SNEP NETWORK

The future of robust onsite wastewater treatment infrastructure

(leveraging research findings, gaps and management strategies to protect public and environmental health)

Alissa Cox, Matthew Dowling, George Loomis, Jose Amador

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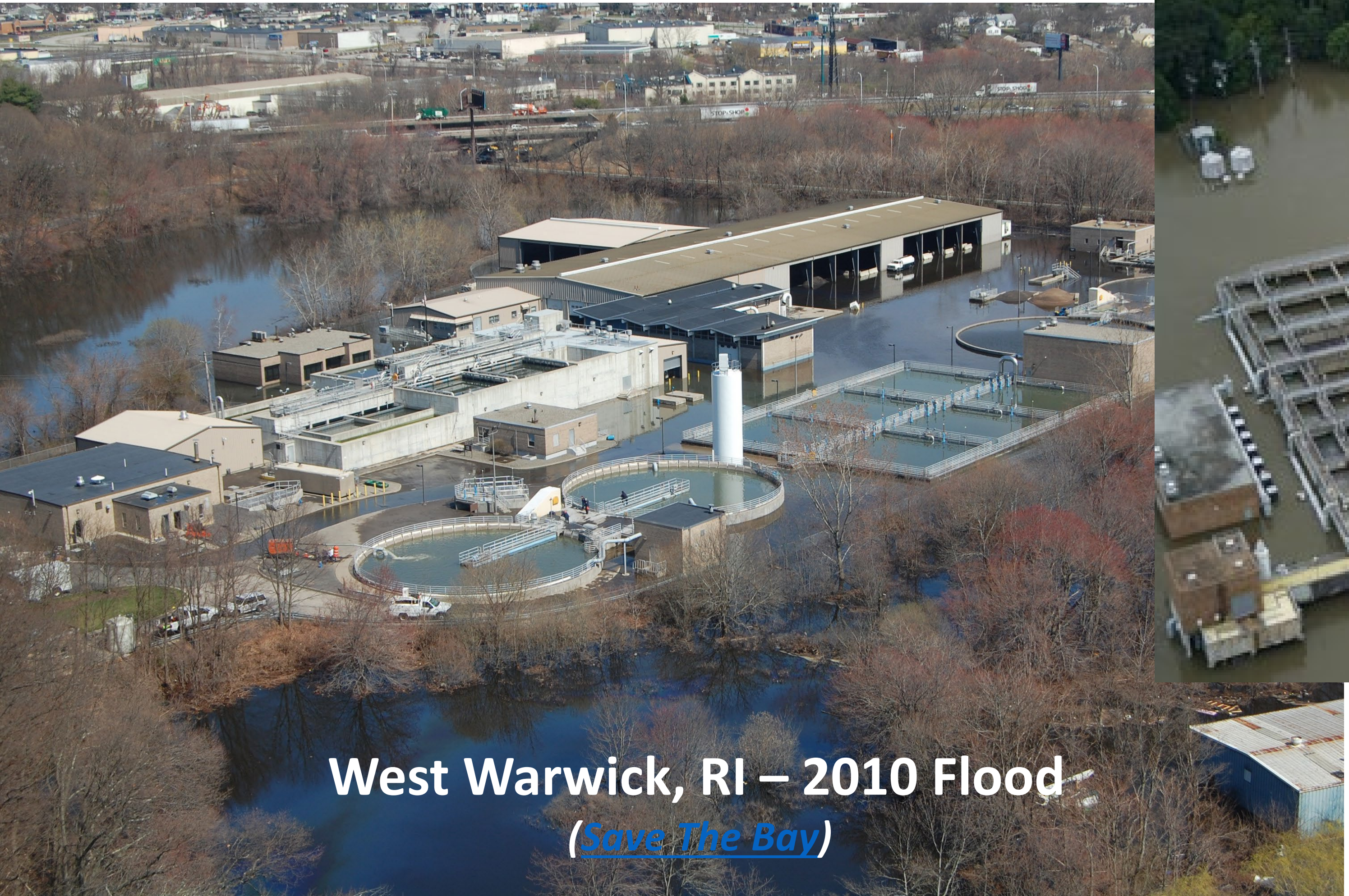
Centralized wastewater infrastructure = vulnerable to climate change

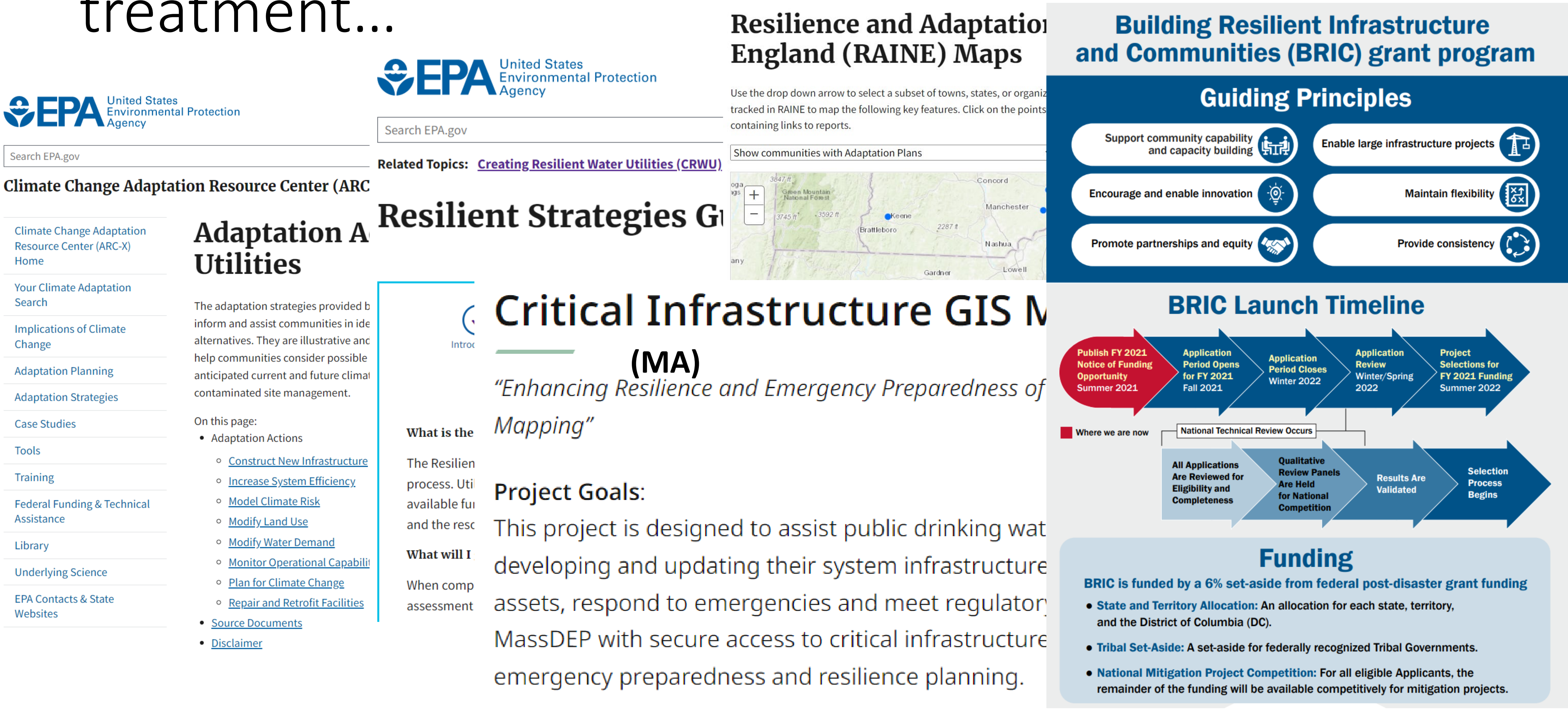
Houston, TX – Harvey 2017
(Eos)



West Warwick, RI – 2010 Flood
(Save The Bay)

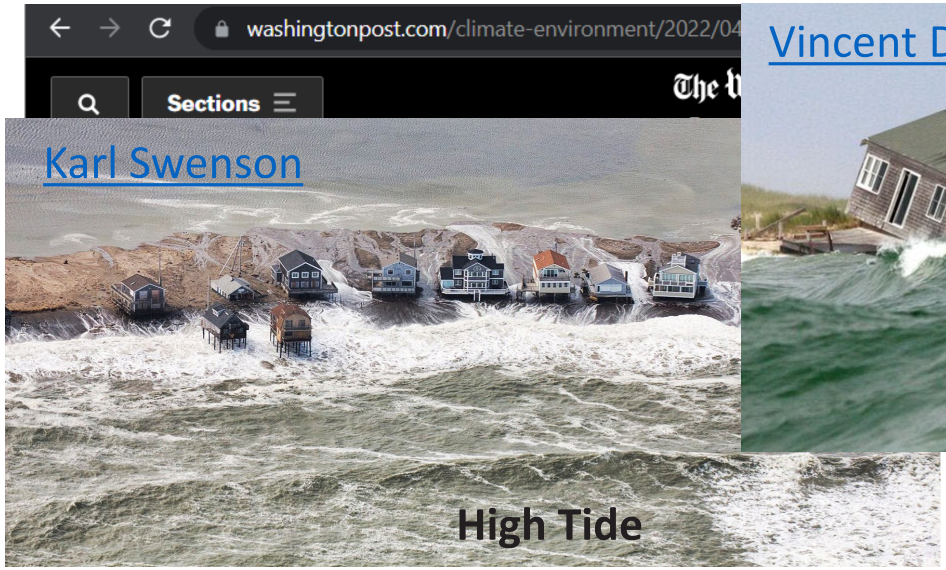
Centralized wastewater infrastructure resiliency

Many resources support climate change adaptation and mitigation for centralized water treatment…



Onsite Wastewater Treatment Systems (OWTS) are infrastructure too!

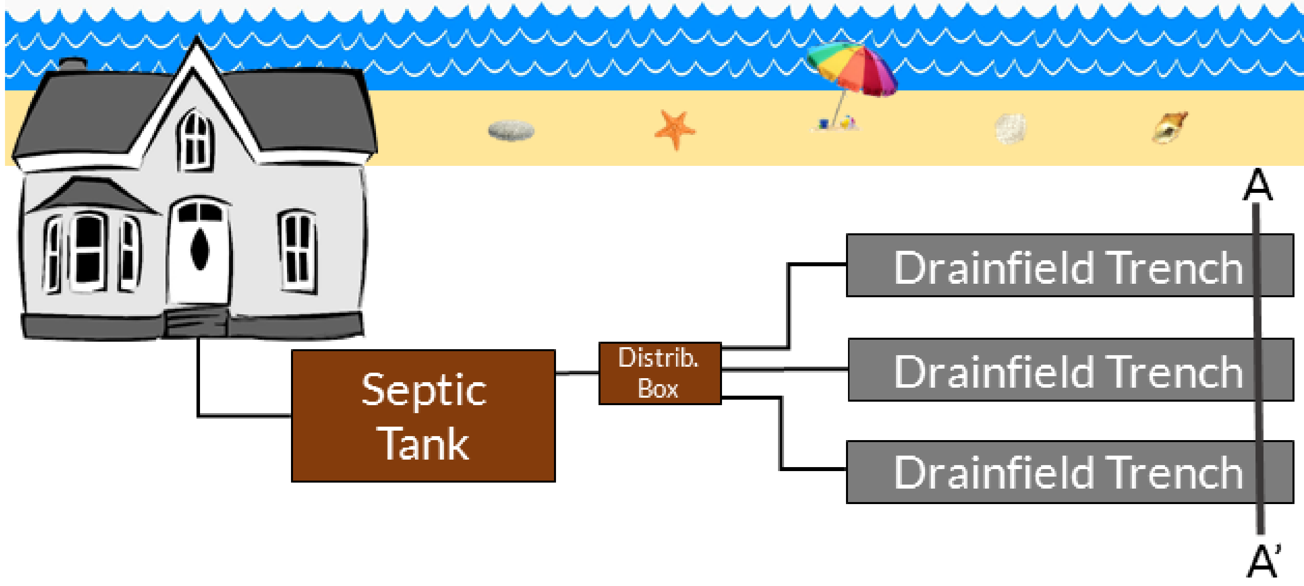
- …But we aren't talking about them!
  - …at least in the Northeast…
- OWTS face threats from altered hydrologic cycle & weather patterns too!
  - Sea level rise, extreme precipitation events, storms, hurricanes, floods…

