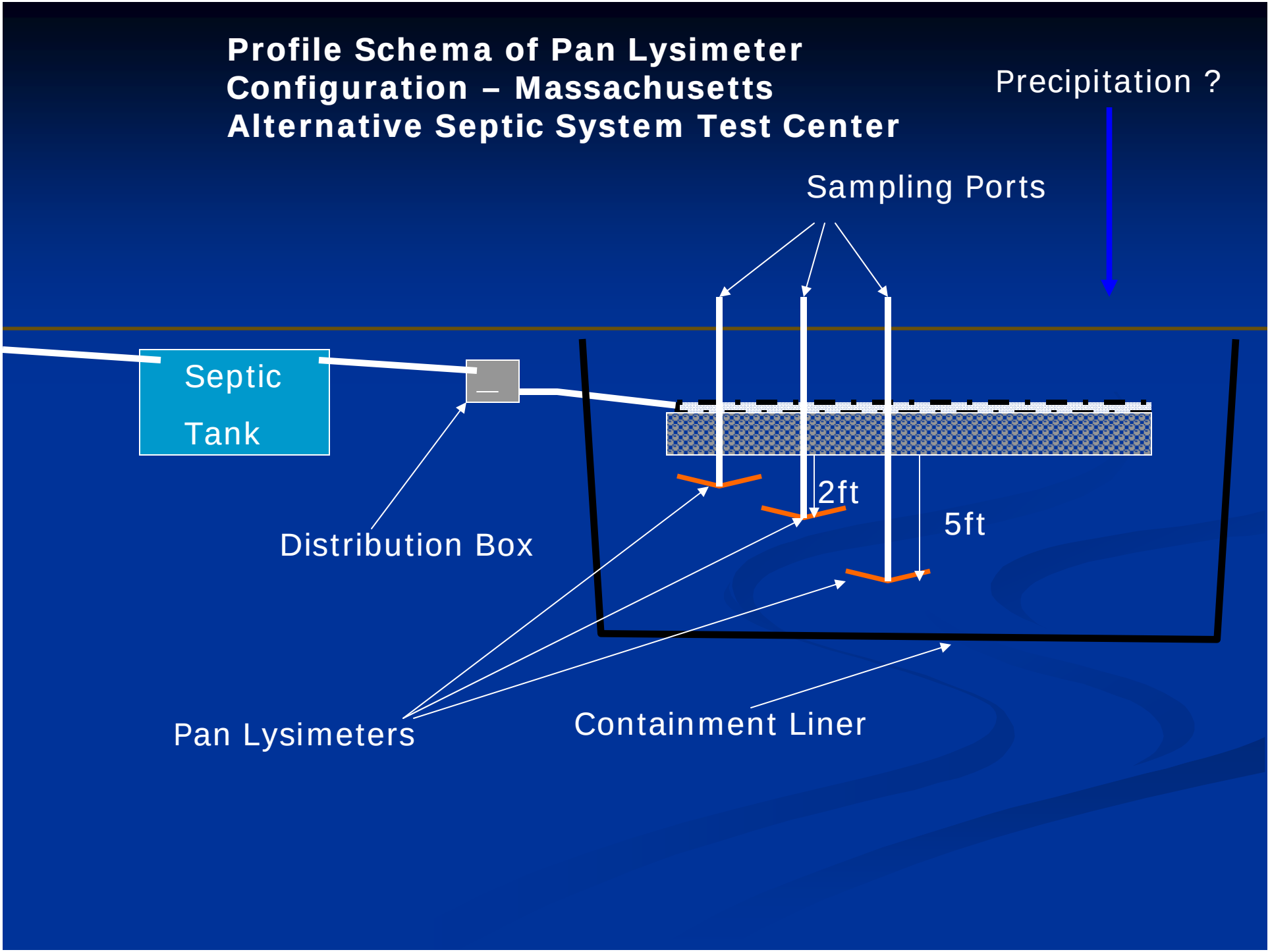
Four Treatment Systems Finished!

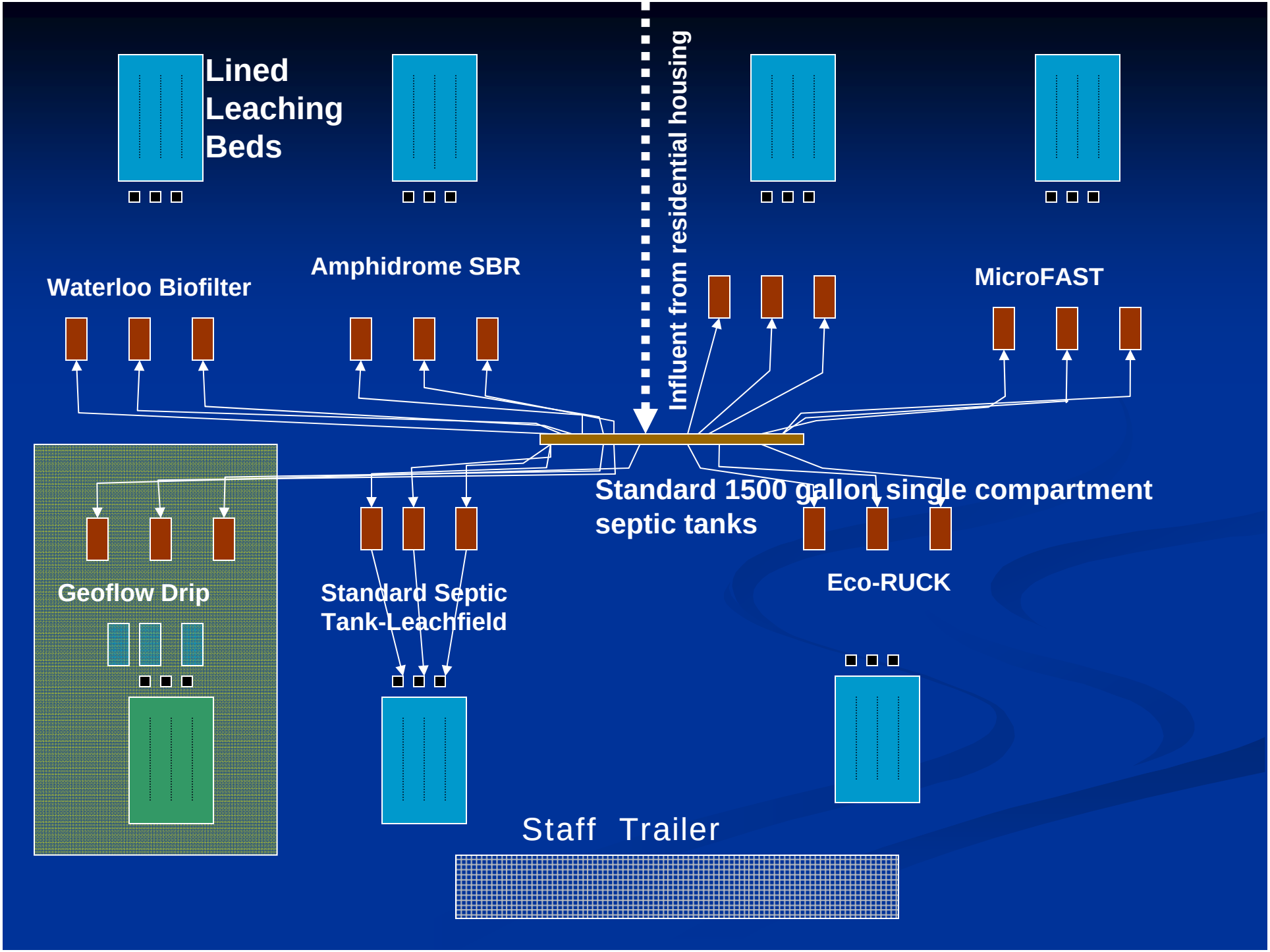

Lined
Leaching
Beds
Influent from residential housing
Waterloo Biofilter
Amphidrome SBR
MicroFAST
Standard 1500 gallon single compartment
septic tanks
Geoflow Drip
Standard Septic
Tank-Leachfield
Eco-RUCK
Staff Trailer

STANDARD “TITLE 5” SYSTEM



Profile Schema of Pan Lysimeter Configuration – Massachusetts Alternative Septic System Test Center

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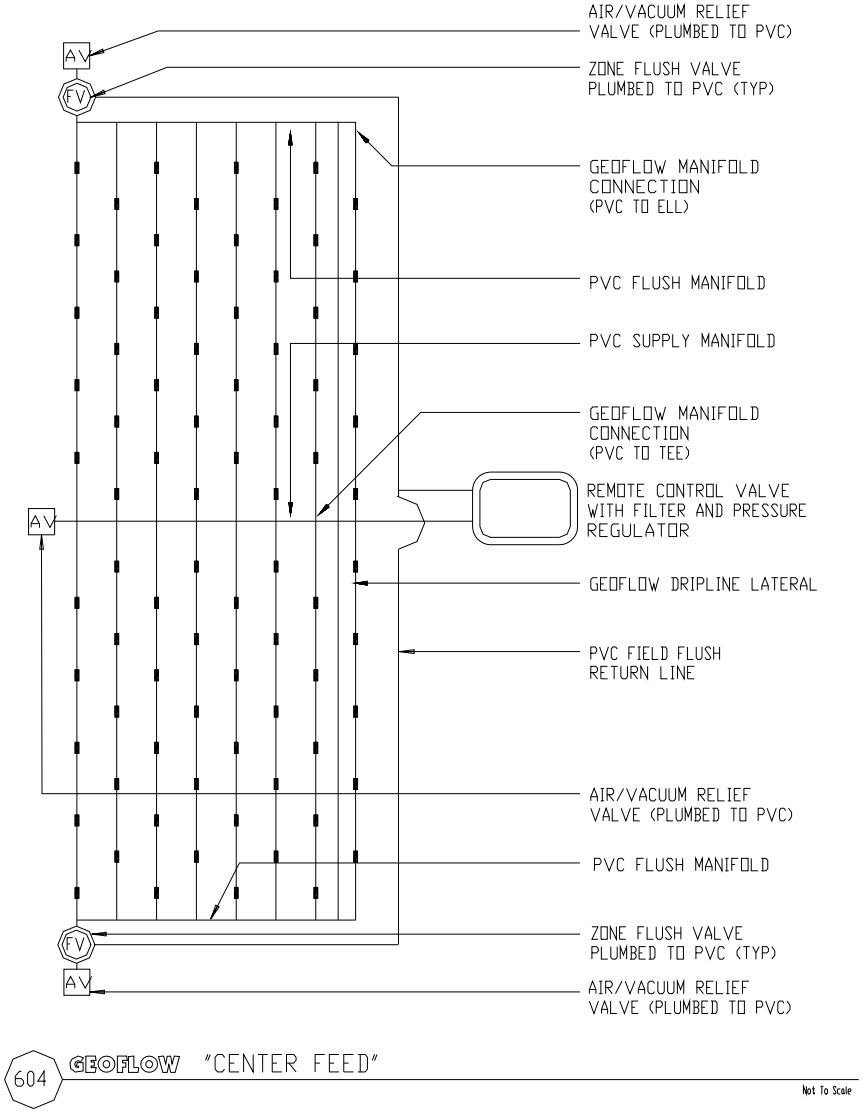
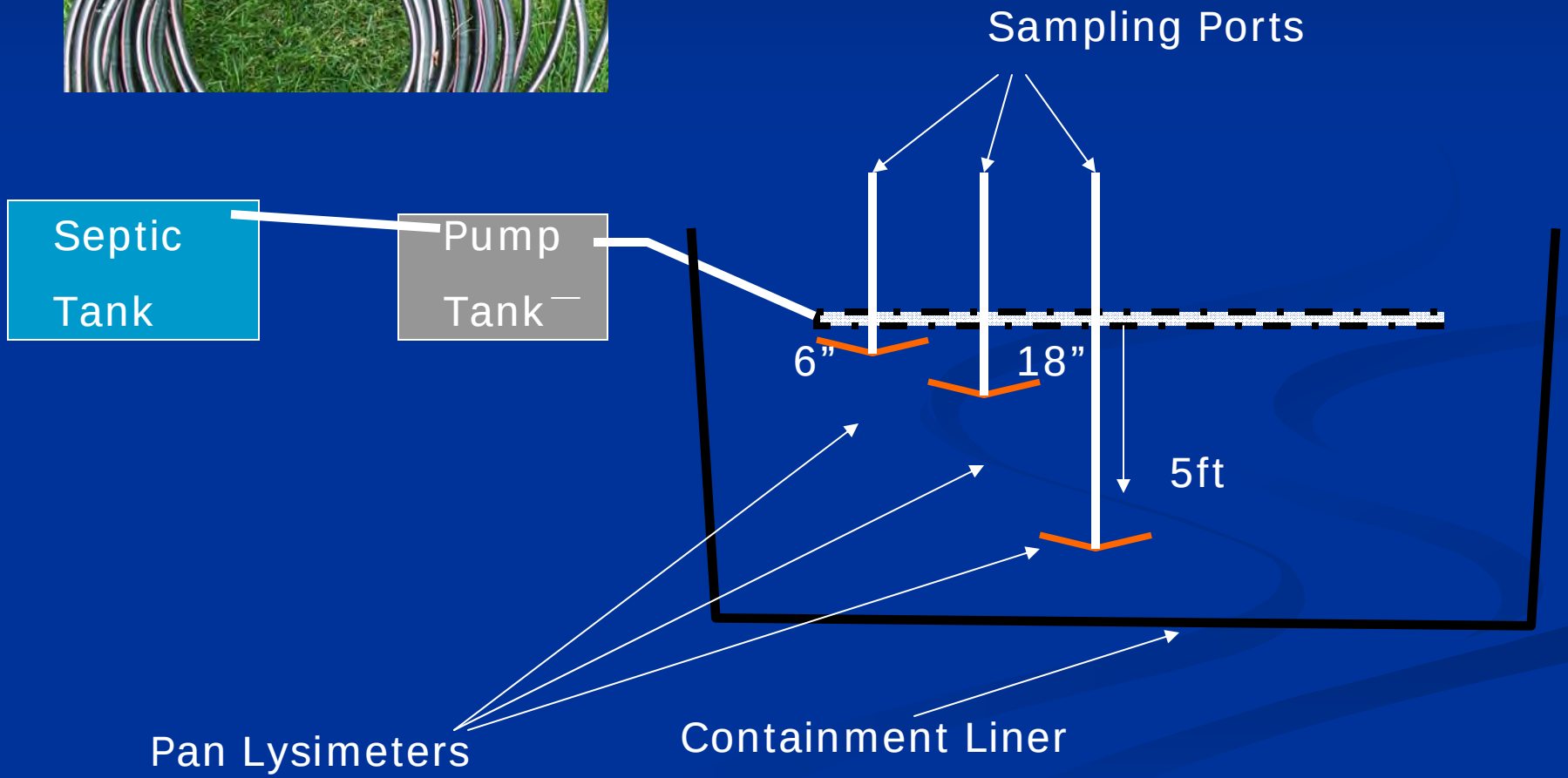
Leaching
Beds
Influent from residential housing
Waterloo Biofilter
Amphidrome SBR
MicroFAST
Standard 1500 gallon single compartment
septic tanks
Geoflow Drip
Standard Septic
Tank-Leachfield
Eco-RUCK
Staff Trailer

