## I/A Systems: What We've Learned and Where We'd Like To Go

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Environmental Project Assistant/Quality Assurance Manager





# Barnstable County

REGIONAL GOVERNMENT OF CAPE COD

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Any mention of a name, product, service, company, or institution does not constitute an endorsement by MASSTC or Barnstable County Regional Government.







The Massachusetts Alternative Septic System Test Center (MASSTC) is the nation's premier third-party testing and research facility for innovative/alternative (I/A) onsite septic treatment technologies. Since 1999, MASSTC has tested dozens of technologies for industry standard certifications, provided space for technology vendors t do R&D work, and conducted original research on topics from constructed wetlands to nutrient and virus removal.

Beginning in the early 1990s, Barnstable County, Massachusetts (Cape Cod) began realizing that nitrogen from septic systems was dramatically affecting our marine environments, causing accelerated eutrophication and nuisance algae blooms.

Searching for technologies to address the issue, the Barnstable County Department of Health and Environment, in conjunction with Massachusetts Coastal Zone Management through the Buzzards Bay Project, began what is now called the Massachusetts Alternative Septic System Test Center (MASSTC). The Test Center began in 1999 testing advanced onsite septic treatment technologies in triplicate under a program of the U.S. Environmental Protection Agency (EPA) called the Environmental Technology Initiative (ETI). Working with EPA and the National Sanitation Foundation (NSF) of Ann Arbor, Michigan, MASSTC conducted a refined nutrient testing protocol in 2002 referred to as the Environmental Technology Verification (ETV). Further refinement of the nutrient standards was completed in 2007 by NSF and has resulted in the NSF Standard 245.

Following over two decades of successful operation thanks to Barnstable County staff, state and federal grant funding and industry support (private companies are issued fees for space, testing and staff oversight), MASSTC continues to serve as an economic driver of the onsite wastewater treatment industry by fostering local and out-of-state investment in innovative/alternative septic system technology. Its facility can accommodate over 20 concurrent tests, allowing companies to conduct research and development on their products or complete any number of standardized test protocols. MASSTC has since become a premier onsite wastewater treatment research facility, hosting numerous research and development efforts by private manufacturers, states and municipalities and conducting protocols for the National Sanitation Foundation International (NSFI)



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### **NSFI**

### National Sanitation Foundation International

#### • NSF/ANSI 40-2019

Residential Wastewater Treatment Systems

The purpose of this Standard is to establish minimum materials, design and construction, and performance requirements for residential wastewater treatment systems. This Standard also specifies the minimum literature that manufacturers shall supply to authorized representatives and owners, as well as the minimum service-related obligations that manufacturers shall extend to owners.

#### • NSF/ANSI 245-2020

Residential Wastewater Treatment Systems - Nitrogen Reduction

This wastewater standard contains minimum requirements for residential wastewater treatment systems having rated treatment capacities of 1514 L/d (400 gal/d) to 5678 L/d (1500 gal/d) that are designed to provide reduction of nitrogen in residential wastewater. Management methods for the treated effluent discharged from these systems are not addressed by this Standard. A system, in the same configuration, must either be demonstrated to have met the Class I requirements of NSF/ANSI 40 or must meet the Class I requirements of NSF/ANSI 40 during concurrent testing for nutrient removal.

#### • NSF/ANSI 350-2020

Onsite Residential And Commercial Water Reuse Treatment Systems

This Standard contains minimum requirements for onsite residential and commercial greywater treatment systems. Systems may include Greywater reuse treatment systems having a rated treatment capacity up to 5,678 L/d (1,500 gal/d); or Commercial greywater reuse treatment systems: This applies to onsite commercial reuse treatment systems that treat combined commercial facility greywater with capacities exceeding 5,678 L/d (1,500 gal/d) and commercial facility laundry water only of any capacity. Management methods and end uses appropriate for the treated effluent discharged from greywater residential and commercial treatment systems meeting this Standard are limited to subsurface discharge to the environment only.