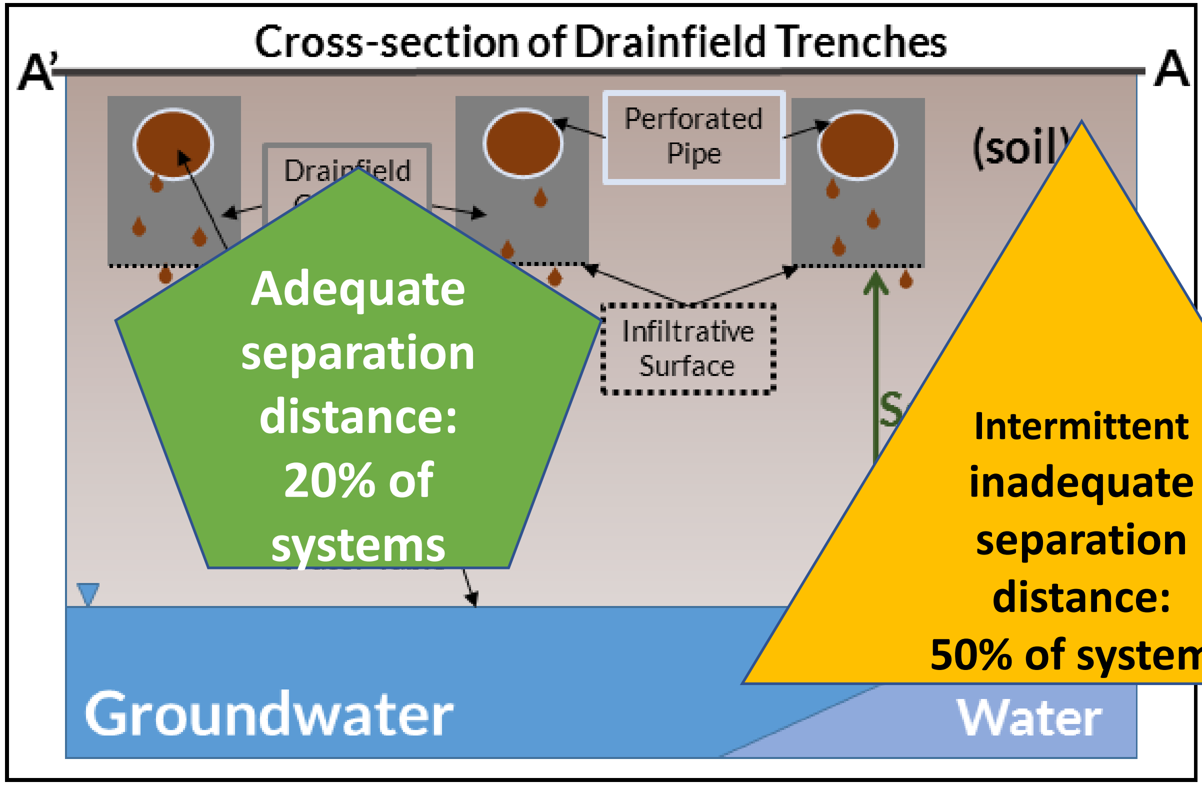


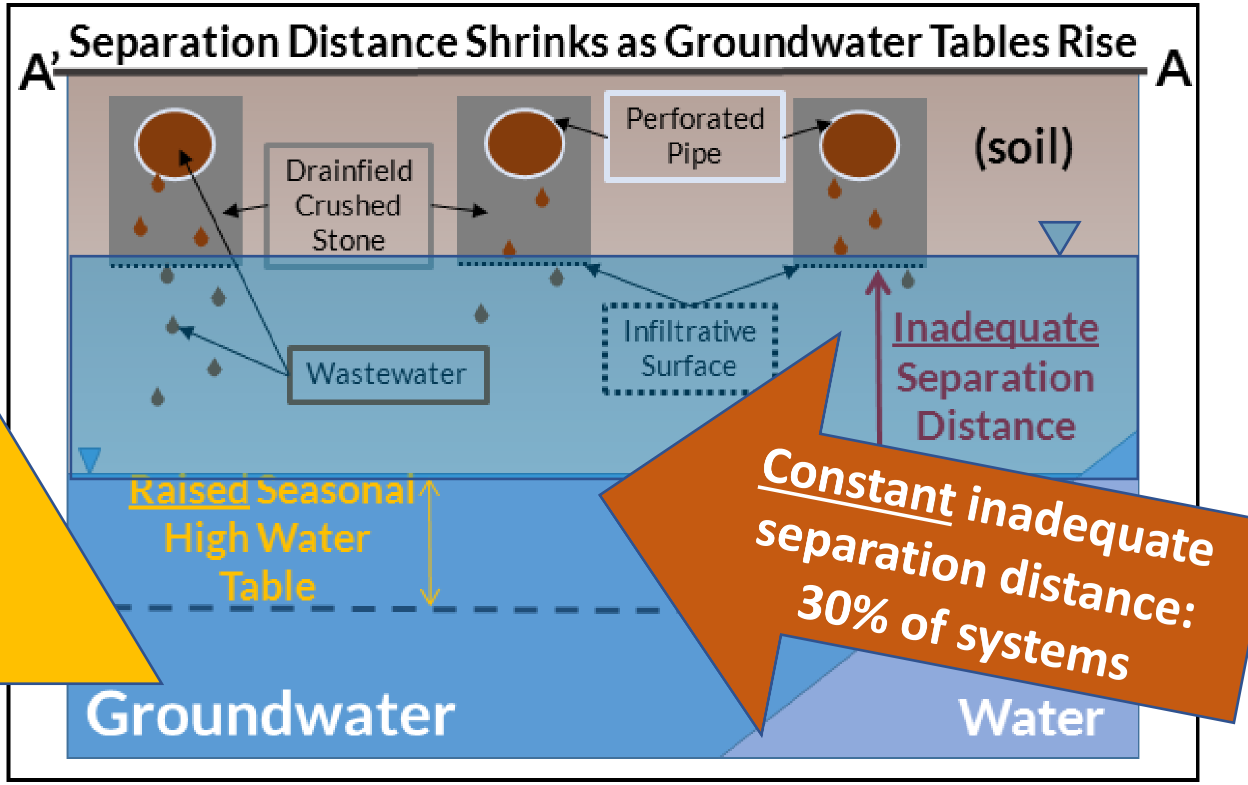

Coastal
septic
systems
SLR & rising
groundwater
tables
Coastal
storms

Coastal septic systems are vulnerable

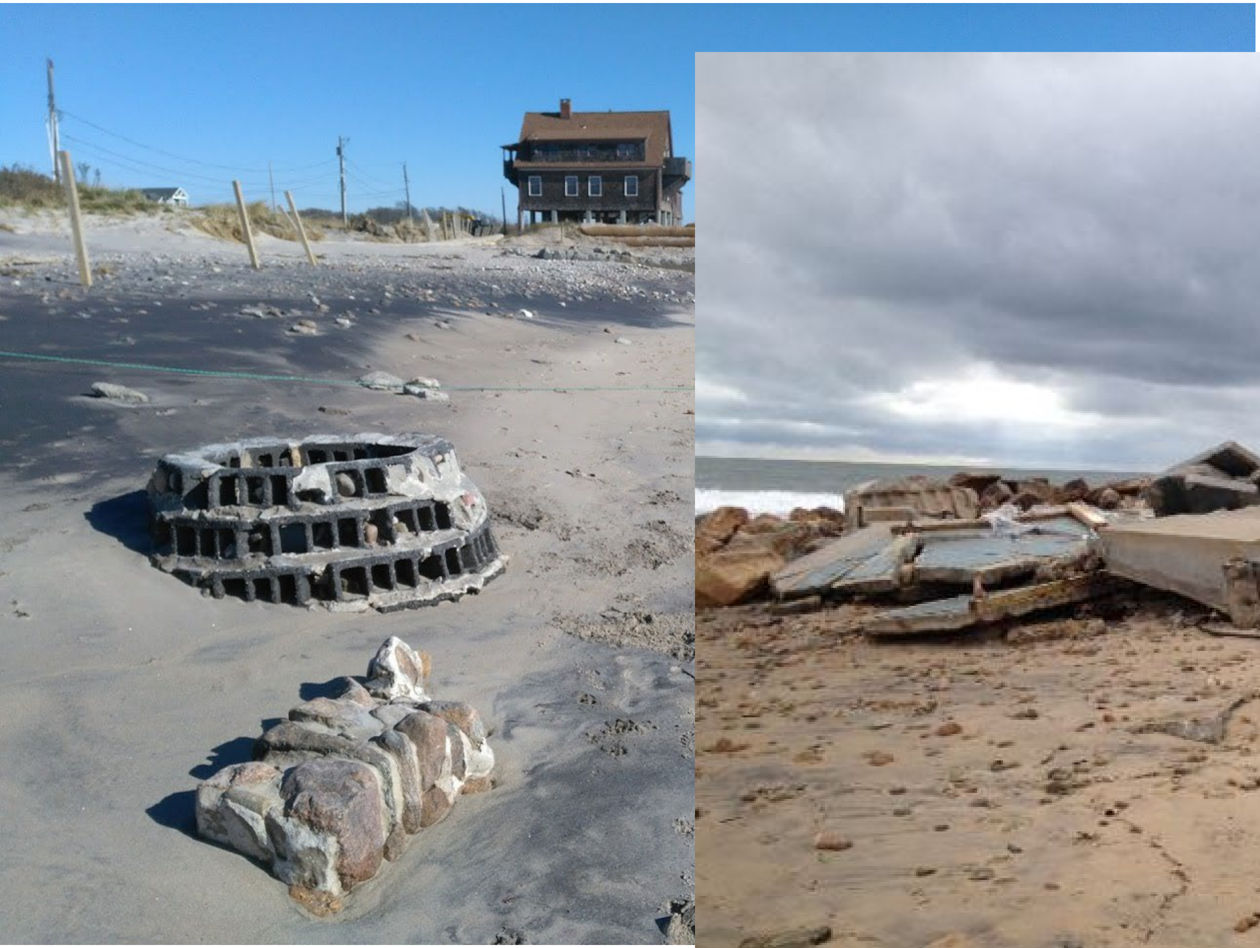
Cox et al. (2020a)







Storms have major impacts on coastal OWTS infrastructure



Storm impacts…

<u>During a Storm:</u>
Flooding and fast-moving water
inundates septic systems
(especially low-lying and near-shore systems)

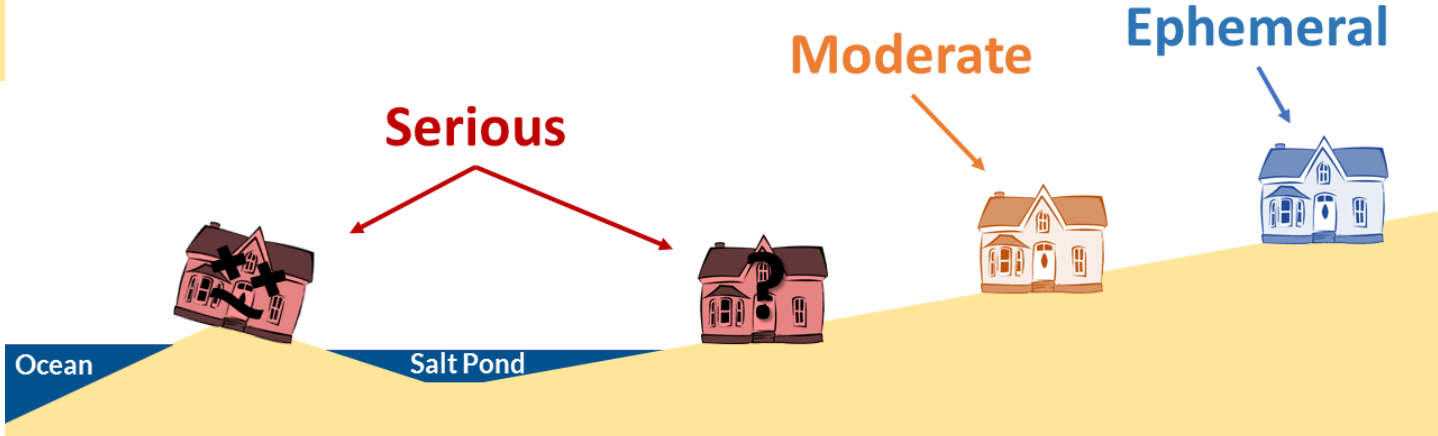
Cox et al. (2020b)

Modeling along southern RI coast, based on 2012 (Sandy) damage & flood maps:

200+ systems	65+ systems	2-5k+ systems

Require repairs / assessment

<u>After a Storm:</u>
Septic systems may be damaged from
long-term flooding or scouring action of
fast-moving water

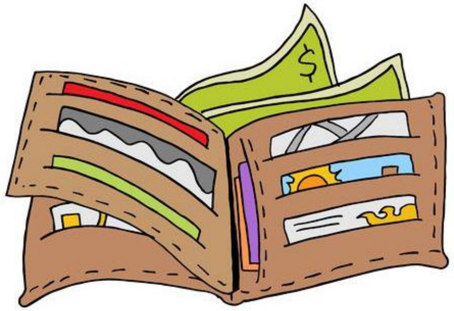


We don’t know what we don’t know

- How many systems were destroyed or damaged & repaired after Superstorm Sandy in 2012?
  - What about during the next storm event?
  - How long does it take a system to regain its function after a flood?
- How are coastal groundwater tables today impacted by floods, sea level rise or large precipitation events?
  - How will this change in the next 30 years? 50 years? 100 years?
- What about advanced systems in coastal & flood-prone areas?
  - If system is not damaged physically, how long until system performs again?
    - Assuming we know ongoing performance…
  - How are systems designed & installed for resilience in extreme events?

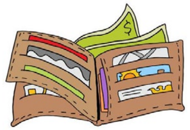
OWTS as a priority… (at scale)

- Permitting usually at state our county level – regulations & approaches vary
- Management & financing approaches for OWTS vary widely
  - Typically managed at town or county level (Northeastern US)
    - Personnel?! – often underfunded / overextended
    - Level of management varies – “in name only” … up to … performance monitoring
  - Funding options for system repairs/upgrades:
    - Property owner $…
    - State Revolving Funds supporting Community Septic System Loan Programs
    - Grants (local, state, federal) as subsidies/cost-shares
    - Disaster recovery funds (post-disaster, e.g. FEMA)



Community Septic System Loan Program - CSSLP

The Community Septic System Loan Program provides attractive financing to homeowners for the repair or replacement of failed, failing or substandard septic systems, or to replace a cesspool with a septic system.



FEMA

Possible solutions

Advice from the Water Utility Climate Alliance (applies to OWTS, too!)

Key messages from WUCA

Warming is here and now. Climate adaptation planning is not just about the future. Water utilities are experiencing the effects of a changing climate on their water resources today.

Document current performance & CC impacts

Know your system and explore its vulnerabilities. Assess your water system to identify vulnerabilities. Risks can only be reduced if they are identified.

Use past data – identify patterns & vulnerabilities

Plan for multiple futures. Predicting the future is not feasible but anticipating plausible warmer future climates is. Prepare to face a variety of scenarios.

Plan for CC, floods, SLR, storms – design systems to be resilient & manage them proactively!

Capacity building and assessment are part of the adaptation equation. Developing the technical and managerial expertise to identify and assess climate risks to a system is as much a part of adaptation as the steps taken to implement risk reduction measures.

Engage & train OWTS professionals & stakeholders; develop systems to assess, address and mitigate CC-related risks

More good advice from the Water Utility Climate Alliance … Leading practices in climate adaptation (for OWTS)

- **Engage** & motivate stakeholders
- **Understand** current OWTS & their relationship to climate change
- **Plan** to manage OWTS, make OWTS more resilient & build capacity
- **Implement** management, data collection & failure analyses
- **Sustain** best practices; adjust approaches as needed

Know your system: Catalog ALL systems

- Create geo-referenced database with **<u>all</u>** systems – state-wide
  - GPS coordinates of tank, d-box, advanced treatment, drainfield
  - Link to most recent permit / certificate of construction & past repairs/upgrades (?)
  - Design flow, system technologies
  - Last inspection / Last pump-out / maintenance visit
  - Private Well / Community well / Municipal water / Other
  - Separation distance (drainfield-SHWT) & depth to GW table from surface
  - In flood plain? Coastal Zone?
  - Owner-occupied? Year-round or seasonally occupied?

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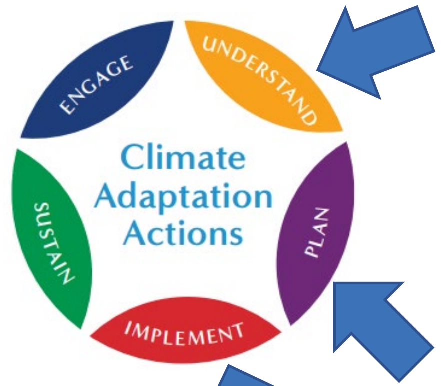
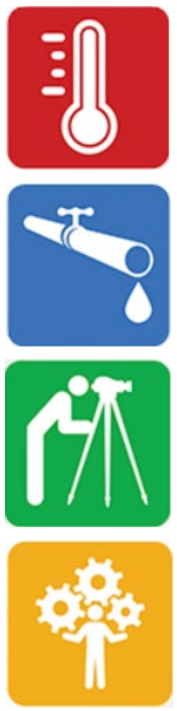
Benefits of knowing your system (via comprehensive centralized database)





- Can track system performance / maintenance, document impacts of climate change, ID aging systems or vulnerable / high-risk systems
- Failure analysis – can look for patterns, ID vulnerable systems to target for upgrades (and subsidies)
  - If add standardized damage assessment protocol (post-disaster) & integrate data, can use data to inform resilience planning, permitting, training/engagement needs
- Centralized/standardized system – easy to integrate additional info without formatting woes & facilitates down-stream analyses
  - ID best practices – share with stakeholders
  - Guide / inform regulation revisions / adaptation strategies

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Treat & manage OWTS as infrastructure!

Know your system: Collect & integrate system performance documentation

- We don't have much data on CC influences in OWTS in the ground
  - Need to collect performance data
  - Know: monitored systems perform better!
- Standardized lab testing is (+) unbiased but (-) expensive and not timely
- There are <u>accurate & inexpensive</u> field-based rapid tests to approximate total N, pH, DO and other parameters
  - Can use as "triage" & inform system adjustments in real time
  - Could train & require service providers to report – and spot-check with lab-tests?

