RioVation®

A PERSPECTIVE ON TREATMENT IN THE SOIL VS TREATMENT IN THE TANK

By:

Gig Drewery and Stephen Moeller

The opinions and statements made in this presentation are those of RioVation® and not those of NOWRA or any sponsors of the 2023 Mega-Conference

Gig Drewery – An OWTS Industry Innovator

Gig and Trina Drewery have been solving onsite wastewater issues for over 30 years

- Early 1980's Gig and Trina began installing ATU's in east Texas
- Went on to found Hydro-Action and patent numerous NSF certified ATU products
  - They were instrumental in getting ATU's approved for use in the state in 1994
- Many of Gig's patents are in public domain and are still widely used in the industry today
- Gig was a founding board member of NOWRA
- Founding president of TOWA
- Served on the NSF joint committee

Gig and Trina's continued passion for solving onsite wastewater treatment issues facing the industry and the environment has led them to develop the innovative RioVation® BioMaze® product line

Soil is the Best Medium to Treat Wastewater

THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

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Using Soil to Remove Pollutants From Wastewater

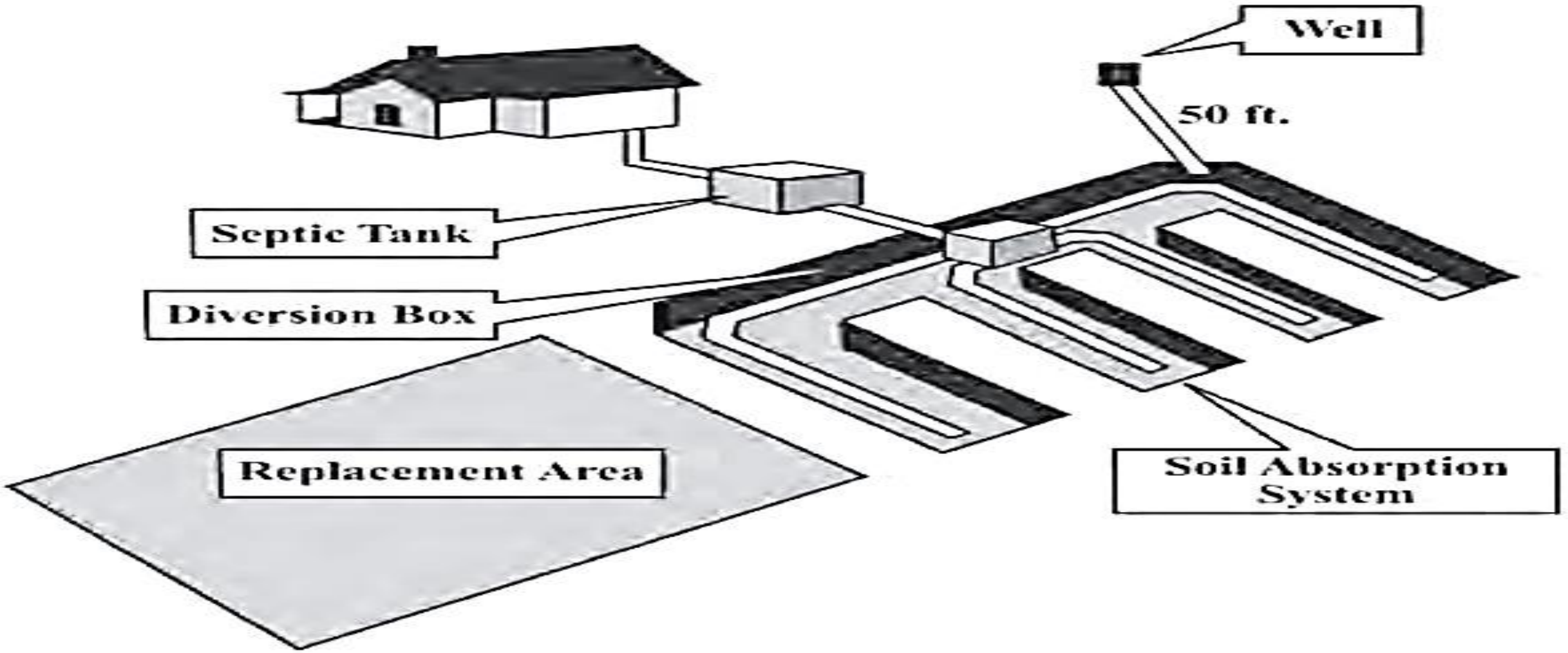
AEX-745

Agriculture and Natural Resources

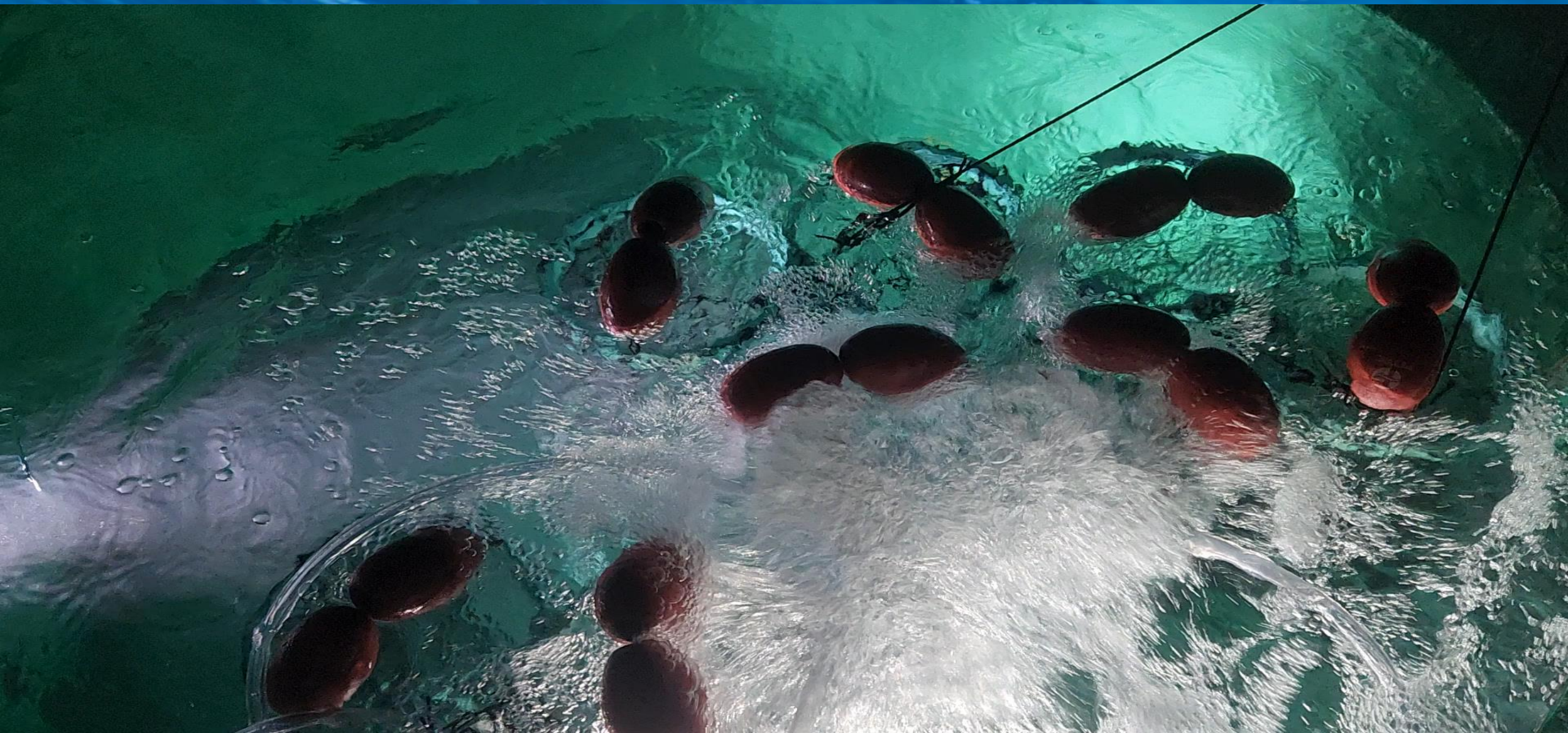
Date: 02/25/2016

Soil is the best medium to treat and disperse wastewater to protect the health of families, neighbors and visitors as well as the environment. Ohio has wonderfully diverse soil resources. Most of Ohio's soils are best suited for growing food and supporting Ohio's largest industry: agriculture.

Why Are We Designing Systems To Fail?



