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Expert Panel Process for Advanced Septic System Technologies

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Expert Panel Process for Advanced Septic System Technologies

FOR THE UNIVERSITY OF NEW HAMPHSIRE
on behalf of
PISCATAQUA REGION ESTUARIES PARTNERSHIP

FB ENVIRONMENTAL ASSOCIATES
DOVER, NH

SEPTEMBER 2023

Macroalgae bloom in the Piscataqua Region watershed (Spruce Creek, Kittery, Maine). Photo by FB Environmental.

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Acknowledgements

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1 Executive Summary

This report describes policy recommendations provided to New Hampshire Department of Environmental Services related to using advanced septic system technologies to remove or retain nitrogen and phosphorus from wastewater, thereby protecting water quality in lakes, streams, beaches, and estuaries. The policy recommendations were developed by an Expert Panel which was convened and facilitated by consultant FB Environmental Associates on behalf of and in collaboration with the Piscataqua Region Estuaries Partnership (PREP). Panelists came from throughout the New England/New York region and were selected based on the depth and quality of experience in soil science, wastewater policy and management, and septic system technologies. They were supported by an Advisory Committee consisting of experienced and engaged New Hampshire stakeholders in the onsite wastewater and environmental water quality fields. The policy recommendations apply not only to the Piscataqua Region Watershed, encompassing the Great Bay and Hampton-Seabrook estuaries watersheds spanning all of coastal New Hampshire and parts of Maine and Massachusetts (Figure 1), but also to all of New Hampshire.

Nutrient pollution from septic systems is a major concern in the Piscataqua Region Watershed (Figure 1), New Hampshire, and throughout New England. Conventional septic systems are designed for sanitation by removing or inactivating pathogens and have not considered nutrients as pollutants until relatively recently. Therefore, changes to septic system design and installation are needed to reduce nutrient loading from septic systems. Those changes include advanced technologies (whole systems and/or system components), changes to soil evaluation, system siting and design, policy adjustments, and planning and financing support.

The Expert Panel process builds on recent work in New Hampshire on this topic. The New Hampshire Shoreland Septic System Study Commission (2020) found that most waterbody segments of the Great Bay Estuary do not meet State Water Quality Standards, and many of these impairments are due to elevated levels of nitrogen. The Great Bay Nitrogen General Permit was issued in 2020 to establish nitrogen effluent limits to wastewater treatment facilities; however, it did not address nutrient pollution due to nonpoint sources including septic systems. An estimated 30% of nonpoint source nitrogen loading in the Great Bay Estuary is from the tens of thousands of septic systems in Piscataqua Region communities (Trowbridge et al., 2014). Nutrient pollution extends to freshwater areas of the Piscataqua Region watershed, as well as throughout New Hampshire. These impacts are becoming more apparent in the rise of cyanobacteria blooms due to phosphorus loading from nonpoint sources, including septic systems, which affect New Hampshire lakes and ponds. These cyanobacteria blooms appear to be increasing in frequency, length, and severity with climate warming and increasingly intense rainfall events. To the extent septic systems are sending high levels of nutrients underground through groundwater, without noticeable odors and without any apparent interruption in wastewater removal from buildings served, nutrient pollution can be invisible from the ground surface.

THE EXPERT PANEL

Marcel Belaval
Deputy Director, USGS New England Water Science Center

Dr. Alissa Cox
Director, URI's New England Onsite Wastewater Training Program

Matthew Dowling
Onsite Wastewater Manager, Town of Charlestown, RI

Michelle Jenkins
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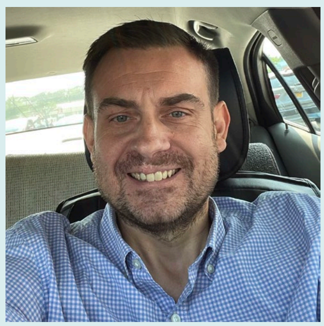

Justin Jobin
Environmental Scientist, Coastal Wastewater Solutions, LLC

David Rocque
Maine State Soil Scientist (Retired)

1.1 Expert Panel Process

Five Expert Panel Meeting were held in which the panel discussed the following:

1. Defining Terms, Roles, Goals, & Methods — *June 12, 2023*
2. Advanced Nitrogen Treatment — *June 29, 2023*
3. Advanced Phosphorus Treatment — *July 12, 2023*
4. Current Policy, Funding, & Initiatives in New Hampshire & Beyond — *July 18, 2023*
5. Policy, Funding, & Incentives Recommendations for New Hampshire — *July 26, 2023*

The Panel followed a "Consensus Continuum" for key decision making to maintain efficiency and fairness of the process (University of Maryland Center for Leadership & Organizational Change). Meetings were facilitated by FB Environmental, though panelists had liberty to diverge from topics if necessary to complete the goal. Expert Panel members were chosen based on their expertise in advanced onsite wastewater engineering, installation, and inspection as well as state and municipal regulatory experience and knowledge.

1.2 Advisory Committee

An Advisory Committee consisting of local New Hampshire state and municipal leaders was convened to guide the Expert Panel recommendations to be applicable to New Hampshire. The Advisory Committee consisted of local New Hampshire municipal and state leaders whose actions would be directly guided by the Expert Panel's recommendations. Advisory committee members were selected with a focus on Piscataqua Region and New Hampshire-area municipal wastewater, state, and EPA Region 1 officials. The members are as follows:

- **Barbara Richter**, Executive Director NH Association of Conservation Commissions
- **Chris Albert**, Chairperson, CSA Environmental Consultants & Granite State Onsite Wastewater Association
- **Ian Dombroski**, Life Scientist, Surface Water Branch, US EPA Region 1
- **Jon Balanoff**, Executive Director, Acton Wakefield Watershed Association
- **Melissa Paly**, Great Bay-Piscataqua Waterkeeper, Conservation Law Foundation
- **Philip Trowbridge**, Land Resources Management Program Manager, New Hampshire Department of Environmental Services
- **Sally Soule**, Coastal Watershed Supervisor, New Hampshire Department of Environmental Services
- **Scott Hazelton**, Subsurface Systems Bureau Administrator, New Hampshire Department of Environmental Services
- **Steve Couture**, Coastal Program Administrator, New Hampshire Department of Environmental Services

1.3 Summary of Expert Panel Recommendations

Table 1. Summary of all recommendations made by the Expert Panel.