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Lancellotti et al. (2017), Ross et al. (2018), Ross et al. (2020)

Know your system: Document current groundwater table dynamics in flood-prone landscape locations

- Establish Groundwater Monitoring Networks
  - Elevation variations & impacts of precipitation, storm or flood events
    - Can be cross-checked and integrated in system design and permitting
  - Assess (changes in) water quality?
    - Could alert locals to problems, especially after catastrophes
  - Idea: leverage community members (volunteers, schools, etc.) to help with data collection
- Establish post-flood/storm protocols
  - Communicate with OWTS users of hazards & best practices before, during & after event
  - Standardize inspection protocols post-event to document damage, problems, performance

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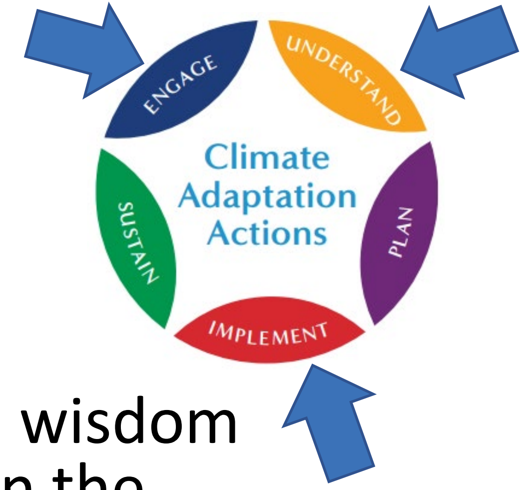
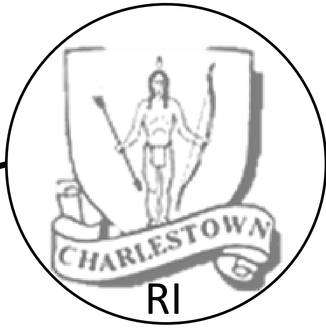
Engage stakeholders



- How can we collate and integrate the accumulated experiences, wisdom and effective approaches or mindsets among the professionals in the OWTS industry?
  - Goal: OWTS = sustainable & robust INFRASTRUCTURE
- How can we make OWTS designs and installations more resilient in vulnerable areas? How can we ensure this occurs?
  - Regulations / rules revisions or requirements in certain areas?
- How can we “make septic systems sexy” for end users?
  - Motivate owners to maintain and/or upgrade systems?



- How can we involve stakeholders / community members in data collection to inform effective approaches and decision-making?

Prioritizing funding

- Time, effort & $ required for:
  - Geo-referenced OWTS databases
  - System details, performance, maintenance, failures
  - Analyzing data, identifying patterns, making recommendations
  - Engaging stakeholders decision-making
  - Incentivizing professionals to apply & integrate best practices for resilience
  - Replacing antiquated and vulnerable OWTS with robust CC-resilient technologies – at scale!
- Infrastructure that protects public and environmental health should not be the sole responsibility of a property owner!
  - Can't expect individuals to be experts in wastewater treatment or system management
  - Managing OWTS ~ centralized utilities = enable proactive management that protects communities and ecosystems

Questions?

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Factors in Homeowners' Willingness to Adopt Nitrogen-Reducing Innovative/Alternative Septic Systems

Alexie Rudman[1], Kate Mulvaney[2], Nate Merrill[2] , Kaytee Canfield[2]

[1] ORISE Fellow, US EPA Office of Research and Development, Narragansett, RI

[2] US EPA Office of Research and Development, Narragansett, RI

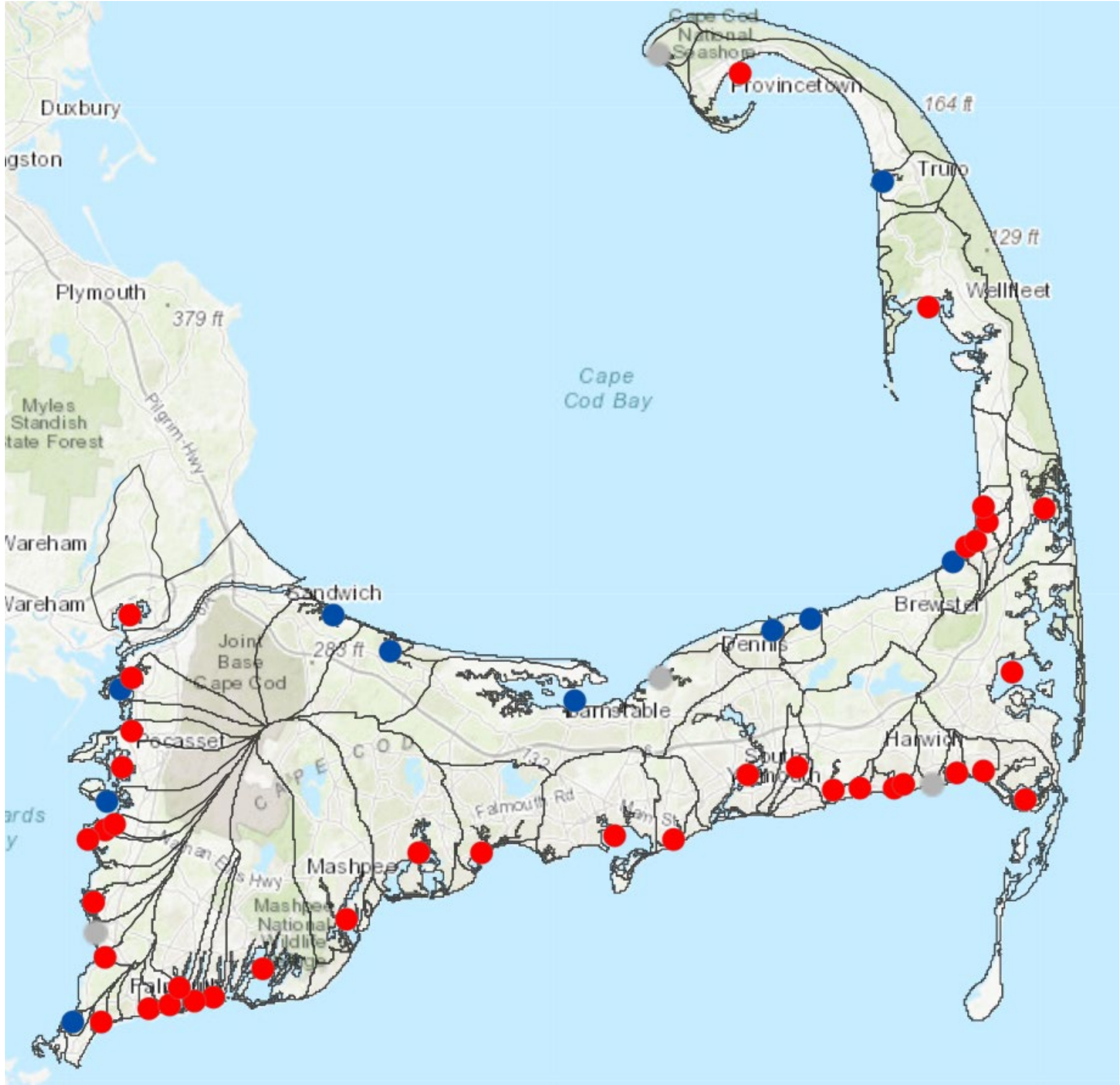
SNEP Symposium webinar May 5th, 2022

Research Context

- Cape Cod waters are impaired by excess nitrogen
  - 80% of controllable load from septic systems

- Stakeholder-centric project working to address nutrient problems
  - Piloting alternative technologies
  - Transferable elsewhere

- Technical and economic efficiency do not determine household-level adoption



"No matter how technologically promising a system might be, it cannot achieve either sanitation or sustainability goals unless people are willing to use it"

-Wood et al. , 2016

Why do this research?

- Unknowns
- Homeowners are end users
- Adoption is voluntary
  - Social desirability is necessary for these to be implemented as a nitrogen-reduction strategy

Source: Barnstable Patriot

Social Dimensions of I/A System Adoption

Research objectives:

1) ID factors that drive/inhibit the adoption of I/A systems

2) ID uncertainties and lessons learned

Research outcomes:

1) Improve how I/As are communicated

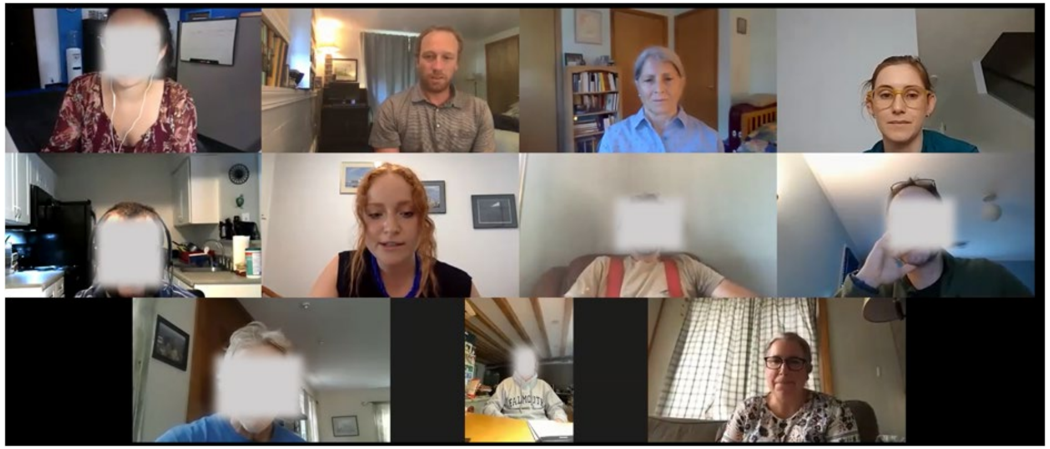
2) Provide guidance target issues to reduce barriers to adoption

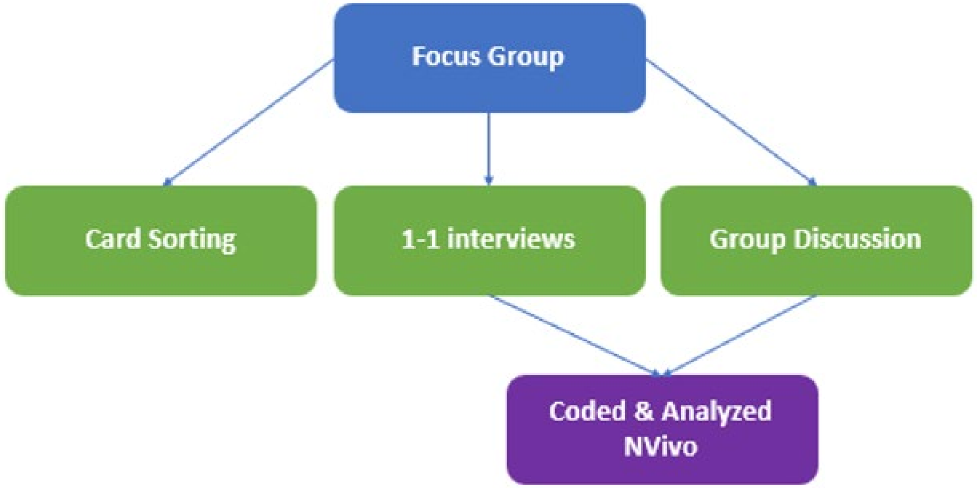
3) Better target homeowner outreach


Source: Newsday

Methods

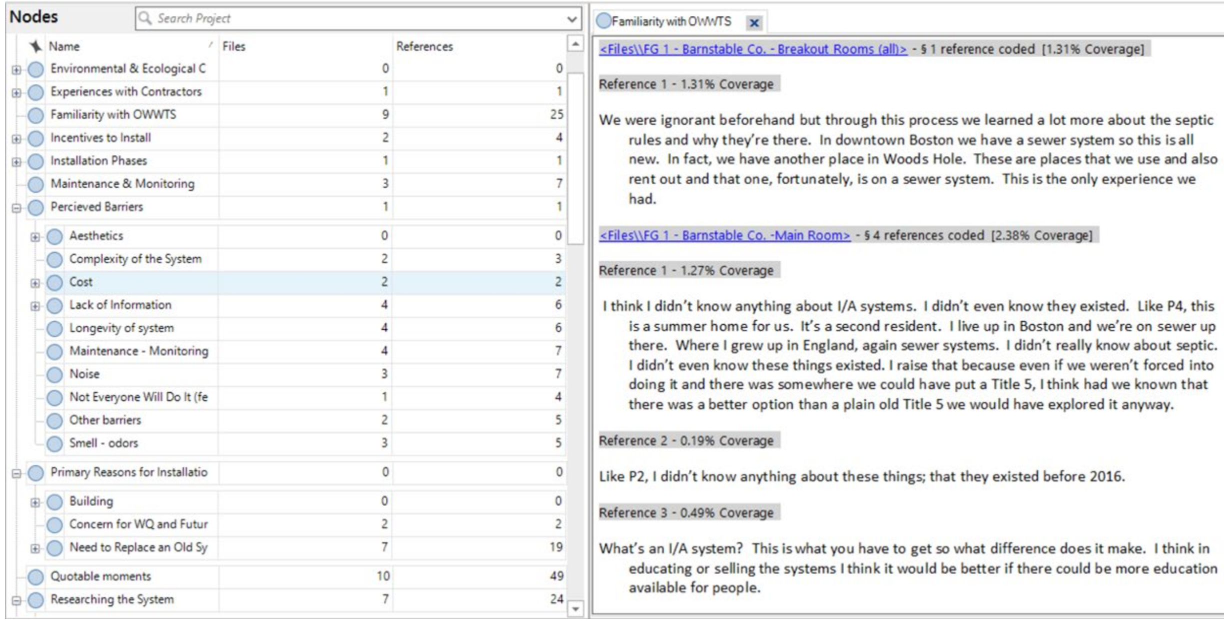
- Literature analysis:
  - Decision-making and behavior change models
    - How & why people make decisions
  - Learned from literature on adoption of similar technologies
    - Agricultural BMPs, solar, electric vehicles
- Virtual Focus Groups with adopters & prospective adopters from MA pilots
- Relied on partners for recruitment
- Consisted of:
  - Card sorting activity (Q-sort)
  - Brief 1-1 interview
  - Semi-structured group discussion