The Next Generation Biofilm Reactor



A Deep Dive into Human Waste Disposal and Treatment History

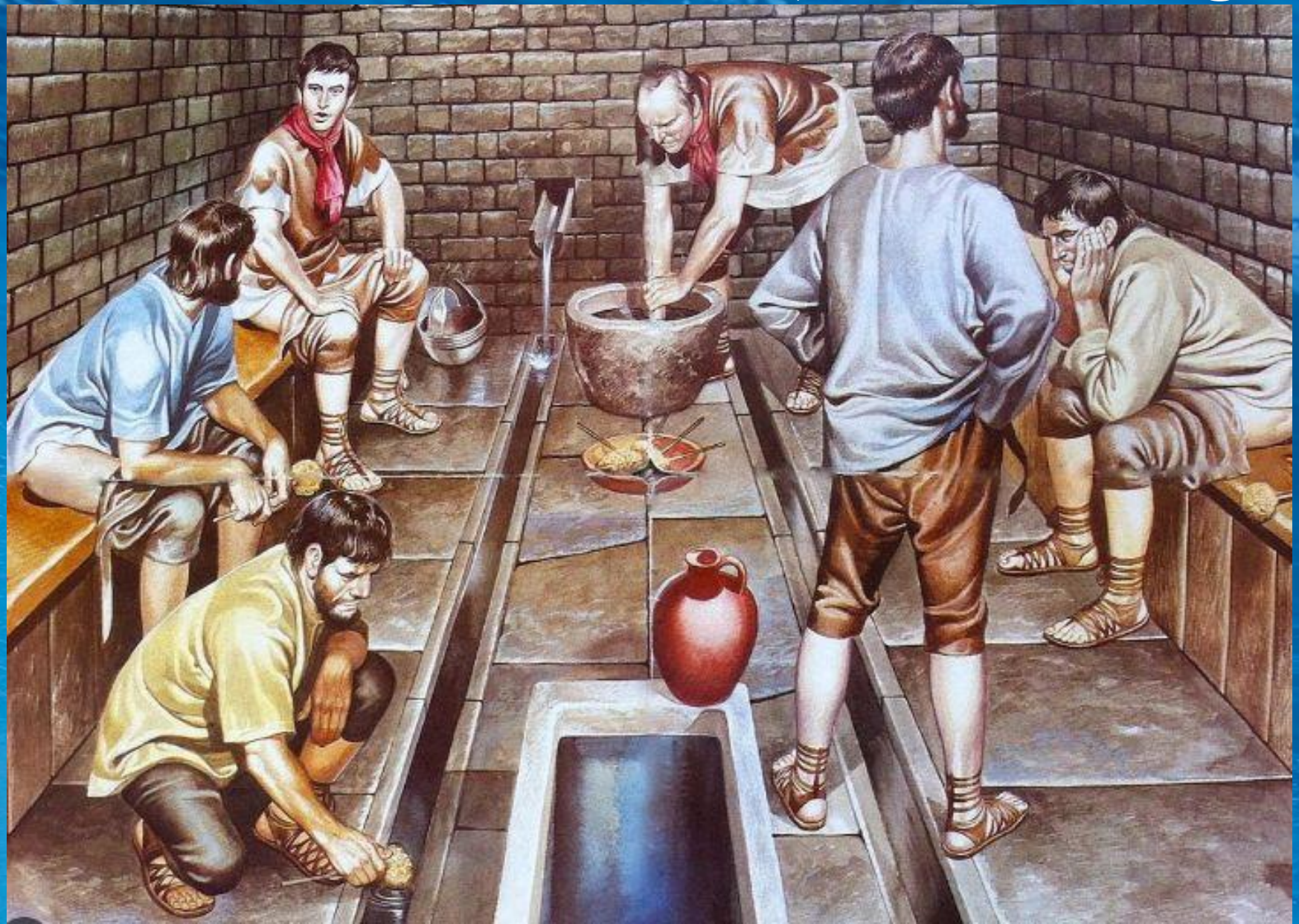
1473 B.C.E - ~3,500 Years Ago

Deuteronomy 23:12, 13

A private place should be designated for use outside the camp, and there is where you should go. A peg should be part of your equipment. When you squat outside, you should dig a hole with it and then cover your excrement.

Early sewers in ancient Rome and Greece

Around 800 B.C.E. or ~2,800 Years Ago

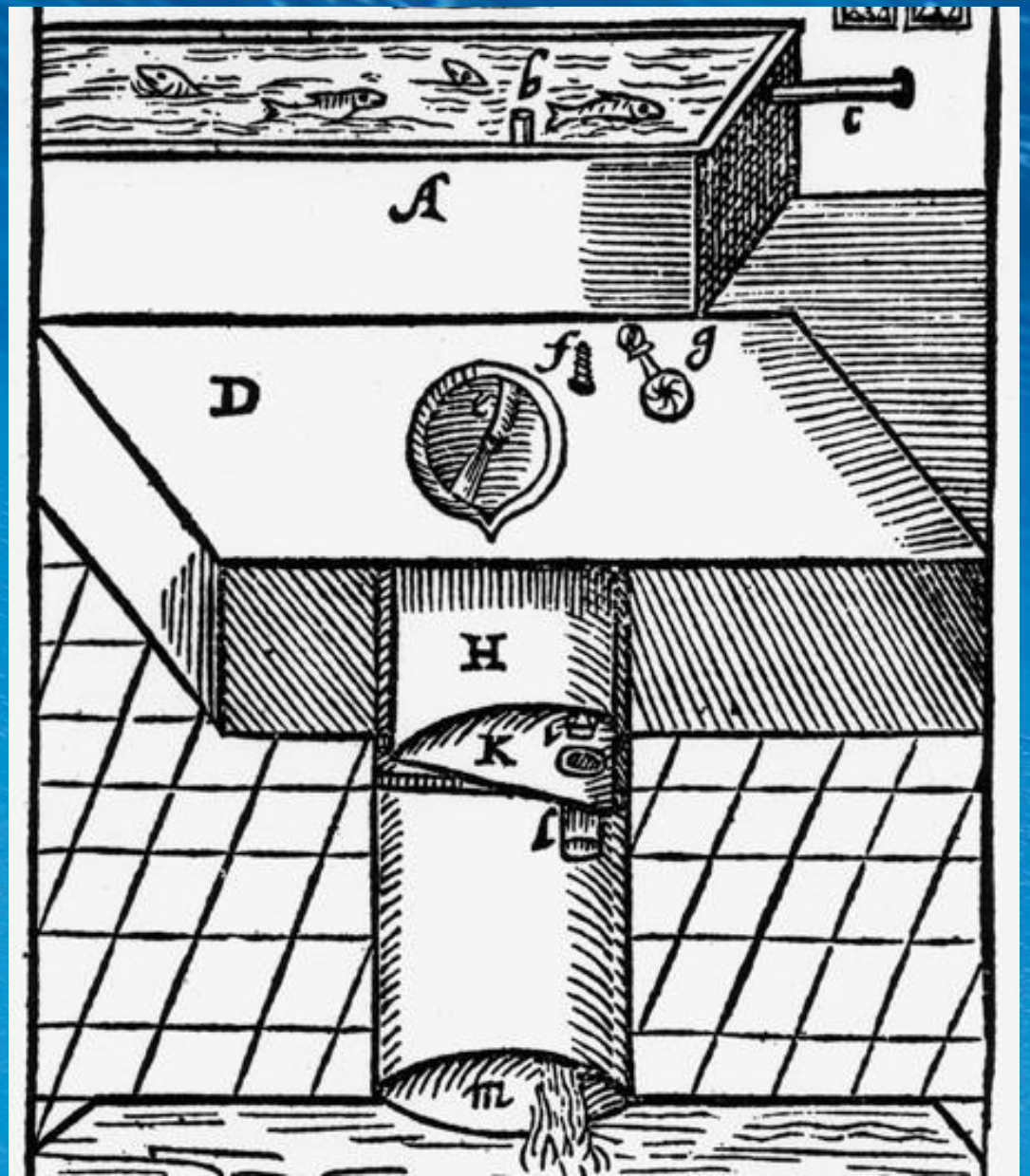


Chamber Pots and Outhouses

Unsanitary conditions were widespread throughout Europe

- **Resulted in pandemics such as the Black Death and cholera**
  - **Tens of millions died from these diseases**
  - **Estimated that 25% of the European population died as a result**

There's Got To Be A Better Way!