RECOMMENDATION	SUMMARY
Rule Changes for all Septic Systems	
Expand Seasonal High Water Table Definition and Add Soil Key (Env-Wq 1006.05)	Add a soil key to the Design Rules which Permitted Designers use to determine the seasonal high groundwater table. The soil key provides consistent and easy to follow guidance for all site designers. The soil key accounts for typical conditions (redoximorphic features are present) and also for less well-known conditions where groundwater is oxygenated.
Disallow Dry Wells	Currently dry wells are allowed under the New Hampshire Individual Sewage Disposal System Rule Env-Wq 1020, but they should be disallowed because they are likely to exacerbate nutrient loading to surface waters.
Anchor or Ballast System Components	Septic systems should be ballasted in flood zones or where saturated ground conditions are expected, because system components can float and break due to buoyancy, causing sewage leaks. The Expert Panel stipulated that this recommendation applies to replacement systems since new systems should be prohibited in saturated or flood prone areas.
Program for Advanced Septic System Technology for Nutrient Reduction	
Adopt Advanced Septic System Technology Approvals from Top Jurisdictions	New Hampshire should provide a rapid pathway to "general approval with conditions" for advanced septic system technologies that have been approved in Massachusetts, Rhode Island, and Suffolk or Nassau counties in Long Island, New York. These jurisdictions have robust, data-driven approval systems in place and have testing data on thousands of real-world installations. It does not make sense for New Hampshire to duplicate or ignore those results.
Establish Inspection, Maintenance, and Monitoring Requirements for Advanced Septic Systems and/or all System in Nutrient Sensitive Areas	Currently, septic systems are installed with no required follow-up to ensure they are being maintained and operated correctly. An inspection program, maintenance documentation requirements, and especially for advanced systems a monitoring program, are recommended to ensure septic systems function well through time. Some municipalities (e.g., Charlestown, Rhode Island) have highly successful inspection and monitoring programs that regularly discover and replace underperforming systems; however, relying on municipalities runs the risk of uneven implementation depending on the resources and level of effort of individual cities and towns. State level inspection programs may work but note that some states (including Rhode Island and New Hampshire) have state-level requirements but lack the staff to enforce them. Enabling and designating Responsible Management Entities (RMEs) to maintain and monitor systems would be ideal, because they are fully funded and have dedicated staff, and they could be required to follow standard operating procedures to ensure consistency from one RME to another if multiple RMEs are established. See Section 5.5.2 for RME descriptions and case studies.
Establish and Maintain a Database of System Inspection and/or Monitoring Results	The Expert Panel strongly agreed that a database of septic system inspections and/or monitoring results is essential in effectively managing advanced septic system technology. A state level database would likely be the most effective and efficient approach. The only reservation was if inspections are not sufficiently rigorous to truly evaluate system performance and nutrient reductions, then the inspection data would have limited value.

RECOMMENDATION	SUMMARY
Map Nutrient Sensitive Areas and Require Adequate Wastewater Nutrient Treatment in those Areas	The Expert Panel agreed that advanced septic system technology should be applied where needed and should not be required where not needed. This optimizes benefits and costs and allows simpler and lower-maintenance conventional systems where possible without impairing water quality. Massachusetts, Rhode Island, and the Long Island (New York) counties have all implemented data-based nutrient sensitive zones. Those zones are the basis for requiring and/or prioritizing upgrades to advanced wastewater treatment.
Establish a Training Program / Policy for Advanced Wastewater Professionals	The Expert Panel agreed that a training program and/or policy for advanced wastewater professionals would promote the professional infrastructure necessary to support effective advanced wastewater treatment in New Hampshire.
Financing and Incentives	
Pilot Advanced Treatment Installation Program	The Expert Panel strongly recommended some form of advanced septic system technology pilot program in New Hampshire.
Establish / Maintain Low-Interest Revolving Loan Programs for Septic Systems	The Expert Panel recommended establishing a low-interested loan program capable of offering rapid support to homeowners facing an unexpected need to replace or upgrade their septic system. Rhode Island's State Revolving Loan program is a clear example. Currently, New Hampshire's State Revolving Loan program is too slow (1-2 year time lag between application and on-the-ground work) to serve this purpose, and changes at the State level are likely necessary to enable that program to respond quickly and cover malfunctioning septic systems.
Seek Funding for Advanced Septic System Projects	The Expert Panel agreed New Hampshire should seek funding from all levels (federal, state, county, local, etc.) to support advanced septic system adoptions. This is longer term support than a pilot program, and ideally would reduce the cost to eligible homeowners of advanced systems to slightly less than conventional systems. For example, on Long Island, New York, Suffolk and Nassau counties layer state and county funding and provide a guided application process for homeowners to facilitate the adoption of advanced septic systems.
Allow Manufacturers to Fund Engineering Review of Advanced Technologies Using NHDES Selected Contractors	The Expert Panel agreed that manufacturer's funding of NHDES selected engineering review was a valid option to speed up the approval process for new technologies that had not been approved elsewhere.
Noteworthy Suggestions	
Utilize Undisturbed Native Soils and Upper Soil Horizons	The Expert Panel generally agreed that the upper layers of native, undisturbed soils usually offer excellent nutrient retention characteristics. When possible, these soil horizons should be used in septic system designs, especially in sandy or gravelly soils.
Pressurized Shallow Drainfields	The Expert Panel repeatedly mentioned the benefits of pressurized shallow drainfields, which typically are installed downstream of nitrogen-reducing septic tank technologies. Their benefits include steady and even dosing of pre-treated wastewater; relatively compact and shallow installations which utilize upper soil horizons to provide additional nutrient removal; and ease of performance monitoring.
Make Nutrient Reduction a Factor in Site Evaluation and System Design	Some panelists noted that nutrient treatment was not a requirement or even a design factor in conventional septic systems in many jurisdictions (including New Hampshire and Maine). In many instances, conventional systems can be designed and sited to achieve greater nutrient treatment, especially for phosphorus, if the rules required it and design guidelines incorporated it.

RECOMMENDATION	SUMMARY
Change Terminology from “Disposal Field” to “Dispersal Field”	The Expert Panel briefly discussed the importance of word choice in promoting more accurate ways of thinking about septic systems among practitioners and the general public. Generally, words should be chosen which connotate wastewater recycling.
Items for Further Research	
How to Measure Septic System Performance	The Expert Panel discussed and was polled on the best approach to monitoring septic system performance. In field monitoring of real-world septic system installations sufficient to calculate nutrient loads was overwhelmingly preferred over monitoring test systems, modeling of performance, or measurements of nutrient concentrations or percentage reduction. Note also that a well-developed, data-based septic system technology testing protocol was developed in 2016 when EPA worked with all five New England states and Long Island towards a regional data sharing agreement.
Responsible Management Entity (RME) for System Maintenance and Insurance	Several panelists noted that the Responsible Management Entity (RME) approach was being used in other states to ensure septic systems were professionally inspected and maintained. They recommended New Hampshire study RME’s as an option.
Soil Color as Proxy for Soil Minerals and Nutrient Retention Capacity	Certain unsaturated native soil horizons can provide significant phosphorus retention without the need for advanced technology; however, there is no consideration of this within the Design Rules. One option would be to use soil color analysis to identify these soils and develop a way to incorporate phosphorus reduction requirements in the Design Rules.

2 Acronyms & Definitions

BOD – Biological oxygen demand, the amount of dissolved oxygen consumed by microbes as they break down organic material in water.

DEP – Department of Environmental Protection

EDA – Effluent Disposal Area, the constructed bed or field where wastewater effluent undergoes the last stage of treatment, term used in New Hampshire's administrative rules for septic systems. Also known as leach field, disposal field, or dispersal field.

Effluent – "liquid component of sewage after solids have settled out," as defined in New Hampshire's administrative rules for septic systems.