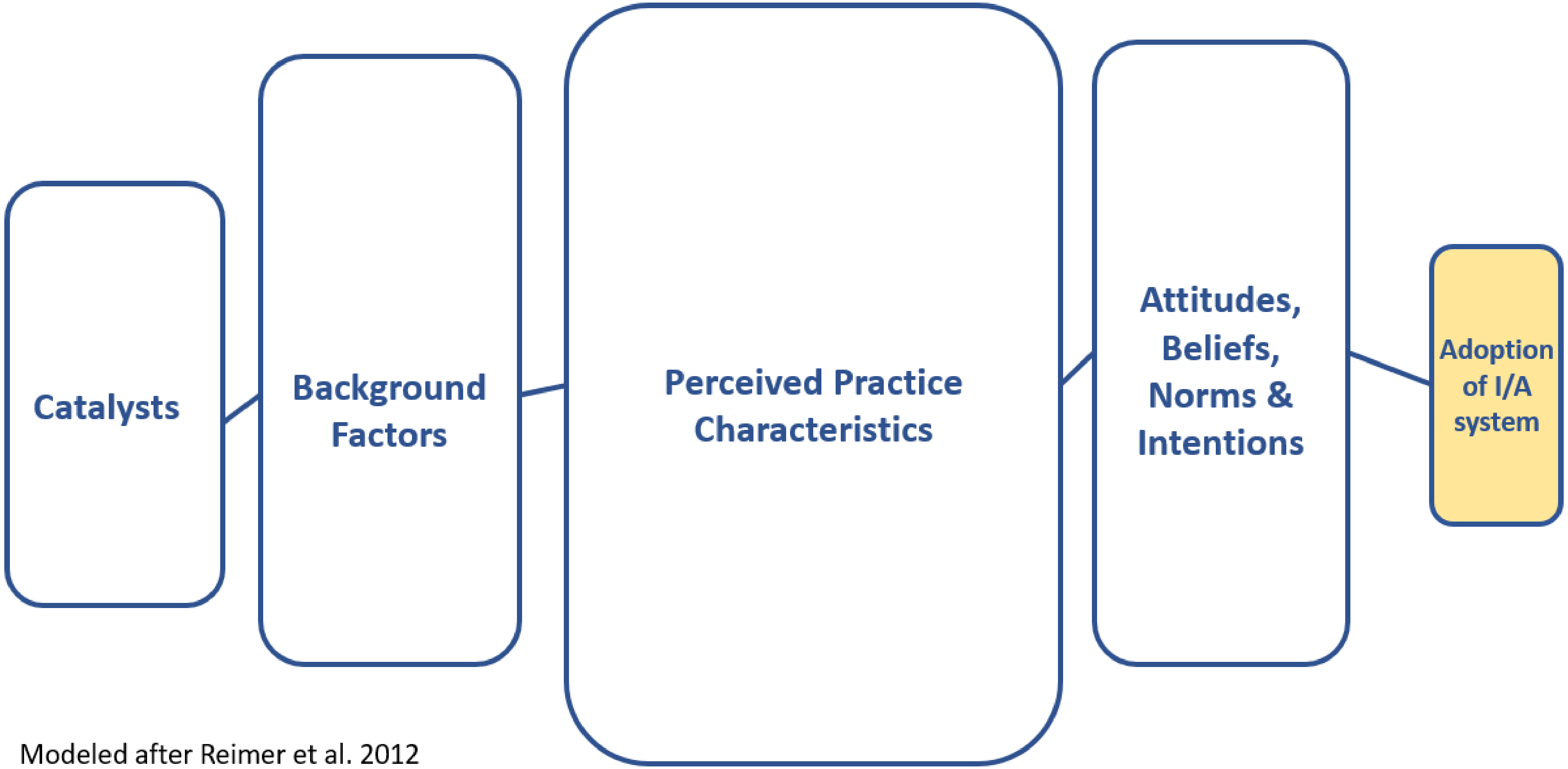


Methods

- Focus groups recorded + transcribed
- Coded in NVivo
  - Intercoder reliability
- Created a model to illustrate factors that comprise homeowners' decision-making around I/A adoption



Results: Mental Model of I/A System Adoption



Modeled after Reimer et al. 2012

Results: Mental Model of I/A System Adoption

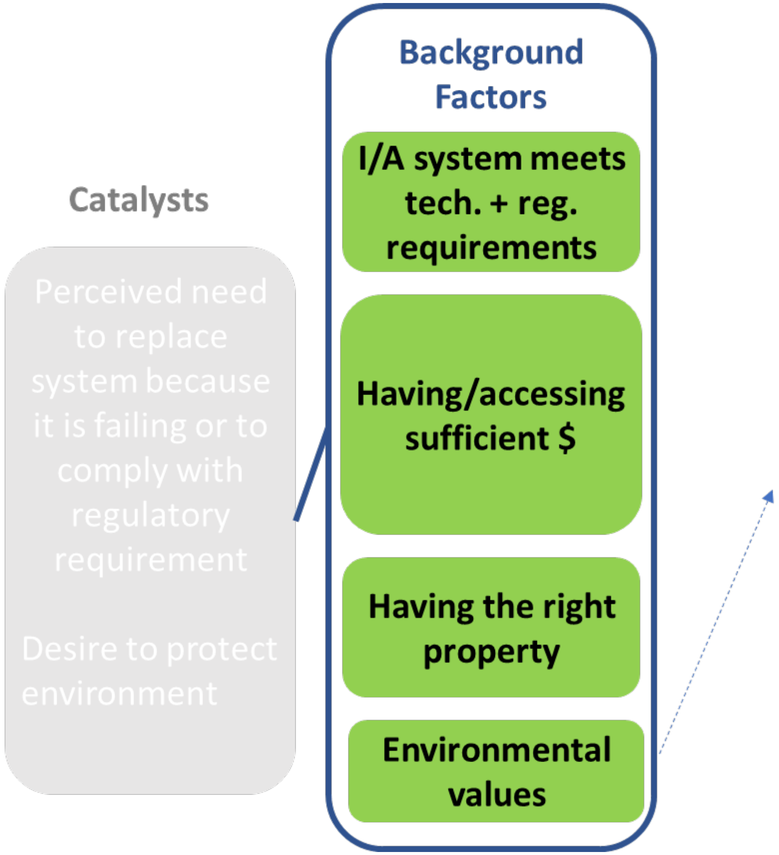
Catalysts

Perceived need to replace system because it is failing or to comply with regulatory requirement

Desire to protect environment

"My system was failing. If I was going to replace it, I was going to upgrade and accomplish the goal of improving the water quality…There was no question in my mind that I wanted to do something that would contribute"

Results: Mental Model of I/A System Adoption



"I've seen the degradation of the cove and harbor markedly over that period of time; it's effectively dead… I did it out of a moral concern that I enjoy the water that I live and play on, and felt I had the resources economically and that it was the right thing to do."

Results: Mental Model of I/A System Adoption

Catalysts

Perceived need to replace system because it is failing or to comply with regulatory requirement

Desire to protect environment

Background Factors

I/A system meets tech. + reg. requirements

Having/accessing sufficient $

Having the right property

Environmental values

Perceived Practice Characteristics

Accessible, trusted info on I/As & install process:
Costs
Logistics of installation
Maintenance & monitoring
System longevity & effectiveness
Trusted coordinating organization

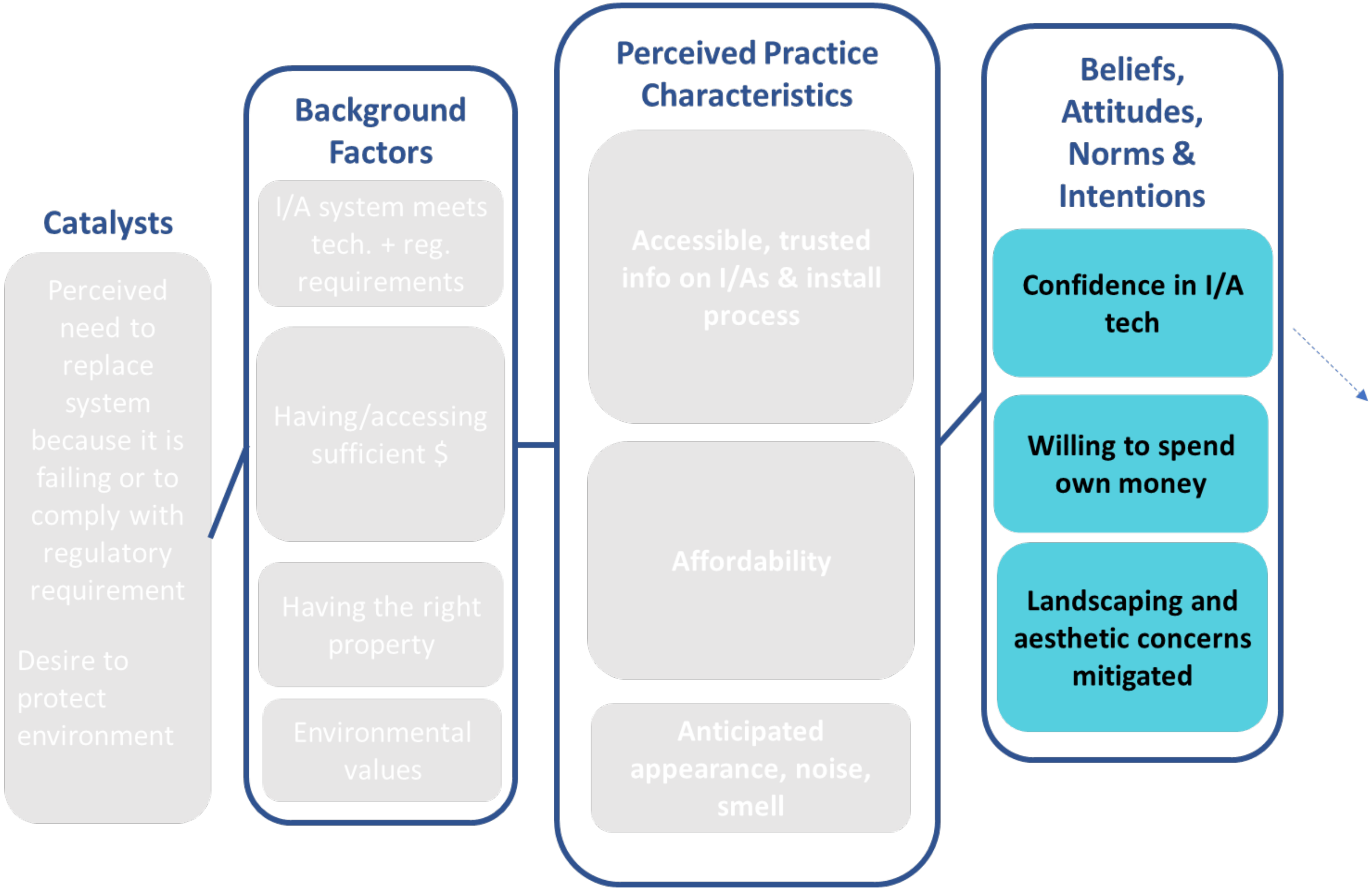
Affordability:
Installation & Long-term Costs
$ Disparity Title V < I/As
Subsidy or incentive available

Anticipated appearance, noise, smell

"No one could give me an idea of what it was going to cost to run this system month to month"

"I don't make that much money so adding another $1,200 a year just to maintain my system which already costs a fortune [is a lot]"

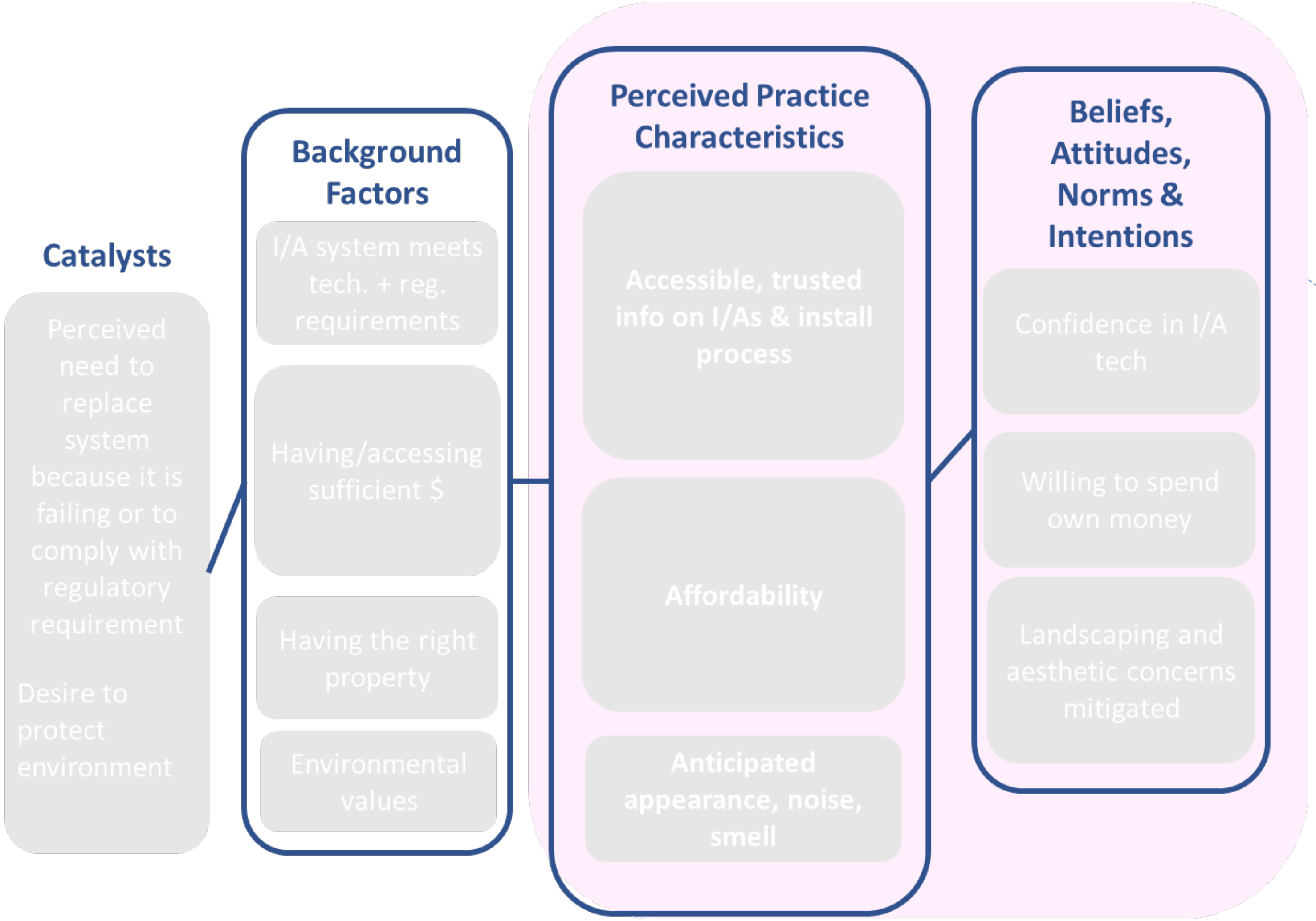
Results: Mental Model of I/A System Adoption



"I have no reason to believe that [pilot organization] would tell us something that wasn't true. And the system they have … seems very simple"

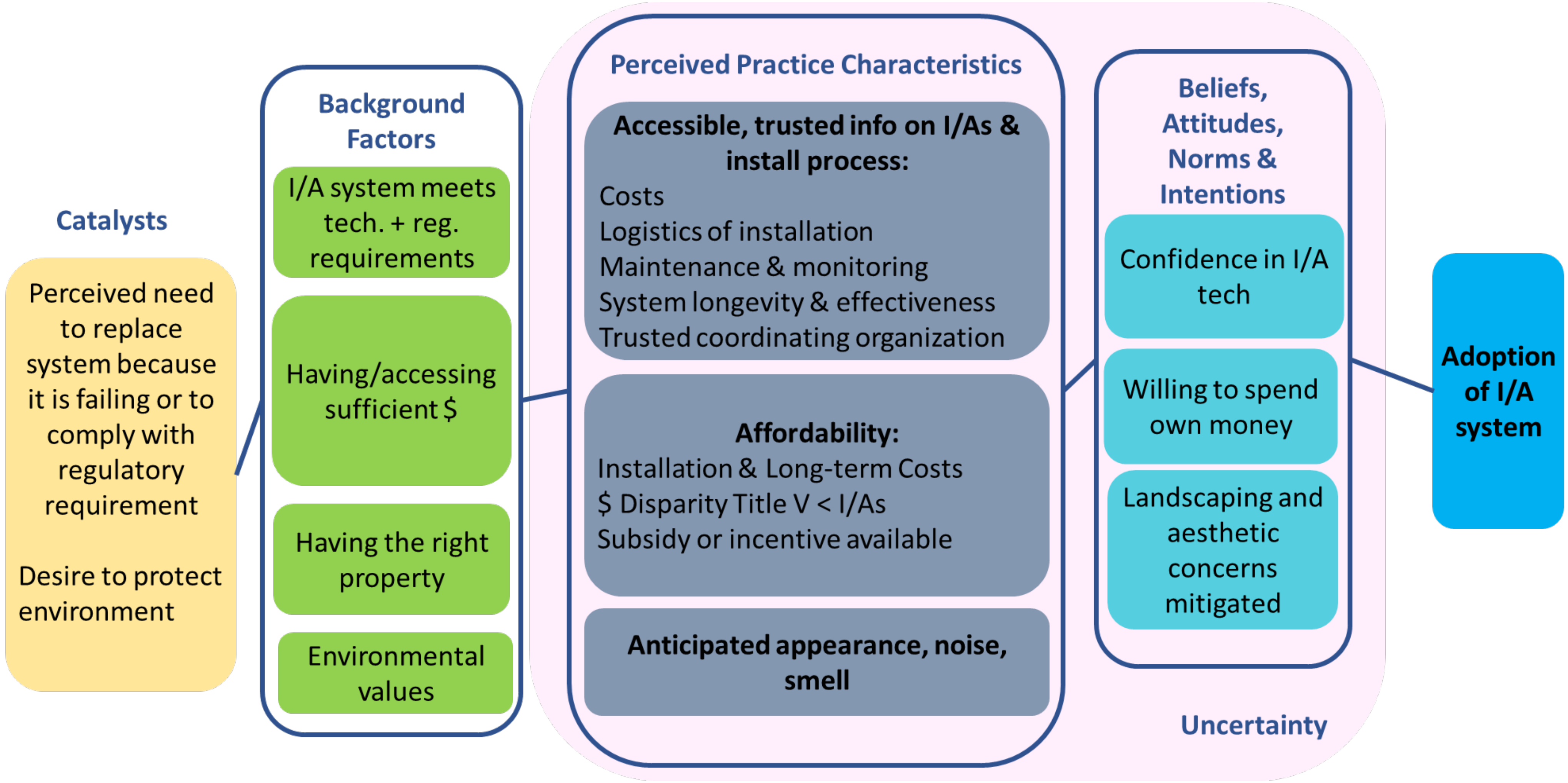
Trust in non-profit organizations!