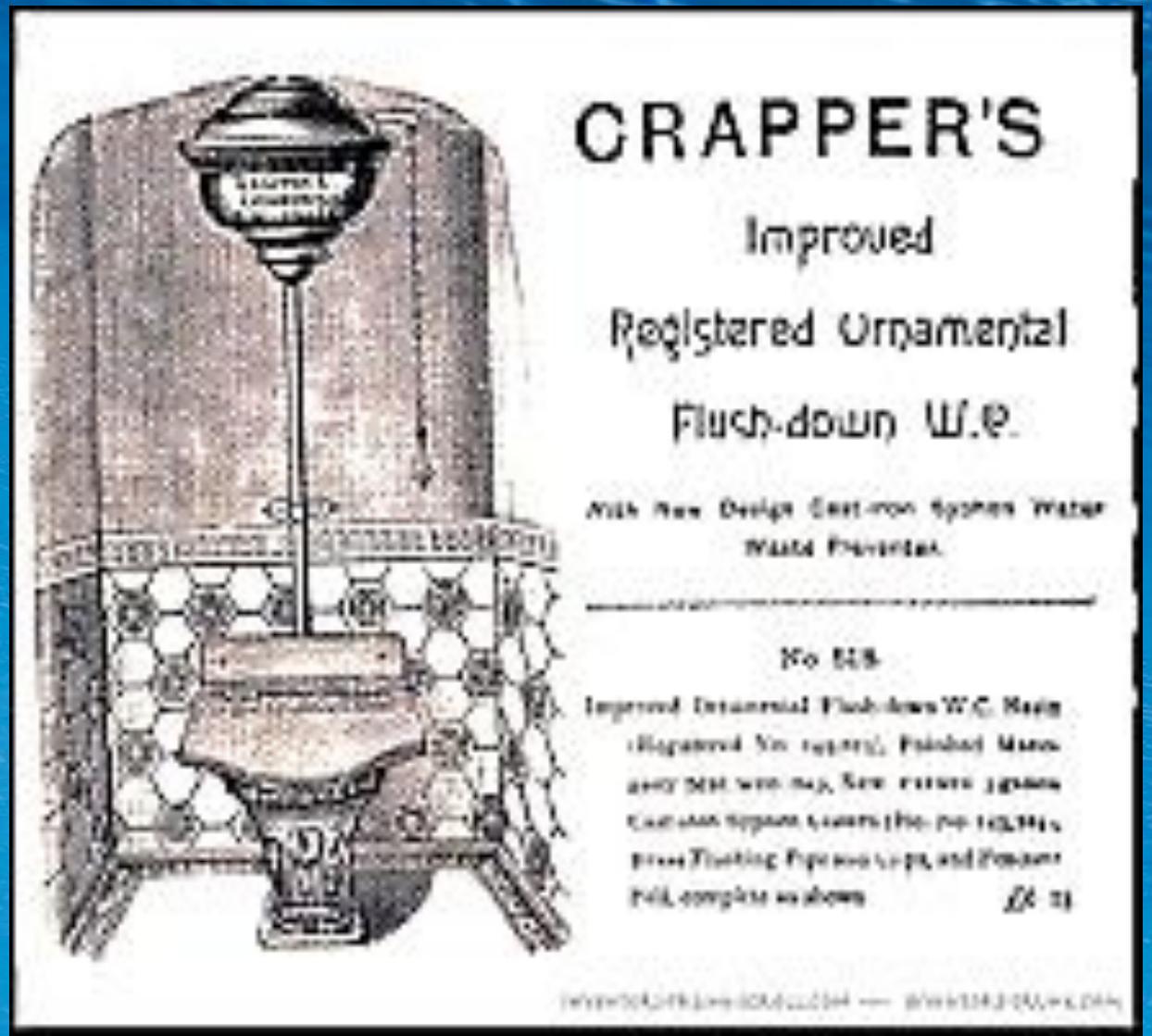


1596 C.E. or 427 Years Ago

Englishman named
Sir John Harington invented the first modern flush toilet

We remember him every time we go to the "John"

We Are Seeing Improvements Along The Way



Late 1800's

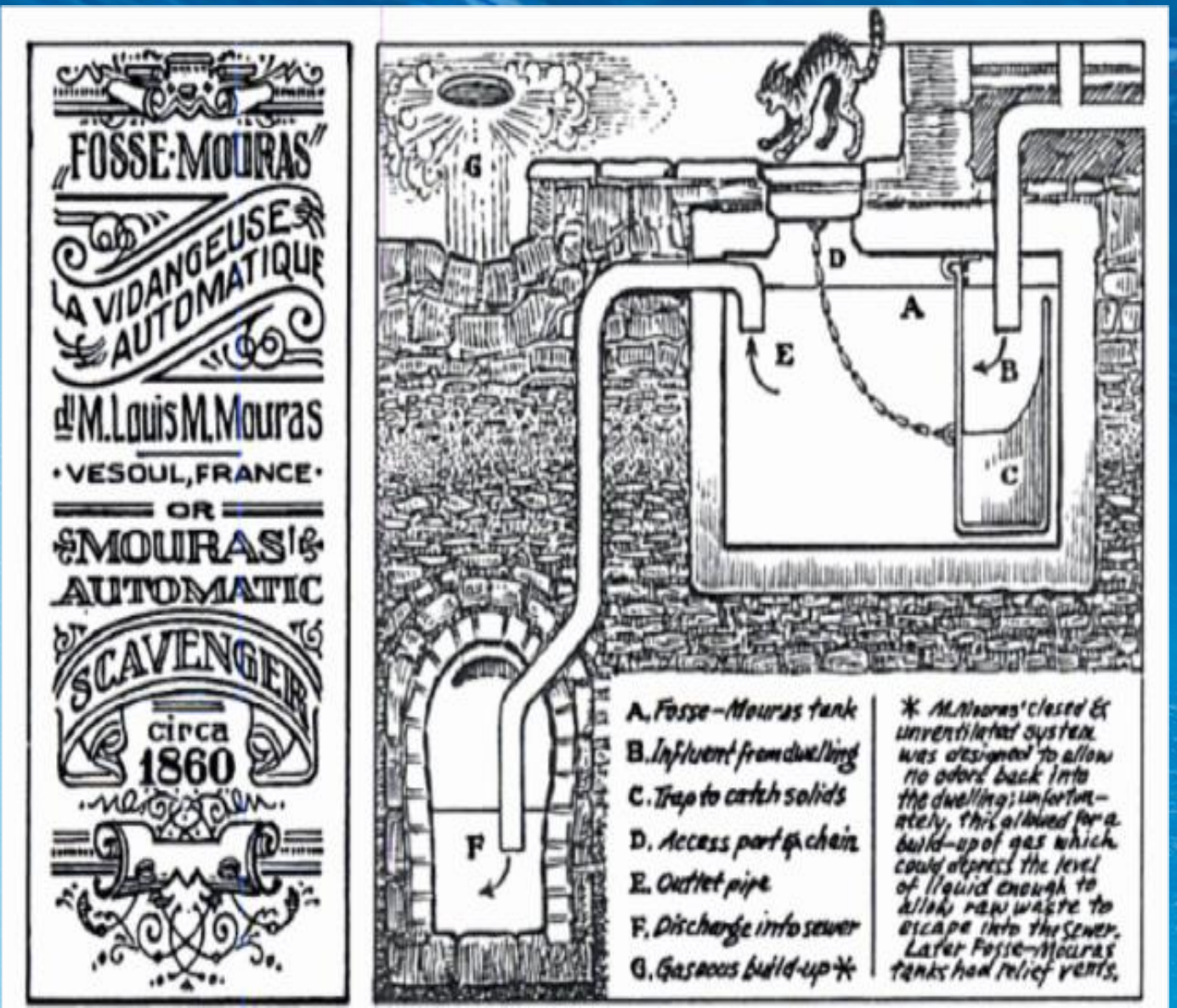
Englishman named Thomas Crapper developed one of the first widely successful flush toilets

Crapper did not invent the toilet but he developed the ballcock which is the tank-filling mechanism that is still widely used in toilets today

We remember him every time we... well, every time we go to the "John"

Focus of sewage management was getting the raw sewage out of the house and onto the street or into a natural body of water where it would be diluted and dissipated

Finally, The First Septic Tank Is Invented



1860

A Frenchman named Jean Louis Mouras invents the first septic tank

1883

Septic tanks are introduced in the United States

We went from covering our waste directly in the soil to emptying chamber pots onto streets and using outhouses to running water and flushing toilets

So Now That We Have Wastewater, What Do We Do With It?