Geoflow® Drip Irrigation

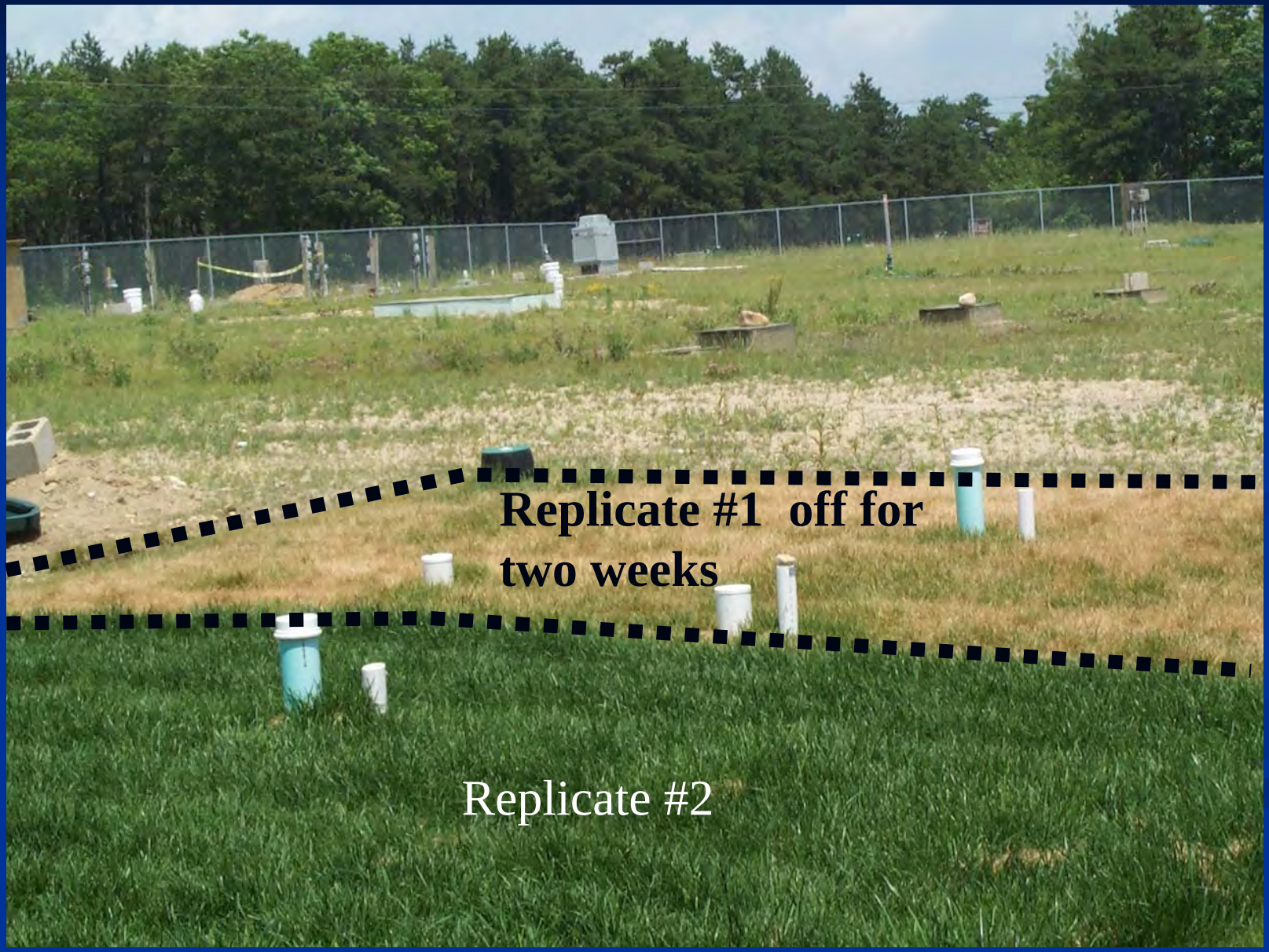


Geoflow® Drip Irrigation

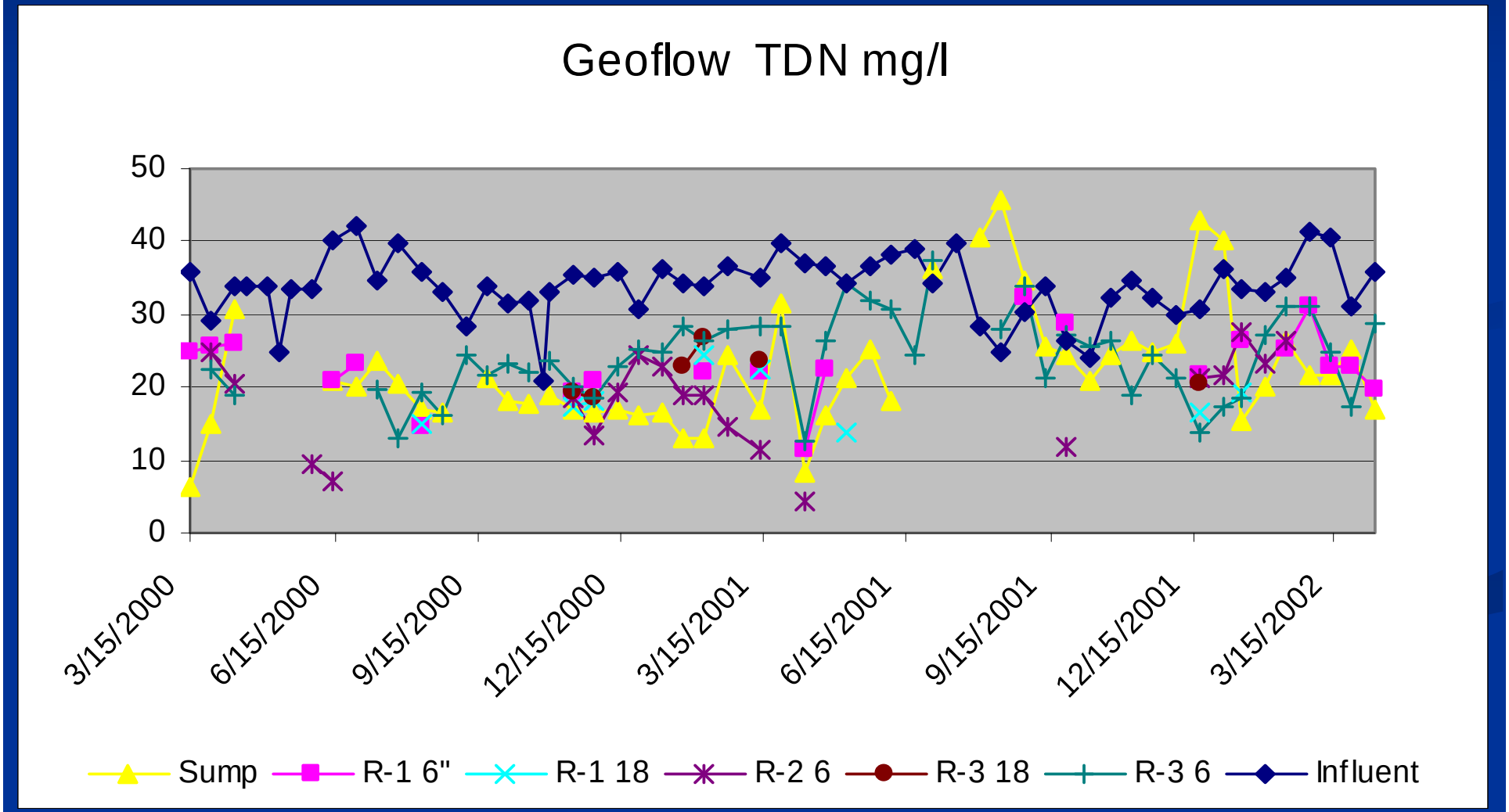
ETI

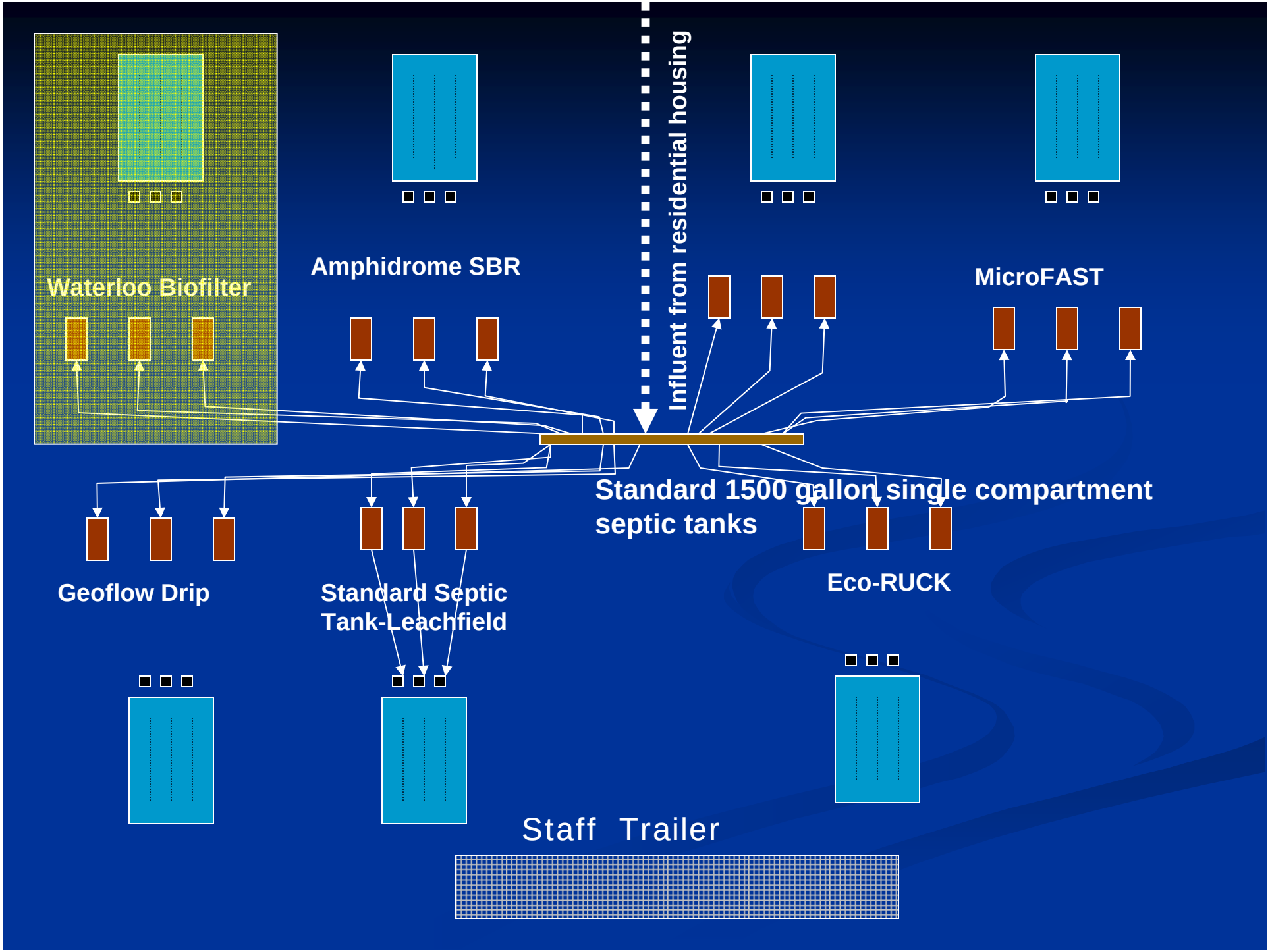


Drip Dispersal

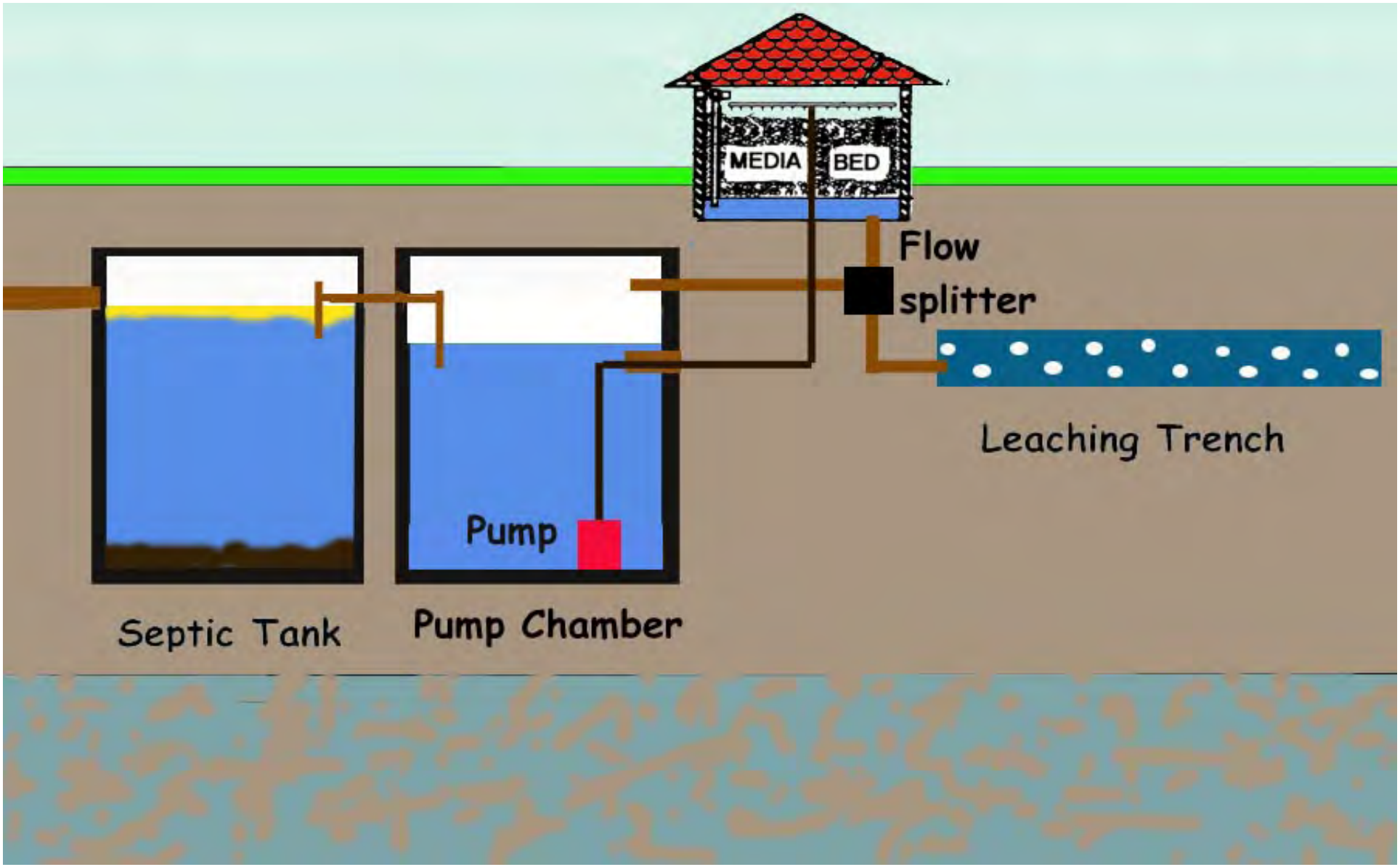


GeoFlow Drip Irrigation

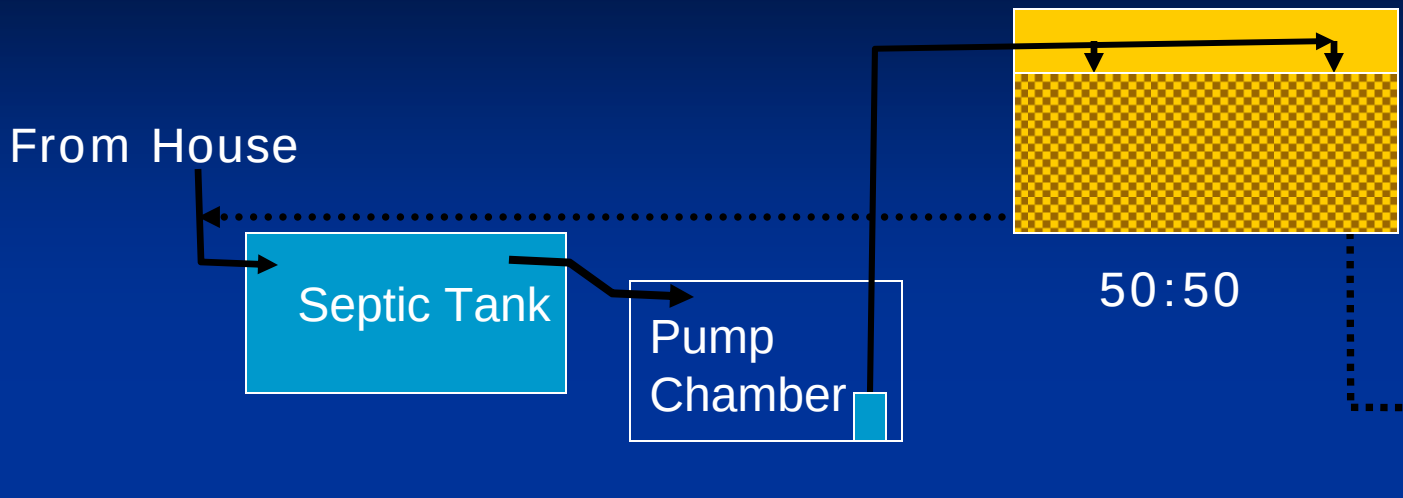



Influent from residential housing
Waterloo Biofilter
Amphidrome SBR
MicroFAST
Standard 1500 gallon single compartment septic tanks
Geoflow Drip
Standard Septic Tank-Leachfield
Eco-RUCK
Staff Trailer

WATERLOO BIOFILTER



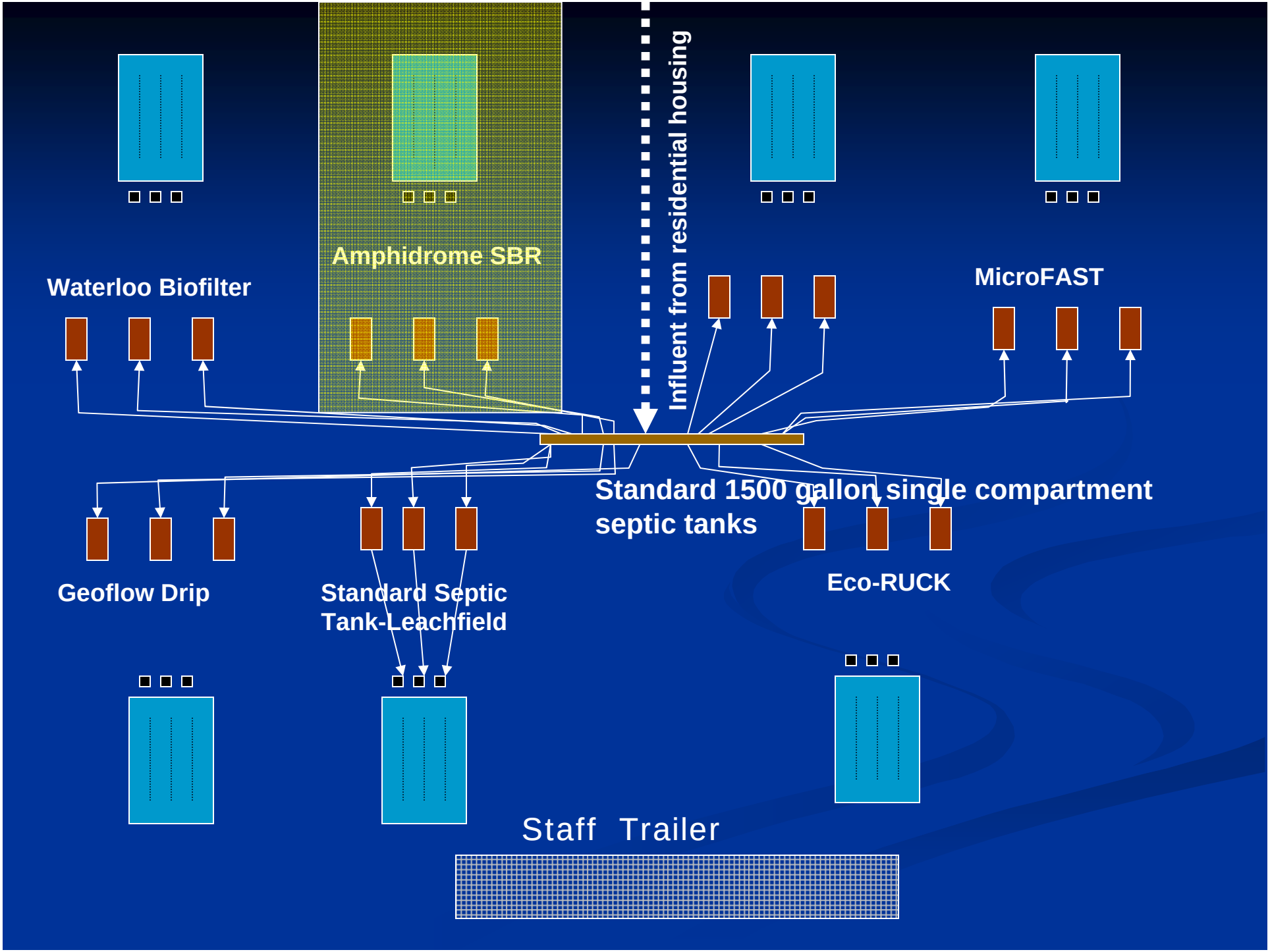
Waterloo Biofilter



Generally TN~15-17 mg/l TN. Excursions related to short circuiting.

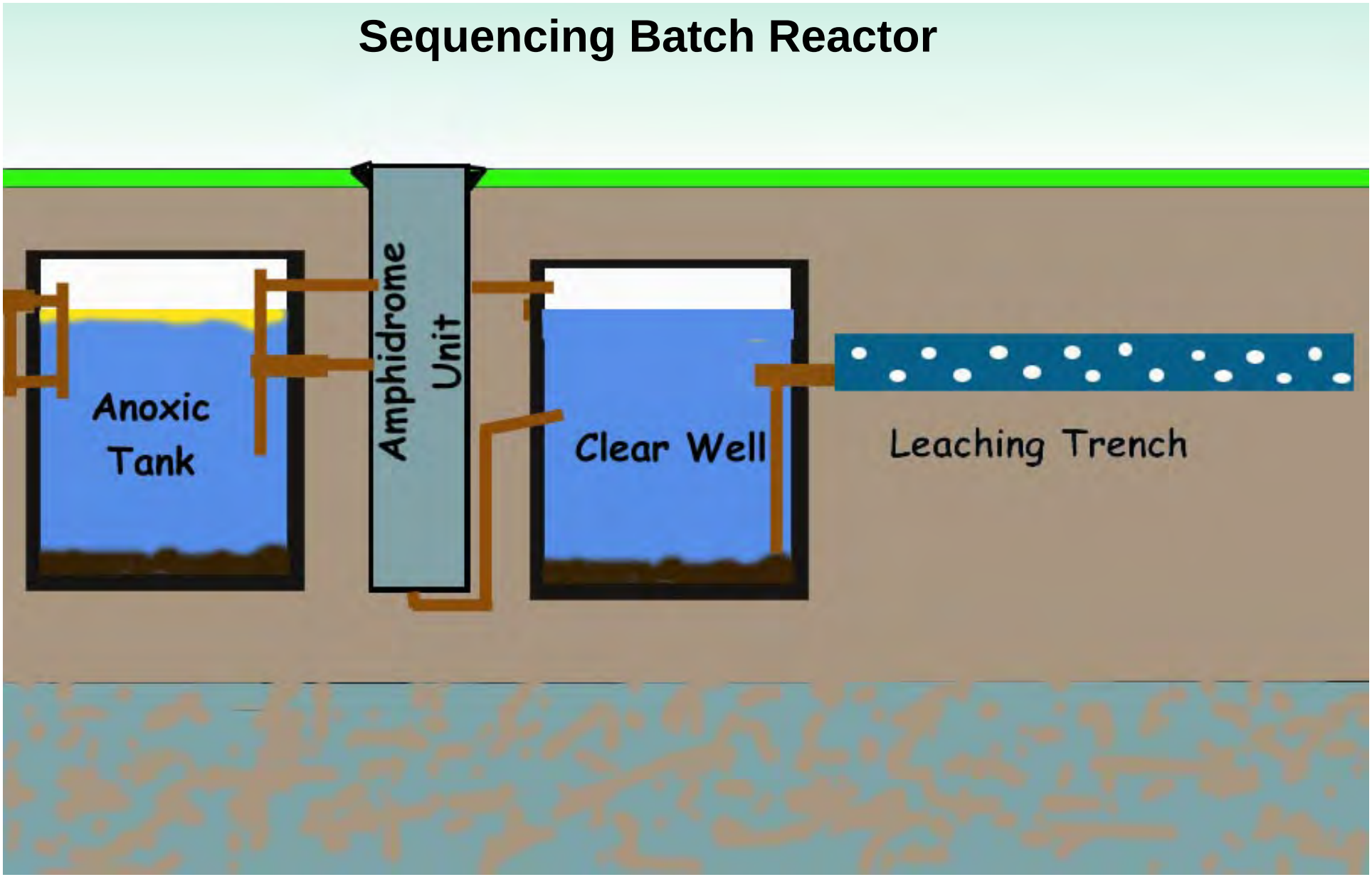
	Influent TN (mg/l)	Effluent TN (mg/l)
Mean	37.5	14.7
Median	38.0	13.9
Count	103	130


SSURE

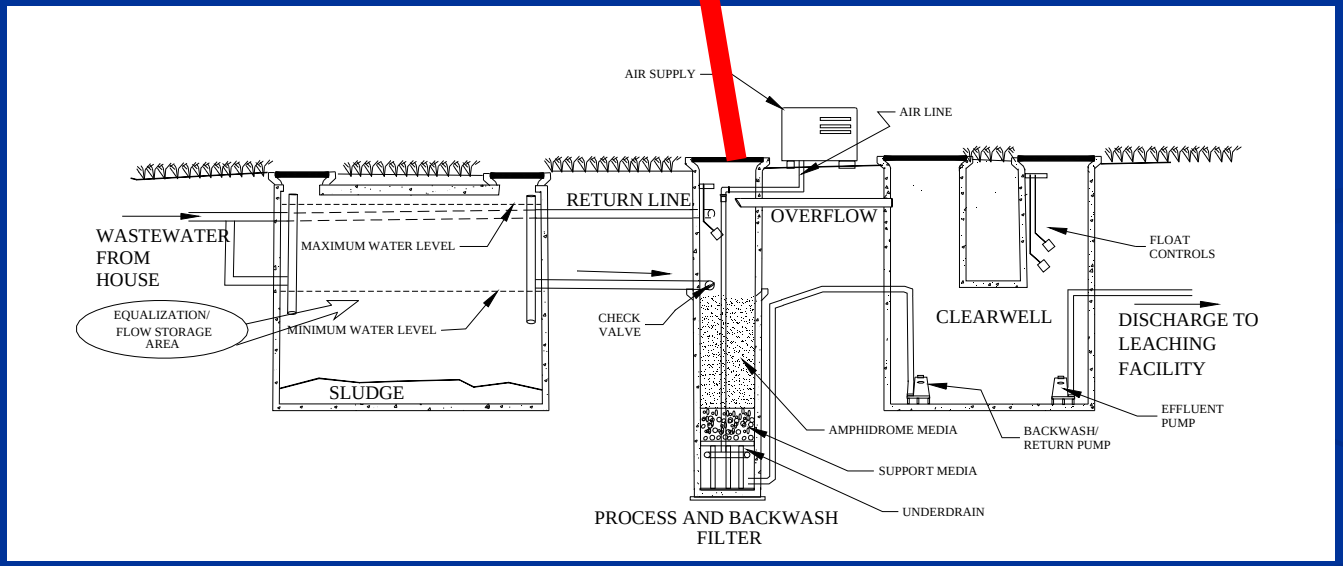

Influent from residential housing
Amphidrome SBR
Waterloo Biofilter
MicroFAST
Standard 1500 gallon single compartment septic tanks
Geoflow Drip
Standard Septic Tank-Leachfield
Eco-RUCK
Staff Trailer