Results: Mental Model of I/A System Adoption

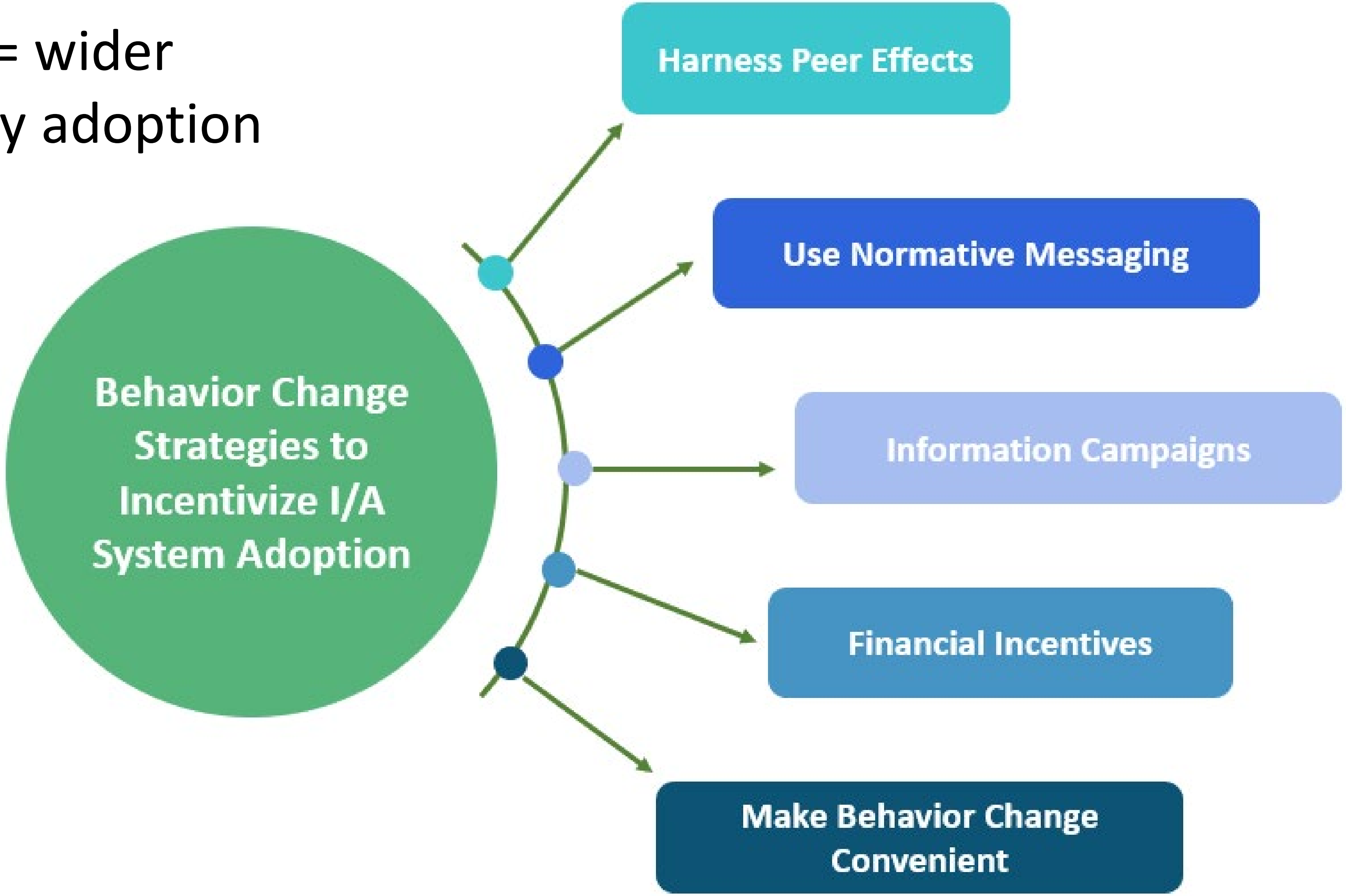


"I think there is confusion on the different systems that are out there. I think for the layman walking into it- trying to navigate the different systems…is a lot for 90% of the consumer homeowners out there to take on."

Results: Mental Model of I/A System Adoption



Diffusion = wider community adoption



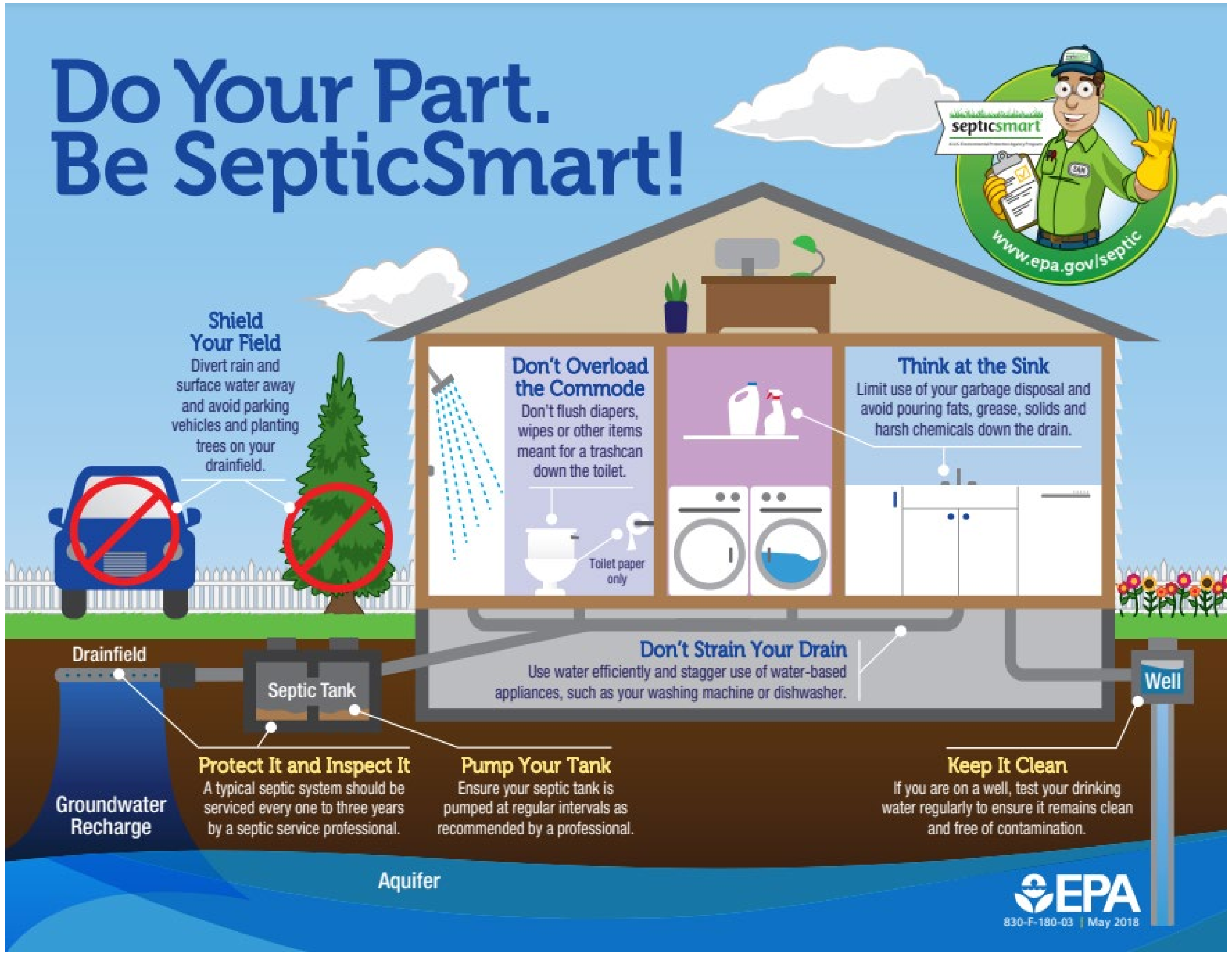
Harnessing Peer Effects

- **Harnessing peer effects:** Modelling a desired pro-environmental behavior to set a new standard of behavior

- Visibility is key
  - ➢ use local and social media to publish testimony from adopters like videos, short articles
  - ➢ demonstration site
  - ➢ signage

- Foster learning from trusted sources

Source: Barnstable Clean Water Coalition


Do Your Part.
Be SepticSmart!
septicsmart
www.epa.gov/septic
Shield Your Field
Divert rain and surface water away and avoid parking vehicles and planting trees on your drainfield.
Don't Overload the Commode
Don't flush diapers, wipes or other items meant for a trashcan down the toilet.
Toilet paper only
Think at the Sink
Limit use of your garbage disposal and avoid pouring fats, grease, solids and harsh chemicals down the drain.
Don't Strain Your Drain
Use water efficiently and stagger use of water-based appliances, such as your washing machine or dishwasher.
Drainfield
Septic Tank
Well
Protect It and Inspect It
A typical septic system should be serviced every one to three years by a septic service professional.
Pump Your Tank
Ensure your septic tank is pumped at regular intervals as recommended by a professional.
Keep It Clean
If you are on a well, test your drinking water regularly to ensure it remains clean and free of contamination.
Groundwater Recharge
Aquifer
EPA
830-F-180-03 | May 2018

Make Behavior Change Convenient

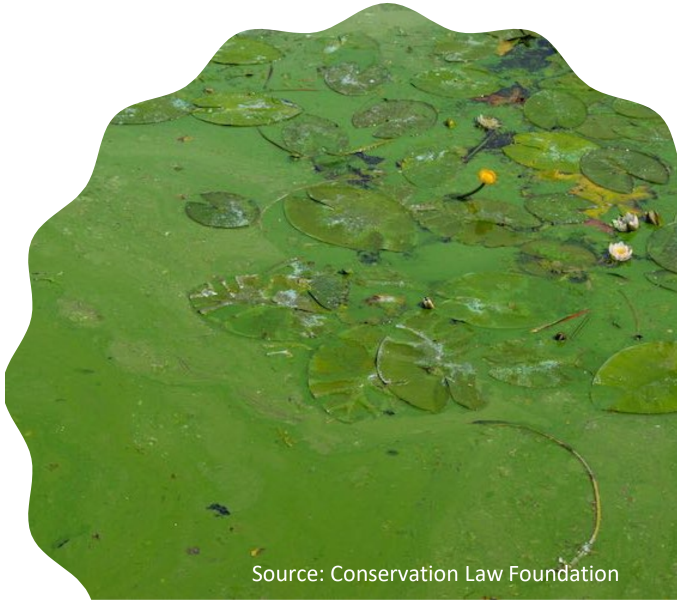
- behaviors perceived as costly b/c they require cognitive effort
  - Competing priorities
  - Permit applications, approvals, research, etc.…
  - Ex: Establishing Responsible Management Entities (RMEs)
  - Ex: Decision-support tools

- Cost - prominent inhibitor of adoption
- Monetary subsidies:
  - Performance-based incentives (PBIs)
  - Tax credits, rebates, exemptions
  - Use to incentivize or disincentivize
- Long-term, low/no interest loans
  - Ex: Barnstable Co. Community Septic Management Loan Program

Takeaways

- Many conditions and considerations drive or inhibit adoption
- Uncertainty & lack of information
- Widespread adoption will require targeted approaches
  - How & by whom these are communicated matters
  - Financial incentives

Stay tuned for our published manuscripts!



Questions?

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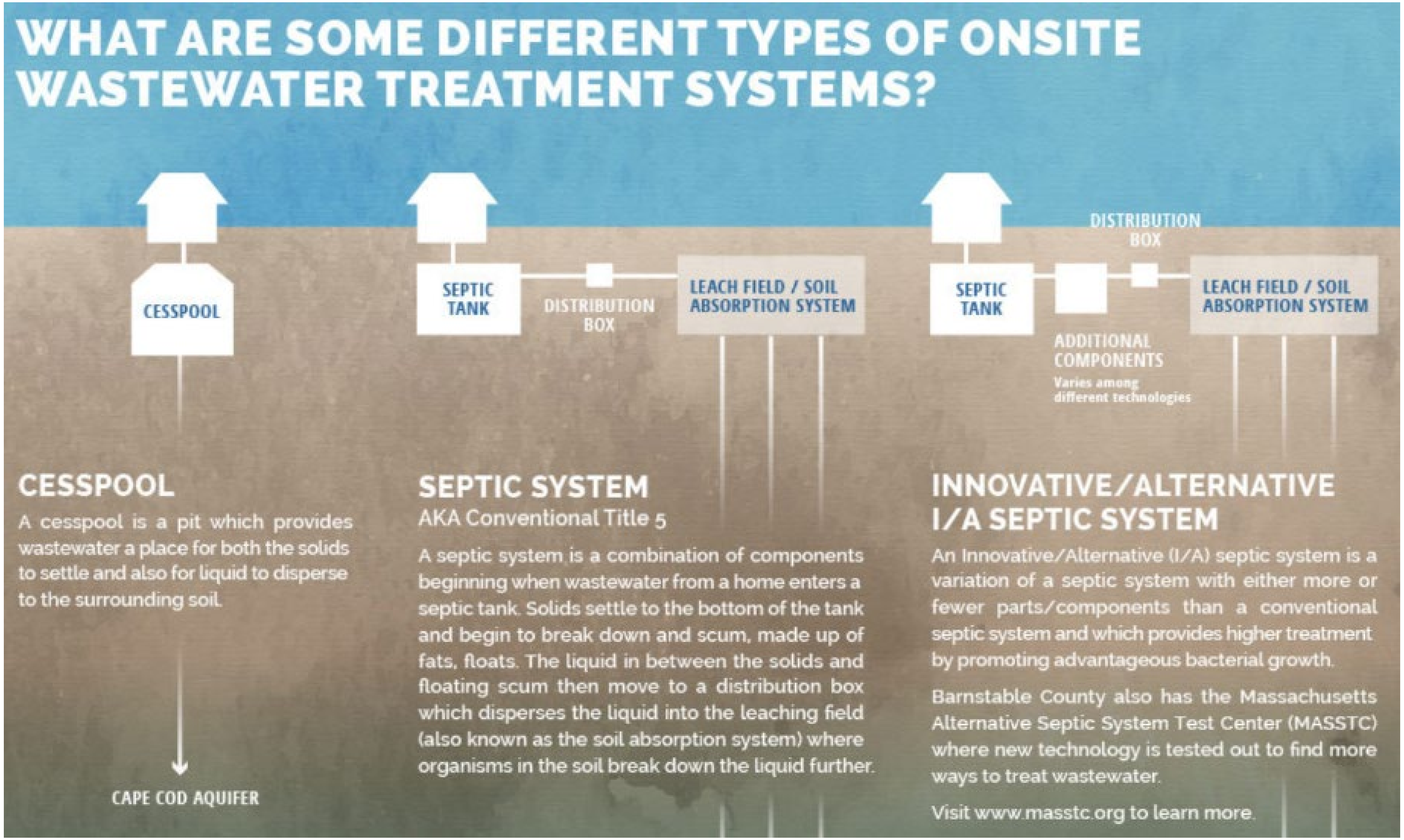
RESPONSIBLE MANAGEMENT ENTITIES