![](_page_14_Picture_1.jpeg)

![](_page_15_Picture_0.jpeg)

![](_page_15_Picture_1.jpeg)

![](_page_16_Picture_0.jpeg)

### Saturated Layered System

Experimental system at MASSTC with a layer of sand above a saturated layer of sand/sawdust mix

![](_page_16_Picture_3.jpeg)

![](_page_16_Picture_4.jpeg)

### **Big Layer Cake**

![](_page_17_Picture_1.jpeg)

![](_page_17_Picture_2.jpeg)

![](_page_17_Picture_3.jpeg)

![](_page_18_Figure_0.jpeg)

![](_page_19_Figure_0.jpeg)

![](_page_20_Figure_0.jpeg)

The Massachusetts Alternative Septic System Technology Center

![](_page_21_Figure_0.jpeg)

![](_page_22_Figure_0.jpeg)

# Layered System with Silt

Experimental system at MASSTC with a layer of sand above a layer of sand/silt/sawdust (another version of a layered system)

![](_page_22_Picture_3.jpeg)

![](_page_22_Picture_4.jpeg)

![](_page_23_Figure_0.jpeg)

### Unsaturated Layered System

Experimental system at MASSTC with a layer of sand above an unsaturated layer of sand/sawdust

Experimental design in collaboration with Stonybrook University

(another version of a layered system)

![](_page_23_Picture_5.jpeg)

![](_page_23_Picture_6.jpeg)

### They work on our test site – but hold your horses!

![](_page_24_Picture_1.jpeg)

Our field installations performed differently than the controlled situation at MASSTC

![](_page_24_Picture_3.jpeg)

![](_page_25_Picture_0.jpeg)

![](_page_25_Figure_1.jpeg)

Used with permission from George Heufelder's *Sand-Sawdust Layer Cakes: The hope of a passive onsite denitrification system*, MHOA October 2021

![](_page_25_Picture_3.jpeg)

### **Layer Cakes Installed in the Field**

![](_page_26_Picture_1.jpeg)

- Layer cake design (unsaturated) installed at 13 sites
- Residences are extremely variable in both use patterns (seasonal) and in influent total nitrogen levels.
- Generally, the layer cakes provide at least 50% total nitrogen removal on average, doing at least 75% total nitrogen removal in warmer weather
- Results from over 8 installations does not allow the assignment of nitrogen concentration that can be consistently achieved

![](_page_26_Picture_6.jpeg)

### **Layer Cakes Installed in the Field**

- A more in-depth look coming from George Heufelder himself (March 24, 2022)
- See YOWA (Yankee Onsite Wastewater Association) to sign up

![](_page_27_Picture_3.jpeg)

![](_page_27_Picture_4.jpeg)

# **Virus Project**

![](_page_28_Picture_1.jpeg)

# Virus project

- Study of the presence of viruses and bacteria at varying soil depths and treatments
- Collaboration with/funding through MassDEP

### 15.212: Depth to Groundwater

(1) The minimum vertical separation distance between the bottom of the stone underlying the soil absorption system above the high ground-water elevation shall be

- (a) four feet in soils with a recorded percolation rate of more than two minutes per inch;
- (b) five feet n soils with a recorded percolation rate of two minutes or less per inch.

(2) For systems with a design flow of 2,000 gpd or greater, the separation from high groundwater as required by 310 CMR 15.212(1) shall be calculated after adding the effect of groundwater mounding to the high groundwater elevation as determined pursuant to 310 CMR 15.103(3).

310 CMR 15.000: THE STATE ENVIRONMENTAL CODE, TITLE 5: STANDARD REQUIREMENTS FOR THE SITING, CONSTRUCTION, INSPECTION, UPGRADE AND EXPANSION OF ON-SITE SEWAGE TREATMENT AND DISPOSAL SYSTEMS AND FOR THE TRANSPORT AND DISPOSAL OF SEPTAGE

![](_page_29_Picture_9.jpeg)

![](_page_29_Picture_10.jpeg)

# Virus project

- Gravity treatment
  - 2 ft
  - 3 ft
  - 4 ft
  - 5 ft
- Pressure distribution
  - 2 ft
  - 3 ft
  - 4 ft

• 5 replicates of each type of treatment (we have sampled 3 replicates)

![](_page_30_Picture_11.jpeg)

![](_page_30_Picture_12.jpeg)

![](_page_31_Figure_0.jpeg)

![](_page_31_Picture_1.jpeg)

### **Virus Project**

![](_page_32_Picture_1.jpeg)

![](_page_32_Picture_2.jpeg)

![](_page_32_Picture_3.jpeg)

![](_page_33_Picture_0.jpeg)

![](_page_33_Picture_1.jpeg)

![](_page_33_Picture_2.jpeg)

![](_page_34_Picture_0.jpeg)

![](_page_34_Picture_1.jpeg)

![](_page_35_Picture_0.jpeg)

![](_page_35_Picture_1.jpeg)
# Virus project

#### • Viruses:

- Male-specific (F+) coliphage
- Somatic coliphage
- Bacteria:
  - Fecal coliform
  - E. coli
  - Enterococcus