AMPHIDROME

Sequencing Batch Reactor

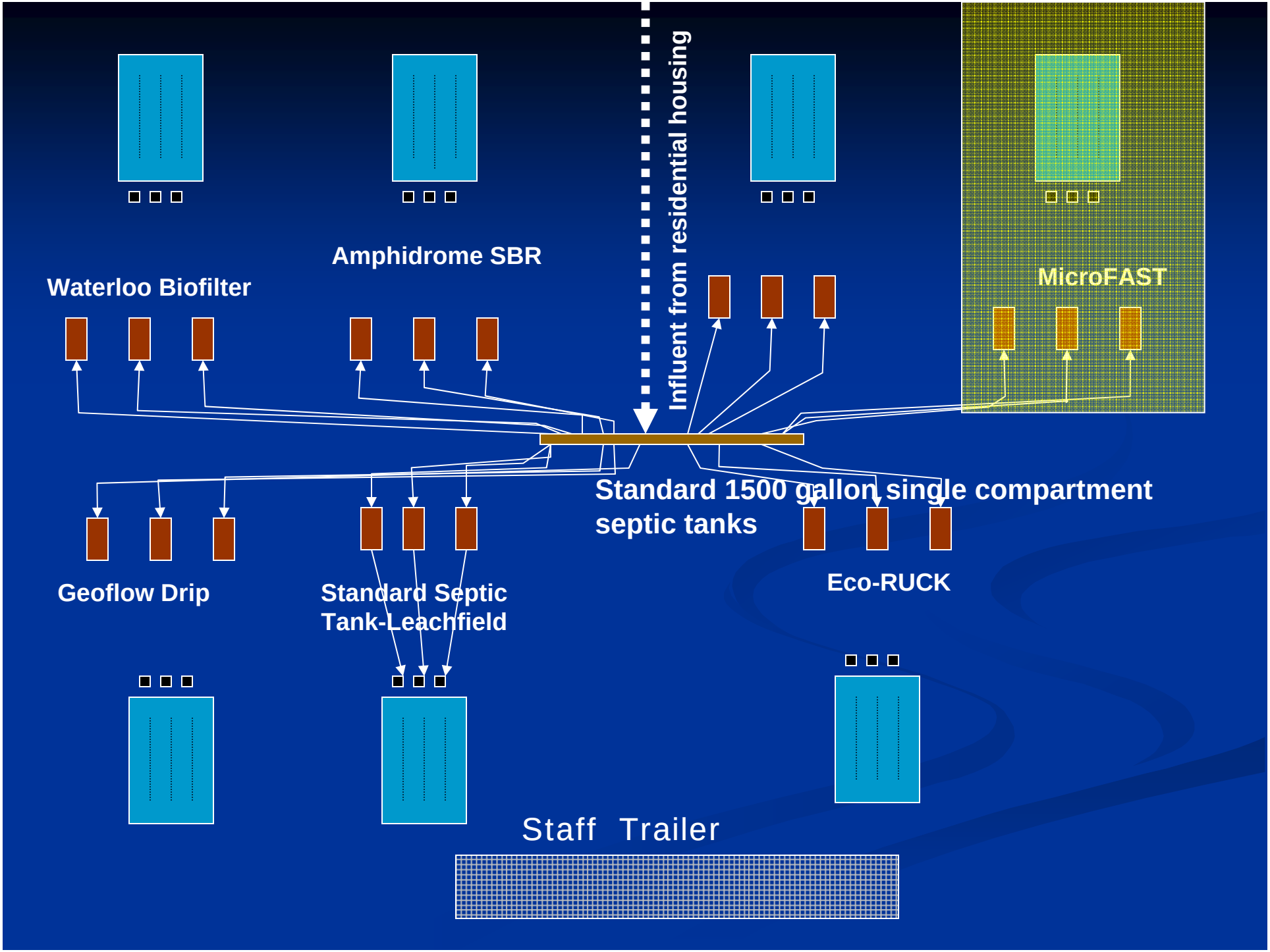


Amphidrome®

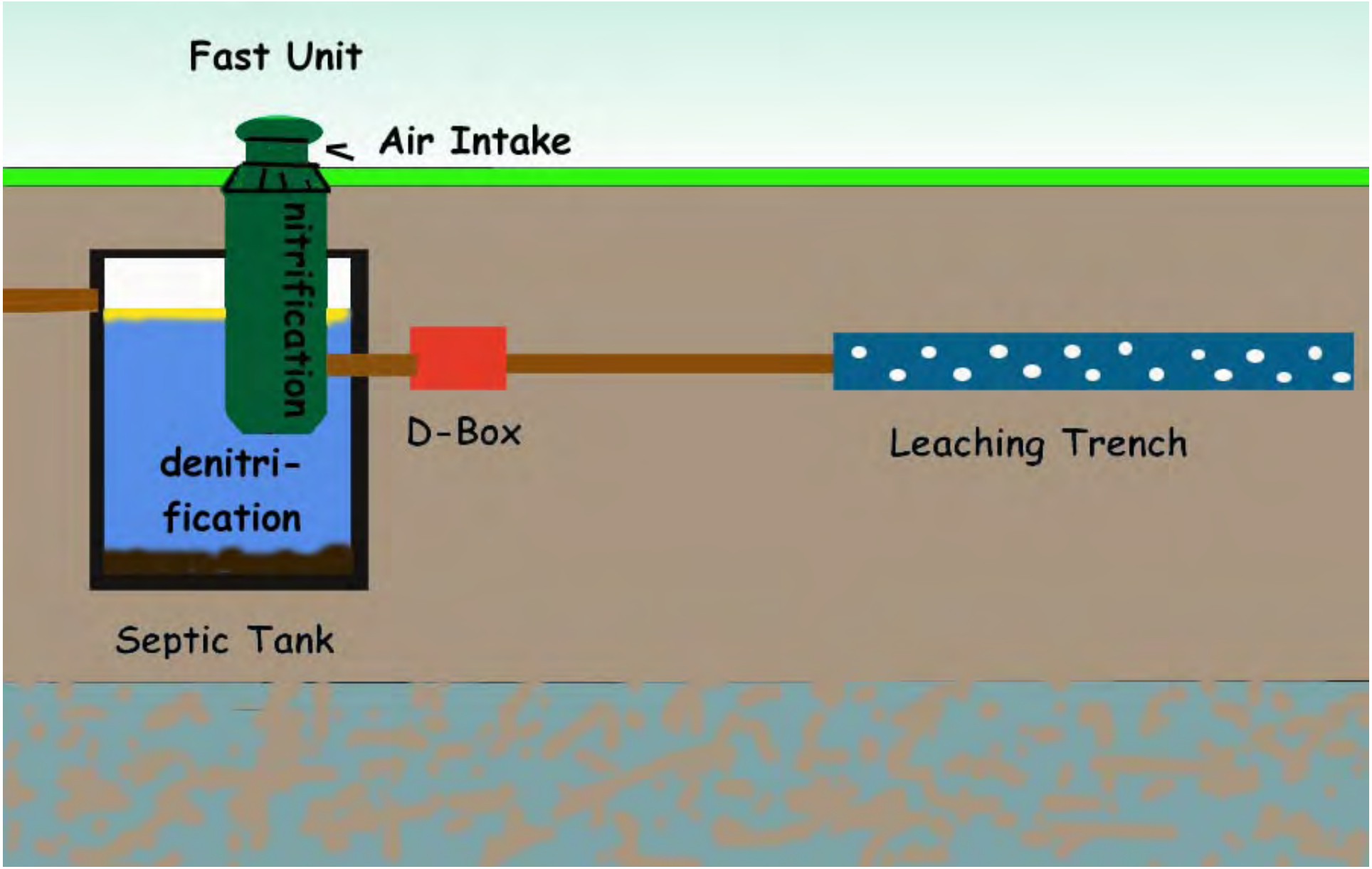


Generally TN<15. Performance excursions related to sludge buildup in primary tank

	Influent TN (mg/l)	Effluent TN (mg/l)
Mean	36.8	10.7
Median	37.0	9.1
Count	60	116

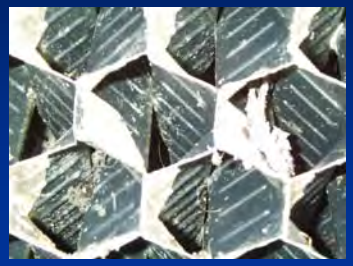

Influent from residential housing
Amphidrome SBR
Waterloo Biofilter
MicroFAST
Standard 1500 gallon single compartment septic tanks
Geoflow Drip
Standard Septic Tank-Leachfield
Eco-RUCK
Staff Trailer

F.A.S.T.

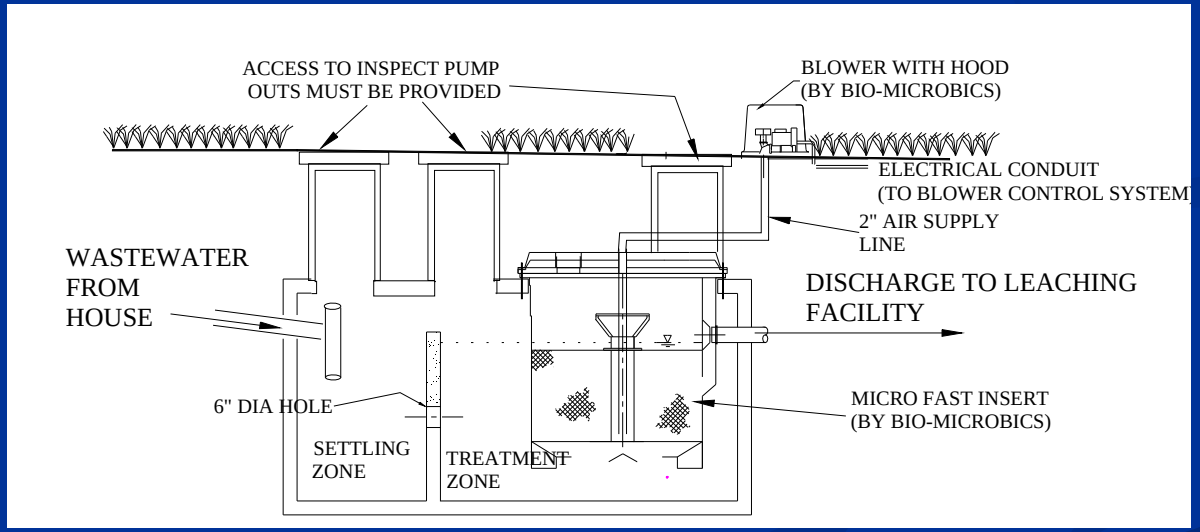

Fast Unit
Air Intake
nitrification
denitri-
fication
D-Box
Leaching Trench
Septic Tank


BIO-MICROBICS®
INCORPORATED
DANGER
ELECTRICAL HAZARD.
Disconnect power before servicing. Failure to do so may result in electrical shock causing bodily injury or death.
This unit to be serviced only by trained and certified Single Home FAST® technicians.

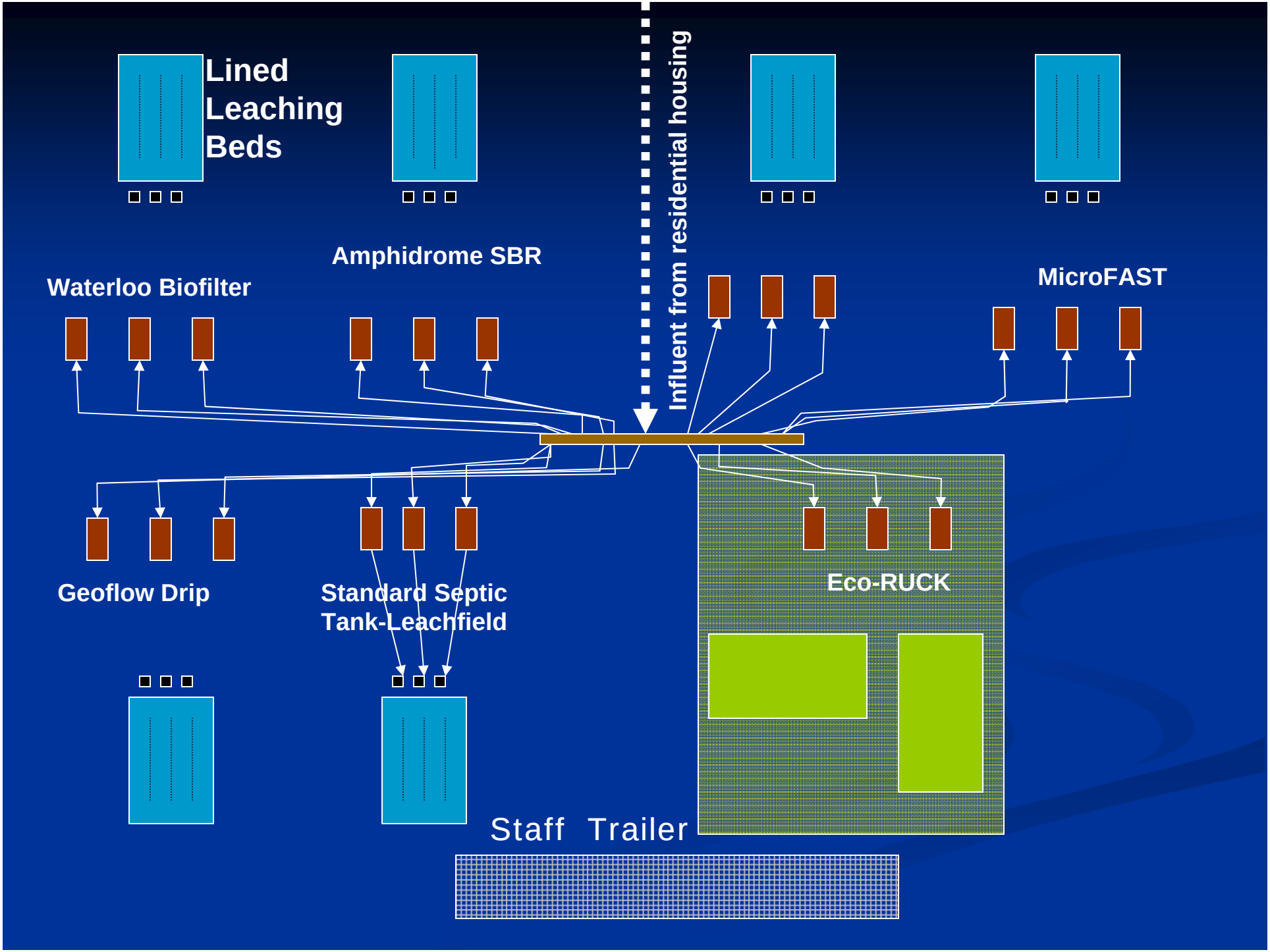
MicroFAST®



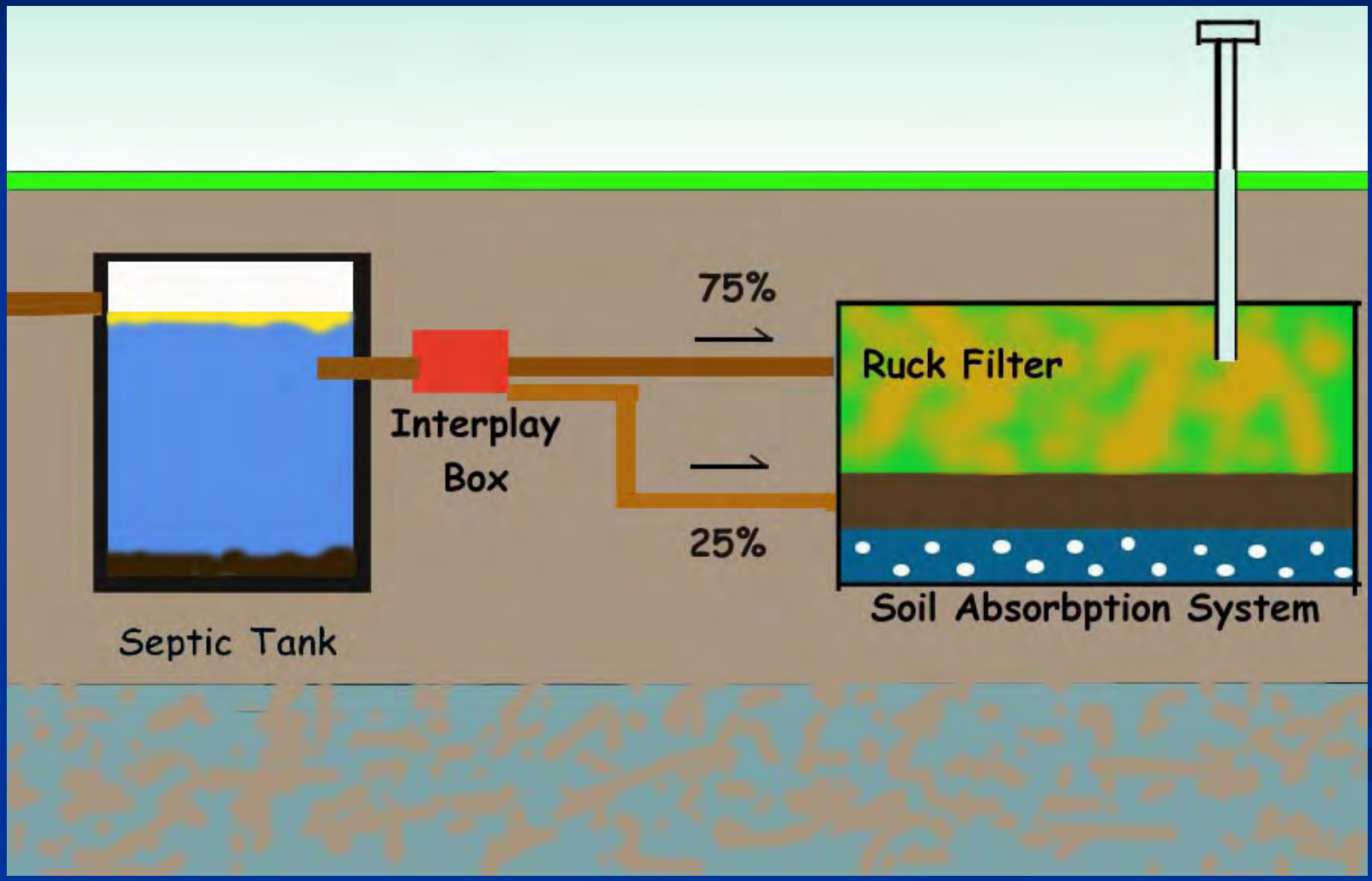
	Influent TN (mg/l)	Effluent TN (mg/l)
Mean	37.5	17.3
Median	38.0	17.1
Count	103	114



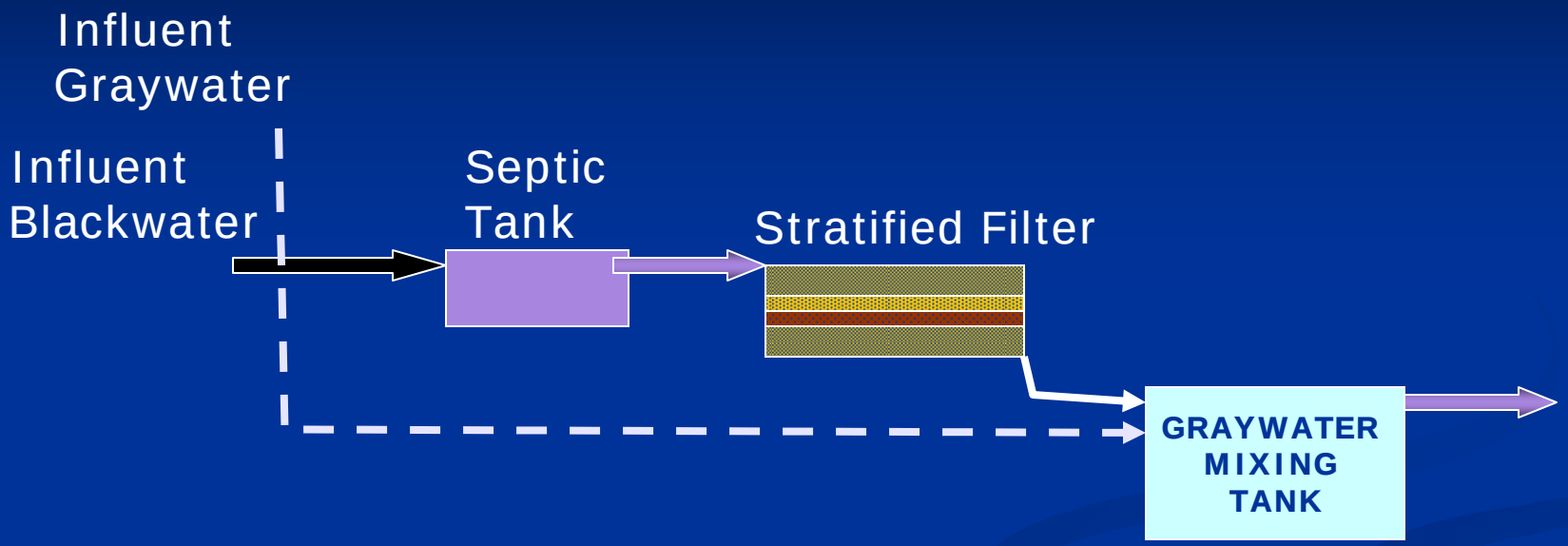
Generally <19mg/l TN, provided that the sludge level is regularly monitored. Excursions related to sludge buildup

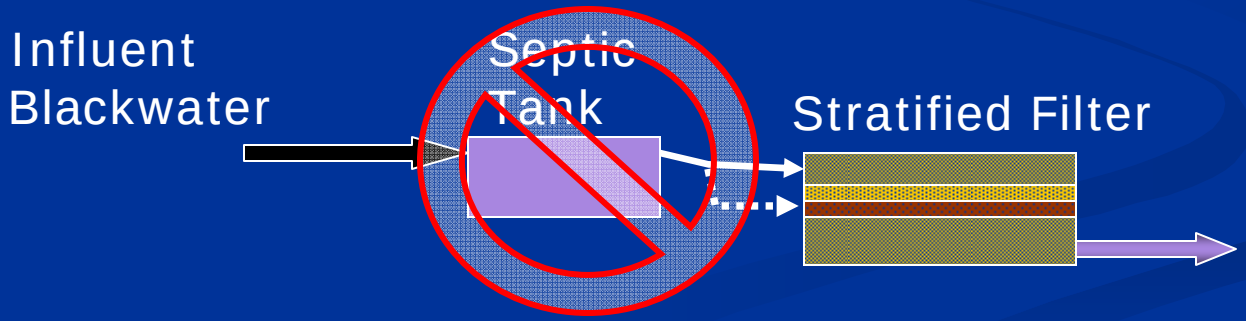

Lined
Leaching
Beds
Influent from residential housing
Amphidrome SBR
Waterloo Biofilter
MicroFAST
Geoflow Drip
Standard Septic
Tank-Leachfield
Eco-RUCK
Staff Trailer