EPA – United States Environmental Protection Agency

I & A, IA, or I/A – "Innovative & Alternative" when applied to septic systems, also known as Advanced Treatment Units or Nutrient-Reducing Septic Systems.

ISDS – Individual Sewage Disposal Systems, term used in New Hampshire's administrative rules for septic systems.

MASSTC – The Massachusetts Alternative Septic System Test Center

Nonpoint Sources of Pollution – Diffuse sources of pollution, including any pollution from individual septic systems. Defined in Section 502(14) of the Clean Water Act.

NEIWPCC – New England Interstate Water Pollution Control Commission

NHDES – New Hampshire Department of Environmental Services

OWTS – Onsite Wastewater Treatment System, or septic system. Term used in Rhode Island administrative rules for septic systems.

PREP – Piscataqua Region Estuaries Partnership

Septic Tank – "Watertight unit designed to receive sewage and other wastes for the purpose of removing substantially all settleable solids," as defined in New Hampshire's administrative rules for septic systems.

TSS – Total suspended solids, the concentration of solid particles that are suspended in water.

USDA – United States Department of Agriculture

USGS – United States Geological Survey

URI – University of Rhode Island

3 Background

Nutrient pollution from septic systems is a major concern in the Piscataqua Region Watershed (Figure 1), New Hampshire, and throughout New England. Conventional septic systems are designed for sanitation, reducing, or rendering unviable pathogens in domestic wastewater. Nutrient attenuation has not typically been a design consideration. Phosphorus and nitrogen are two key nutrients in domestic wastewater. Increasing cyanobacteria blooms in lakes due to excess phosphorus loading, and ecological impairment of estuaries from nitrogen loading, have focused attention on the need to reduce the release of these two nutrients through updated onsite wastewater policies and technologies. This Expert Panel process was conducted to assist the Piscataqua Region Estuaries Partnership develop policy recommendations for New Hampshire Department of Environmental Services applicable to the Piscataqua Region Watershed and New Hampshire generally.

This Expert Panel process builds on recent progress to better understand and address the issue of septic systems and nutrient pollution in New Hampshire. The New Hampshire Shoreland Septic System Study Commission was established by the New Hampshire Legislature via HB 475 in May of 2019 to research the problem of inadequately performing septic systems and ways to address them, completing its work in October of 2020. Among other findings, it reported that septic systems serve 85% of New Hampshire households. Conventional septic systems are only designed to remove pathogens and are not designed to remove nutrients such as nitrogen and phosphorus, so even a properly functioning system may be a source of nutrient pollution to surface waters. Septic systems are contributing to reduced water quality in New Hampshire's freshwaters (phosphorus) and estuarine waters (nitrogen). In particular, New Hampshire lakes are experiencing a concerning trend of increased cyanobacteria blooms which, beyond greatly degrading a lake's aesthetics and interfering with recreation, can sometimes be toxic to humans and animals. Yet effective action is possible to reduce cyanobacteria blooms. Finally, reducing nitrogen and phosphorus pollution by upgrading septic systems is generally less expensive than installing public sewer systems (New Hampshire Shoreland Septic System Study Commission, 2020).

Most waterbody segments in the Great Bay Estuary are formally listed as impaired due to nitrogen pollution (NHSSSC, 2002). Excess nitrogen reduces water quality, contributes to eelgrass decline, and can reduce dissolved oxygen which fish and other organisms need to survive. Septic systems serve half of the residents in the Great Bay watershed and contribute significantly to nutrient pollution in this watershed (New Hampshire Shoreland Septic System Study Commission, 2020). A study in 2014 estimated Great Bay watershed septic systems contributed 30% of nonpoint source nitrogen loads to the watershed, and septic systems within 200 meters of waterbodies sent 60% of their nitrogen to rivers and estuaries (Trowbridge et al., 2014). More recently, an analysis of water quality data by PREP indicated that while overall nitrogen concentrations in the Great Bay watershed were roughly the same from 2012 to 2020, nonpoint sources of nitrogen were up 15% in 2017-2020 compared to 2012-2016 (PREP, 2023). EPA Region 1 issued a Great Bay Total Nitrogen General Permit for 13 eligible wastewater treatment facilities discharging to the Great Bay watershed starting on February 1, 2021. A series of upgrades to wastewater treatment facilities (many prior to the General Permit) in the region reduced nitrogen pollution from point sources, but no corresponding reduction in nitrogen pollution from septic systems and other nonpoint sources has yet occurred (PREP, 2023). Generally, the forms of nitrogen within septic system effluent are highly soluble in water and can travel long distances if and when they reach underlying groundwater. Almost all the nitrogen that reaches groundwater tends to discharge to surface waters like lakes, streams, and coastal waters, where it contributes to water quality impairment. Nitrogen is generally considered the limiting nutrient in estuarine and marine waters and has been of the greatest concern along the coast. However, research also indicates nitrogen can drive increased *toxicity* in freshwater algal blooms (Gobler et al., 2016), especially in non-nitrogen-fixing species such as *Microcystin*, which are known to be potentially toxin producing. Therefore, nitrogen reduction is applicable to freshwater lake watersheds as well.

The forms of phosphorus within septic system effluent are not as soluble and mobile as nitrogen. Phosphorus typically binds to unsaturated soils relatively close to each septic system but, similar to nitrogen, can travel long distances in groundwater. Factors which can cause or increase phosphorus pollution from septic systems includes inadequate vertical separation distance from seasonally high groundwater; highly transmissive soils with low ion exchange capacity and a lack of biological activity including plant roots, common in sand or thin soils over fractured bedrock; system damage which causes leaks or other treatment failures; or homeowner neglect or overloading which causes septic systems to perform poorly. Phosphorus is typically considered the limiting nutrient in freshwater systems. It has been widely documented as the cause of many lake algal blooms which can severely limit recreational activities, greatly increase the cost of drinking water treatment, and in some cases may be toxic to animals and humans.

Climate change is and will continue to exacerbate the sources and effects of nutrient pollution on lakes and estuaries. An increase in nonpoint source nitrogen pollution in the Piscataqua Region Watershed was attributed to greater rainfall, which transported more nonpoint pollution sources to waterbodies (PREP, 2023). The list of New Hampshire lakes and ponds affected by cyanobacteria blooms increases each year. Research indicates the severity of lake cyanobacteria blooms appears likely to increase with increasing temperatures and large storm events due to climate change (Huisman et al., 2018). Many species of cyanobacteria are expected to benefit from climate warming as their growth is supported in warmer waters and they can outcompete other phytoplankton by regulating their buoyancy in the water column (O'Neil et al., 2012). The anticipated increase in large storm events is also likely to increase nutrient loading to lakes, which would promote cyanobacterial growth (Wang et al., 2018).

For all of the above reasons, updating policies and technologies to limit nitrogen and phosphorus loading from septic systems to surface waters is increasingly urgent. This Expert Panel process focused on how to do so and produced the following recommendations for New Hampshire.