- With the advent of the septic tank we began disposing of wastewater into:
  - Storm sewers
  - Cesspits sometimes called drywells or seepage pits
  - Surface lagoons

- Challenges persisted with these disposal methods
  - Major epidemics of cholera and typhoid fever persisted, due primarily to improper disposal of wastewater and resulting contamination of water
  - States eventually began to regulate separation of drainfield from seasonal high water table

Fast forward to today – In the United States septic systems serve approximately 25% of homes, more than 26 million septic systems

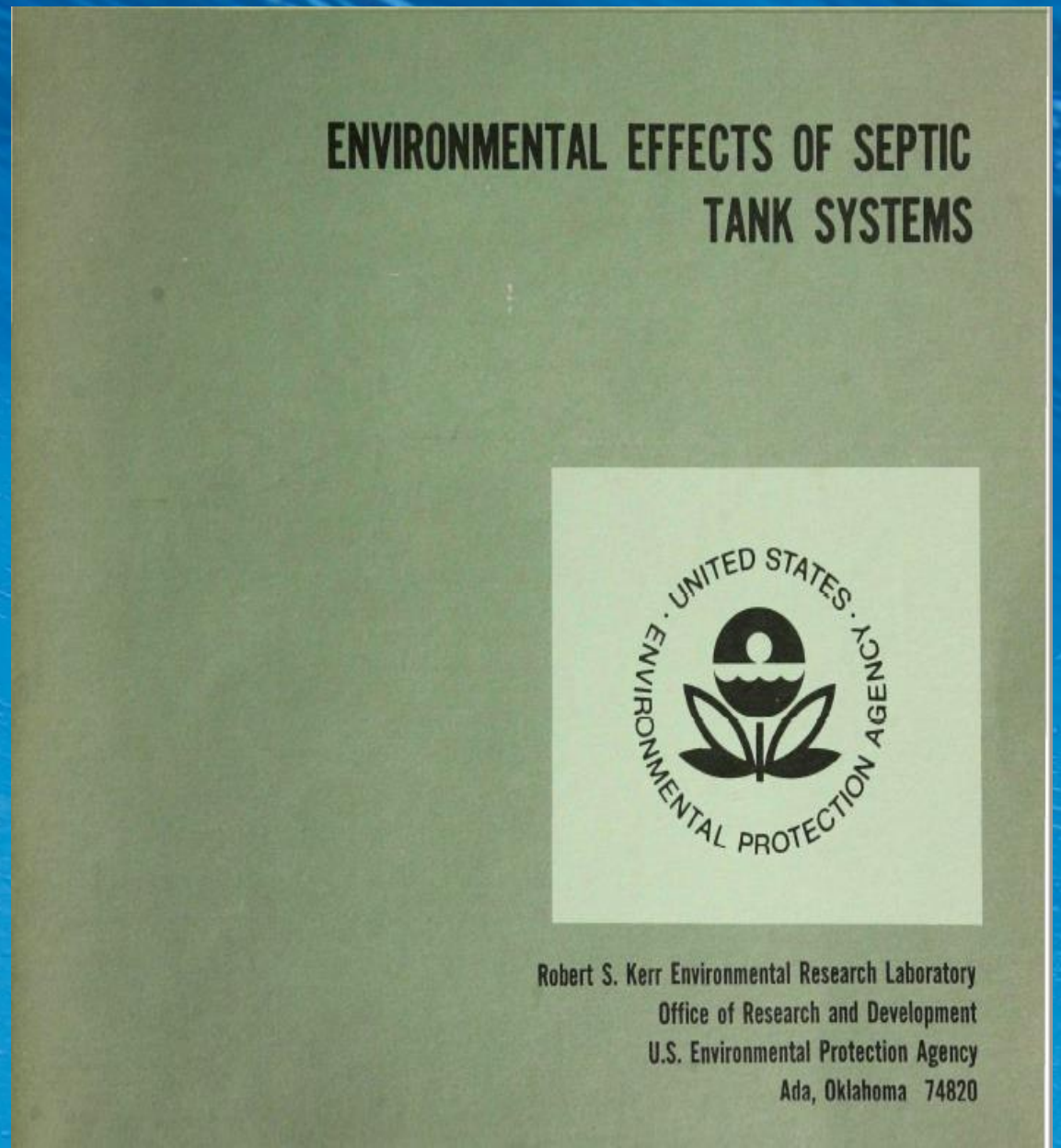
Collectively we now generate more than

4 billion gallons of onsite septic effluent A DAY

Equivalent to 500,000 tractor trailer loads or

100,000,000 bath tubs full of sewage a day

1977 Robert S. Kerr Environmental Lab EPA Report



EPA-600/3-77-096
August 1977

ENVIRONMENTAL EFFECTS OF SEPTIC TANK SYSTEMS

by

Marion R. Scalf and William J. Dunlap
Ground Water Research Branch
Robert S. Kerr Environmental Research Laboratory
Ada, Oklahoma 74820

and

James F. Kreissl
Systems and Engineering Evaluation Branch
Municipal Environmental Research Laboratory
Cincinnati, Ohio 45268

What Did The EPA Conclude in 1977?

Septic systems have performed a vital function of environmental sanitation, particularly in rural and sparsely developed suburban areas. However, some estimates indicate that less than one-half of all systems in use today perform satisfactorily for the entire design life of fifteen to twenty years (2). Many public health authorities feel that conventional septic systems are suitable only where population density is strictly limited and soil conditions are suitable for effective absorption. Otherwise, these systems may contaminate ground and surface waters and result in sanitary nuisances and health hazards.

As noted earlier, some investigators estimate that as many as one-half of all septic tank-soil absorption systems are not operating satisfactorily. It is probably more than coincidence that another estimate classifies more than half of the soil in the United States as unsuitable for septic systems with respect to the percolation rate.

SARA HEGER – UNIVERSITY OF MINNESOTA

Onsite Sewage Treatment Program & Former President of NOWRA

“Seems we are still facing many of the challenges they outlined in 1977”

SOIL-BASED WASTEWATER TREATMENT

José A. Amador & George W. Loomis

The University of Rhode Island, Kingston, Rhode Island

Our book addresses the needs of practitioners, engineers, scientists, regulators, resource managers, planners, and others with a need to know about septic systems. It arose after discussions about the need for a text that integrated current understanding of the hydrologic, physical, chemical, and biological processes involved in the treatment of wastewater using soil. In our experience, people working with septic systems – ourselves included – have a fragmented understanding of what these systems are, how they function, how wastewater moves through soil, how and which pollutants are removed, and how these systems impact the environment and public health. The relevant information is scattered across disciplines, information sources and audiences. This book is an attempt to collect and integrate this information in one place, and provide a scientific framework for understanding soil-based wastewater treatment.

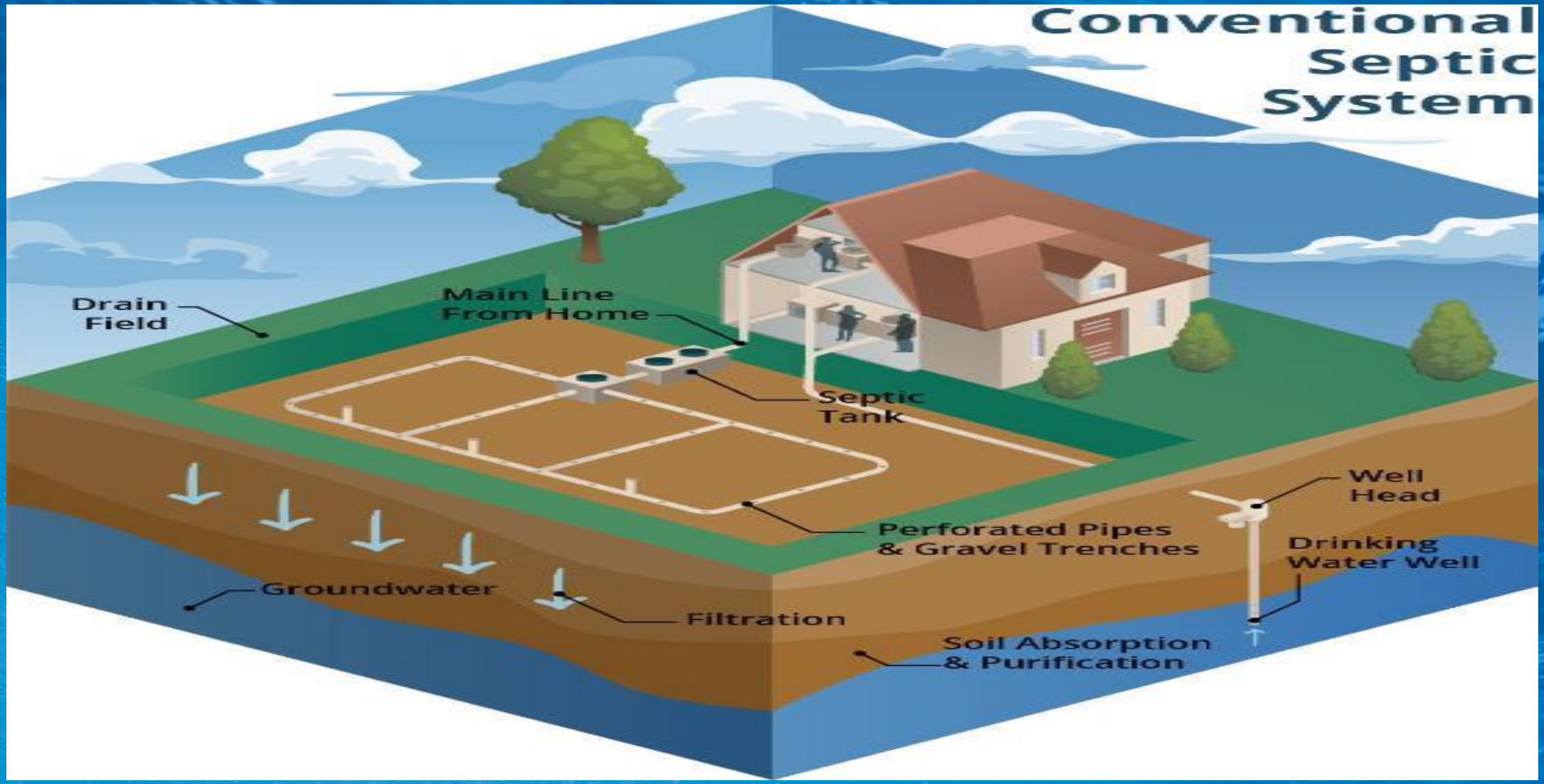
A Perspective on the History and Future of On-Site Wastewater Systems