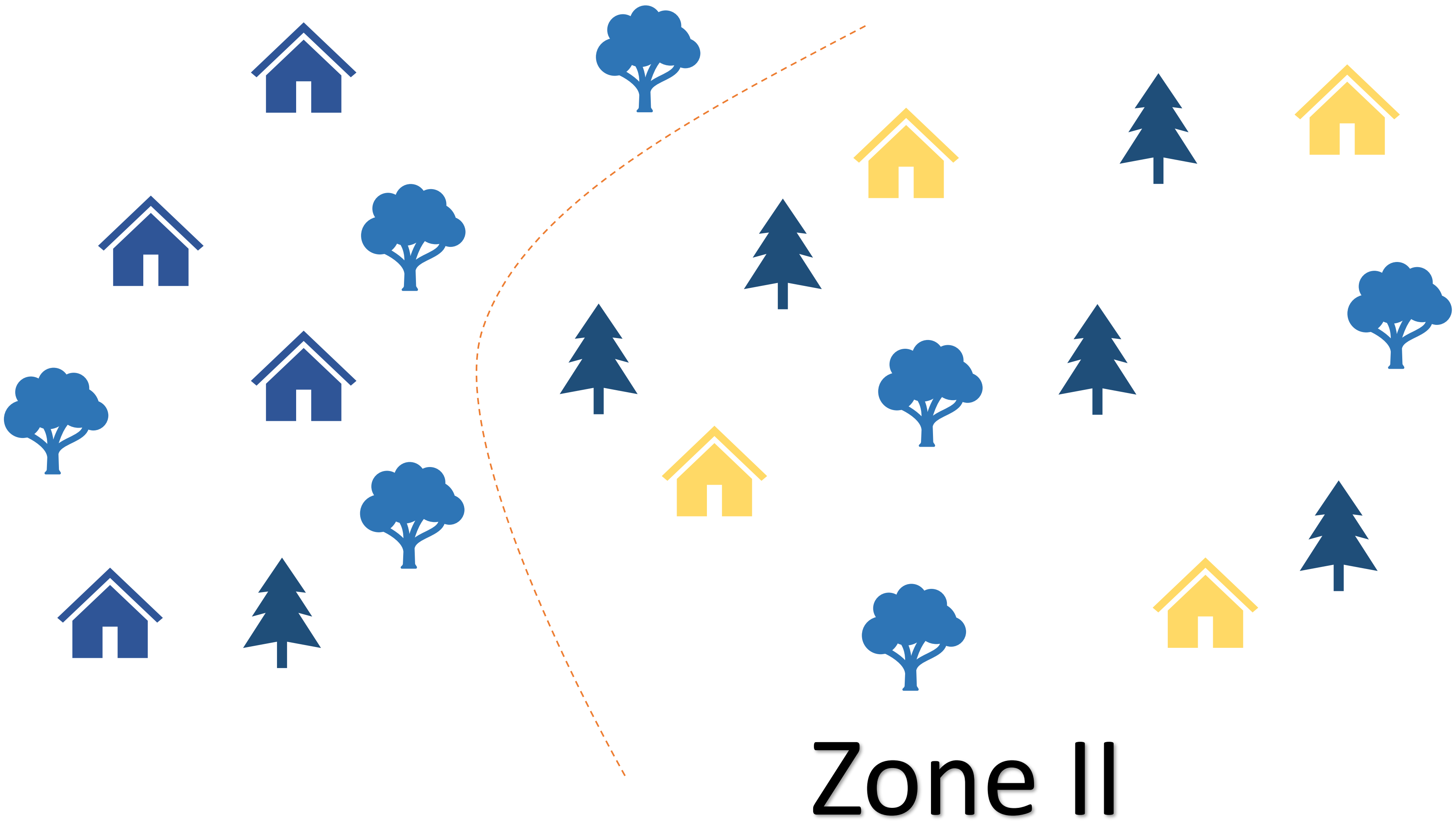
FOR EFFECTIVE I/A SYSTEM MANAGEMENT

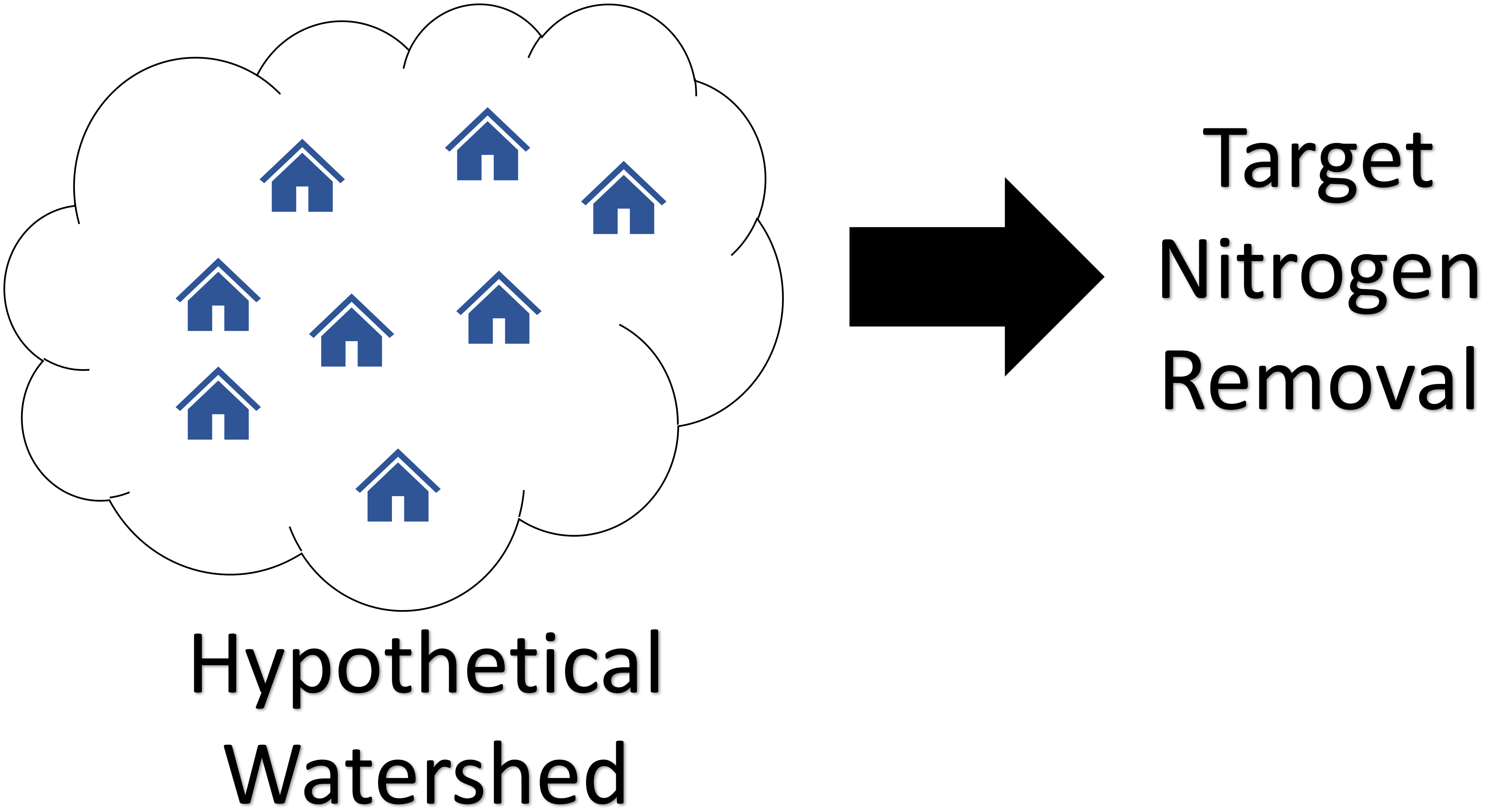
Brian Baumgaertel
Director, Massachusetts Alternative Septic System Test Center
Senior Environmental Specialist
Barnstable County Department of Health and Environment