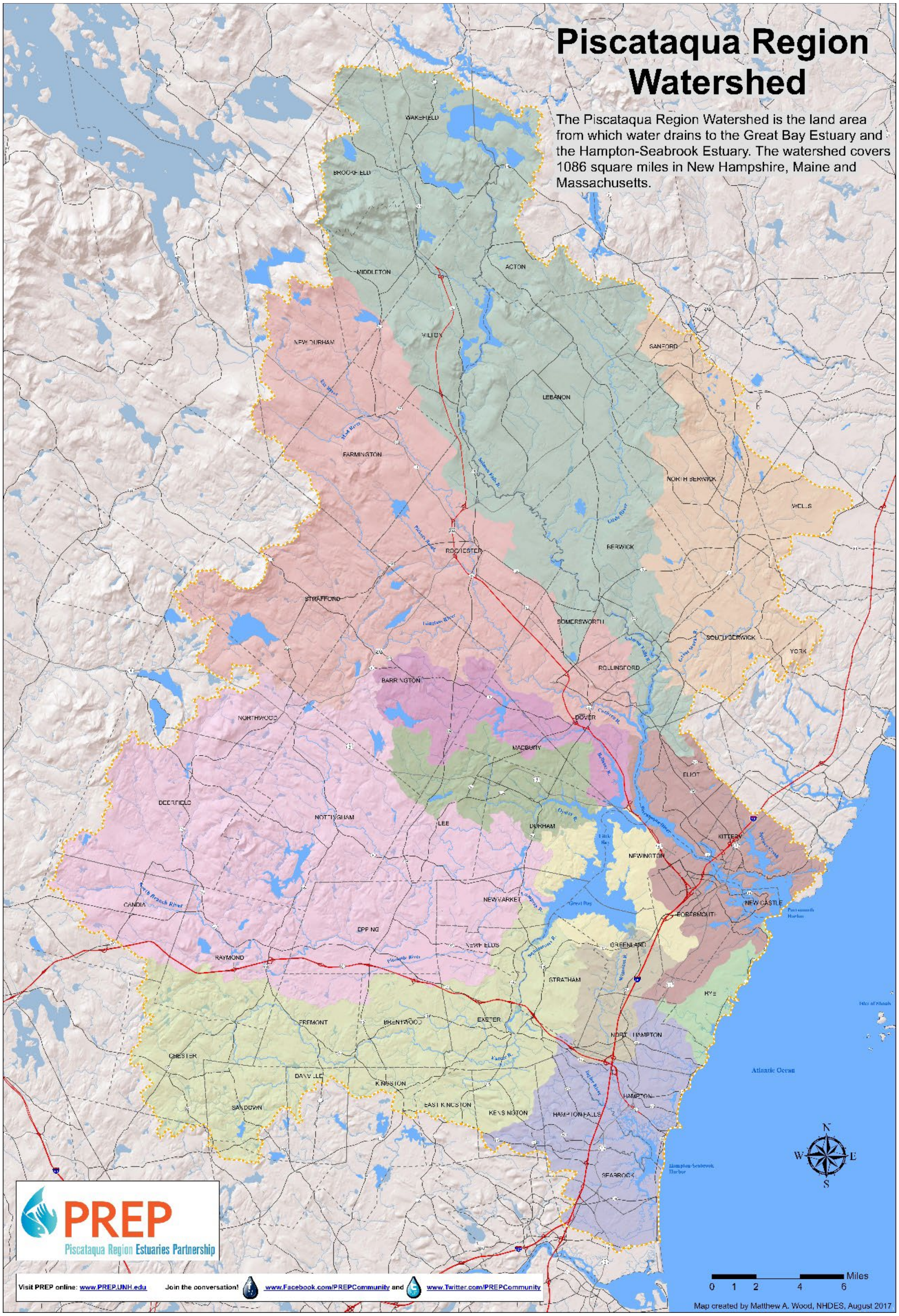

Figure 1. Piscataqua Region watershed.

4 The Expert Panel Process

4.1 Introduction

An Expert Panel is a group of six to eight people who are highly knowledgeable on a certain topic who help assess existing science to make recommendations to address a management need at hand. To develop this process for decision-making in New England, the National Estuarine Research Reserve System created the FAST process:

Frame Your Question – *Assess previous work, stakeholder input, case studies, previous panel processes, and available resources to define your management need or question.*

Assemble the Team – *Create a core team to ensure coordination and completion of work, an advisory committee of intended users to provide input, and an expert panel to make science-based recommendations.*

Sustain Momentum – *Make clear expectations, defined charges, consistent schedules, and real work for all parties to maintain momentum.*

Take it on the Road – *Continue outreach after making recommendations with the help of your advisory committee.*

The Expert Panel process was modeled after *Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model*, a process based on independent peer reviews at the National Academy of Sciences. First implemented in New Hampshire as part of a National Estuarine Research Reserve project, the Expert Panel process and FAST were used to provide timely, science-based solutions to coastal environmental problems. The process excels at synthesizing expert opinion on natural resources and policy questions when scientific data are vague, insufficient, or unattainable with available time and resources (GBNERR et al., undated). Septic system research is limited by experimental space and cost constraints, long-time horizons, and regulatory limitations, thus FAST is appropriate. The Expert Panel process was refined as a part of the *Credit for Going Green* project, conducted by the Great Bay National Estuarine Research Reserve, UNH Stormwater Center, and Roca Communications. The *Credit for Going Green* project used the Expert Panel process to develop consensus-based recommendations to help New Hampshire stakeholders use buffers to meet in-stream pollution reduction targets (UNH-SC et al., 2019). The Piscataqua Region Estuaries Partnership used this Expert Panel process again in 2022 for the *Clean Sweep* project which created recommendations for implementing credits for street sweeping in New Hampshire communities to decrease pollutant loads (PREP & UNH-SC, 2022). The Advanced Septic System Technologies Expert Panel is the third Expert Panel process effort in the Piscataqua Region Watershed aimed at reducing nutrient loading to ground and surface waters.

4.2 Expert Panel Charge and Membership

The Advanced Septic System Technologies Expert Panel was given a charge, and then offered substantial autonomy in how they would fulfill that charge. An initial charge developed by the New Hampshire

Department of Environmental Services and Piscataqua Region Estuaries Partnership was refined based on input from an Advisory Committee. The final charge was:

> *The Expert Panel's charge is to identify and recommend advanced septic system treatment technologies, including retrofits or add-ons to existing systems, which have been proven and other geographic areas applicable to New Hampshire. For the identified technologies, this panel will determine nutrient removal efficiencies, summarize operations and maintenance requirements, estimate the expected useful life of the system, estimate capital and long-term costs, recommend potential funding opportunities, and develop a summary of policy options that could be implemented to promote implementation.*

NHDES, PREP, the Advisory Committee, and the project team assisted in identifying potential panelists to invite. Expert Panel members were chosen based on their expertise and experience in advanced onsite wastewater management, policy, research, training, and soil science in New England. Most panelists had decades of experience, and the panel had experience at multiple levels including municipal, state agency, federal agency, university research, and nonprofit organizations. The panel had experience in each of the following states: Maine, Massachusetts, Rhode Island, and New York (Long Island and upstate). Panelists are listed in Table 2, see also Appendix A: Expert Panelists. While other Expert Panels had selected a chairperson, this Expert Panel decided to proceed with project staff facilitation without a chair.