Ongoing research has established that in order to effectively treat sewage and protect water quality, primary consideration must be given to soil suitability, topography, and landscape position. The following are soil properties that we look for in siting an on-site system:

- **Texture – Determines the rate at which water moves through the soil**
- **Drainage/permeability – Also determines the rate of water movement**
- **Color – Provides evidence of the historical water table position. We can't treat sewage in saturated soil**
- **Structure –The better the soils aggregate or hold together without compacting, the better the water movement and potential treatment**
- **Depth – Determines contact time and distance between the zone of waste application and any restrictive horizons within the soil wastewater treatment**
- **Landscape position – The position of a potential treatment site on a landscape can dramatically influence treatment. Avoid areas with converging slopes or complex topography**

Courtesy: Dr. Rubin

What if we get it wrong? Is Our Drinking Water Safe?



When We Fail – People Suffer!

- In AZ during 1989, failure of the leaching field, due to excessive flow, at a resort area resulted in approximately 900 cases of gastroenteritis
- In FL during 1974, a drinking water well was contaminated by sewage from a nursery school, and resulted in approximately 1,200 cases of gastrointestinal distress
- The Log Den, a restaurant in Wisconsin closed June 1, 2007, three weeks after it opened due to 229 becoming ill with Norovirus which causes vomiting and diarrhea

  Though properly permitted, this septic system failed. Septic wastes leached into the ground, through fissures in the soil and rock reaching the limestone aquifer that supplied the restaurant's water well.

The close proximity of on-site water and wastewater systems in subdivisions, reliance on marginal or poor soils for on-site wastewater disposal, and a general lack of understanding by homeowners about proper septic system maintenance pose a significant threat to public health in the 21st century

Are They Working?

- The capacity, construction, and technology of onsite waste systems is highly variable, and this influences the ability of a OWTS to treat waste
- Reports frequently demonstrate that a large proportion of systems are in failure due to poor construction, under-sizing of systems relative to their hydraulic loads, or improperly assessed soil capacity in drain fields
- Additional bathrooms, more people moving into the home, and the addition of garbage disposals to a home may substantially increase the volume and strength of the wastewater flowing into the system, compromising system function

Estimated that almost 70% of the OWTS present a potential health and environmental risk due to their age

Weather Events & Climate Change Affect Soil Treatment!

Weather Events & Climate Change Affect Soil Treatment!

The Washington Post
Democracy Dies in Darkness

CLIMATE & ENVIRONMENT

Backed-up pipes, stinky yards: Climate change is wrecking septic tanks

By Jim Morrison

April 12, 2022 at 7:00 a.m. EDT

Weather Events & Climate Change Affect Soil Treatment!

As climate change intensifies, septic failures are emerging as a vexing issue for local governments

- From Miami to Minnesota, septic systems are failing, posing threats to clean water, ecosystems and public health
  - Of the 120,000 in Miami-Dade County, more than half of them fail to work properly at some point during the year
- More intense storms compromise systems
- Too little precipitation also creates problems
- Freezing drainfields cause failures, soil microbes less active when colder

Realistically we don't really have a good picture of how bad the problems are and how bad they will get with climate change and aging systems

Some Of The Factors Influencing Failure of Soil Based Systems

- Climate change
  - Wetter, dryer, hotter, colder, water table/sea level rise, etc.
  - As temperature increases, overall respiration of soil organisms increases, so less oxygen is available in the soil profile
- Hydraulic overloading
  - More people move into the home or a garden-tub is added for example overloads undersized drainfields and increases moisture in soil
- Biological overloading – too much organic matter in the effluent
  - Appliances, such as garbage disposals and dishwashers changes the strength of the wastewater
- Biomat plugging is often the result
  - Moisture in the soil and a lack of oxygen compounds the issue

Only takes a biomat the thickness of two pennies (3/32) to cause a system failure

There Are a LOT OF IF's in Soil Based Treatment

A representative of the National Environmental Services Center at West Virginia stated:

"If the systems are correctly designed and installed,
if the site is properly evaluated, and
if they are maintained,
then they are pretty effective..."

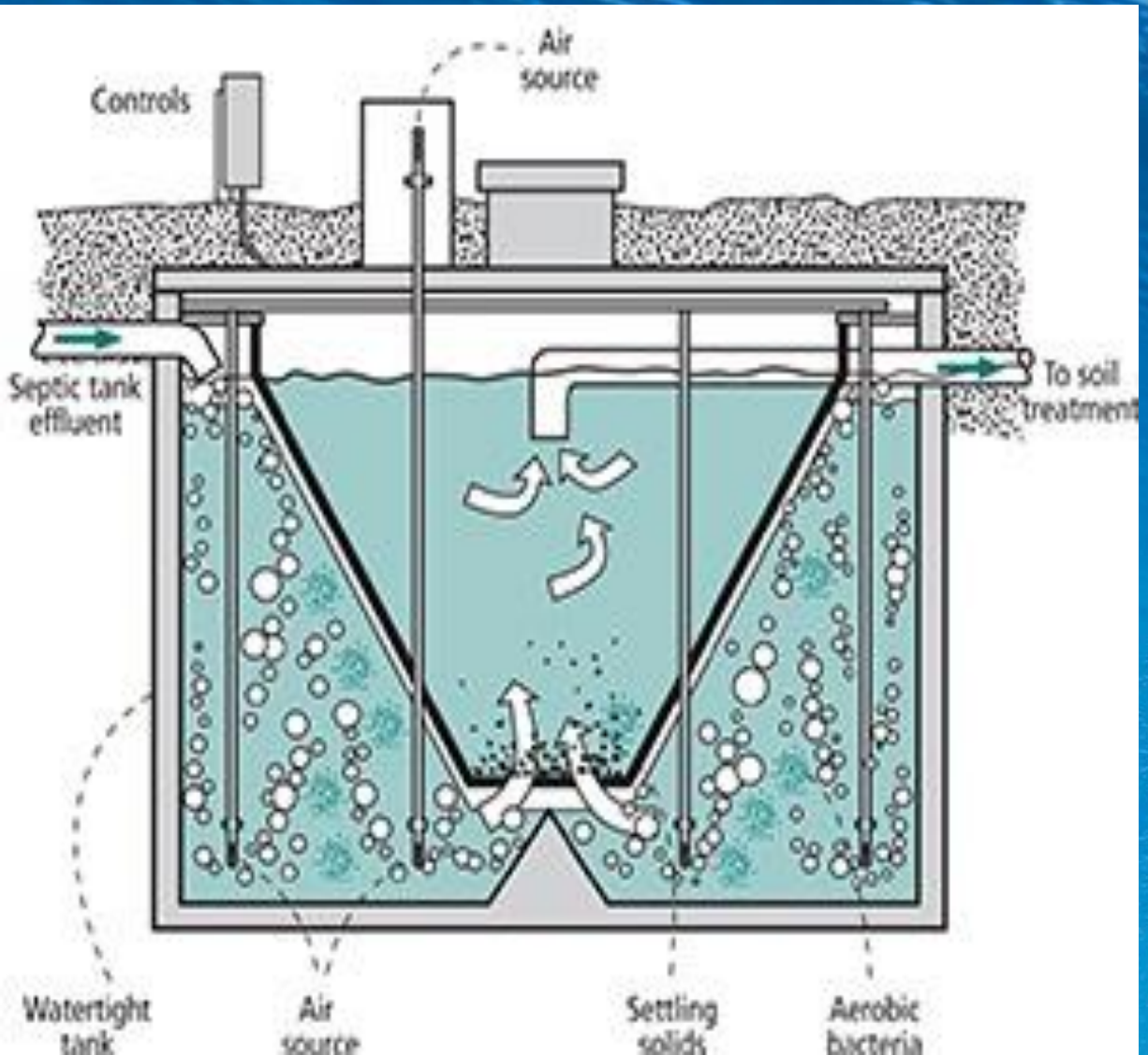
There are a lot of If's and variables in that statement as to whether a septic system can and will function as intended to treat the wastewater