# Virus project

- Samples are collected
- Samples are concentrated by ultrafiltration in the lab
- Concentrated samples are combined with antibiotic-resistant bacteria (host)
- The plaques (where the virus, if present, has lysed the bacteria) are counted
- Results are in PFU/L (plaque forming units per liter)
- EPA Method 1642/1643



















# **Results pending...**









**Environmental Topics** 

Laws & Regulations About EPA



#### Human Enteric Viruses and Viral Surrogates as Measures of Water Reuse Potential from **Centralized and Decentralized Wastewater** Treatment

#### EPA Grant Number: R840259

Title: Human Enteric Viruses and Viral Surrogates as Measures of Water Reuse Potential from Centralized and Decentralized Wastewater Treatment Investigators: Heufelder, George, Baumgaertel, Brian, Olmsted, Emily Michele, Regan, Kathleen , Pancorbo, Oscar C Institution: Barnstable County Department of Health and Environment and Massachusetts **Department of Environmental Protection** EPA Project Officer: Ludwig-Monty, Sarah Project Period: August 1, 2021 through July 31, 2024 **Project Amount:** \$1,239,655 **RFA:** Viral Pathogen and Surrogate Approaches for Assessing Treatment Performance in Water Reuse (2021) <u>RFA Text | Recipients Lists</u> **Research Category:** Water Treatment

Source: https://cfpub.epa.gov/ncer\_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract\_id/11217/report/0



#### **Related Information**

**Contact Us** 

- Research Grants
- P3: Student Design Competition
- <u>Research Fellowships</u>
- Small Business Innovation Research (SBIR)
- Grantee Research Project Results Search

# Virus project – EPA STAR funding *Our project continues!*

- Sample for male-specific and somatic coliphage viruses (still)
- Samples sent to MassDEP-WES lab where droplet digital (ddPCR) and quantitative polymerase chain reaction (qPCR) will provide even more viral data
  - indigenous human adenoviruses, human noroviruses GI and GII, as well as the human viral surrogates crAssphage, pepper mild mottle virus, and human associated Bacteroides HF183 target gene sequence
- Samples from additional wastewater treatment sources (beyond gravity/pressure and various depths) – including from three wastewater treatment plants





- Shubael Pond is a high-density housing neighborhood (approximately 0.25 acre, regularly spaced lots)
- Pond was closed for most of summer in 2019 due to cyanobacteria blooms
- There is concern for groundwater in this area



#### PROJECT GOALS

- Project partners plan to replace traditional septic systems with new enhanced innovative nitrogen reducing septic systems in up to 10-20 houses in a small neighborhood.
- Quantify performance and cost effectiveness of individual systems
- Assess cumulative impact on local groundwater and surface water receptors
- Assess social acceptability of enhanced innovative/alternative (IA) septic systems and factors determining adoption
- Communicate lessons learned to local, state, regional and federal partners and interested stakeholders in watersheds similarly compromised by legacy septic systems



#### • MASSTC is the operator and sampler

- Staff collect monthly samples for some parameters (mostly nitrogen and phosphorus) and quarterly for other parameters
- Staff sample both influent and effluent







- 10 sites installed
- 15 planned
- 5 sites sampled thus far (all NitROE systems)
  - Only 1 or 2 sample results available







Phosphorus cycle is very different from nitrogen cycle



Phosphorus is a necessary nutrient but in excess can cause issues in freshwater bodies.

While nitrogen removal is a cycle that ends in a gas (atmospheric nitrogen), phosphorus accumulates.



There are multiple sources of phosphorus impacting our lakes and ponds – our project is aiming to look at the source of wastewater phosphorus at the single-family, residential level.



- Install at least 6 systems with technologies claiming to remove phosphorus from wastewater
- Provide a \$5,000 subsidy as incentive to homeowners
- Provide donated equipment (when possible/offered)
- Provide at least one year of monitoring



- Soils-based technologies
  - PercRite <sup>®</sup> by American Manufacturing Company, Inc.
  - GeoMat ™by Geomatrix
- Electrochemical technologies
  - EC P<sup>®</sup> by Waterloo Biofilter
  - CRX II by FujiClean USA™
  - DpEC by Premier Tech Aqua
- Polymer technologies
  - Phos 4 Fade® by Norweco ®
  - Busse by BusseNY®
- Reductive Iron Dissolution technologies
  - PhosRID ™by Lombardo Associates, Inc.
- Composting toilet
- BioBarrier<sup>®</sup> by BioMicrobics