Table 2. Advanced Septic System Process Expert Panel Members.

Panelist	Position & Affiliation
Marcel Belaval	Deputy Director, U.S. Geological Survey New England Water Science Center
Alissa Cox	Director, University of Rhode Island New England Onsite Wastewater Training Program
Matthew Dowling	Onsite Wastewater Manager, Town of Charlestown, Rhode Island
Justin Jobin	Environmental Scientist, Coastal Wastewater Solutions, LLC
Michelle Jenkins	Information Officer, New England Interstate Water Pollution Control Commission
David Rocque	Maine State Soil Scientist (Retired)

4.3 Expert Panel Collaboration and Decision Making

The project team provided the Expert Panel with a suggested outline of meeting topics to fulfill the charge, which the panel accepted. Five total meetings were held, with the topics and dates held as follows:

1. Defining Terms, Roles, Goals, & Methods *June 12, 2023*
2. Advanced Nitrogen Treatment *June 29, 2023*
3. Advanced Phosphorus Treatment *July 12, 2023*
4. Current Policy, Funding, & Initiatives in New Hampshire and Beyond *July 18, 2023*
5. Policy, Funding, & Incentives Recommendations for New Hampshire *July 26, 2023*

At the beginning of the process, the panel agreed to adhere to the following collaboration best practices:

1. Commit the time, energy, and resources needed to meet project objectives;

2. Recognize the validity of differing points of view;
3. Recognize the complexity involved in buffer-related issues;
4. Be prepared to listen intently to understand others' views; and
5. Regard disagreements as problems to be solved, not battles to be won.

Additionally, to maintain efficiency of the process and respect inevitable differences in opinions, the panel agreed to use the "Continuum of Consensus" developed by the Center for Leadership and Organizational Change at the University of Maryland (Figure 2). This decision-making framework was previously used in New Hampshire for the *Credit for Going Green Expert Panel* through the Great Bay National Estuarine Research Reserve and the University of New Hampshire Stormwater Center. In this approach, there were five levels of consensus. The top two ("Endorsement" and "Agreement with Reservations") were considered to constitute acceptance of recommendations that were discussed and voted on in the final meeting. Following this process allowed key decisions to be made without the need for a unanimous agreement.

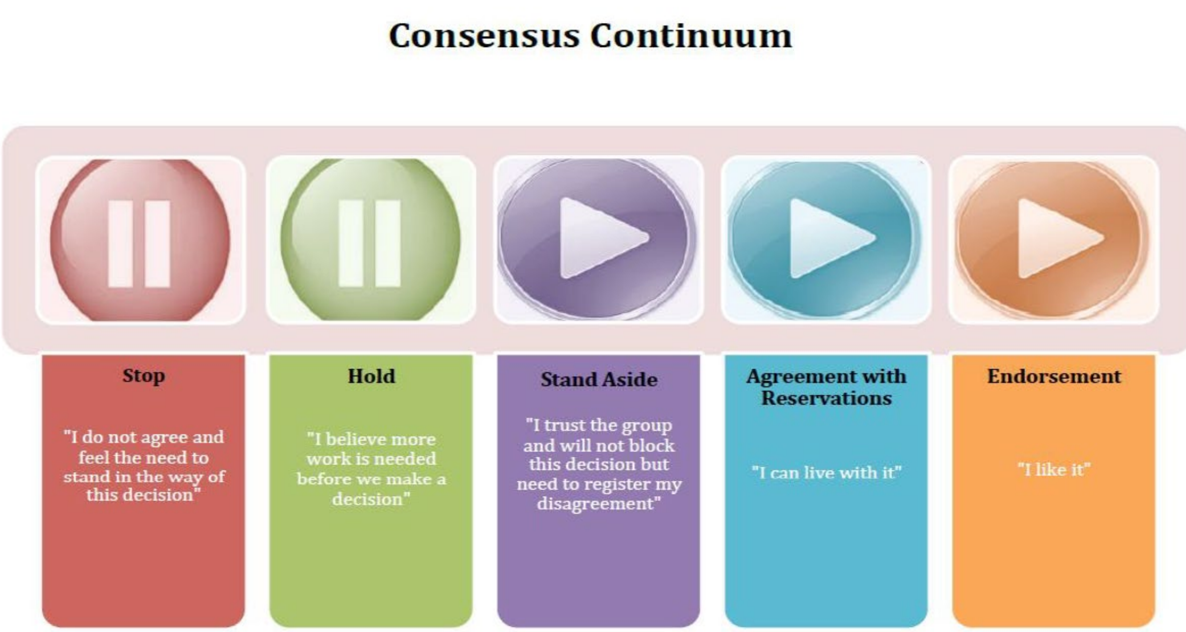

Figure 2. Continuum of consensus followed by Expert Panel members for key decision-making.

Expert Panel meetings were facilitated by FB Environmental. Prior to each meeting, the panelists received a detailed agenda of topics to be discussed, though members had liberty to diverge from these topics if desired to achieve the charge. Additionally, before each meeting, a poll was sent to the panelists to prime them for the next meeting and to gauge opinions or experience on the next meeting topic. A collaborative online folder (via OneDrive) was shared with all panelists to allow for document and resource sharing on relevant topics. Panelists shared 76 documents during the process. All documents were reviewed by FB Environmental and are provided to PREP and NHDES with this report.

4.4 Advisory Committee Goals and Membership

The Expert Panel was intended to inform New Hampshire on a range of best policy options from throughout New England and other areas with similar conditions to New Hampshire. For this reason, the panelists were all from out of state. An Advisory Committee of New Hampshire stakeholders was therefore formed to guide the Expert Panel process and review its recommendations to ensure they were applicable to New Hampshire. The Advisory Committee's experience and knowledge of prior policy research on advanced septic systems, the New Hampshire administrative rulemaking processes, existing programs, and relevant history provided valuable insight which better informed and refined the Expert Panel's recommendations. In addition, the Advisory Committee shared 37 documents, all of which are provided to PREP and NHDES with this report.

The Advisory Committee conducted preliminary review of the Expert Panel process, suggested edits to the charge, and met once on April 26, 2023, before the Expert Panel was formed. The Advisory Committee was updated approximately midway through the Expert Panel process, and then met once more on August 18, 2023, to review and comment on the recommendations. The final committee meeting also allowed for a discussion and review from several points of view, including state regulatory, state, and federal nonpoint source watershed assistance, septic system and soil science professionals, and environmental advocacy groups. These committee members represented New Hampshire leaders whose activities would be directly affected by many of the Expert Panel's recommendations, and who were in a position to communicate the outcomes of the panel to colleagues and constituents, laying the groundwork for further discussion and action. Advisory Committee members and affiliations are listed in Table 3.

Table 3. Advanced Septic System Process Advisory Committee Members.