Anerobic (Septic) only treats 20-40% of waste in the tank

Remove the IF's and the Variables from the Equation!

- When you move the majority of the treatment from the soil back into the tank your treatment process:
  - Has a controlled environment
  - Is not as susceptible to climate and environmental changes
  - Easily adjusts to wastewater strength and flow rate variables
  - Treats ~90% of the waste in the tank
  - Removes and prevents Biomat clogging thus keeps the drainfield clean and functional
  - Discharges cleaner effluent into the soil where final treatment can be accomplished
  - Minimizes public and environmental health risks

Suspended Growth vs Fixed Film Attached Growth



Biofilm water treatment has been taking place in nature for thousands of years

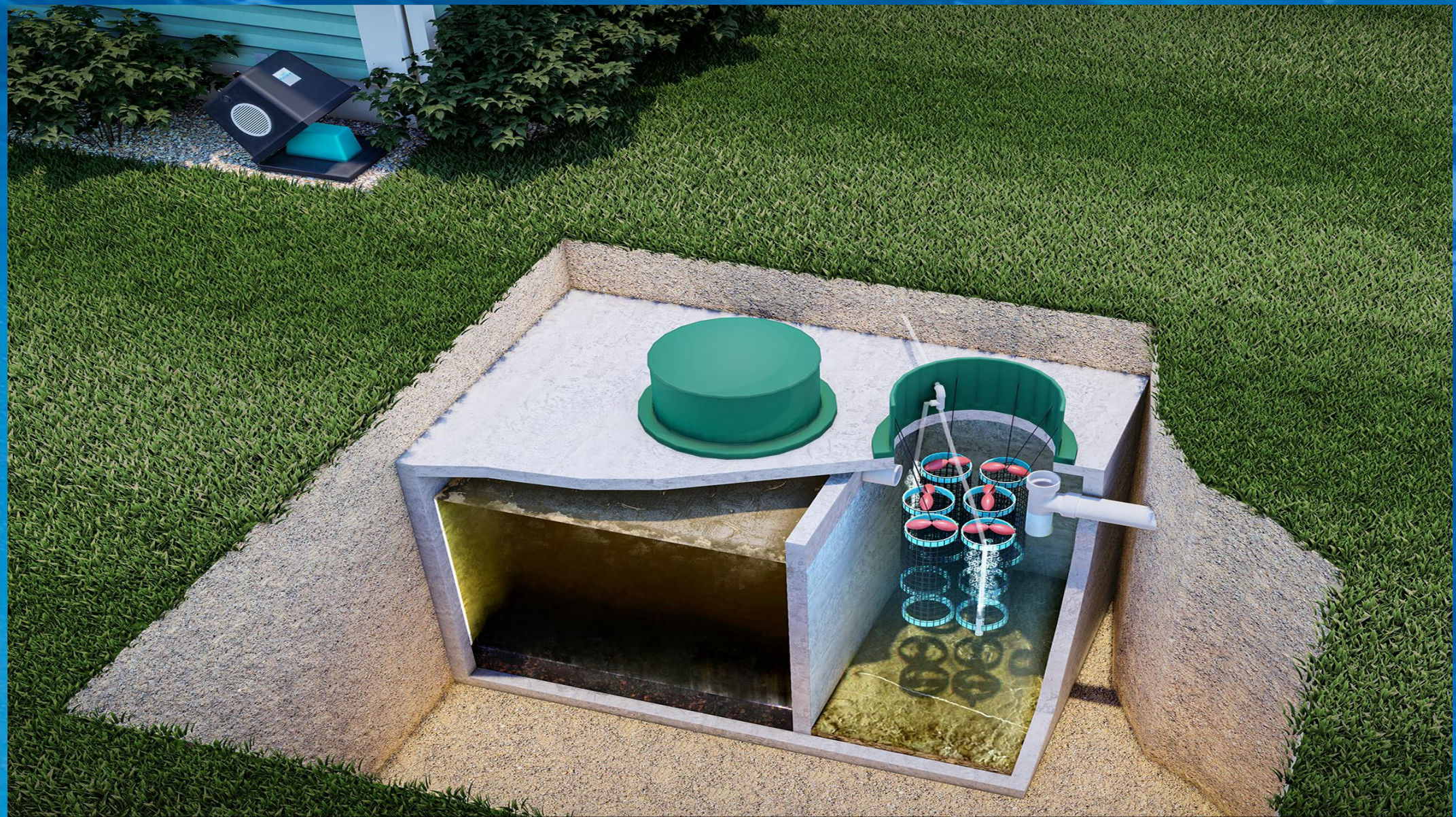
In rivers, water is purified as it is aerated over rocks which act as media to host biofilm

Biofilm Technologies Have Many Advantages

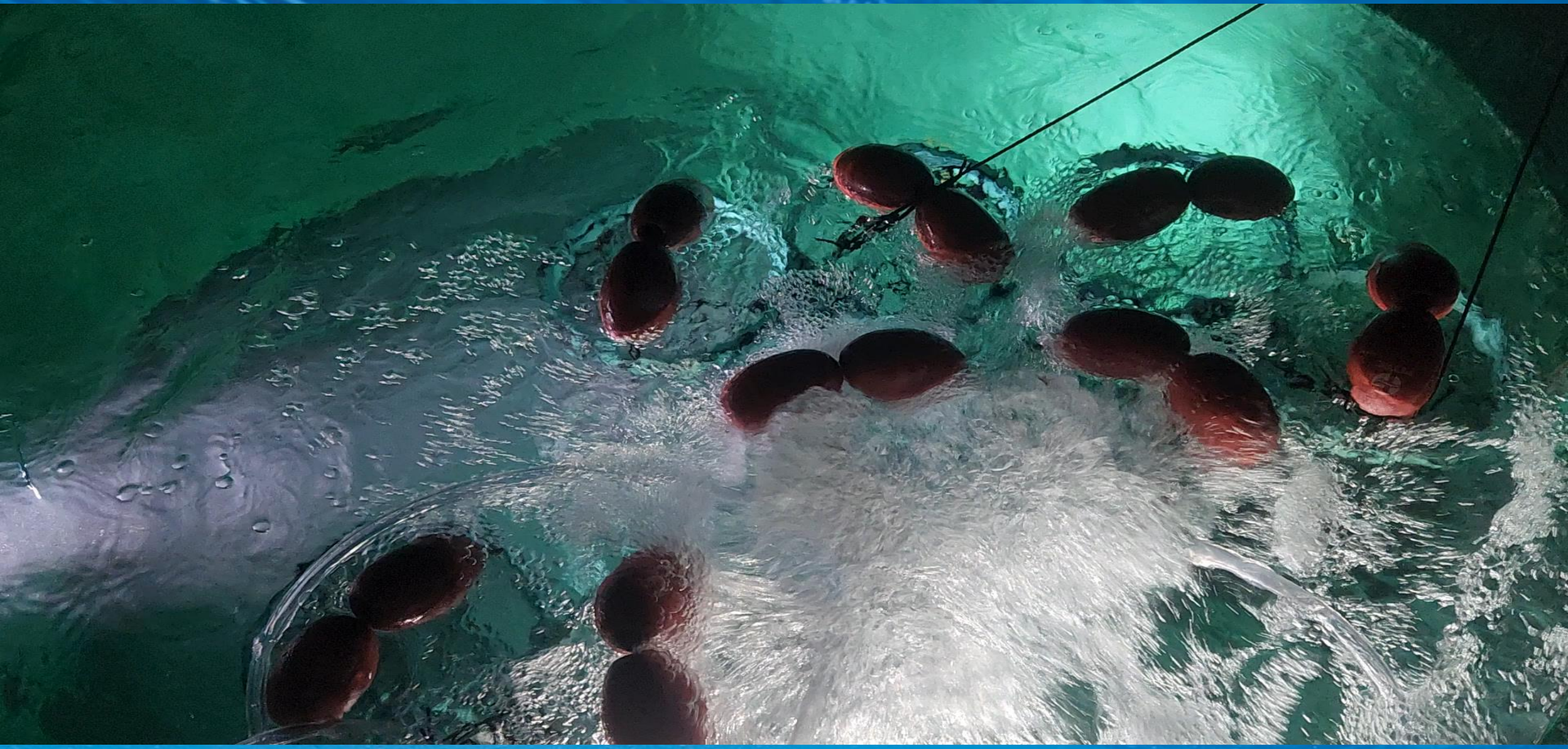
- Operational flexibility
- Lower space requirements
- Reduced hydraulic retention time
- Resilience to changes in the environment
- Remarkably superior in pollutant elimination
- Tolerates stresses such as starvation, chemical cleaners and antibiotics
- Tolerates around 2 times the volumetric organic loads over activated sludge
- Biofilm cells display characteristics and behavior that are superior to their planktonic (single cell) counterparts (found in SG ATU)