EcoRUCK


75%
Ruck Filter
Interplay
Box
25%
Soil Absorbption System
Septic Tank

RUCK and ECO-RUCK





ETV

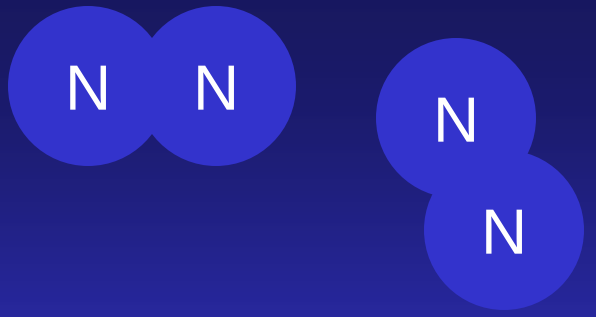
Environmental

Technology

Verification

One system 14 months

Nitrogen Removal



2 Years, biweekly sampling

E T I

Environmental Technology Initiative

14 months monthly sampling -stresses

E T V

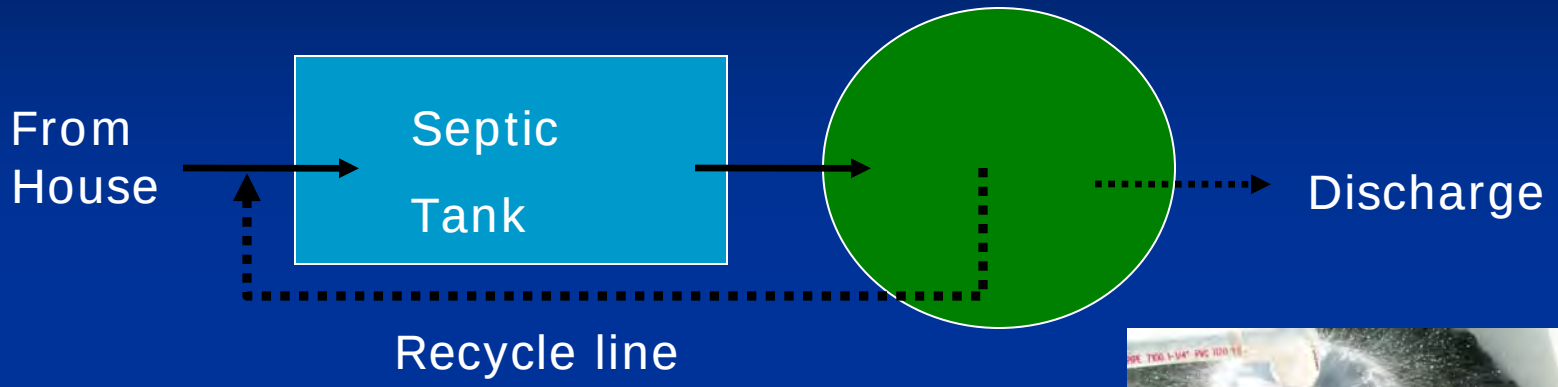
Environmental Technology Verification

28 week – 3x/week sampling -stresses

Standard 245

The evolution of a standard

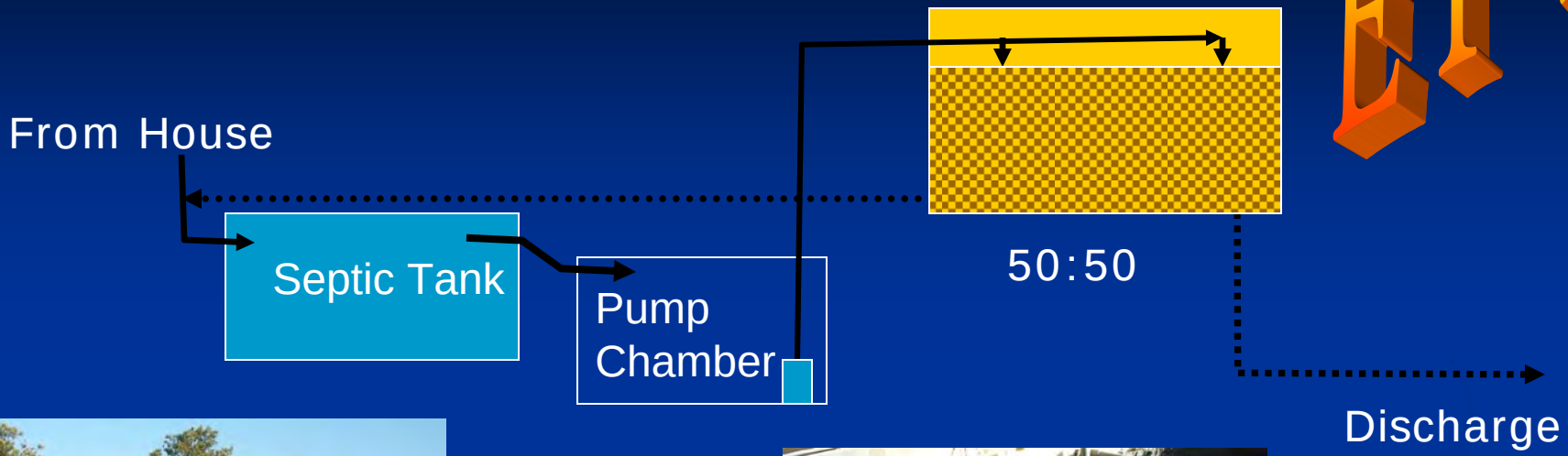
Bioclere



	Effluent (TN mg/l)	Influent (TN mg/l)
Mean	15.6	37.9
Median	13.5	38.0
Count	52	82


A.W.T. ENVIRONMENTAL INC.
241 DUCHAINE BLVD.
NEW BEDFORD, MASS. 02745
MODEL W/G-550 S/N 133
500 GPG
NSF STANDARD 40 CLASS 1

Waterloo Biofilter



SEPTITECH

From House

SEPTITECH UNIT

SEPTIC TANK

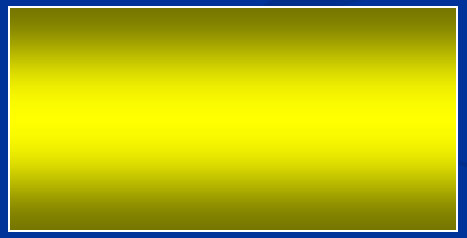
	Influent TN (mg/l)	Effluent TN (mg/l)
Mean	38.0	13.8
Median	38.0	13.8
Count	98	57


CAVOSSA
CAT
315
CAT
CAVOSSA

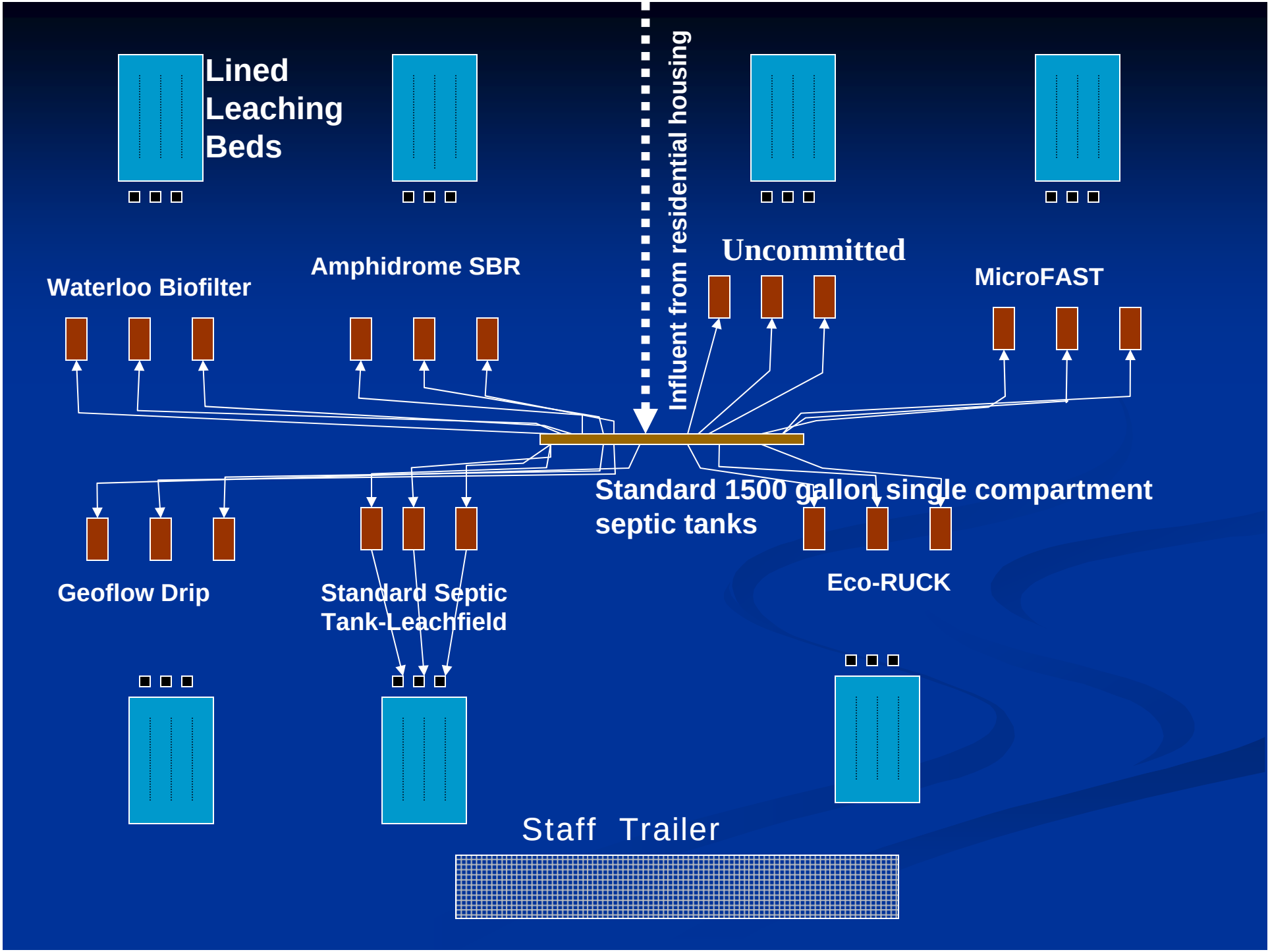
OTHER

UNITS

BEING



TESTED


Lined
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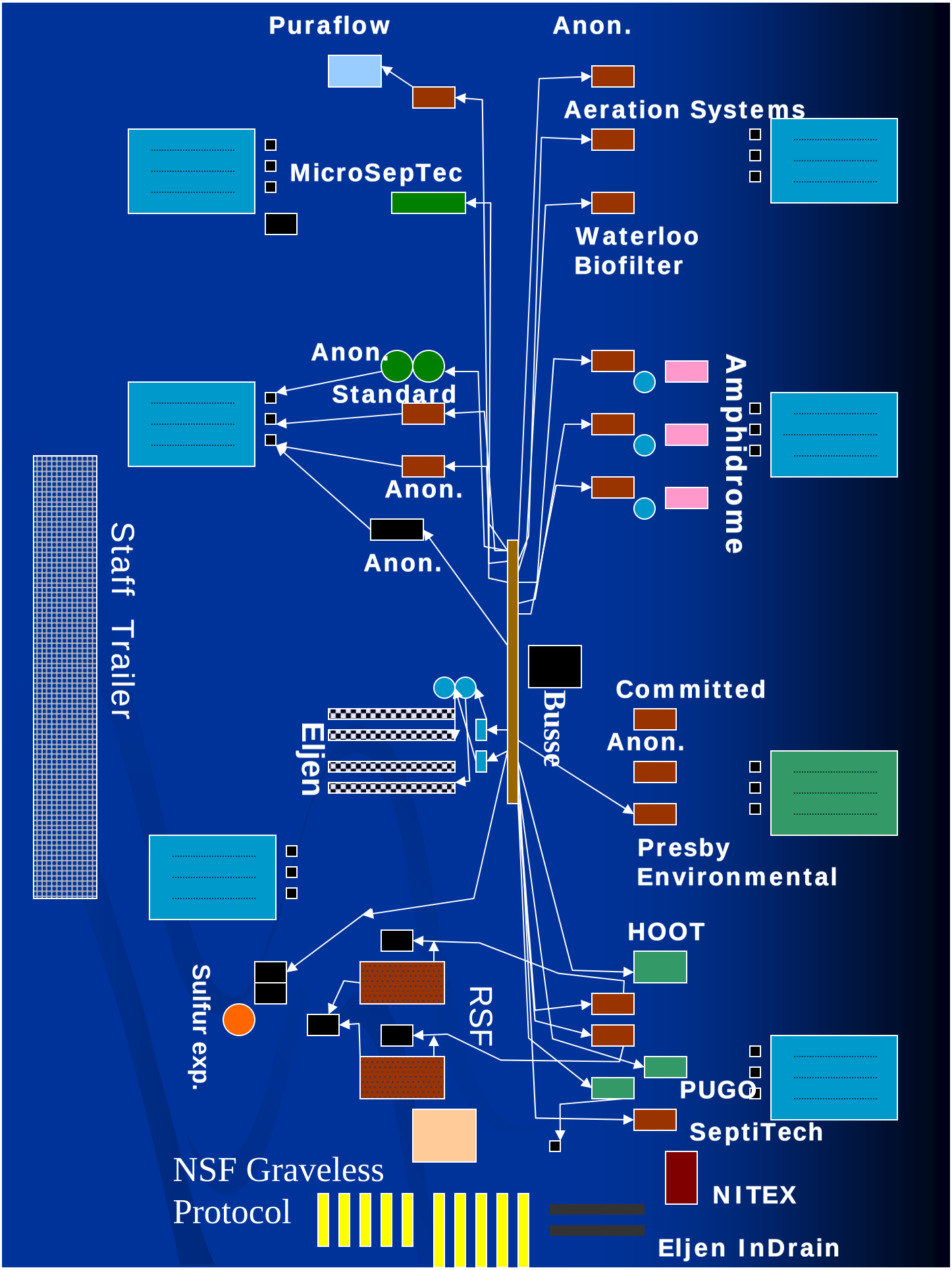
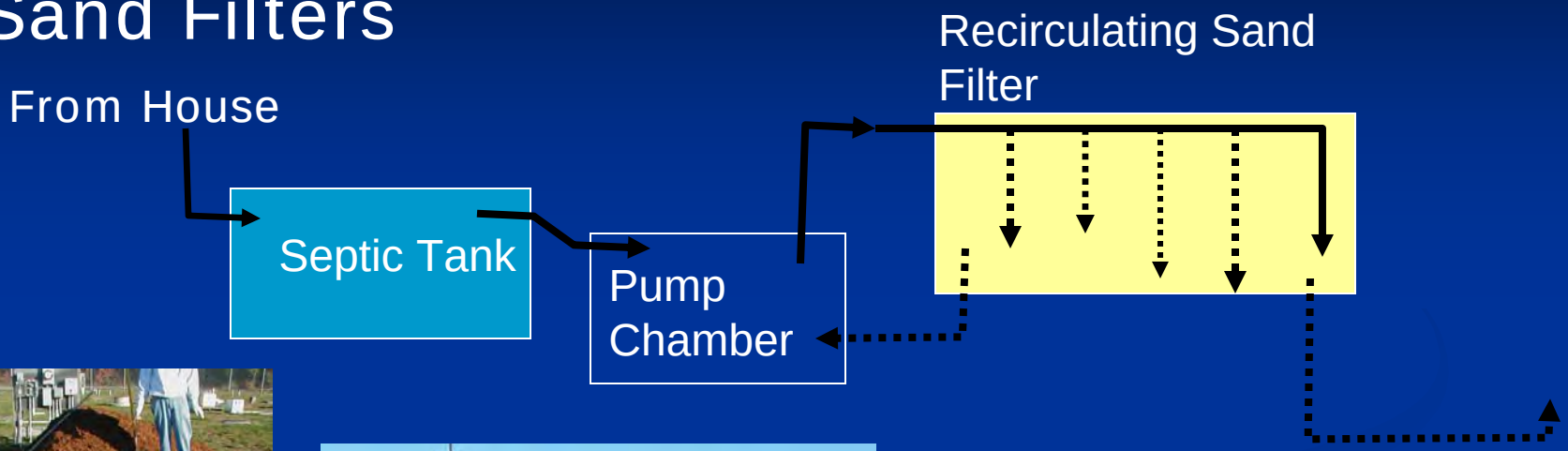
Standard 1500 gallon single compartment
septic tanks
Geoflow Drip
Standard Septic
Tank-Leachfield
Eco-RUCK
Staff Trailer

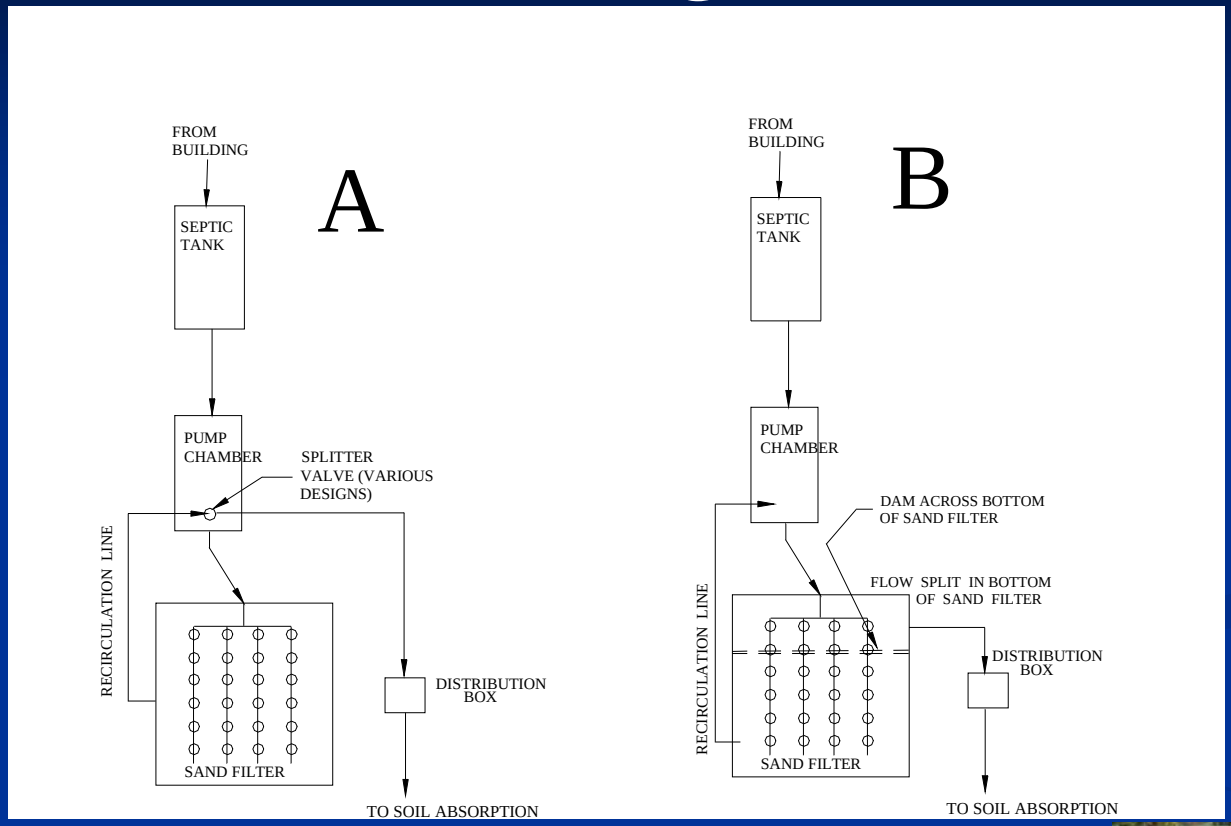

Puraflow
Anon.
Aeration Systems
MicroSepTec
Waterloo
Biofilter
Anon.
Standard
Anon.
Anon.
Amphidrome
Staff Trailer
Busse
Committed
Anon.
Eljen
Presby
Environmental
HOOT
Sulfur exp.
RSF
PUGO
SeptiTech
NSF Graveless
Protocol
NITEX
Eljen InDrain

RSF Recirculating Sand Filters



Generally expect TN~ 20-25 mg/l, but there are possibilities for higher removal rates with design modifications and oversight.