Member	Position & Affiliation
Barbara Richter	Executive Director, New Hampshire Association of Conservation Commissions
Chris Albert	Granite State Onsite Wastewater Association & CSA Environmental Consultants
Ian Dombroski	Life Scientist, Surface Water Branch U.S. Environmental Protection Agency
Jon Balanoff	Executive Director, Acton Wakefield Watersheds Alliance
Melissa Paly	Great Bay-Piscataqua Waterkeeper, Conservation Law Foundation
Philip Trowbridge	Land Resource Management Program Manager, NHDES
Sally Soule	Watershed Management Supervisor, NHDES
Scott Hazelton	Subsurface Systems Bureau Administrator, NHDES
Steve Couture	Coastal Program Administrator, NHDES Coastal Program

5 Expert Panel Recommendations

The following policy recommendations were summarized from Expert Panel input provided over the five meetings in June and July of 2023. Five of the six panelists were present for the final meeting and voted on potential policy recommendations (Matt Dowling could not attend). Using the Continuum of Consensus developed by the Center for Leadership and Organizational Change at the University of Maryland, Expert Panel members were asked to vote on policy recommendations. Policy recommendations which received “endorsement” and/or “approve with reservations” are presented. The few policy options for which one or more panelists voted “hold” or “stand back” are not presented. Voting results are indicated in italics. One policy idea is the result of a pre-meeting poll, as noted below.

Some ideas were discussed extensively, and panel members expressed general agreement or interest, but a policy recommendation was not fully articulated. Those cases are presented in Section 5.4 Noteworthy Suggestions and Section 5.5, Items for Further Research.

All recommendations were presented to the Advisory Committee after the Expert Panel had concluded. The Advisory Committee asked for further clarification or raised concerns on a few recommendations. These concerns are addressed below under each recommendation.

5.1 Rule Changes for all Septic Systems

5.1.1 Expand Seasonal High Water Table Definition and Add Soil Key (Env-Wq 1006.05)

Summary: Add a soil key to the Design Rules which Permitted Designers use to determine the seasonal high groundwater table. The soil key provides consistent and easy to follow guidance for all site designers. The soil key accounts for typical conditions (redoximorphic features are present) and also for less well-known conditions where groundwater is oxygenated.

Expert Panel Votes: Endorsement (5)

Septic system effluent must flow through unsaturated soils to treat or retain nutrients. Generally, a larger vertical separation distance between the infiltration pipes and groundwater leads to more complete removal or retention of nitrogen and phosphorus due to longer residence times and additional contact between the effluent and mineral surfaces of the soil (Karathanasis et al., 2006; Mechtensimer & Toor, 2017). By contrast, Effluent Disposal Areas (EDA), hereafter referred to as “disposal fields,” which are temporarily or permanently in or close to groundwater are prone to failure or poor performance. Some failures may be observable from the ground surface, such as soggy soils or odors. Others may not be visible at all from the ground, such as when septic tank effluent simply drains into the groundwater table with minimal nutrient attenuation and the nutrient-rich groundwater later flows into to surface waters. Groundwater levels fluctuate through the year; therefore, Permitted Designers examine soil features (e.g., color, texture, etc.) to determine the highest seasonal groundwater level, which is then used by septic system designers to plan a system which maintains a minimum vertical separation distance above the seasonal high groundwater table. These rules were intended for sanitation purposes but are also fairly effective in nutrient treatment.

Currently, New Hampshire Administrative Rule Env-Wq 1006.05[1] defines the seasonal high water table using only redoximorphic soil features created by anoxic groundwater (containing little to no oxygen). However, in some areas of Maine (and likely in similar areas in New Hampshire), groundwater has been found to be consistently oxygenated (David Rocque, personal communication). In these soils, redoximorphic features are absent and different soil features are present (e.g., translocated organic matter, darkened colors, etc.). While redoximorphic features are widely recognized, soil evaluators are often not familiar with these oxygenated groundwater features. Nonetheless, if a septic system is placed in or very near oxygenated groundwater, it will fail just as it will in or near anoxic groundwater. Studies indicate that failure to accurately locate the seasonal high water table can lead to inadequate vertical separation distances, especially in coastal areas where the water table fluctuates regularly (Cox et al., 2020a). Often, this leads to inadequate treatment of nutrients or pathogens and can make the systems more susceptible to failure or poor performance. Incorporating a key for identifying the seasonal high water table standardizes the process across all site evaluations to prevent such oversights and provides a specific method for determining the depth of seasonal high groundwater, whether it is oxygenated or anoxic.

Maine's subsurface rules have adopted an expanded definition of seasonal high water table which accounts for oxygenated groundwater (State of Maine Division of Environmental Health et al., 2014). The rules incorporate a soil drainage key to identify soils with either anoxic or oxygenated groundwater (see Appendix B). The panel recommends revising New Hampshire's Design Rules in Env-Wq 1006.05 – Seasonal High Water Table Definition to account for oxygenated groundwater. The benefit of a soil drainage key is that it provides a standardized process for all Permitted Designers to follow as they identify the seasonal high water table. It is relatively simple and easy to use, and it provides a mechanism for determining the seasonal high water table, whether oxygenated or anoxic, regardless of groundwater depth.

The Advisory Committee expressed concerns that the recommendation may not be relevant for New Hampshire, as the state has generally deeper seasonal high groundwater tables and quite different soils than Maine. David Rocque, who brought the issue of oxygenated groundwater to the panel's attention, encouraged New Hampshire soil scientists to review the soil key closely to determine whether it fits New Hampshire conditions as well as Maine's. He also provided this quote to address these concerns:

> "While I am not an expert on the soils found in New Hampshire, I have had some experience looking at them. I was (and still am) a member of the Hydric Soils in New England Technical Committee that developed the standard for determining hydric soils in New England. Every year, for about 25 years, the committee would hold a field exercise in one of the New England States to look at standard soil conditions and some problem soil conditions. I organized several of those workshops here in Maine. I distinctly remember looking at a couple of workshop sites in New Hampshire that had hardpan sandy loam glacial till soils where committee members were struggling with making hydric soil determinations. I was able to identify evidence of an oxygenated groundwater

[1] NH rules also accessible via https://www.des.nh.gov/rules-and-regulatory/administrative-rules

table at those locations, similar to what we have here in Maine. The [New Hampshire] folks knew those sites were wet but lacked the redoximorphic features typically associated with poorly drained soils and the vegetation was not supportive of the sites being classified as a wetland. That was because the sites were not anaerobic. They were wet but not anaerobic. As you can understand, oxygen in a wet soil may prevent it from being hydric, but a septic system does not care if the groundwater has oxygen in it or not. Any kind of seasonal groundwater table is problematic for a septic system. First, if the disposal field is installed too close to or in the seasonal groundwater table, there will be hydraulic issues. Saturated soil cannot accept additional water from a septic system. Second, the groundwater table will provide the mechanism for transporting effluent downgradient to a surface waterbody or wetland (Note: almost all oxygenated groundwater tables are found on sloping sites where there is a confining layer (hardpan or bedrock. For the most part, the soils are sandy loam glacial tills).