- Where are we now?
- 1 system has been monitored for almost 3 years now
  - Site has Waterloo EC-P technology
  - Not grant-subsidized
- 1 system recently given Pilot Use approval
- 1 system planned to be installed in spring
- Still communicating with interested homeowners









#### Wastewater phosphorus is only part of the puzzle





# Learn more about all the projects named on our website:

#### https://www.masstc.org/projects



# Barnstable County Innovative/Alternative Septic System Tracking Program



## Barnstable County I/A Septic System Tracking Program

- Tracks compliance of real-world I/A systems on Cape Cod and additional participating towns (all 15 towns on mainland Cape Cod, Nantucket, 5 on Martha's Vineyard, 4 off Cape – 25 total)
- More than 3,600 active permits
- More than 39,700 sample reports
- More than 57,000 inspection reports
- Coordination with MassDEP to track all Pilot Use systems





https://septic.barnstablecountyhealth.org/charts/countsmap



#### https://septic.barnstablecountyhealth.org/charts/bubblecounts



MassDEP Executive Office of Energy & Environmental Affairs

#### Department of Environmental Protection One Winter Street Boston, MA 02108 • 617-292-5500

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Lieutenant Governor

Kathleen A. Theoharides Secretary

> Martin Suuberg Commissioner

Dear Permittee:

June 4, 2021

This letter is to inform you of a change to the reporting requirements of your Innovative/Alternative (IA) Site Specific Piloting Approval.

The Department has authorized Barnstable County to act as its agent and receive all information pertaining to Operator inspections and all required monitoring data for Site Specific Piloting approvals. This information will now be submitted to the Barnstable County Septic Management Program's IA Tracking Database as follows:

- Submittal of sampling or monitoring data and Operator inspection results within 45 days of each sampling date and each inspection date, to the local approving authority and to the Department. Submittal to the Department will be through the Barnstable County Septic Management Program's IA Tracking Database: <u>https://septic.barnstablecounty/health.org/</u>. Submittal to the Local Approving Authority must be in accordance with their requirements.
- The inspection results reported must include the information recorded/required on a DEP approved inspection form (<u>https://www.mass.gov/lists/title-5-septic-system-forms#title-5-inspections-&-pumping-forms-</u>) and the Company's technology inspection checklist.

To begin using the Barnstable County Septic Management Program's IA Tracking Database, the Massachusetts Certified Operator of the IA system needs to register each site at: <u>https://septic.barnstablecountyhealth.org/</u>.

Once on the home screen, click "Sign Up" in the upper right of the screen. Barnstable County assesses an annual Database User fee to the Operator for each site that is registered. Once the site is registered, the owner of the IA system will be able to set up an account (at no cost) in order to view the data submitted for their system.

Please be advised that effective **September 3, 2021**, all IA Technology Site Piloting Approvals will be required to submit inspection and monitoring information required by DEP electronically through Barnstable County Septic Management Program's IA Tracking Database.

If you have any questions or require assistance with the registration, please contact Linda Barba via email at: <u>linda.barba@mass.gov</u> or Emily Michele Olmsted at <u>emilymichele.olmsted@barnstablecountv.org</u> or click on 'Contact' in the top menu bar on the Barnstable IA Tracking Database site.

> Sincerely, /S/Marybeth Chubb Marybeth Chubb, Section Chief Wastewater Management Program

The electronic signature above constitutes the signature of the person signing this document and has the same effect as if the person had signed the document with an original signature.

This information is available in alternate format. Contact Mishelle Waters-Ekanem, Director of Diversity/Civil Rights at 817-282-5751. TTY# MaccRelay Service 1-800-438-2370 MassDEP Website: www.mass.gov/dep

Printed on Recycled Paper

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#### [...]

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# Excerpts from June 4, 2021 letter from MassDEP to Pilot Use permit holders

#### Barnstable County I/A Septic System Tracking Program

Program website:

https://septic.barnstablecountyhealth.org/



## Major takeaways

- Watch out for our project updates in the future
  - Virus
  - Shubael
  - Phosphorus
  - Others I haven't named
- Check out the real world I/A systems





#### There is no magical solution to every wastewater problem!






## Emily Michele Olmsted Environmental Project Assistant/Quality Assurance Manager <u>emilymichele.olmsted@barnstablcounty.org</u> 508-375-6901

## <u>https://www.masstc.org/</u> <u>https://septic.barnstablecountyhealth.org/</u>