Recirculating Sand Filter



Nitrex

From House

Septic Tank

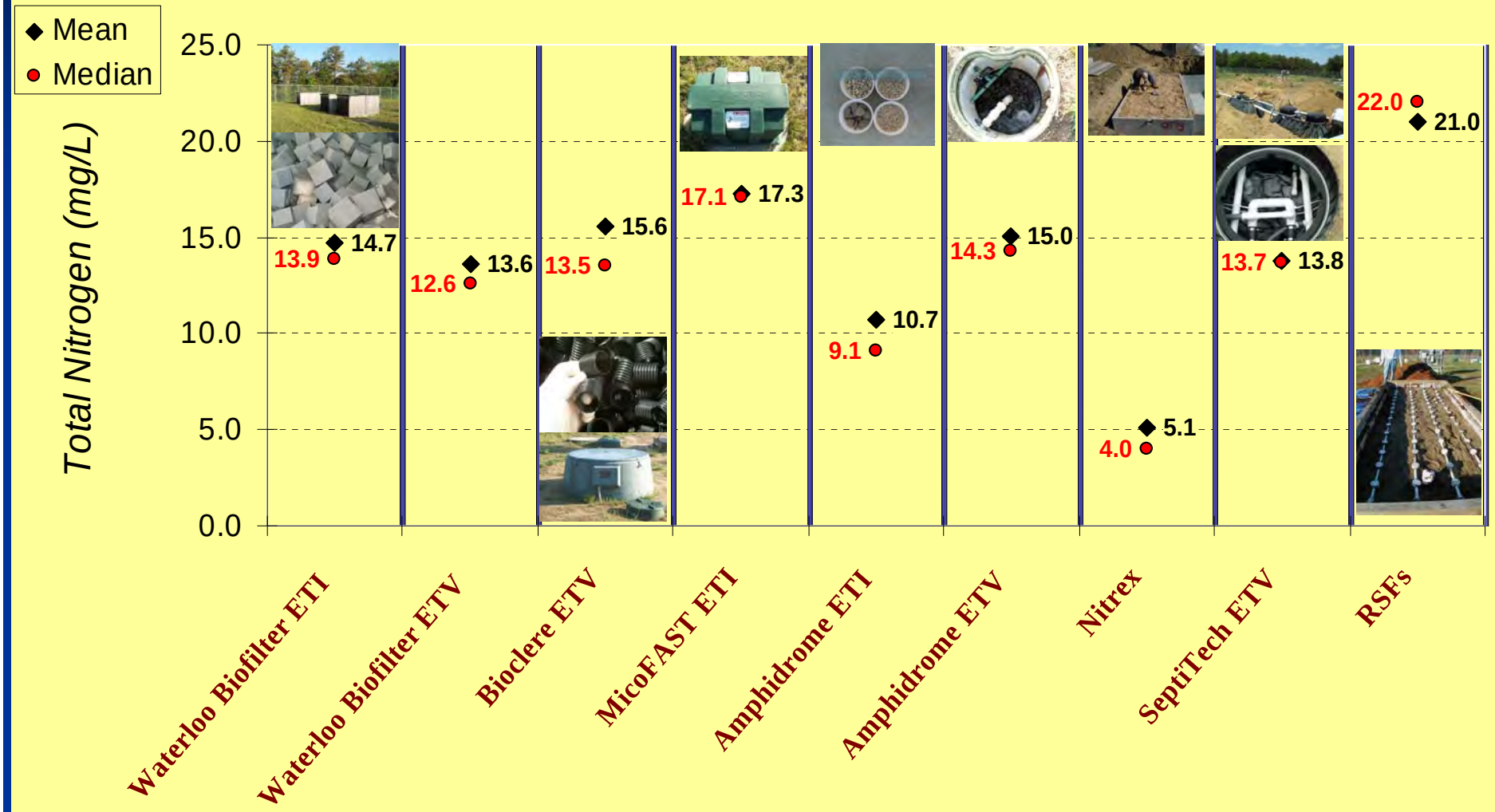
Pump Chamber

Recirculating Sand Filter

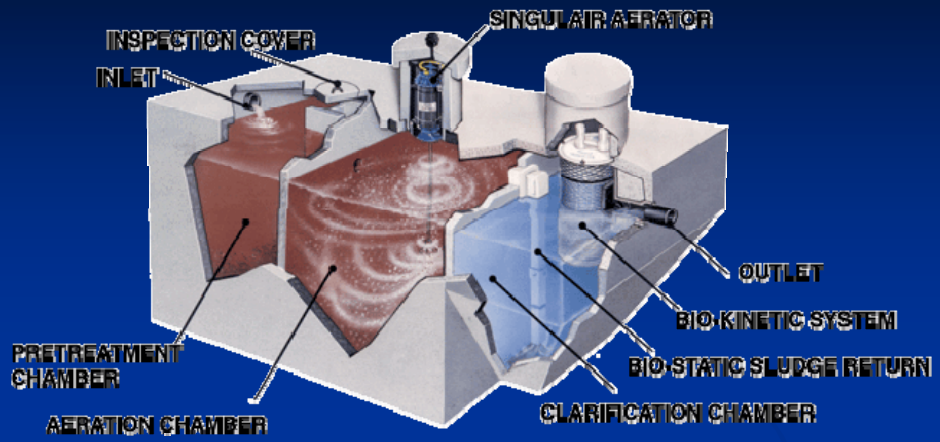
Nitrex Filter

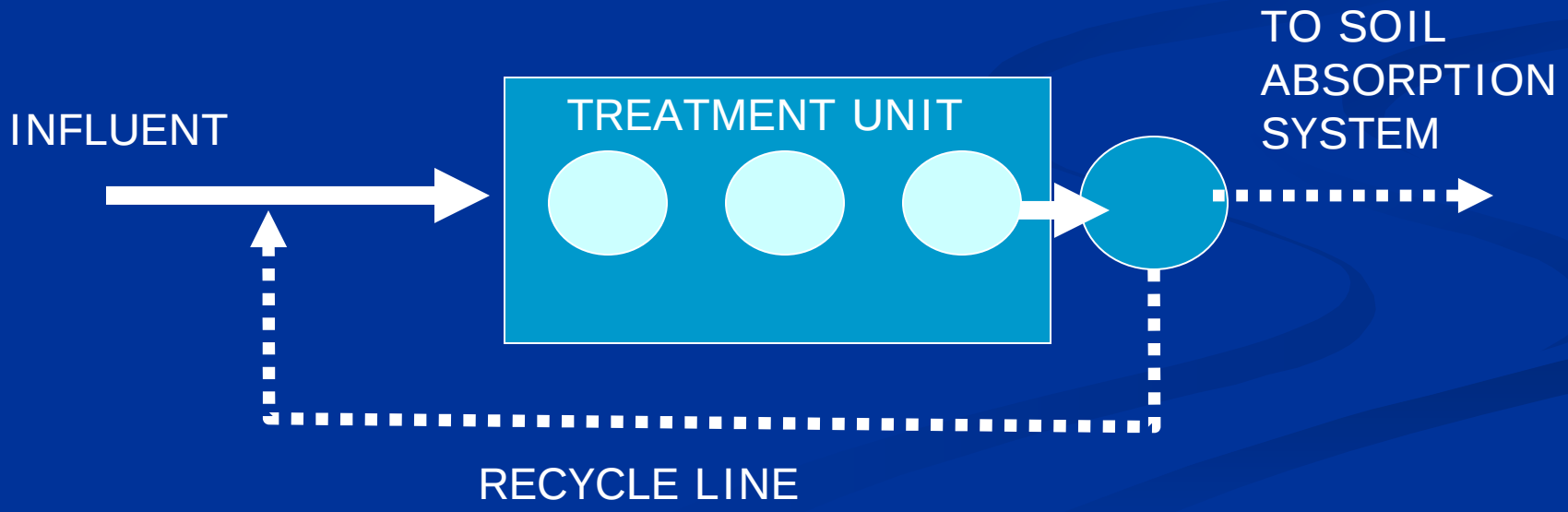
Discharge

Performance Comparison of Selected Denitrification Systems Tested at the Massachusetts Alternative Septic System Test Center 1999-2004.



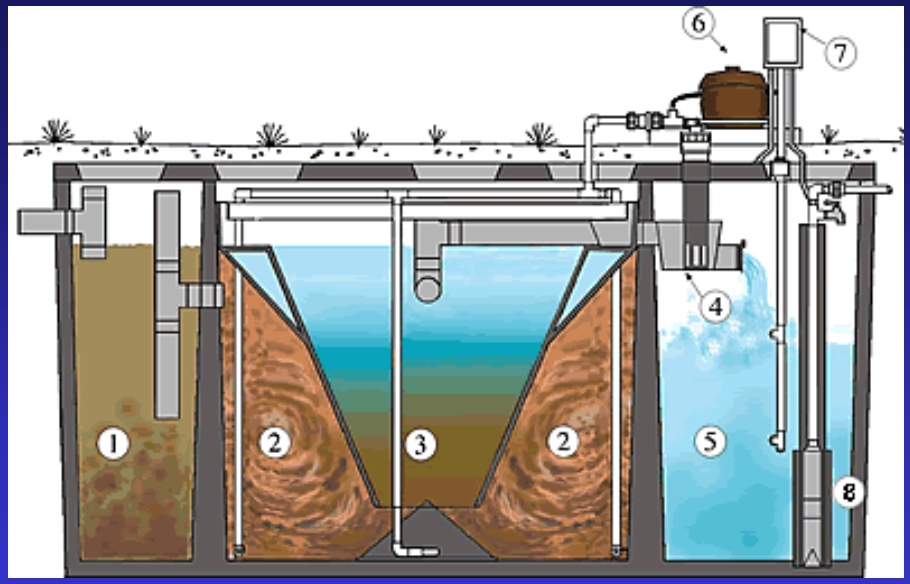
Norweco R&D


INSPECTION COVER
INLET
SINGULAIR AERATOR
OUTLET
BIO-KINETIC SYSTEM
BIO-STATIC SLUDGE RETURN
CLARIFICATION CHAMBER
PRETREATMENT CHAMBER
AERATION CHAMBER


INFLUENT
TREATMENT UNIT
TO SOIL ABSORPTION SYSTEM
RECYCLE LINE

MicroSeptec R&D

HOOT



Presently repeating a Standard 245 following a successful test in Texas

www.hootsystems.com/systems/hoot.html

HOOT

Puraflow™

Treatment using peat

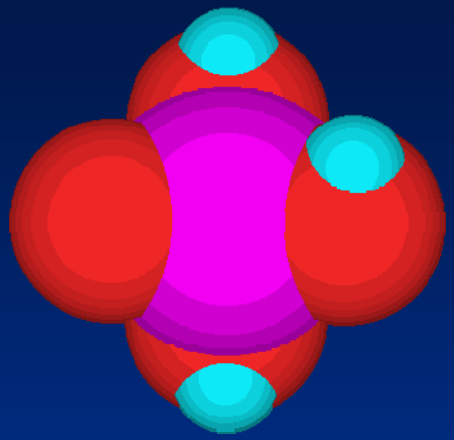
Partial List of Particiupants in Testing at the Massachusetts Alternative Septic System Test Center

Std. Septic Tank-Leach Trench	ETI, R&D, Other
Amphidrome®	ETI, ETV, R&D
Waterloo Biofilter®	ETI, ETV, R&D For Denitricifation
Waterloo Biofilter® (Single Pass)	Other
GeoFlow® Drip	ETI
MicroFAST®	ETI, R&D
Bioclere®	ETV, NSF STD40
SeptiTech®	ETV
Nitrex	Other (denite)

MicroSeptec®	Other
EcoPure®	Other
Zabel Scat®	Other
ReCip®	ETV
Piranha	Other
RSFs (Generic)	ETI, R&D, Other
OAR (Microbiological Enhancement)	R&D, Other
Phosphex	Phosphorus Removal
PhosRID	Phosphorus Removal

Special Projects

Phosphorus - No free Ride



PROJECT SUMMARY

Test five onsite technologies for phosphorus removal capability.

Report available on technologies tested as well as a review of relevant literature.

One technology (PhosRID®) continues research and development at MASSTC.

The RID ™ unit

Total Phosphorus.
Mean 5.2 mg/l
Median 5.2 mg/l

Total Phosphorus
Mean 3.9 mg/l
Median 4.1 mg/l

Iron Dissolution (solubilized iron combines with phosphate)

Total Phosphorus.
Mean 0.2 mg/l
Median 0.3 mg/l

Septic Tank

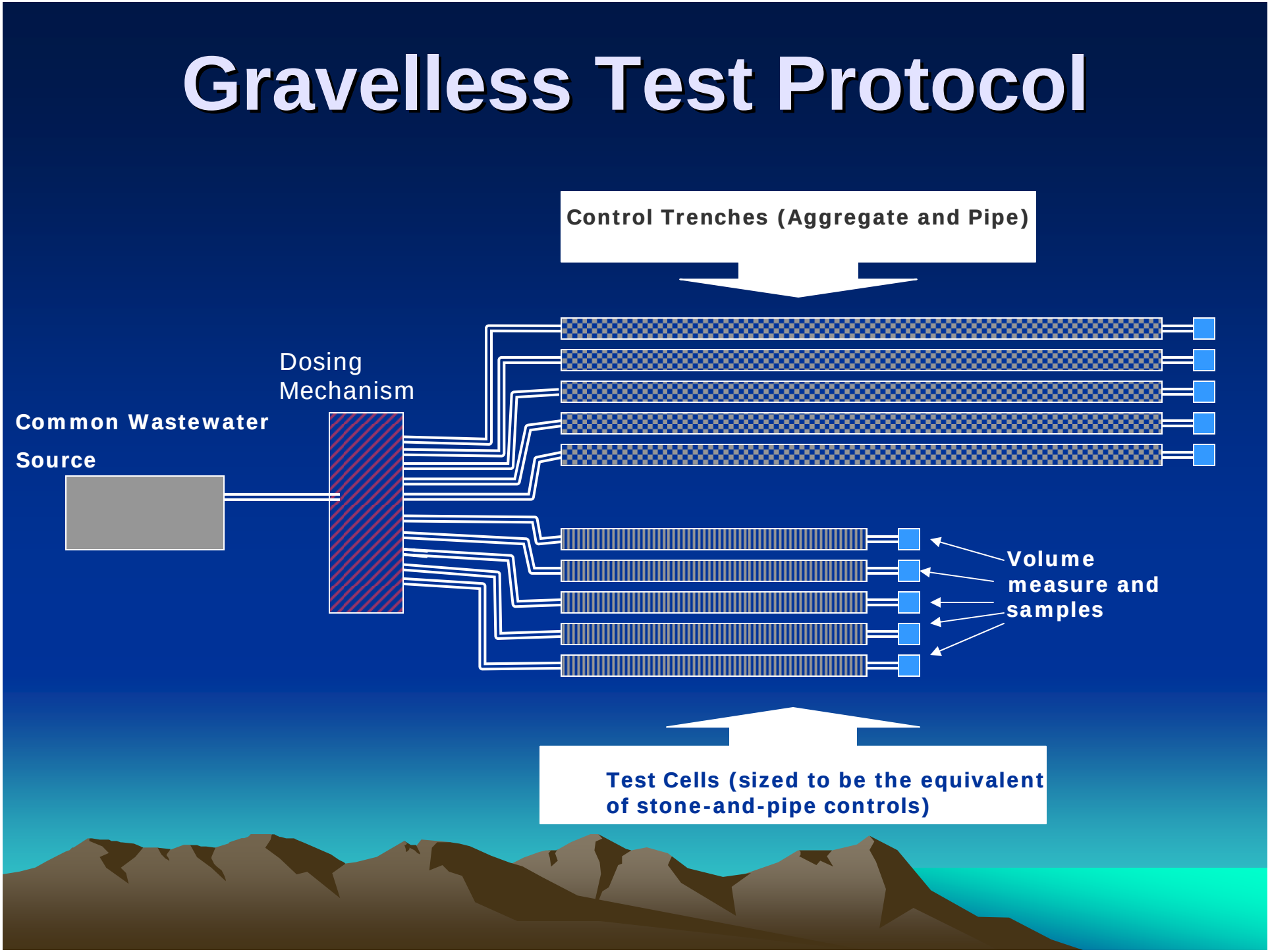
Soluble iron compounds containing phosphorus precipitate on sand filter

Remaining iron-phosphorus compounds precipitate on sand as strengite

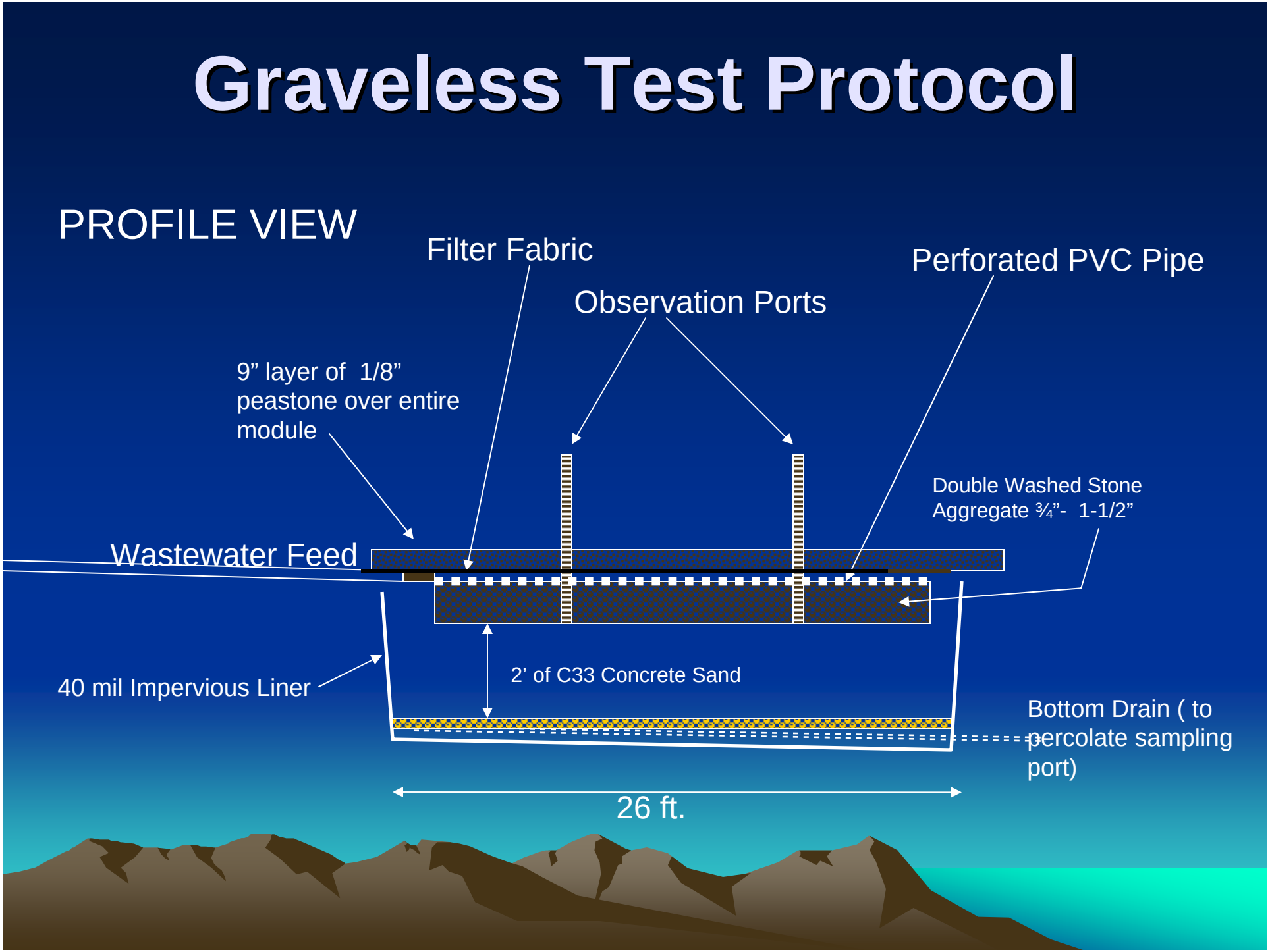
Influent

Mean 5.7 mg/l
Median 5.7 mg/l

Gravelless Test Protocol

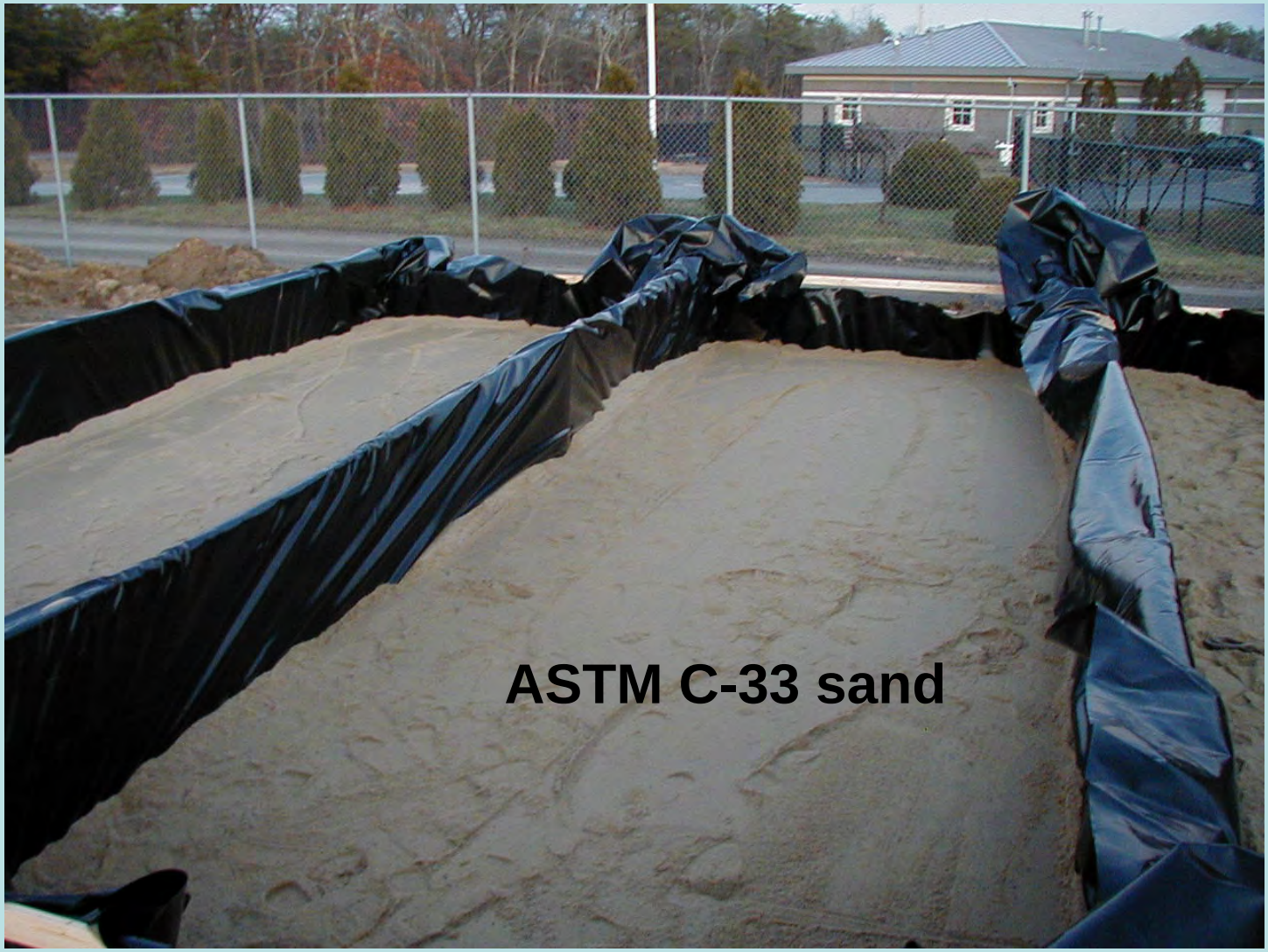


Graveless Test Protocol



Each test cell was placed in its own liner. Sand was compacted in 6-inch lifts.

Each test cell was compacted to an estimated "standard" firmness to the elevation of the basal area of the soil absorption component.



After each test cell was compacted to an estimated and standard degree, soil core samples were taken to verify soil in-place properties.

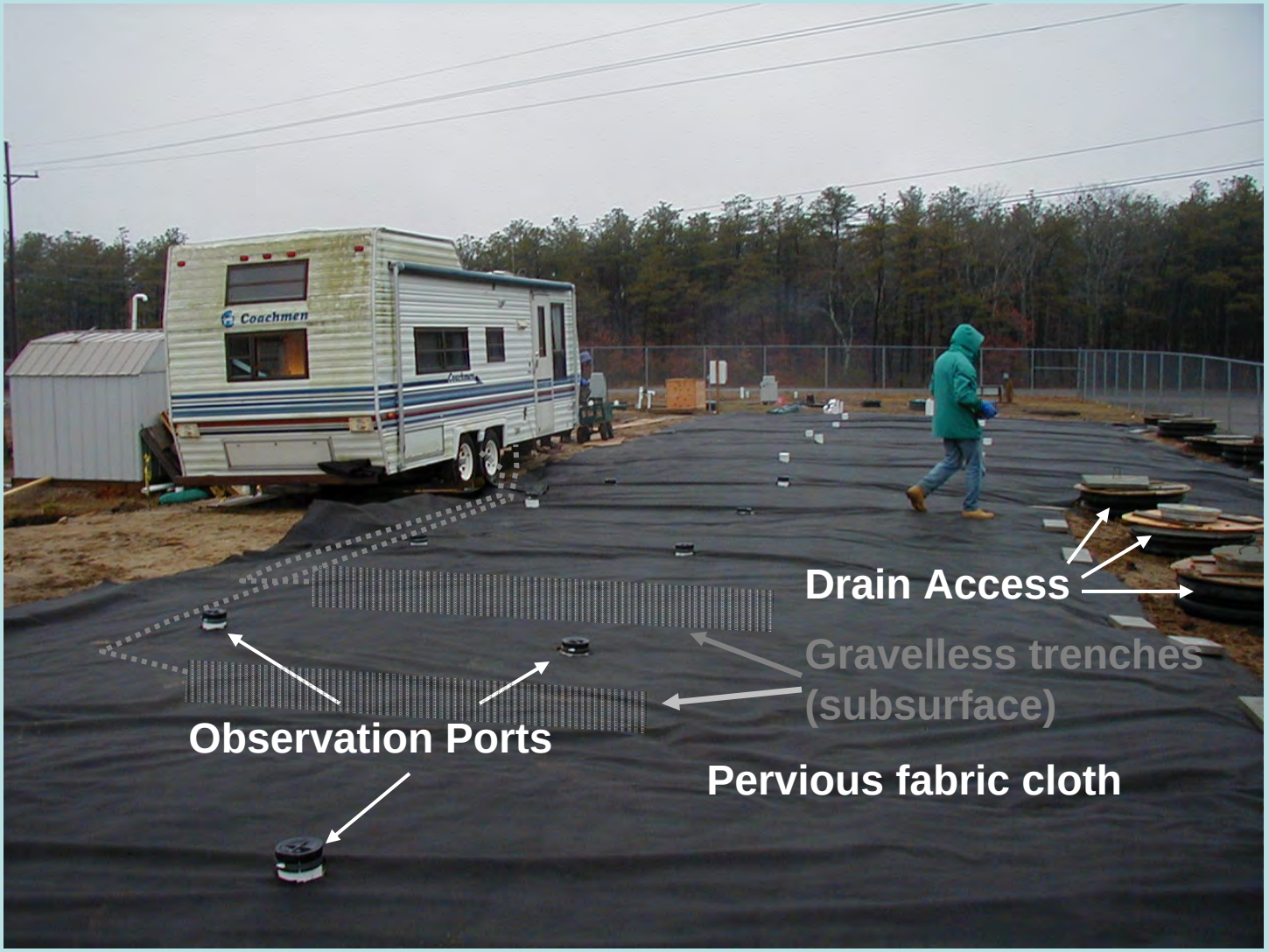
Stone trenches were constructed having the same basal width as the gravelless product.