The Next Generation Biofilm Reactor

BM2624 Biofilm Reactor Installed In A Two Compartment Tank

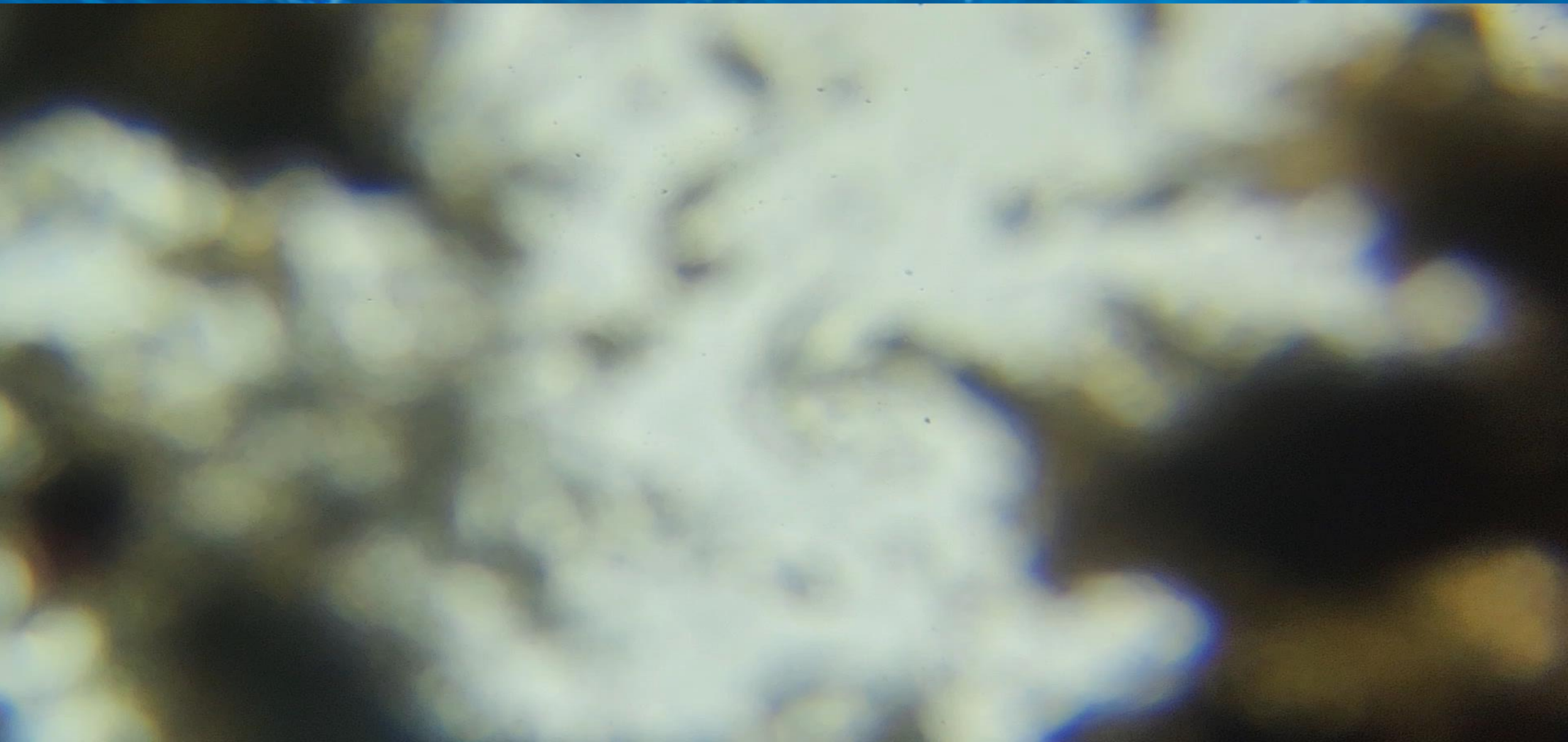


Biofilm Reactor Demonstration



Results of a Biofilm Reactor Installation

Not Only Bacteria Biofilm – Higher Life Forms



Biofilm Reactor

Effluent Grab Sample at the

TEXAS A&M UNIVERSITY

RELLIS Research Facility

Biofilm Reactor

Sludge Judge Sample at the

TEXAS A&M UNIVERSITY

RELLIS Research Facility

Biofilm Reactor

BM2624 Installed in a Snyder two compartment poly tank with loose fitting baffle wall

Analytical Results

Lab ID: G2307187001 **Date Collected:** 07/25/2023 10:00
Sample ID: 4424-2ND FINAL TANK **Date Received:** 07/25/2023 14:30

Parameter	Results	Units	PQL	MDL	DF	Prepared
WET CHEMISTRY (SM 2540D)						
Total Suspended Solids	3.2	mg/L	2.0	2.0	1	07/28/2023 14:10
WET CHEMISTRY (SM 5210B)						
Carbonaceous BOD (CBOD)	2.3	mg/L	2.0	2.0	1	07/26/2023 10:45

Biofilm Reactor

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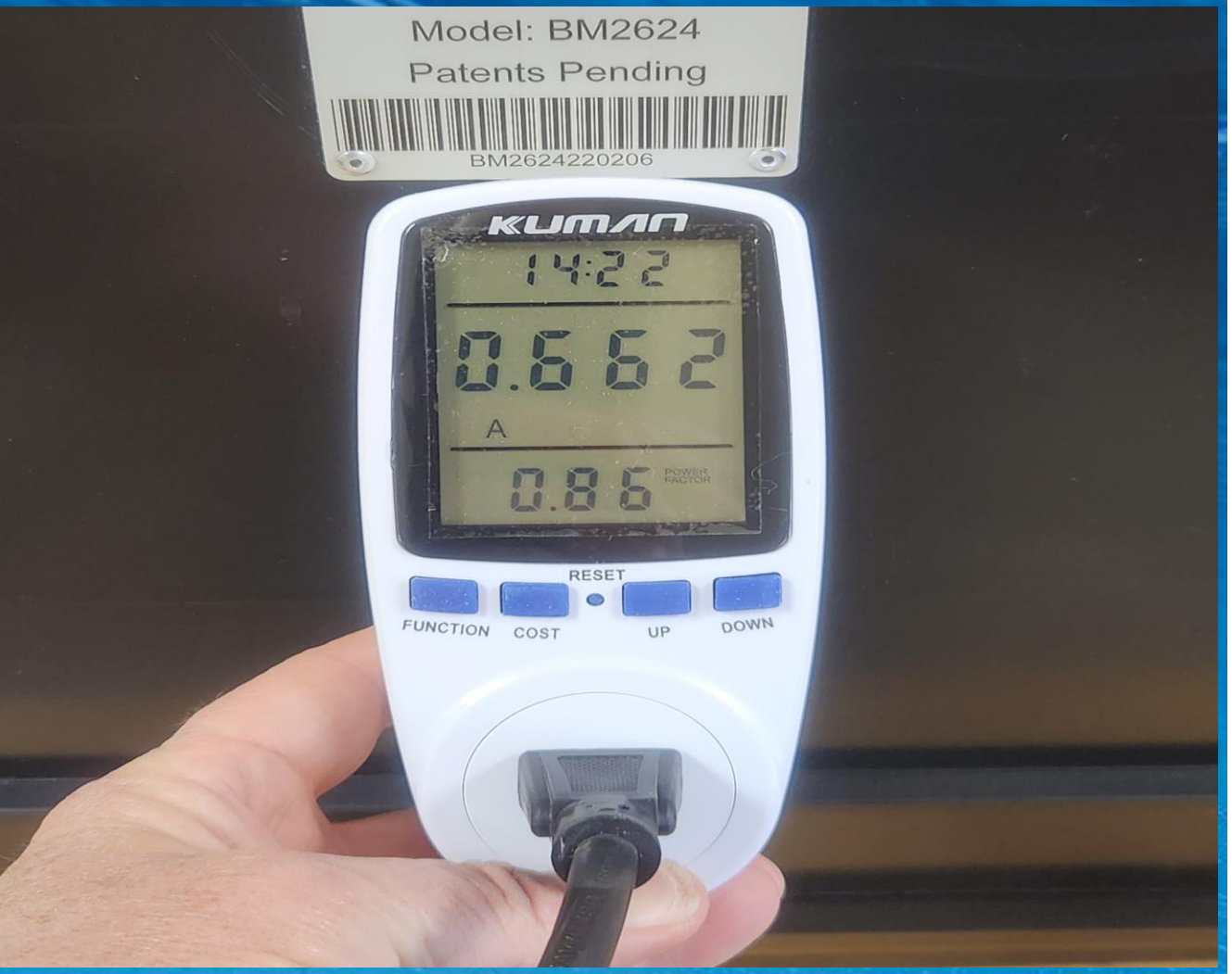