I/A Vs. Septic Systems



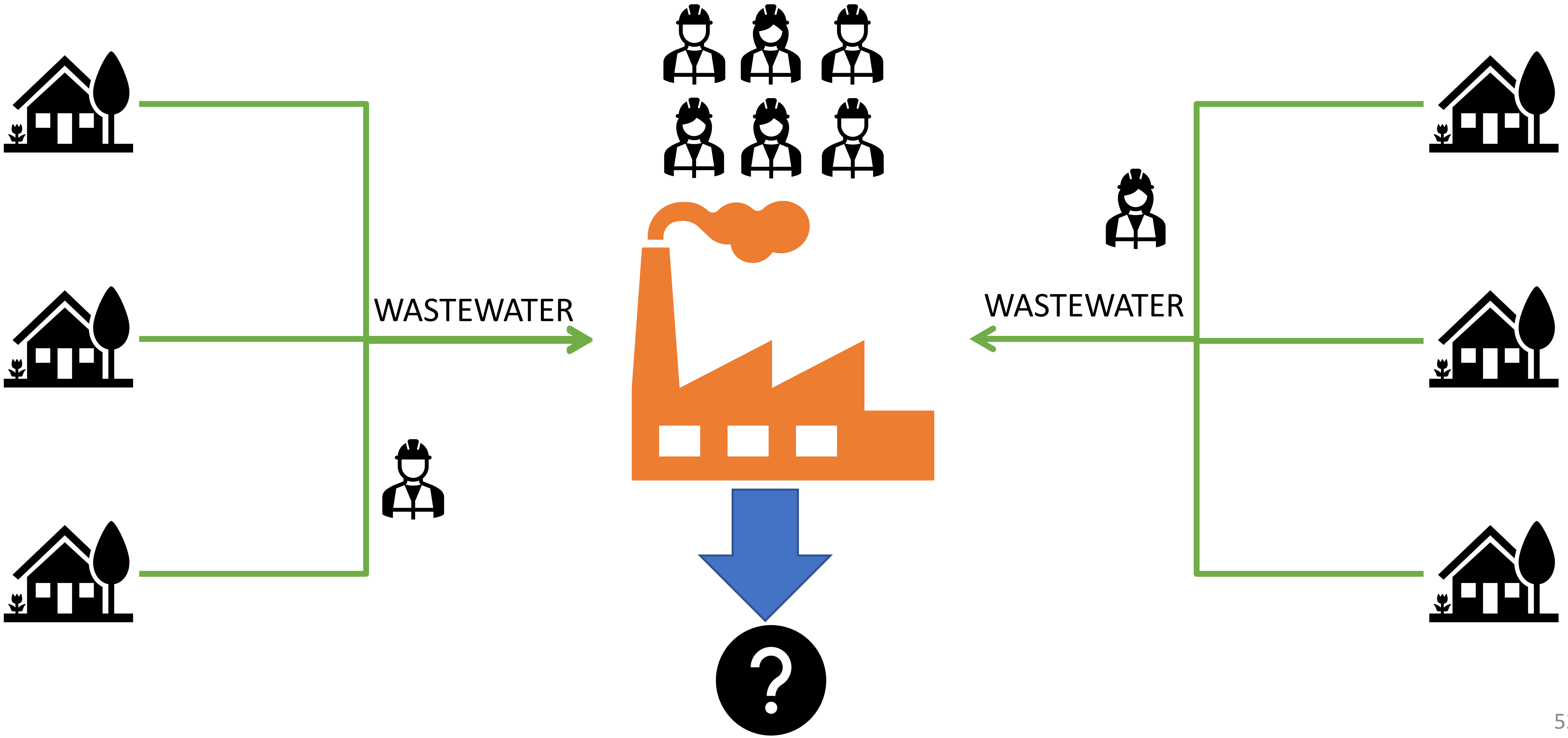
Individual systems for individual needs



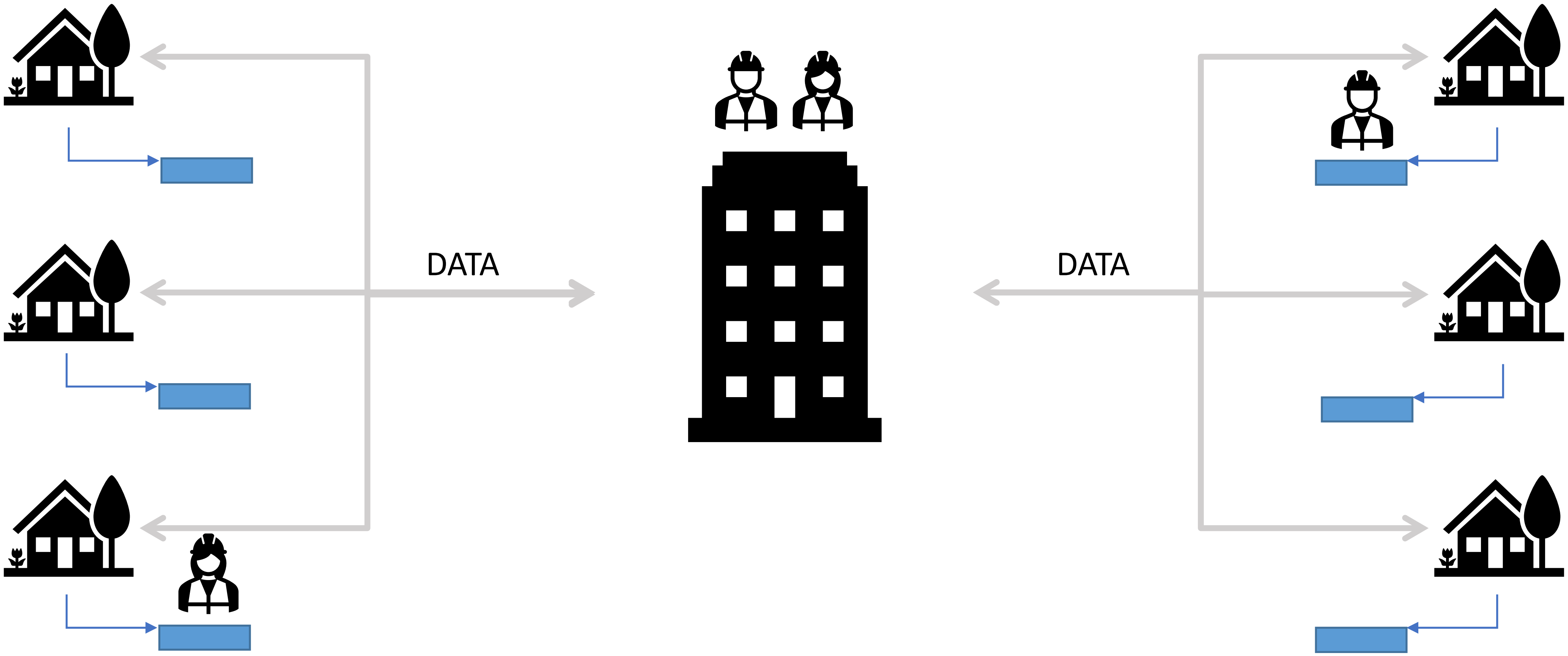

Target
Nitrogen
Removal
Hypothetical
Watershed

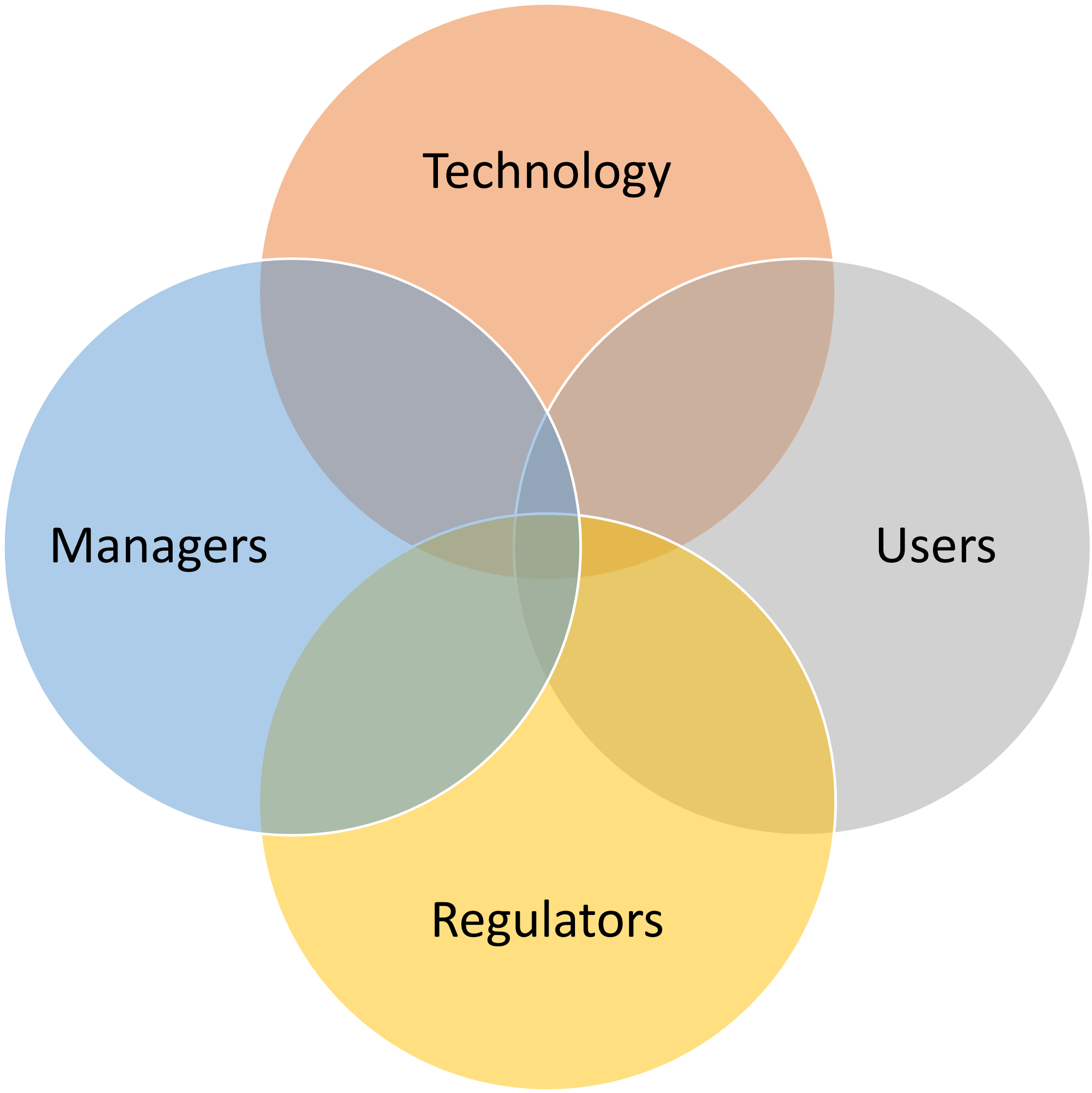
19 mg/L

Centralized Wastewater Treatment Infrastructure



Decentralized Wastewater Treatment Infrastructure




Technology
Managers
Users
Regulators

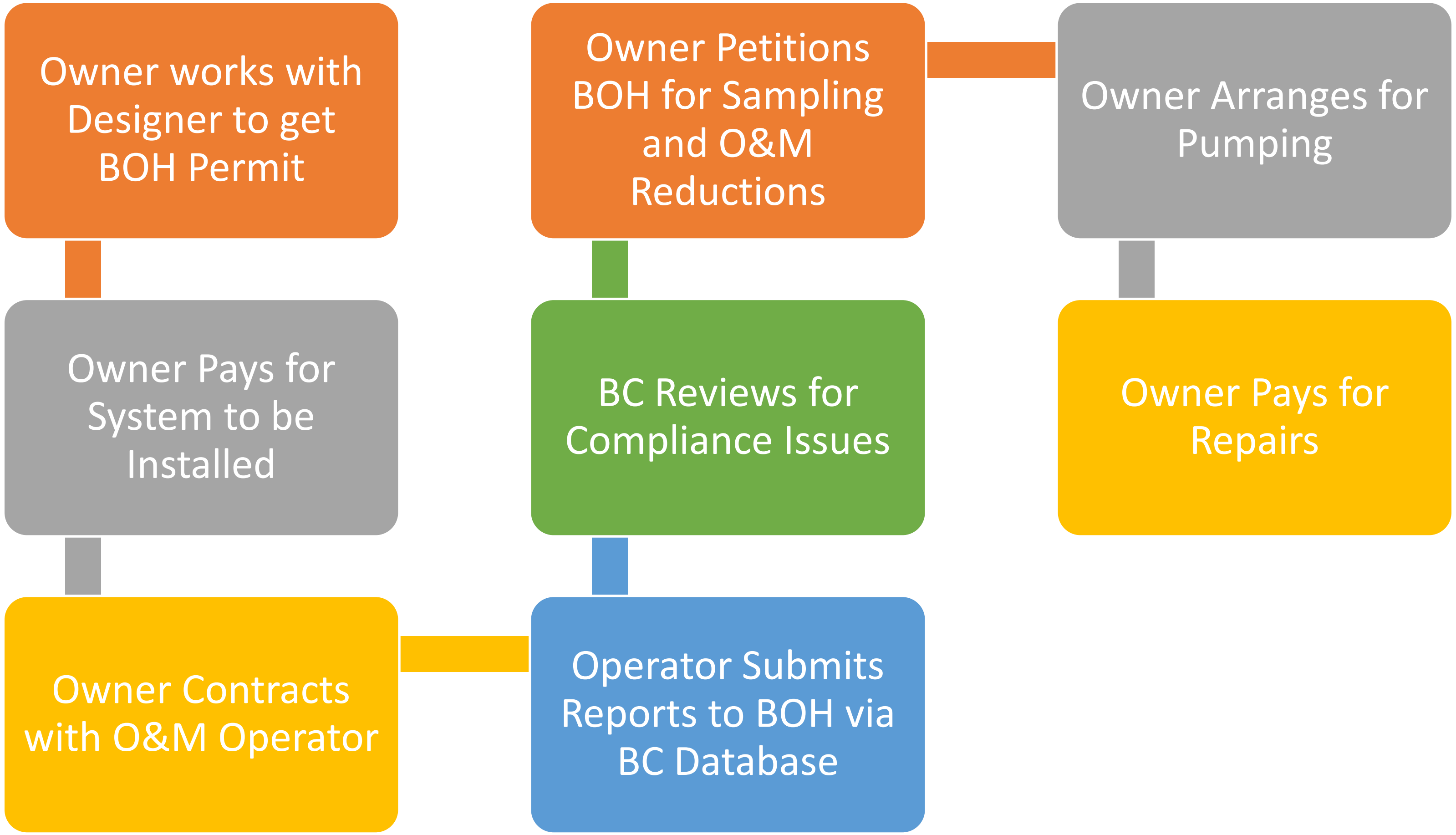
Responsible Management Entities

- An organization or collection of organizations tasked with overseeing the cradle-to-grave lifecycle of onsite wastewater treatment infrastructure

Before there were rme’s

There was chaos

How it Works Now (In Barnstable County)



5 Levels of RME

1. Homeowner Awareness
2. Maintenance Contracts
3. Operating Permits
4. RME Operation and Maintenance
5. RME Ownership

Model 1 – Homeowner Awareness

Applications

- Low environmental sensitivity.
- Sites suitable for fully compliant systems.

Description

- Systems properly sited and constructed based on prescribed criteria (like Title 5).
- Owners made aware of maintenance needs through reminders.
- <u>Inventory of all systems.</u>

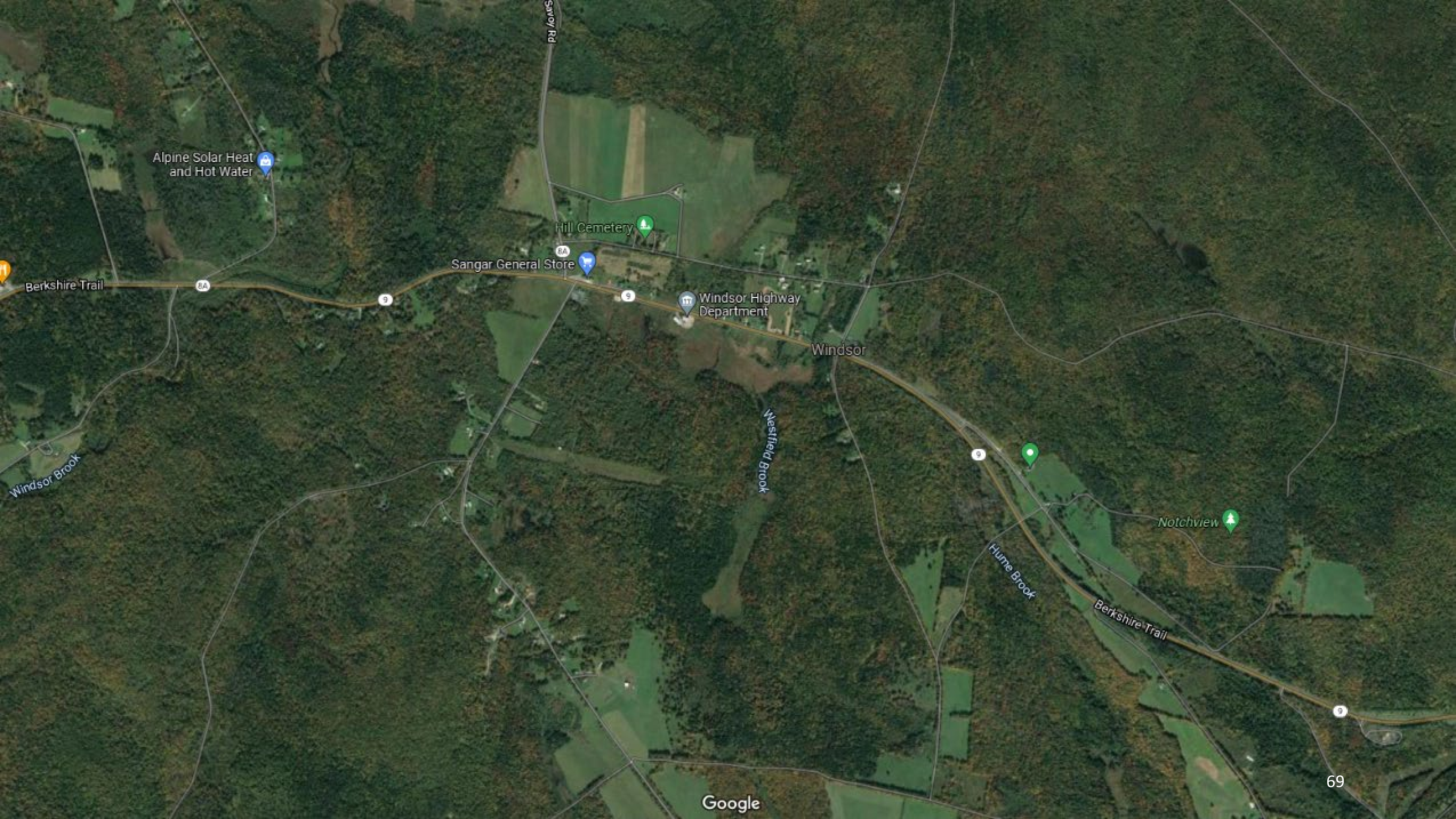
Model 1 – Homeowner awareness

Benefits

- Code-compliant system.
- Ease of implementation; based on existing, prescriptive system design and site criteria.
- Provides an inventory of systems that is useful in system tracking and area-wide planning.

Limitations

- No compliance/problem identification mechanism.
- Sites must meet siting requirements.
- Cost to maintain database and owner education program.


Savoy Rd
Alpine Solar Heat and Hot Water
Hill Cemetery
8A
Sangar General Store
Berkshire Trail
8A
9
9
Windsor Highway Department
Windsor
Westfield Brook
9
Windsor Brook
Notchview
Hume Brook
Berkshire Trail
9
Google

Model 2 – Maintenance Contracts

Model 2 – Maintenance Contracts

Applications

- Areas of low to moderate environmental sensitivity where sites are marginally suitable for conventional onsite systems due to small lots, shallow soils, or low permeability soils.
- Small clustered systems

Description

- Systems properly sited and constructed.
- More complex treatment options, including mechanical components or small clusters of homes.
- Requires service contracts to be maintained.
- Inventory of all systems.
- Service contract tracking system

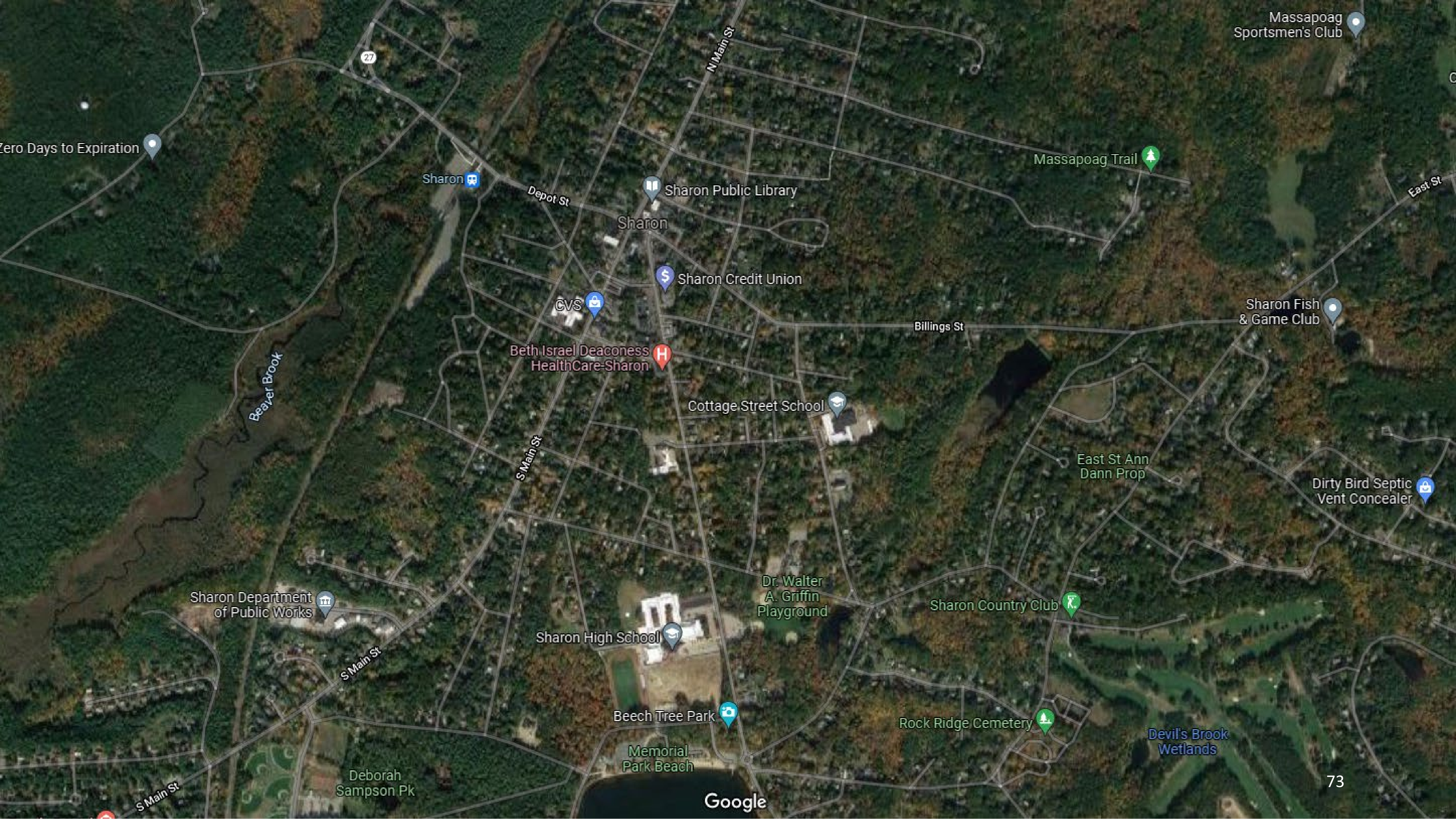
Model 2 – Maintenance Contracts

Benefits

- Reduces the risk of treatment system malfunctions.
- Protects homeowner investment.