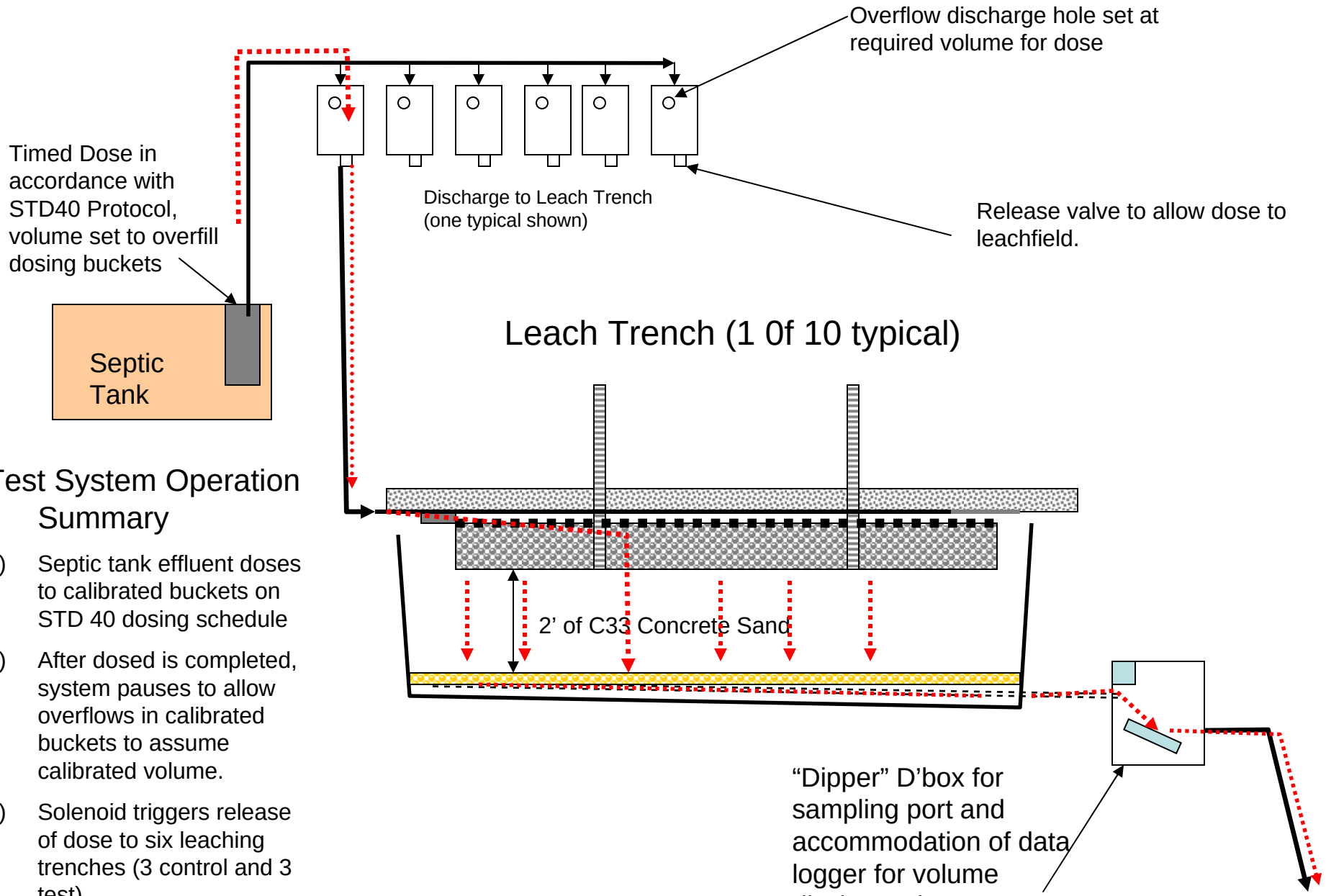
Gravelless structures were sized according to reductions (in comparison with stone trenches) specified by the manufacturer.

****Details blurred to prevent the identity of product used in pilot tests.**


Coachmen

All test cells were covered with a permeable fabric cloth to prevent plant growth.

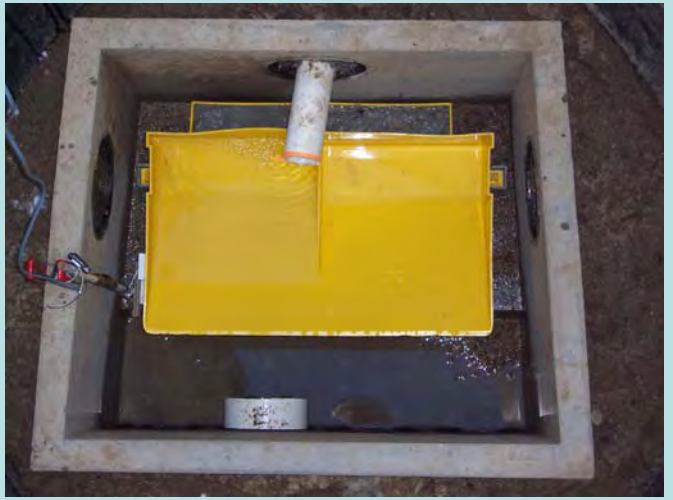




Test System Operation Summary

1) Septic tank effluent doses to calibrated buckets on STD 40 dosing schedule
2) After dosed is completed, system pauses to allow overflows in calibrated buckets to assume calibrated volume.
3) Solenoid triggers release of dose to six leaching trenches (3 control and 3 test)
4) Solenoids close and await next cycle


Coachmen



New Concepts

New Concepts

What if the wastewater was treated within the house?

Busse

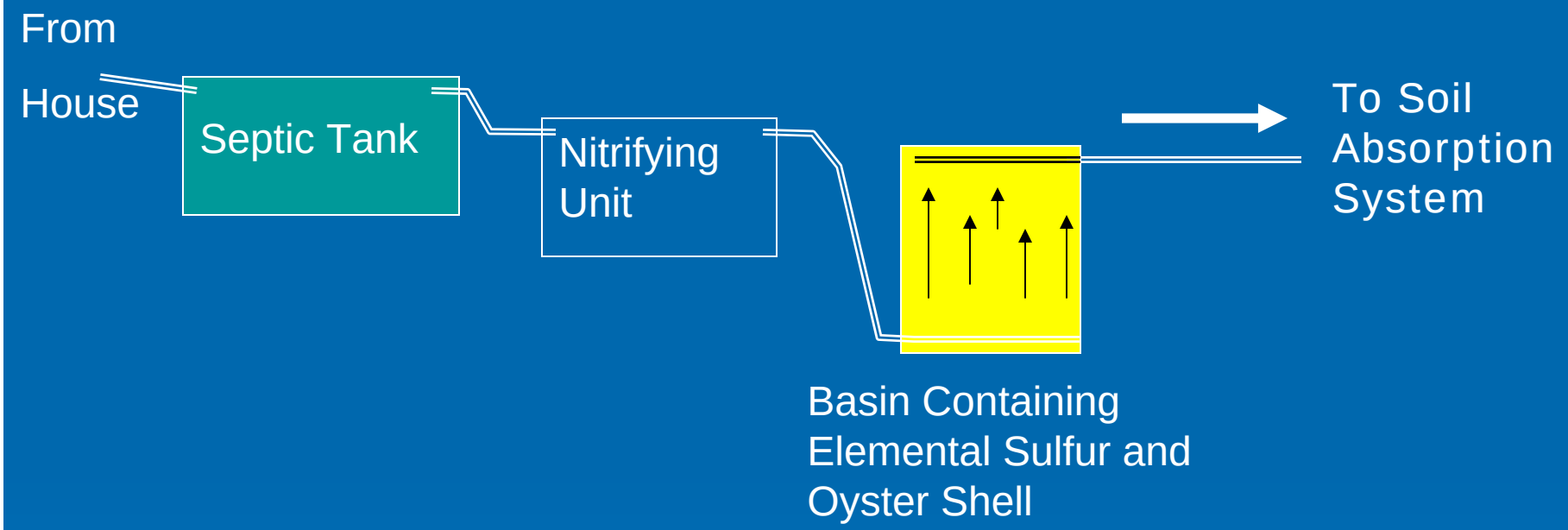
Wastewater Alternatives

Using Elemental Sulfur to Reduce Nitrate

Theoretical Basis: Nitrified effluent enters sulfur container where organisms oxidize the sulfur (reducing the nitrate to nitrogen gas). The oyster shells buffer the production of acid as the sulfur is oxidized.

Wastewater Alternatives

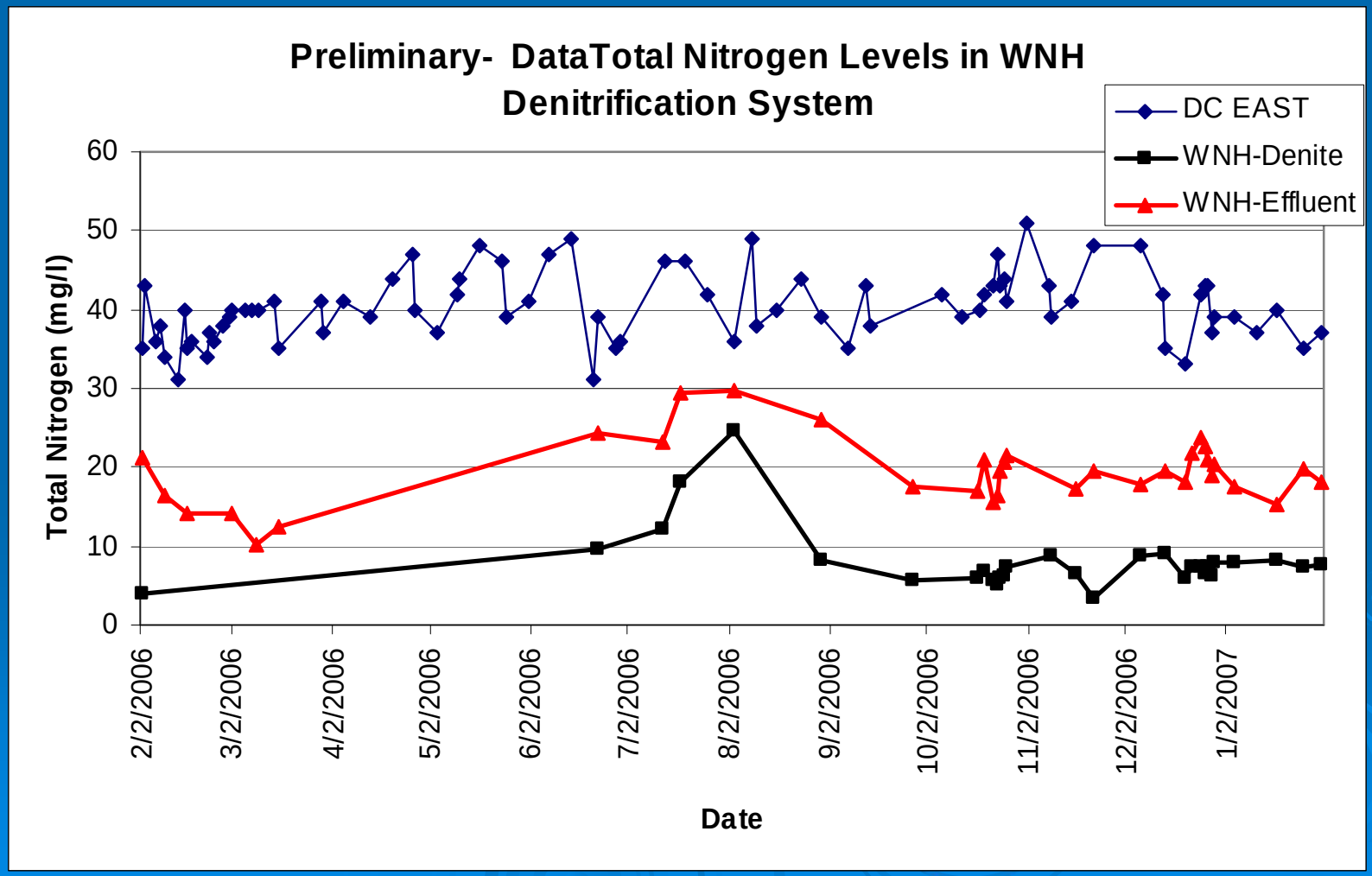
Using Elemental Sulfur to Reduce Nitrate



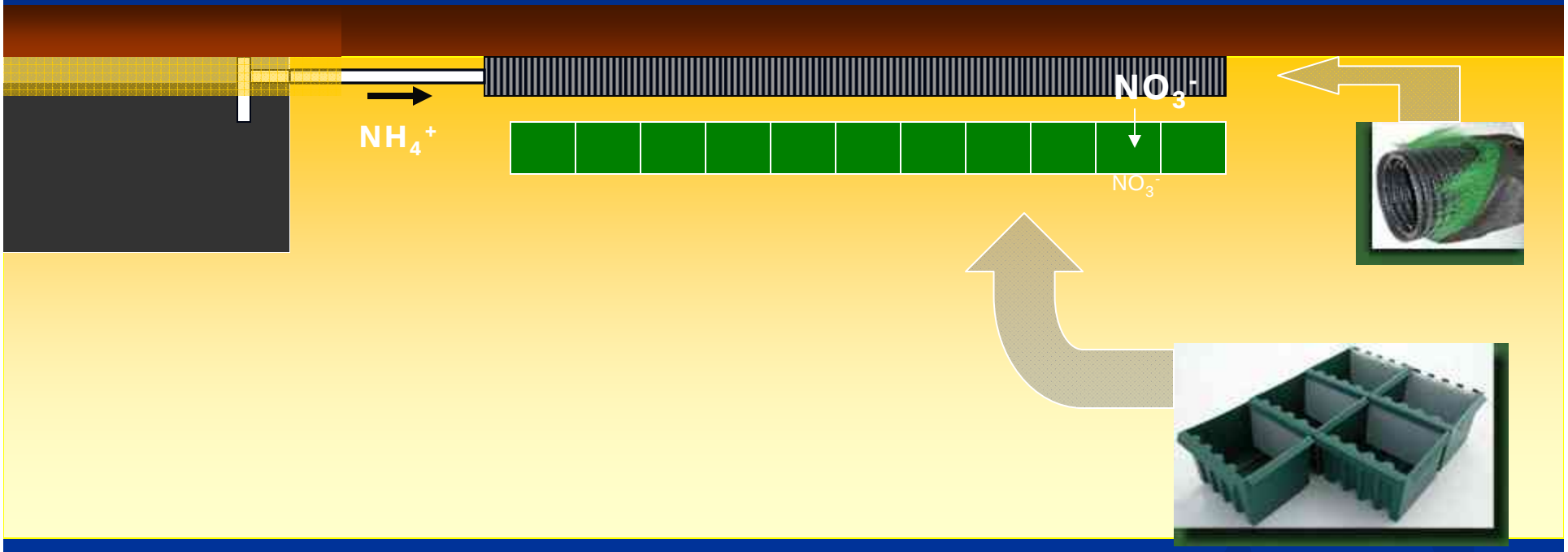
Theoretical Basis: Nitrified effluent enters sulfur container where organisms oxidize the sulfur (reducing the nitrate to nitrogen gas). The oyster shells buffer the production of acid as the sulfur is oxidized.

Wastewater Alternatives

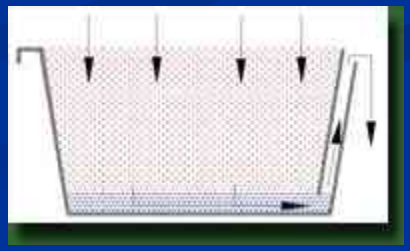
Using Elemental Sulfur to Reduce Nitrate



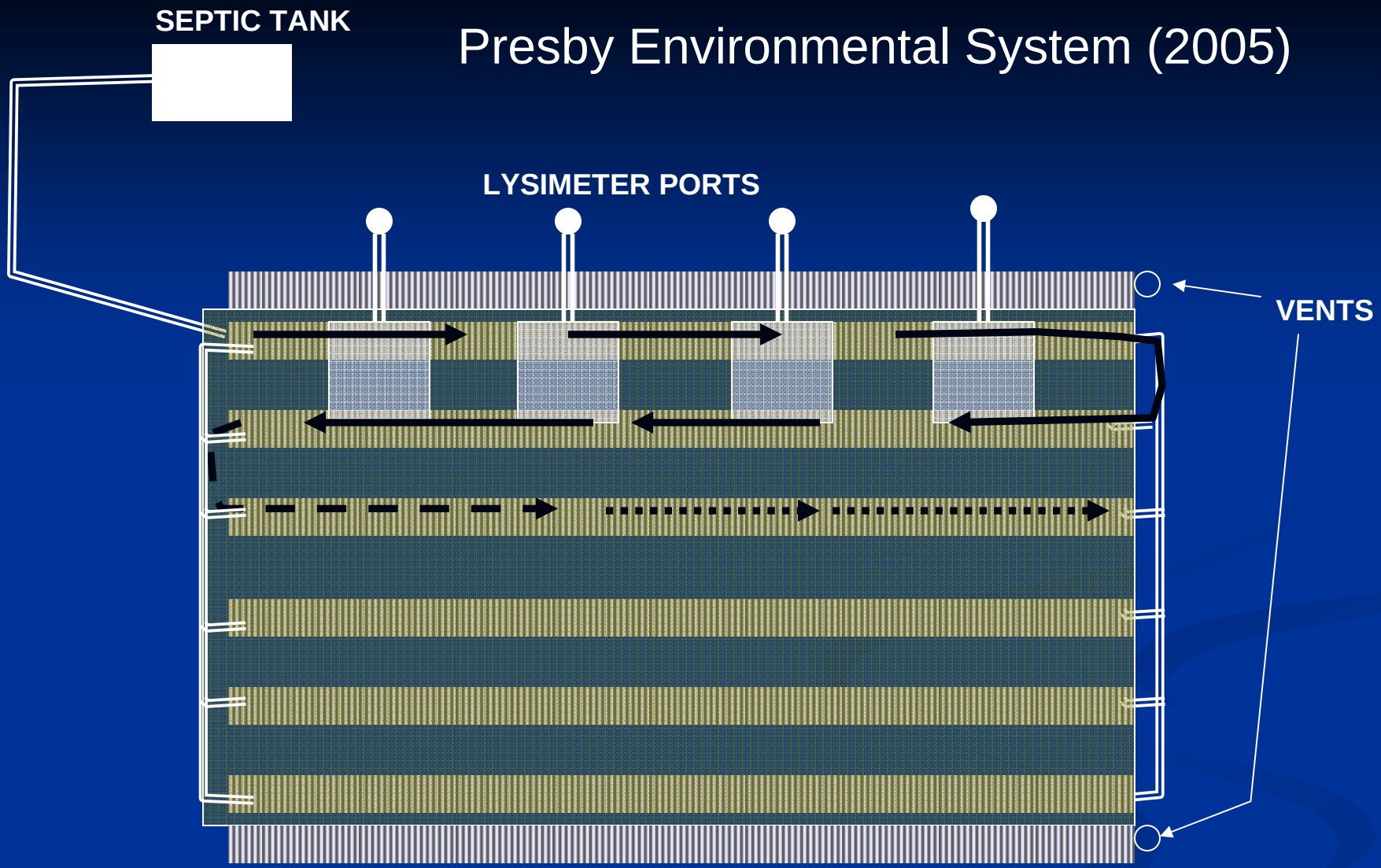
Presby Environmental - Denyte



The promise of passive denitrification



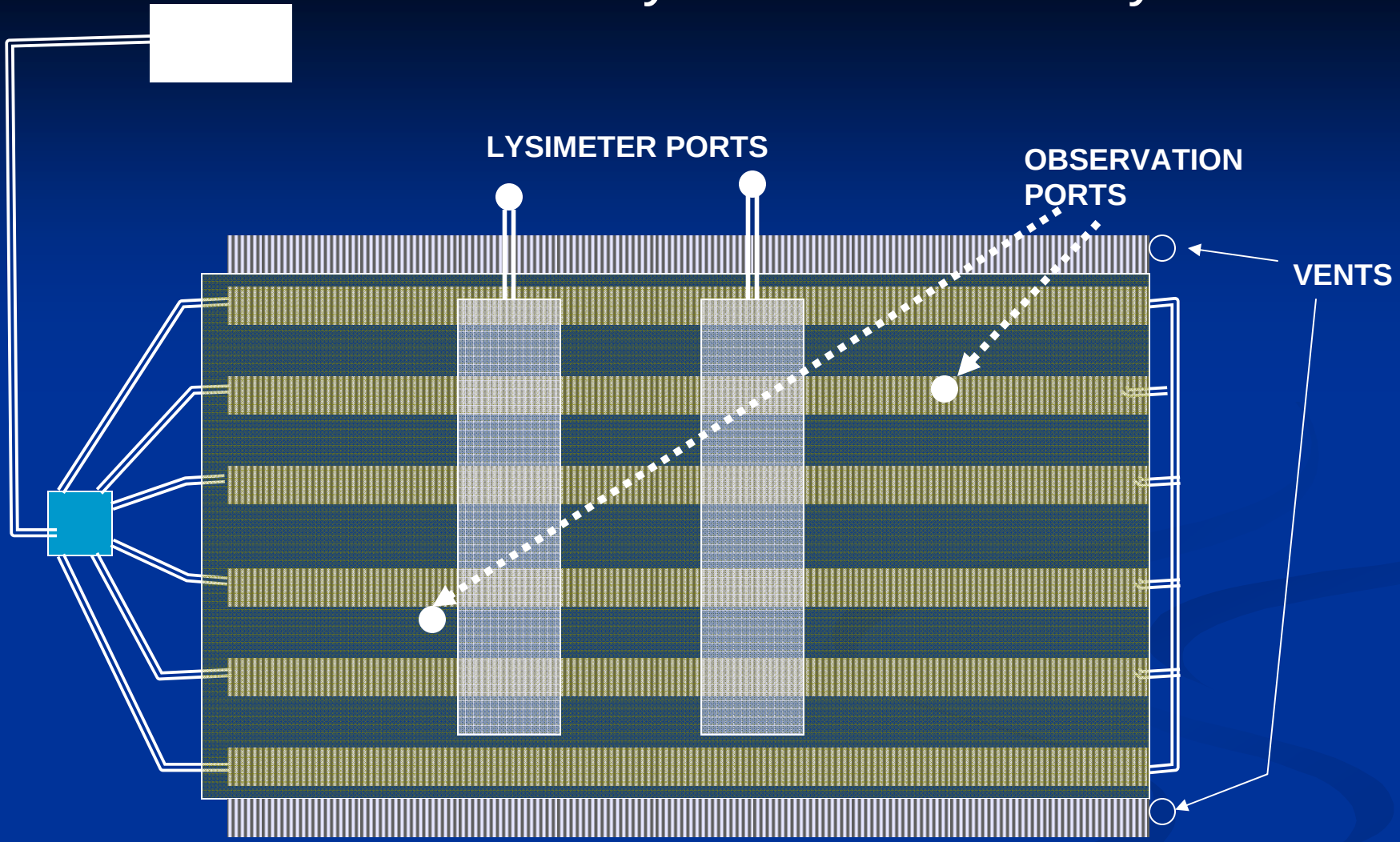
Presby Environmental System (2005)