Oxygenated groundwater table soils are a huge use and management issue here in Maine because they are not well understood. The problem is the greatest in our hilly and mountainous regions, but this condition is also prevalent in coastal areas where the soils are sandy loam glacial till. New Hampshire has a lot of hilly and mountainous areas with sandy loam glacial till soils. Working on such soils without a good understanding of how they work can and does significantly contribute to storm water runoff issues as well as overwhelming culverts, ditches, and other stormwater conveyances. One of my guiding principles as the State Soil Scientist, and continues today, is to help people understand and work with the natural hydrology, particularly soil hydrology. It is nearly impossible to properly protect surface waterbody quality without a good understanding of the natural hydrology."

David Rocque, panelist and Maine State Soil Scientist (retired)

The Maine subsurface rules soil key is presented in Appendix B: Maine Soil Key.

5.1.2 Disallow Dry Wells

Summary: Dry wells are allowed under the Design Rules but should be disallowed because they are likely to exacerbate nutrient loading to surface waters.

Expert Panel Votes: Endorsement (3), Agreement with Reservations (2)

Dry wells are currently allowed for wastewater disposal through New Hampshire Individual Sewage Disposal System Rule Env-Wq 1020. This rule would need to be revised to adopt the proposed change (see suggested revision below).

Dry wells were generally discouraged by panelists. A dry well is a seepage pit, similar to a cesspool, where wastewater is held and dispersed through a concrete cylinder. They were viewed as similar to chamber systems (which are widely accepted) but tend to be installed deeper in the soil, closer to the groundwater table, and therefore represent a greater threat of nutrients entering ground and surface waters. Having a shallow vertical separation distance between the dispersal area and the groundwater or other restrictive layer can lead to inadequate treatment since there is a shorter flow path and less contact time between the effluent and soil mineral surfaces. Seepage pits such as dry wells have been regarded to be inadequate as an effluent dispersal area by the EPA since 2001 (see “Seepage Pits May Endanger Ground Water Quality” EPA, 2001). One panelist mentioned they could sometimes work in certain soils (e.g., well-drained ablation till, a loamy gravel; see “Reservations” below) and the installation does not extend below the zone of biologic activity. Other panelists stated they would simply disallow them, and noted there were other system types, such as chambers, which work regardless of soil type. Dry wells differ from chambers in that chambers disperse effluent through bottom area with very little side wall usage whereas dry wells disperse of effluent primarily through sidewall area with very little bottom area usage. Dry wells only work if installed in highly permeable soils. Chambers systems work on all soil textures.

Advisory Committee members inquired whether there were additional references supporting this recommendation. In response, panelist Justin Jobin indicated that in Rhode Island, “deep leaching Chambers” (also called galleys) were allowed in 2001 where the groundwater table was greater than eight feet deep; but by 2010, Rhode Island had prohibited them completely. URI Cooperative Extension states the “deep leaching chambers” are not recommended for nitrogen sensitive areas (URI, 2005). Justin also stated, “In addition, the deep placement, poor oxygen transfer, and limited treatment capacity of leaching pits, pools, and galleys make them outdated technologies (Amador and Loomis, 2018).”

Figure 3. A septic dry well in New Hampshire in poor condition. Photo Credit: Peter C. Russell (Russell Inspection Services) via InterNACHI Inspection Community.

A proposed revision to the dry wells section of the New Hampshire Individual Sewage Disposal System rules (Env-Wq 1020) is provided below. The current rule text dealing with dry wells, which is not shown, is recommended to be deleted, thus prohibiting dry wells for wastewater disposal. An explicit prohibition to that effect may be added. The proposed policy is intended to prohibit new dry wells, while still requiring abandoned dry wells to be filled with earth or stone for the sake of safety.

> PART Env-Wq 1020 DRY WELLS
> Env-Wq 1020.05 Abandoned Dry Wells. Abandoned wastewater dry wells shall be filled with earth or stone.

Reservations

David Rocque stated that one suitable soil type for dry wells is ablation till (a loamy gravel) provided it is well-drained. Even so, David would limit how deep into the soil a dry well could extend as it should not extend below the zone of biologic activity. David would not allow dry wells in coarse-textured soils.

5.1.3 Anchor or Ballast System Components

Summary: Septic systems should be ballasted in flood zones or where saturated ground conditions are expected, because system components can float and break due to buoyancy, causing sewage leaks. The Expert Panel stipulated that this recommendation applies to replacement systems since new systems should be prohibited in saturated or flood prone areas.

Expert Panel Votes: Endorsement (2), Agreement with Reservations (3)

Septic system components (advanced or conventional) often contain enclosed air spaces (e.g., in the top of partially full tanks, pipes, etc.) which cause those components to become buoyant in saturated ground conditions. This buoyancy can cause components to shift position or pop out of the ground during flood or high water table conditions. Septic systems in coastal areas are particularly susceptible to flood damage during large storm events (Cox et al., 2020b). Anchoring or ballasting potentially buoyant system components can reduce damage from flooding. Panelists recommended that first-time systems should not be permitted in flood zones, but that the need for replacement systems in flood zones occurs. Some panelists noted that adequate ballasting or anchoring would require sufficient engineering and a degree of nuance and discretion on the part of engineers. Another panelist said that areas susceptible to flooding from future sea level rise should be included in this policy. The Advisory Committee noted that ballasting may be needed in areas outside of flood zones, including areas with shallow water tables.

Several states already require anchoring of systems. Maine requires “anti-floatation measures” for septic tanks. In Colorado, state regulations require septic tanks to be anchored in locations where groundwater or floodwaters may cause instability issues (5 Colo. Code Regs. § 1002-43.9). Similarly, Wisconsin requires anchoring of systems subject to saturated conditions. Wisconsin uses the following formula to determine the necessary weight of the anchor (SPS Appendix 383, A-383.43 (8) (g)):

$$\begin{aligned}&\mathit{Component\ weight} + \mathit{anchor\ weight}\\&\qquad = 1.5 * \mathit{volume\ of\ water\ displaced\ by\ the\ component} * \mathit{weight\ of\ the\ water}\end{aligned}$$

New York State suggests septic tanks installed in groundwater be anchored, with the caveat that tanks not properly anchored should not be completely dewatered (NYS DOH Bureau of Water Supply Protection, 2012). Suffolk County, New York specifically has standards for anchoring systems based on their buoyancy. The designer must provide a calculation demonstrating that the weight of the component combined with the weight of the anchor or ballasting is 1.5 times the weight of the water displaced. Though other states do require anchoring septic systems through regulations, it is generally agreed that anchoring of system components is a best practice to avoid both system and environmental damage caused by flooding.

Reservations

The panel also discussed whether system components which protrude above the ground surface should be disallowed in flood zones. David Rocque stated that some flood zones experience high velocity flooding while others experience low to no velocity flooding. In low to no velocity flood zones, above grade system components are not at risk of washing away due to the force of moving water and thus do not need to be prohibited. He also stated that in areas where mounded systems are necessary (e.g., elevated groundwater levels), other techniques can be used or precautions taken to prevent the mounded system from washing away. David also added that no new systems should be installed in flood zones and that only replacement systems should be allowed in flood zones. Alissa Cox agreed with Rocque and added that sufficient engineering would be required to stabilize systems which could be a hurdle in the process. She also stated that future sea level rise inundation areas should be included in these flood zones.