Limitations

- Difficulty in tracking and enforcing compliance because it must rely on the owner or contractor to report a lapse in a valid contract for services.
- No mechanism provided to assess effectiveness of maintenance program.


Massapoag
Sportsmen's Club
N Main St
27
Zero Days to Expiration
Sharon
Depot St
Sharon Public Library
Sharon
Massapoag Trail
East St
Sharon Credit Union
CVS
Billings St
Sharon Fish
& Game Club
Beth Israel Deaconess
HealthCare-Sharon
Beaver Brook
Cottage Street School
S Main St
East St Ann
Dann Prop
Dirty Bird Septic
Vent Concealer
Dr. Walter
A. Griffin
Playground
Sharon Department
of Public Works
Sharon Country Club
Sharon High School
S Main St
Beech Tree Park
Rock Ridge Cemetery
Devil's Brook
Wetlands
Memorial
Park Beach
Deborah
Sampson Pk
S Main St
Google

Model 3 – Operating Permits

Model 3 – operating permits

Applications

- Areas of moderate environmental sensitivity such as wellhead or source water protection zones, shellfish growing waters, or bathing/ water contact recreation.
- Systems treating high-strength wastes or large-capacity systems.

Description

- Establishes system performance and monitoring requirements.
- Allows engineered designs but may provide prescriptive designs for specific receiving environments.
- Regulatory oversight by issuing renewable operating permits that may be revoked for noncompliance.
- Inventory of all systems.
- Tracking system for operating permit and compliance monitoring.
- Minimum for large-capacity systems

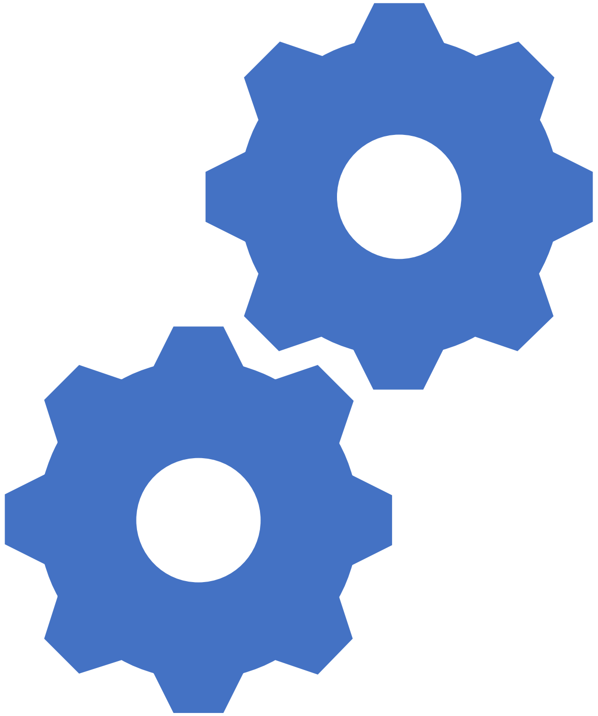
Model 3 – Operating Permits

Benefits

- Allows systems in more environmentally sensitive areas.
- Operating permit requires regular compliance monitoring reports.
- Identifies noncompliant systems and initiates corrective actions.
- Decreases need for regulation of large systems.
- Protects homeowner investment.

Limitations

- Higher level of expertise and resources for regulatory authority to implement.
- Requires permit tracking system.
- Regulatory authority needs enforcement powers.



Model 4 – RME Operation and Maintnenace

Applications

- Areas of moderate to high environmental sensitivity where reliable and sustainable system operation and maintenance (O&M) is required, e.g., sole source aquifers, wellhead or source water protection zones, critical aquatic habitats, or outstanding value resource waters.
- Clustered systems

Description

- Establishes system performance and monitoring requirements.
- Professional O&M services through RME (either public or private).
- Provides regulatory oversight by issuing operating or NPDES permits directly to the RME. (System ownership remains with the property owner.)
- Inventory of all systems.
- Tracking system for operating permit and compliance monitoring.

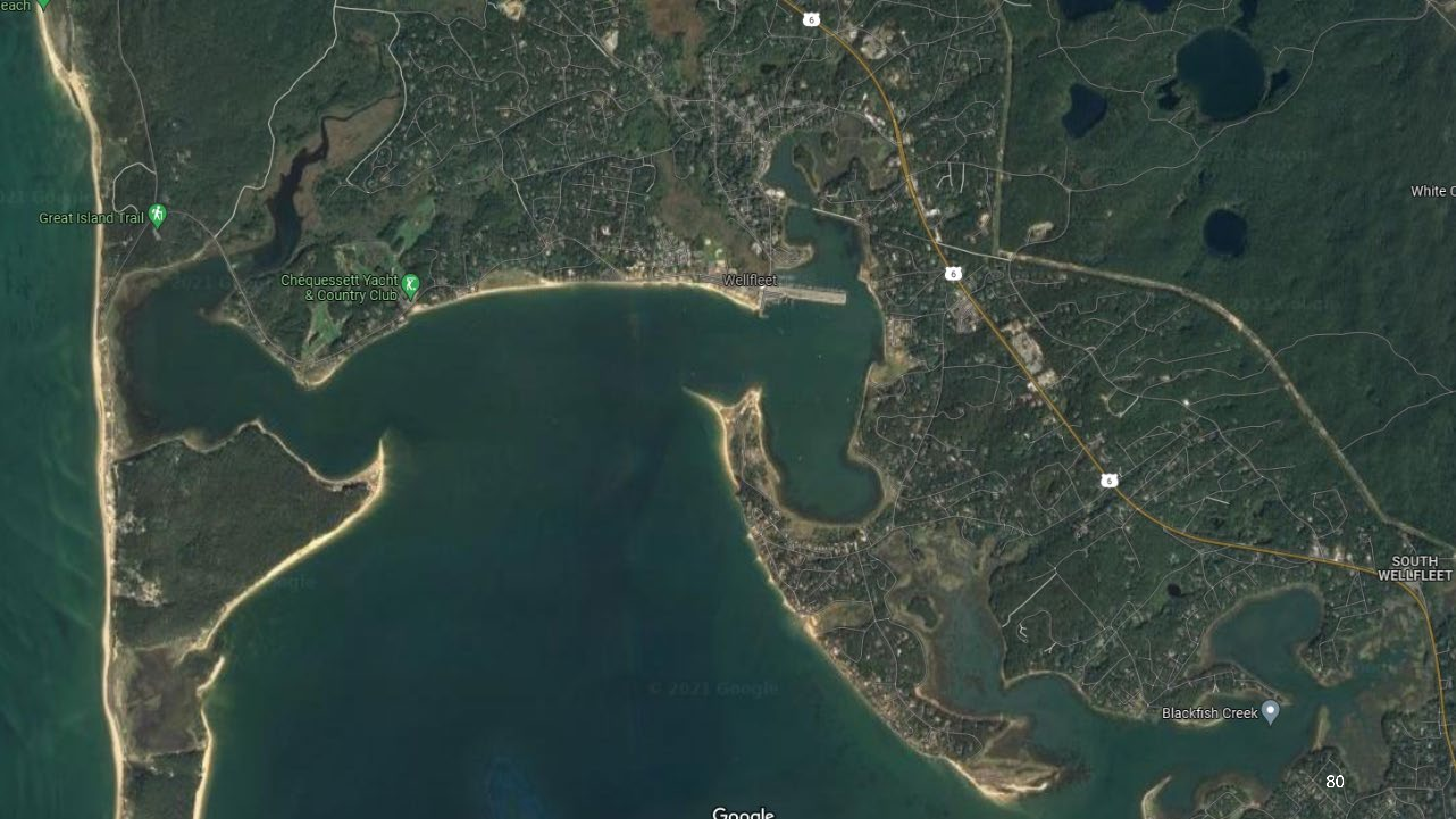
Model 4 – RME Operation and Maintenance

Benefits

- O&M responsibility transferred from the system owner to a professional RME that is the holder of the operating permit.
- Identifi es problems needing attention before failures occur.
- Allows use of onsite treatment in more environmentally sensitive areas or for treatment of high-strength wastes.
- Can issue one permit for a group of systems.
- Protects homeowner investment.

Limitations

- Enabling legislation may be necessary to allow RME to hold operating permit for an individual system owner.
- RME must have owner approval for repairs; may be conflict if performance problems are identified and not corrected.
- Need for easement/right of entry.
- Need for oversight of RME by regulatory authority.



Great Island Trail
Chequessett Yacht & Country Club
Wellfleet
White C
SOUTH WELLFLEET
Blackfish Creek
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Model 5 – RME Ownership

Model 5 – RME Ownership

Applications

- Areas of greatest environmental sensitivity where reliable management is required. Includes sole source aquifers, wellhead or source water protection zones, critical aquatic habitats, or outstanding value resource waters.
- Preferred management program for clustered systems serving multiple properties under different ownership (e.g., subdivisions).

Description

- Establishes system performance and monitoring requirements.
- Professional management of all aspects of decentralized systems through public/private RMEs that own or manage individual systems.
- Qualified and trained owners and licensed professional owners/operators.
- Provides regulatory oversight by issuing operating or NPDES permit.
- Inventory of all systems.
- Tracking system for operating permit and compliance monitoring.

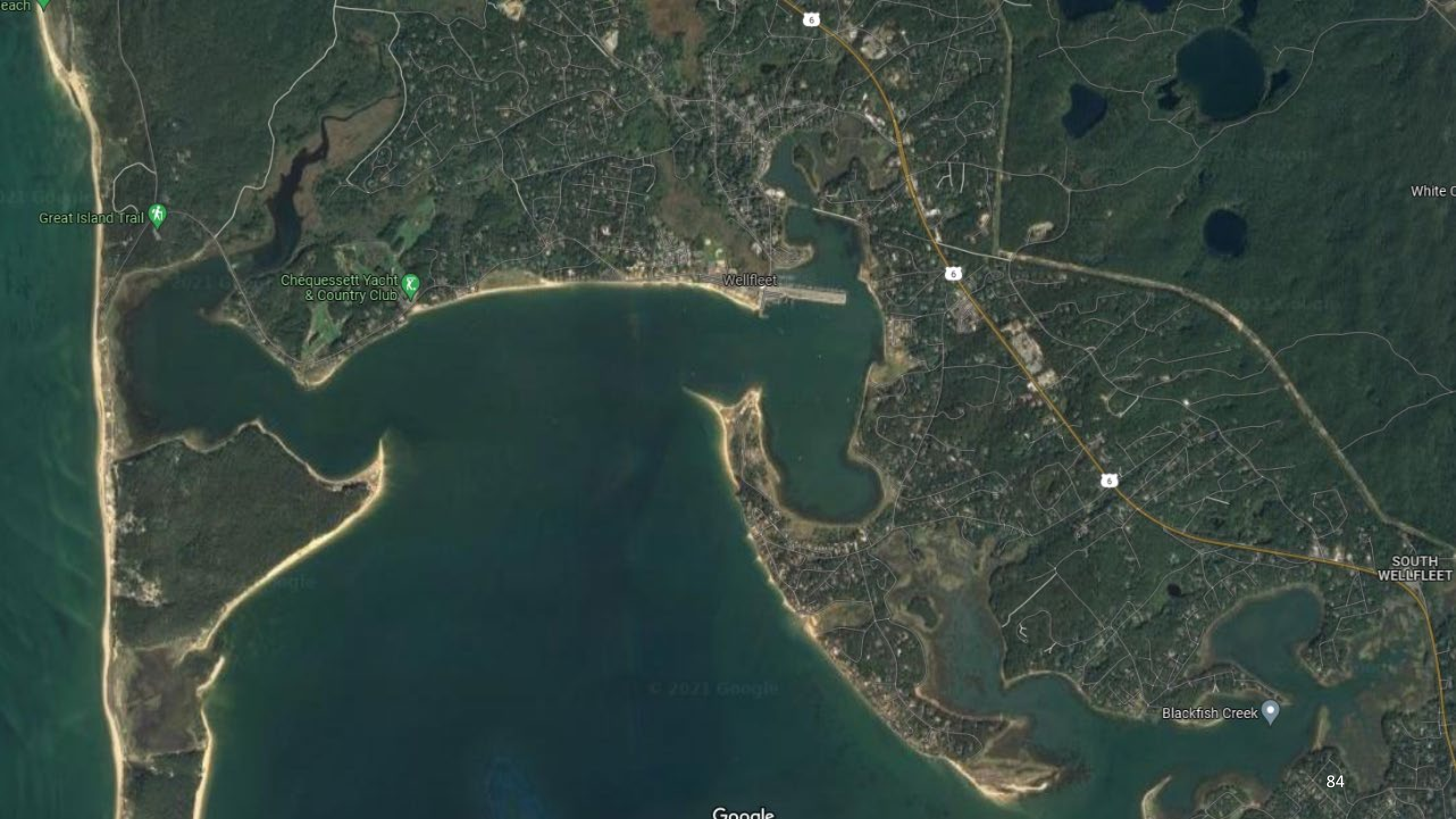
Model 5 – RME Ownership

Benefits

- High level of oversight if system performance problems occur.
- Simulates model of central sewerage, reducing the risk of noncompliance.
- Allows use of onsite treatment in more environmentally sensitive areas.
- Allows effective area-wide planning/watershed management.
- Removes potential conflicts between the user and RME.
- Greatest protection of environmental resources and owner investment.

Limitations

- Enabling legislation and/or formation of special district may be required.
- May require greater financial investment by RME for installation and/or purchase of existing systems or components.
- Need for oversight of RME by regulatory authority.
- Private RMEs may limit competition.
- Homeowner associations may not have adequate authority.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Wellfleet
6
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WELLFLEET
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THANK YOU

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