Previous design was serially fed resulting in overloading of the carbon source in some areas and underutilization of carbon source in other areas


10/04/2007

Presby Environmental System



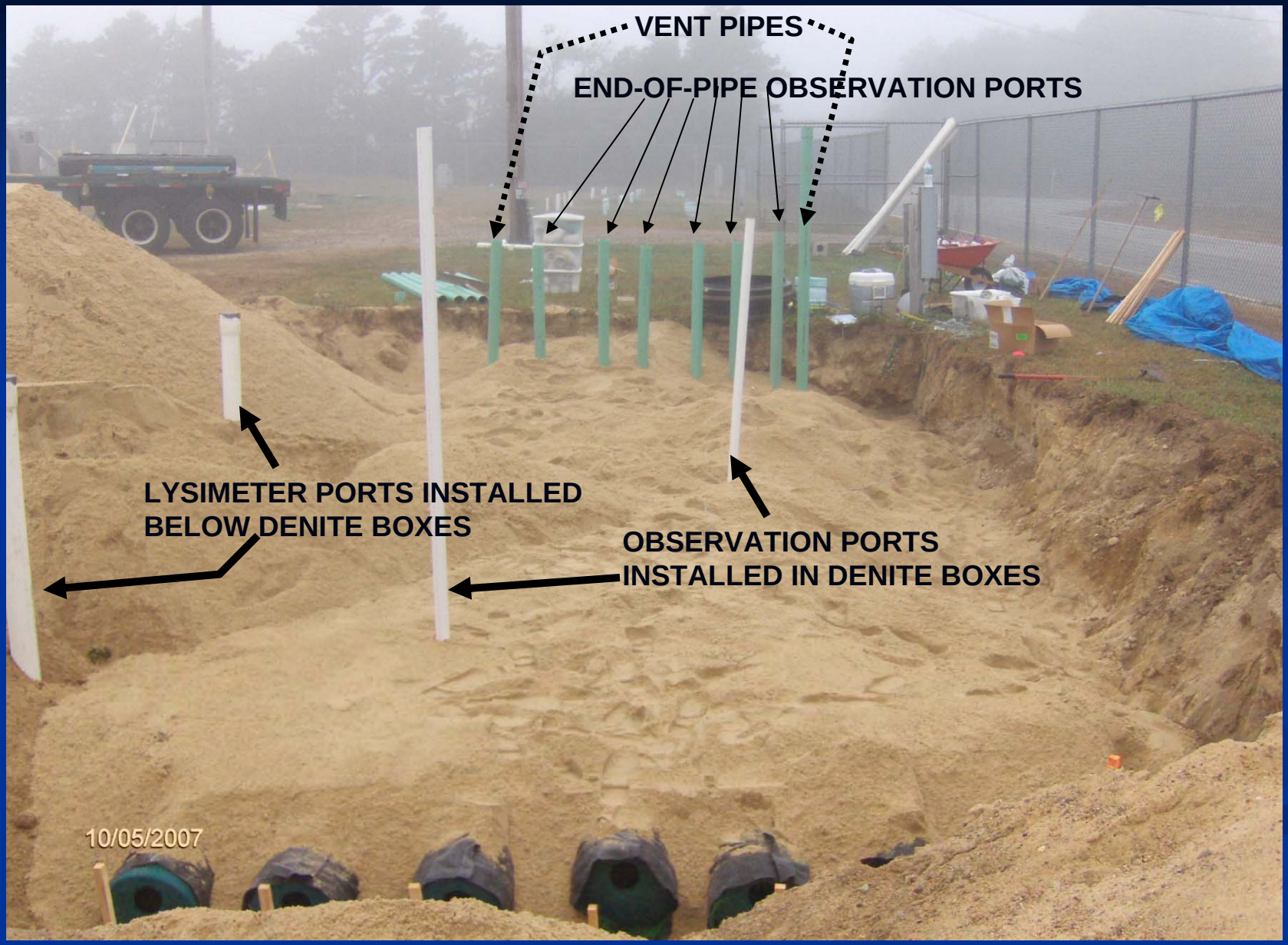
INSTALLATION OF SAMPLING LYSIMETER

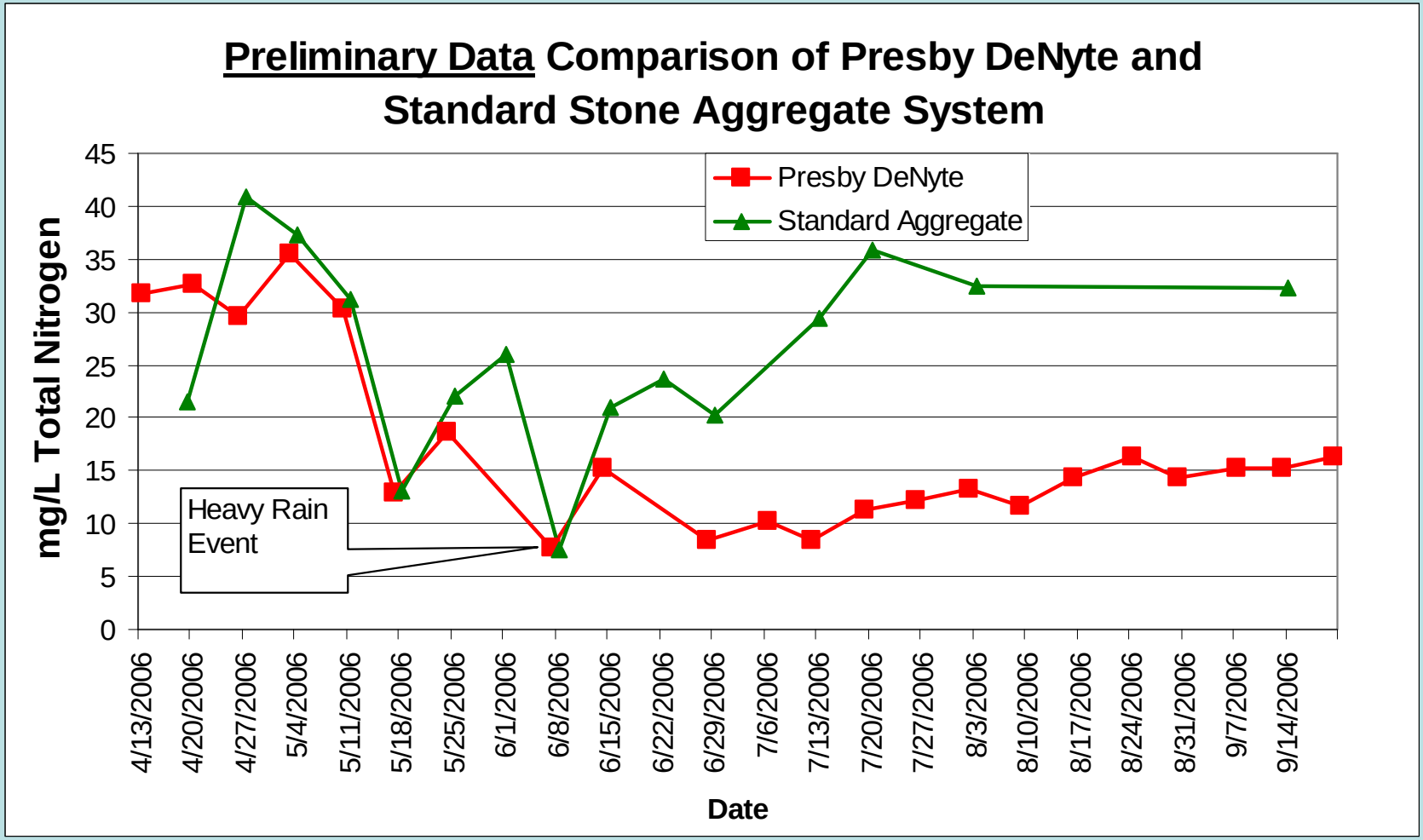
CARBON SOURCE BOXES POSITIONED BELOW THE LEACHING PIPE.

PIPE

6” OF C-33 SAND

DENITE BOX


VENT PIPES
END-OF-PIPE OBSERVATION PORTS
LYSIMETER PORTS INSTALLED
BELOW DENITE BOXES
OBSERVATION PORTS
INSTALLED IN DENITE BOXES
10/05/2007

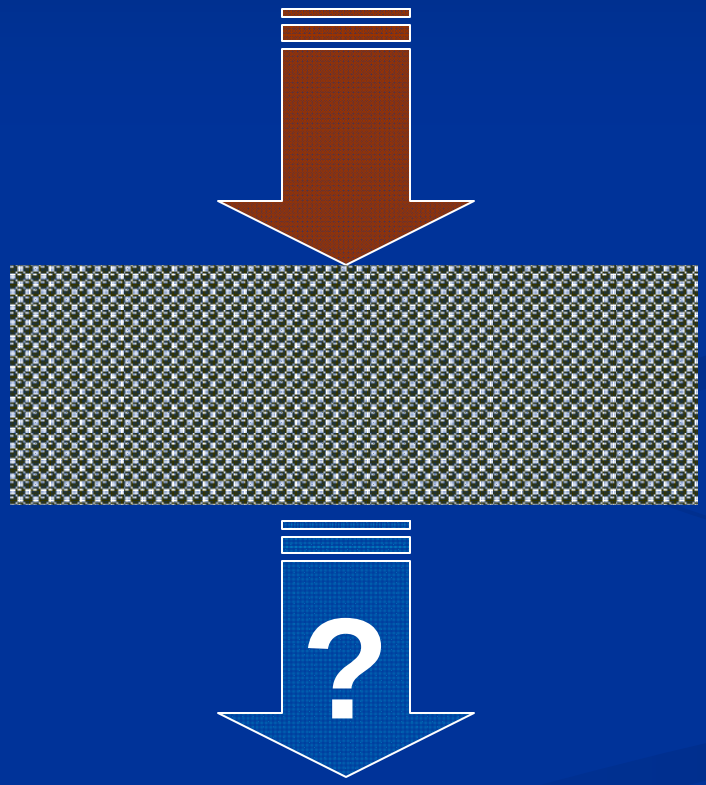

Preliminary Data Comparison of Presby DeNyte and Standard Stone Aggregate System
mg/L Total Nitrogen
45
40
35
30
25
20
15
10
5
0
Presby DeNyte
Standard Aggregate
Heavy Rain Event
4/13/2006
4/20/2006
4/27/2006
5/4/2006
5/11/2006
5/18/2006
5/25/2006
6/1/2006
6/8/2006
6/15/2006
6/22/2006
6/29/2006
7/6/2006
7/13/2006
7/20/2006
7/27/2006
8/3/2006
8/10/2006
8/17/2006
8/24/2006
8/31/2006
9/7/2006
9/14/2006
Date

Bottomless Technologies

Technologies that are situated directly on the soil and have no point discharge.

- Eljen Indrain
- Presby

How do we evaluate bottomless systems ?



Creating and underdrain to capture the percolate passing through bottomless systems.

Constructing the bottomless systems within the liner.


CAVOSSA
07/02/2007

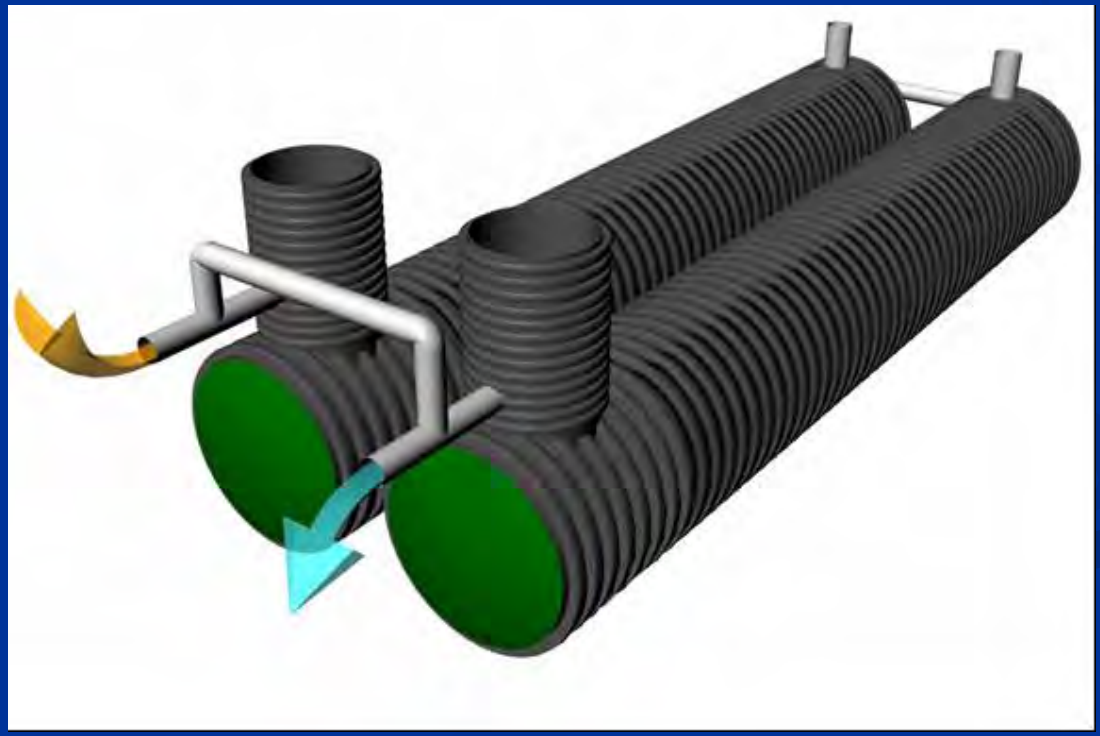

07/02/2007

Eljen Indrain is presently testing their bottomless product under three modes

- Gravity fed
- Pressure to a distribution box
- Pressure distribution

Basic Septic Tank Research

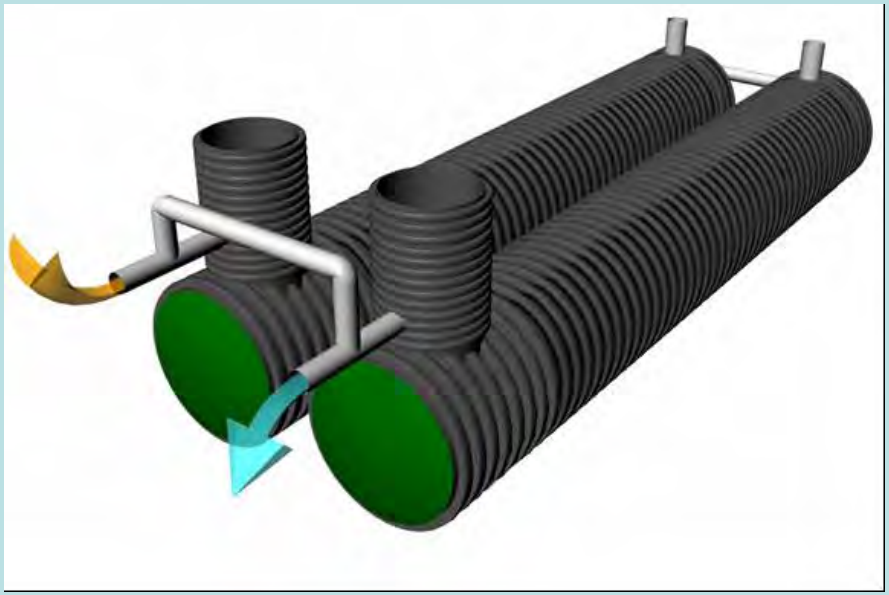
Waterloo Biofilter is conducting research and development of the WaterTube™ tank and comparing effluent results with standard one and two-chambered tanks.



Septic Tank Research

Comparing the WaterTube™ to standard concrete tanks using a "CSA B66" Protocol

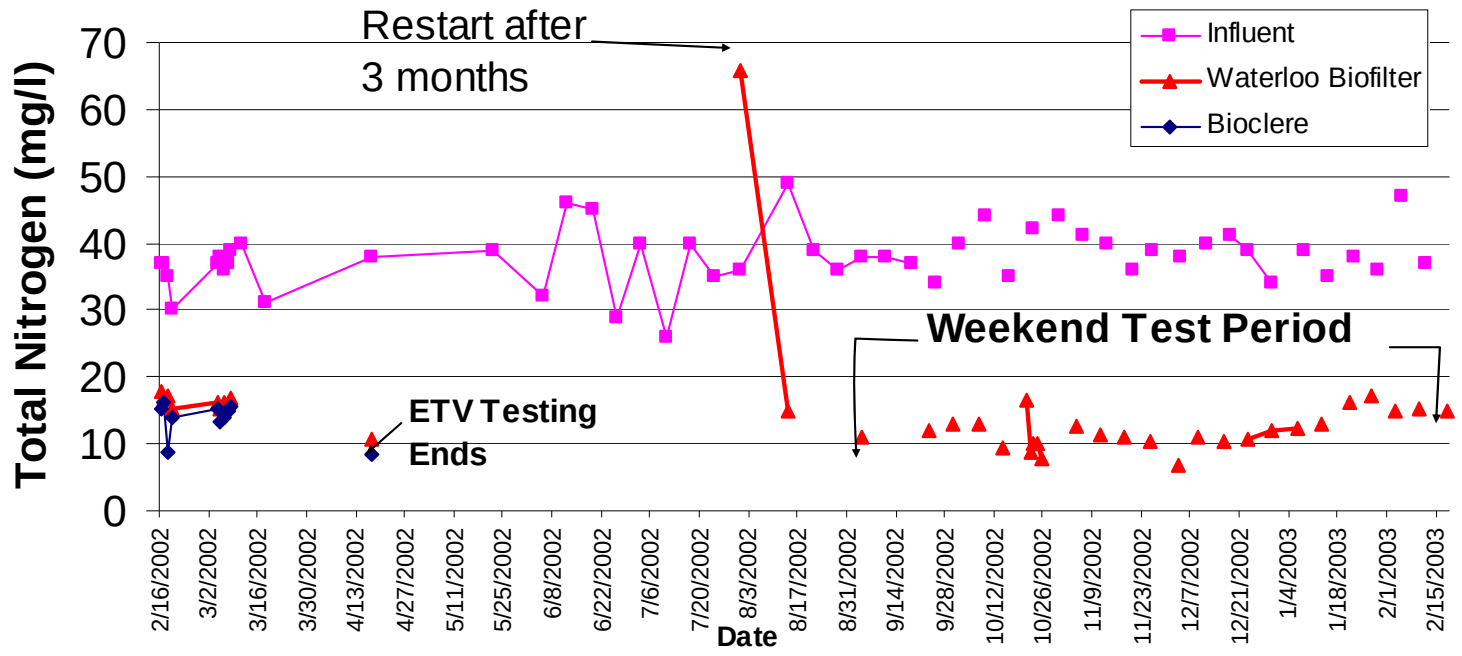
	WaterTube	Reference Tank	WaterTube: Reference Ratio
cBOD (mg/L)			
Mean	155	171	0.91
Median	155	160	0.97
TSS (mg/L)			
Mean	42	51	0.82
Median	40	45	0.89
COD (mg/L)			
Mean	303	332	0.91
Median	296	315	0.94



- 1 Year testing protocol
- Stress Tests
- 50% design flow (750 gpd)
- Cold weather (<10 deg C) for three months.

What about Seasonal applications ?