Electricity Calculator

Use the calculator below to estimate electricity usage and cost based on the power requirements and usage of appliances. The amount of time and power that each appliance is used varies significantly between households, so for the best results, adjust the usage for each appliance to most accurately reflect your personal usage.

Result

The following is the estimated average electricity usage for this appliance along with the cost of the electricity over varying spans of time.

Electricity usage	Cost	Time span
1.66 kWh	$0.25	per day
11.6 kWh	$1.74	per week
50.4 kWh	$7.56	per month
605 kWh	$90.73	per year

This calculator assumes there are 30.44 days in a month and 365.25 days in a year on average.

Typical appliance: Define your own

Appliance power: 69 watt [W]

Use/run at: 100 % capacity

Usage: 24 hours per day

Electricity Price: $0.15 per kWh

Calculate Clear

So, Soils Are Good for Wastewater Treatment. Right?

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Using Soil to Remove Pollutants From Wastewater

AEX-745

Agriculture and Natural Resources

Date: 02/25/2016

Soil is the best medium to treat and disperse wastewater to protect the health of families, neighbors and visitors as well as the environment. Ohio has wonderfully diverse soil resources. Most of Ohio's soils are best suited for growing food and supporting Ohio's largest industry: agriculture.

What Percentage Of Ohio's Soils Are Just Right?

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Using Soil to Remove Pollutants From Wastewater

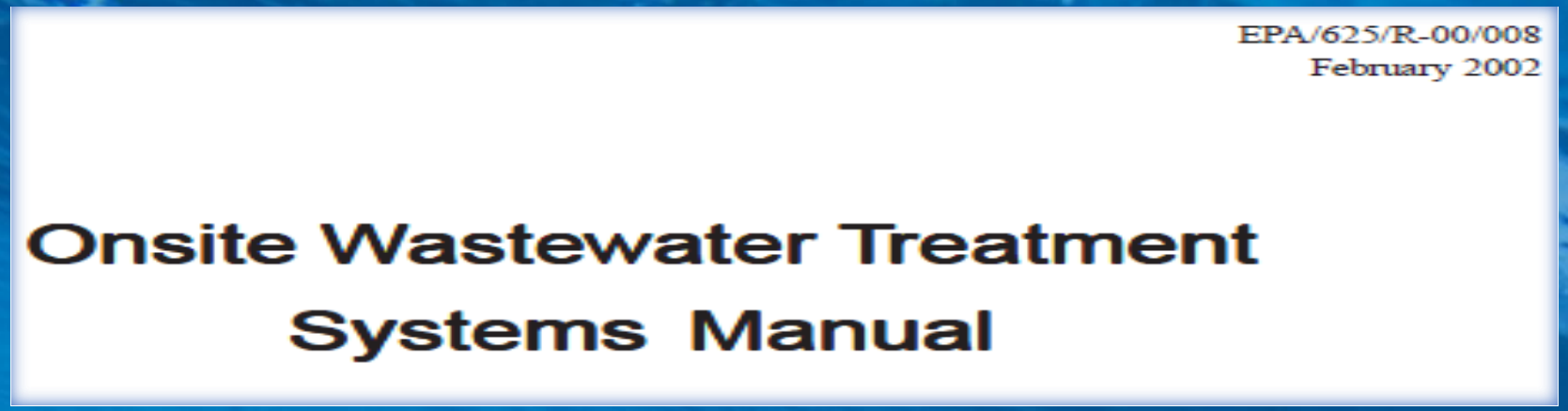
AEX-745
Agriculture and Natural Resources
Date: 02/25/2016

Limiting Layers

Many soils do not provide adequate depth to remove pollutants and treat wastewater. Like Goldilocks, some soil layers are too permeable for good contact between soil and effluent, and some are not permeable enough to allow for the movement of air and water. Only 16 percent of Ohio's land area is just right and has soils ideally suited to traditional septic system leach fields. Zones in the soil where wastewater cannot be treated are called **limiting layers**. Limiting layers are:

What About The Soils In The Rest Of the U.S.?

Up to half of the land area in the United States has soils NOT suited for conventional subsurface soil absorption fields



- Septic densities in some areas exceed the capacity of even suitable soils
- Many septic systems are located too close to ground or surface waters
- Others are not designed to handle increasing wastewater flows
- Conventional onsite system installations are not typically adequate for
  - minimizing nitrate contamination of ground water
  - removing phosphorus compounds
  - attenuating pathogenic organisms (e.g., bacteria, viruses)

Soil *is* an Excellent Medium for Wastewater Treatment

But

Estimated that less than 1/2 of the soils making up the United States are suitable for Wastewater Treatment

And

The Soils that are suitable for wastewater treatment live in very unpredictable and hostile environments

SO

We can keep rolling the dice and leaving more than 4 billion gallons a day of septic effluent treatment to chance in the soil

OR

We move the treatment into the tank where ~90% of the waste can be removed and leave the remaining ~10% for the soil to finish

The Cost of Maintaining Status Quo?

WWEMA
Water & Wastewater Equipment Manufacturers Association Inc.

Adopted by WWEMA Board of Directors on May 6, 2020

Eliminating Failing Septic Tanks in the United States
Final Position Statement

I. Issue Overview

Every year a quarter of the U.S. population discharges an astounding one trillion gallons of raw, untreated wastewater and other toxic materials into more than 21 million septic tanks, nearly half of which do not function properly.

Florida's Indian River Lagoon

156-mile-long estuary spans five counties along the Atlantic East Coast

Between December 2020 and December 2022 over 2,000 manatees died

Florida's Indian River Lagoon Water Quality Issues
Fertilizer or Septic to Blame?

SEWAGE, NOT FERTILIZER FUELING NITROGEN SURGE IN INDIAN RIVER LAGOON

Blooms of red drift macroalgae stranding on the shoreline near Turkey Creek, an Indian River Lagoon tributary, during the study period. (Photo credit: Brian Lapointe)

Findings of the study, published in the journal Marine Pollution Bulletin , show recent estimates for residential fertilizer contributions to the Indian River Lagoon are much lower than the originally defined contribution of 71 percent. In fact, current nitrogen loading estimates represent a 21 percent contribution from residential fertilizers compared to 79 percent from septic systems. These loading estimates are similar to those reported in other septic system-impacted urbanized estuaries.

Water quality and harmful algal blooms have worsened in the northern Indian River Lagoon and Banana River, leading to unprecedented seagrass die-offs and starvation of manatees.

Bad Publicity and Lawsuits Against Florida State EPA

Its Time We Move **Treatment**

Out of the Uncontrolled and Hostile Environment of the Soil

Into The Tank

"Let's Clear Some Things UP For You!"

RioVation®

Q & A Session