Total Nitrogen - mg/l (TKN+nitrate+nitrite) at the Discharge of the Waterloo Biofilter Operated Under a Simulation for Weekend Usage- Massachusetts Alternative Septic System Test Center

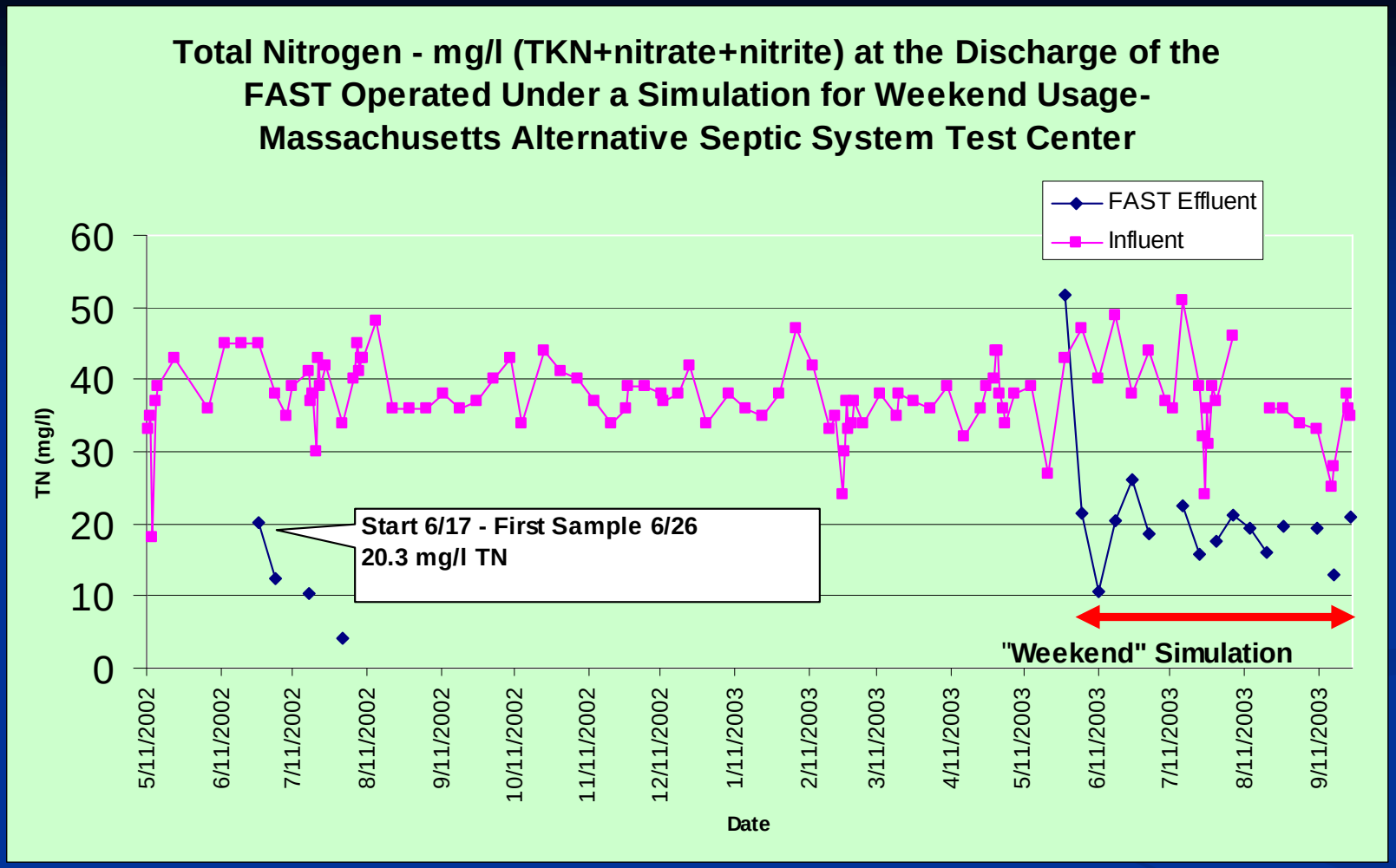


Test Protocol

Monday A.M –Thursday P.M. System Off

Friday A.M – Monday 7:00 A.M System On

Composite Sampler set Sunday 7:00 A.M.- Monday 7:00 A.M.

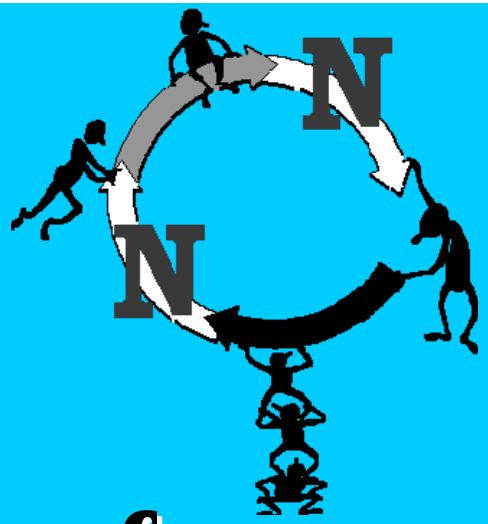


Test Protocol

Wednesday A.M. –Monday A.M. System Off

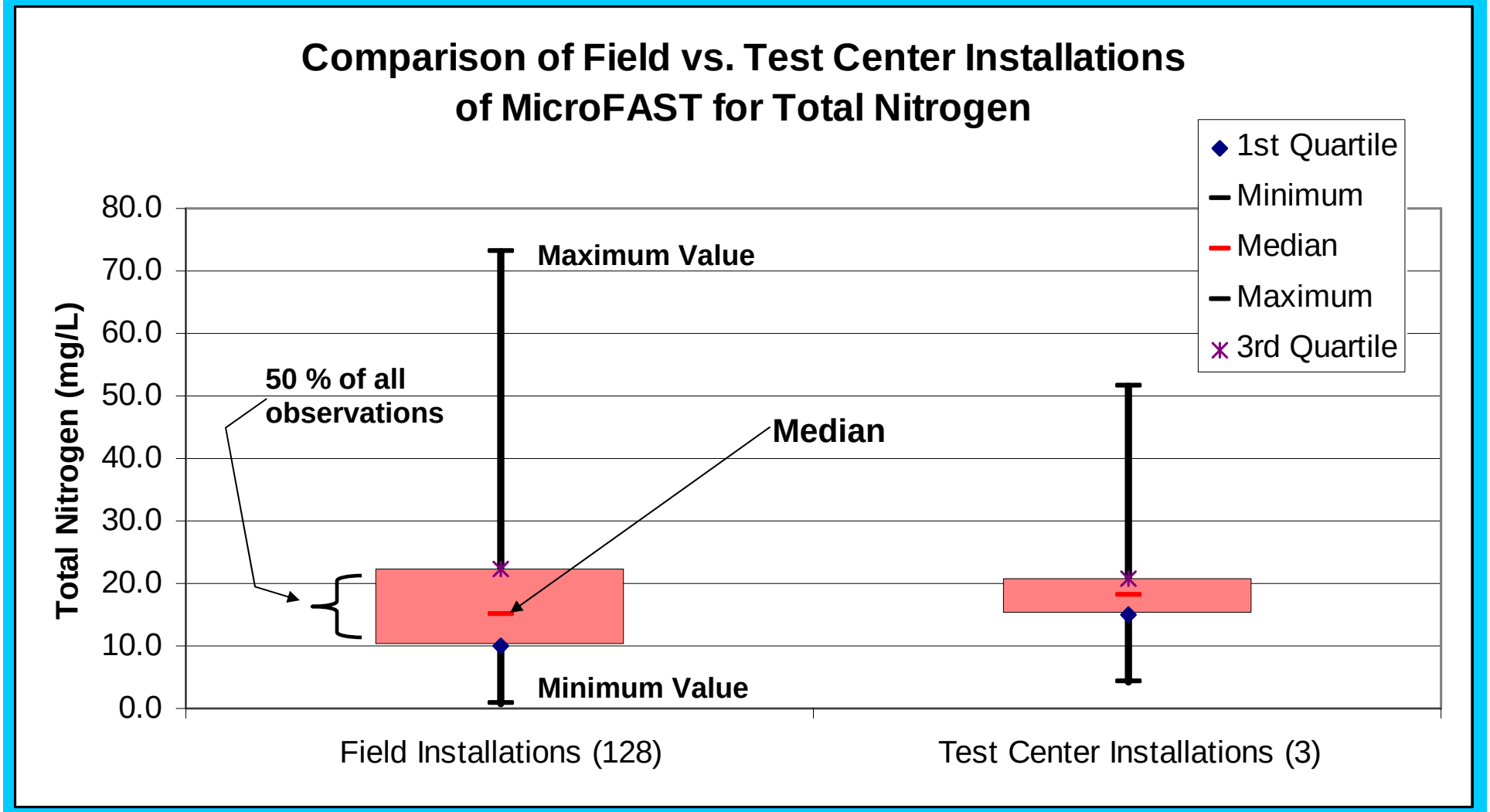
Monday A.M. – Wednesday 7:00 A.M. System On

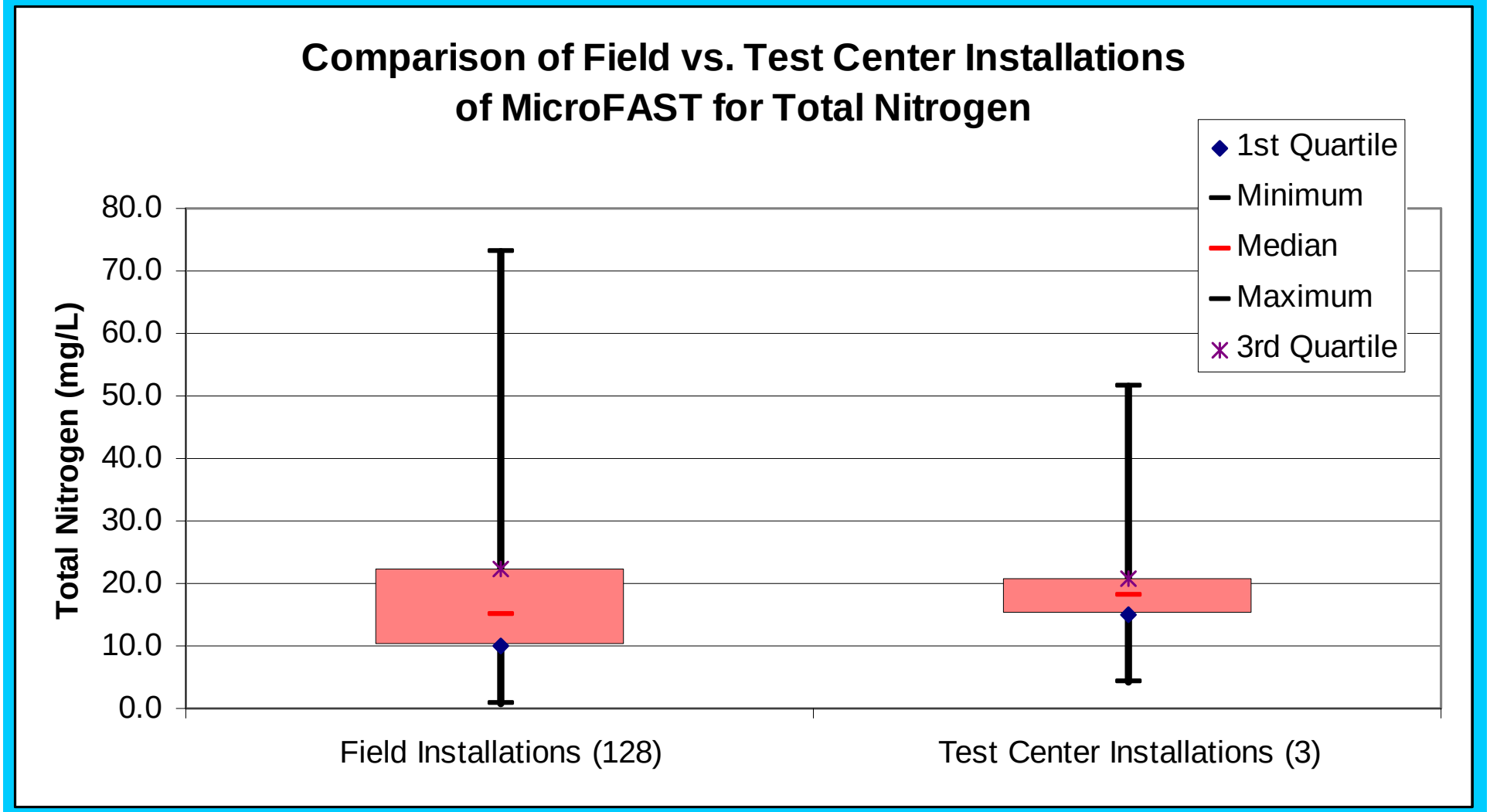
Composite Sampler set Tuesday 7:00 A.M.- Wednesday A.M.

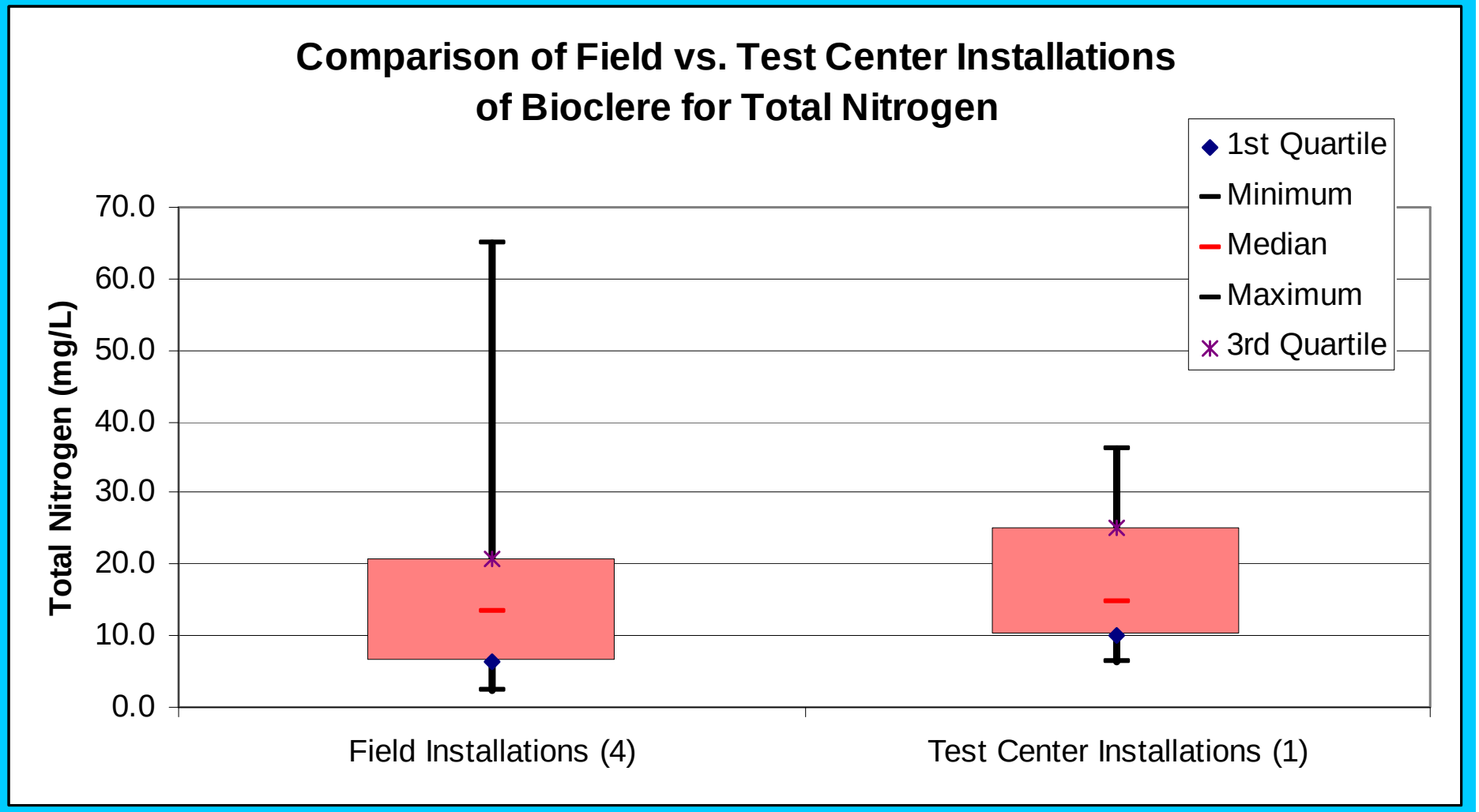


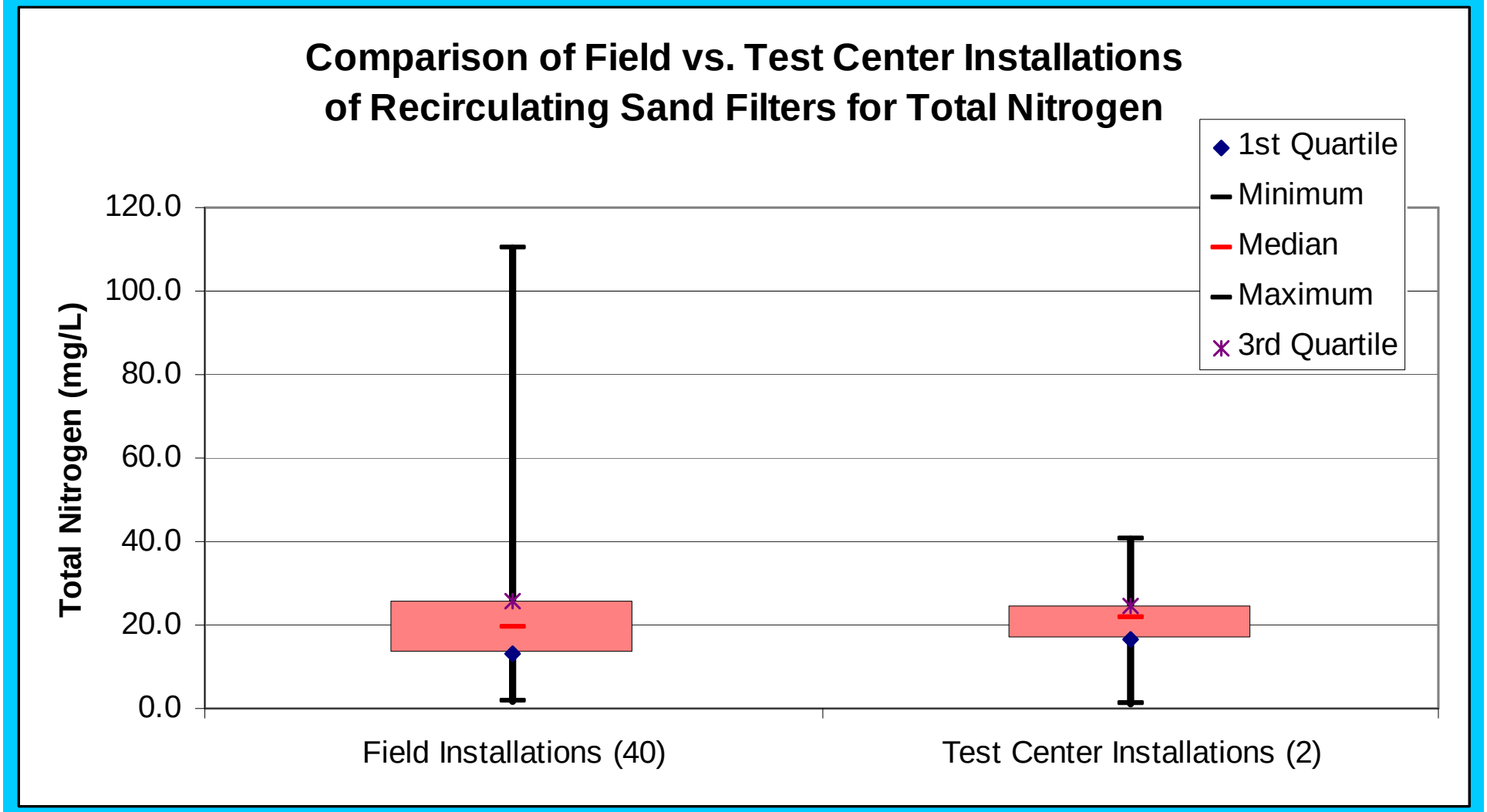
Test Center Performance Data Compared with Residential Field Installations

Technology	Median TN mg/L Field Installations	Median TN mg/L Test Center Installations	Difference	Higher Value
MicroFAST®	**15.2**	**17.9**	**2.7**	**Test Center**
Bioclere®	**13.5**	**14.6**	**1.1**	**Test Center**
Recirculating Sand Filter	**19.5**	**21.8**	**2.3**	**Test Center**

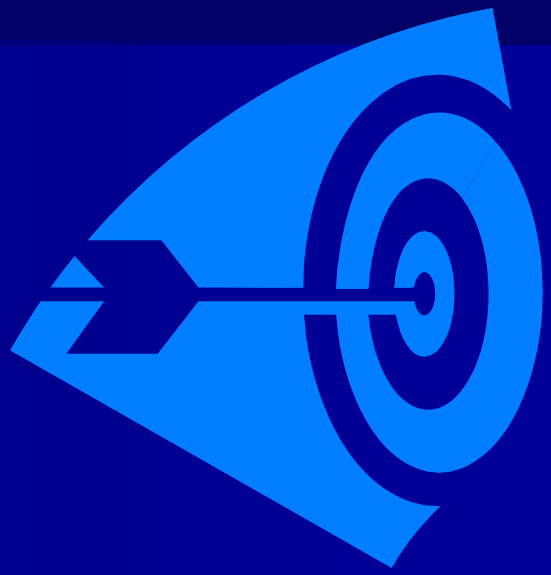

Comparison of Field vs. Test Center Installations of MicroFAST for Total Nitrogen
1st Quartile
Minimum
Median
Maximum
3rd Quartile
Total Nitrogen (mg/L)
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Maximum Value
50 % of all observations
Median
Minimum Value
Field Installations (128)
Test Center Installations (3)


Comparison of Field vs. Test Center Installations of MicroFAST for Total Nitrogen
1st Quartile
Minimum
Median
Maximum
3rd Quartile
Total Nitrogen (mg/L)
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Field Installations (128)
Test Center Installations (3)


Comparison of Field vs. Test Center Installations of Bioclere for Total Nitrogen
1st Quartile
Minimum
Median
Maximum
3rd Quartile
Total Nitrogen (mg/L)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Field Installations (4)
Test Center Installations (1)


Comparison of Field vs. Test Center Installations of Recirculating Sand Filters for Total Nitrogen
1st Quartile
Minimum
Median
Maximum
3rd Quartile
Total Nitrogen (mg/L)
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Field Installations (40)
Test Center Installations (2)

Conclusion



Test Center nitrogen data appear to be a reasonable conservative approximation of performance in “real” situations.

Test Center data indicate performance 7-15% below that of “real” situations.

Major Reports

- http://www.buzzardsbay.org/etiresults.htm (Five Major Reports)
- http://www.epa.gov/etv/verifications/vcenter9-3.html (Six Major Reports)
- http://ciceet.unh.edu/progressreports/2005/3_2005/sengupta2003/ (Results of sulfur experiments)

The End

Operated by

Barnstable County Department of Health and the Environment

In cooperation with

Massachusetts DEP

New England Region EPA

George Heufelder, M.S., R.S. and
Keith Mroczka
Barnstable County Department of Health and Environment
&
Massachusetts Alternative Septic System Test Center
MASSTC@cape.com (Ph. 508-563-6757)