5.2 Program for Advanced Septic System Technology for Nutrient Reduction

5.2.1 Adopt Advanced Septic System Technology Approvals from Top Jurisdictions

Summary: New Hampshire should provide a rapid pathway to "general approval with conditions" for advanced septic system technologies that have been approved in Massachusetts, Rhode Island, and Suffolk or Nassau counties in Long Island, New York. These jurisdictions have robust, data-driven approval systems in place and have testing data on thousands of real-world installations. It does not make sense for New Hampshire to duplicate or ignore those results.

Expert Panel Votes: Endorsement (5)

The panel recommended that New Hampshire should rapidly offer "general approval with conditions" to any advanced septic system technology that has been approved in two of the following three jurisdictions: Massachusetts, Rhode Island, and Long Island, New York (Nassau or Suffolk County). Massachusetts, Rhode Island, and the Long Island counties have particularly robust approval processes which are detailed below. All three jurisdictions' approvals are data-based and iterative, such that the higher tiers of approval indicate systems which have been installed and tested in real world situations. Several jurisdictions have issued detailed performance reports and numbers of each type of system installed, especially Suffolk County, New York and Charlestown, Rhode Island.

The conditions of approval in New Hampshire should include routine maintenance and a minimum level of performance testing which shows adequate nutrient removal and overall performance in New Hampshire (see the Horsley Witten Group statistical analysis mentioned below). Conditional approval should be designed such that it provides an avenue to revoke approval of any system type which proves to be obsolete or otherwise fails to protect public health and/or the environment. Conditions of approval in New Hampshire should include periodic documented maintenance, inspections, and performance monitoring. The Expert Panel specified that those conditions should be developed by New Hampshire and *not* adopted from other jurisdictions, since their maintenance, inspection, and monitoring programs are not as uniformly robust as their approval processes.

A full engineering review and fulfilling monitoring requirements is time and resource intensive and was mentioned by NHDES staff on the Advisory Committee as a known bottleneck to advanced treatment for nutrient reduction. This approach would allow New Hampshire to avoid relying on lengthy and duplicate testing regimes and allow new technologies to enter the New Hampshire market if they have been successfully implemented in nearby regions. Developing lengthy testing requirements similar to other jurisdictions represents a costly and time-consuming barrier to technologies that are likely to work well in New Hampshire. It diverts resources, including NHDES staff time overseeing these approval processes, away from other priorities. By adopting an approval process that relies on well vetted, stringent approval requirements in selected jurisdictions, New Hampshire would be able to focus time and resources towards performance monitoring, operations and maintenance programs, funding, and enforcement.

Each jurisdiction has different levels of approval. It is suggested that only approval levels based on real-world performance testing data are used. These approval levels are:

- Rhode Island: Class One or Class Two
- Massachusetts: General Use or Provisional Use
- Suffolk County or Nassau County, New York: General Use or Provisional Use

The Expert Panel had limited time available and did not articulate all the details involved in implementing this recommendation. Once the Expert Panel and Advisory Committee concluded their work, project staff at FB Environmental, with support from panelist Justin Jobin of Coastal Wastewater Solutions, followed up with additional research.

In 2015, in concert with EPA, Delaware, Maryland, Pennsylvania, Virginia, and West Virginia signed a Memorandum of Cooperation to share performance data from nitrogen-reducing septic systems. They developed standard protocols for provisional and final field testing of nitrogen-reducing pretreatment units, without superseding any state laws or rules on septic systems. In essence, these five states adopted tools to streamline and regionalize the data collection used to approve advanced septic system technology.

In 2016, EPA initiated a similar data sharing effort in New England and Long Island, in which all New England states including New Hampshire participated. The effort produced a statistical analysis to determine the minimum dataset needed to evaluate a septic system technology. The analysis was conducted by Horsley Witten Group, Inc. on performance data from installed advanced treatment septic systems in Barnstable County, Massachusetts. The analysis examined data from 208 systems using 12 technologies with over 4,000 sample points total. Horsley Witten determined that between 8 and 20 systems needed to be sampled at least 12 times each to assess performance at a 90% confidence level (Horsley Witten Group Inc., 2017, as cited in Freese et al., 2017). The project also developed a Test Plan

Application Template, intended as a standard procedure to evaluate new technologies. Despite this progress, the New England/Long Island data share project did not result in a Memorandum of Cooperation as it did in the Chesapeake Bay watershed, and thus no shared regional approach was adopted. An important factor was that Rhode Island and Massachusetts already had well established approval processes which would need to be changed if they joined a regionalized effort. Nonetheless, Long Island's Suffolk and Nassau counties in New York did implement a version of the data share approach. They adopted testing protocols that relied on the Horsley Witten statistical analysis, and Suffolk County adopted a shortened version of the Test Plan Application Template (a detailed methodology for testing septic system technologies, also produced under the data share effort).

The Expert Panel's recommendation to utilize advanced technology approvals from specific northeastern jurisdictions with robust, data-based approval processes can be seen as a pathway toward a streamlined, regionalized approval framework. New Hampshire could use approvals in these other jurisdictions as the basis for allowing a limited number of installations in the state, on the condition that 20 in-state installations are tested a minimum of 12 times using procedures based on the Test Plan Application Template, and if test results show acceptable performance, additional installations may proceed. For systems not yet approved in other jurisdictions, New Hampshire may rely on its current approval requirements including engineering review.

For tables of system types approved by each jurisdiction, see Appendix C: Tables of Approved System Types in Selected Jurisdictions. Appendix C Table 4 shows systems approved in a single jurisdiction and Table 5 shows systems approved in two of three jurisdictions as proposed above. Below, details are provided on the approval processes in the three jurisdictions proposed, along with the recommended, data-based approval levels to count toward rapid approval in New Hampshire.

Massachusetts has three tiers of approval: Piloting Use, Provisional Use, and General Use. A system may be piloted in Massachusetts if field performance data from other states shows that the system provides a level of protection comparable to that of a conventional system. No more than 15 systems may be installed while being piloted and each must be tested for at least 18 months. If at least 75% of the piloted sites perform the expected level of treatment for at least 12 months, the system is granted provisional approval. Once a technology has provisional approval, at least 50 systems must be monitored for three years. If at least 90% of systems attain a level of protection at least as high as that of a conventional system (less than 19 or 25 mg/L, depending on flow) over the three-year period, the system will be certified for General Use. **Only systems approved for Provisional Use or General Use in Massachusetts fulfill the recommended criteria for rapid "general approval with conditions" under the proposed approval process.** In each Massachusetts General Use approval, there are specifications made for maximum facility design flow, facility type (e.g., residential, commercial, etc.), and system effluent water quality parameter ranges. Generally, operation and monitoring requirements for all General Use approved systems are set to the following:

- Systems with a design flow of 660 gallons may not have effluent with a total nitrogen concentration of more than 19 mg/L;
- Systems with a design flow of 550 gallons may not have effluent with a total nitrogen concentration of more than 25 mg/L;
- The pH of the effluent must remain between 6.0 - 9.0;
- Dissolved oxygen shall equal or exceed 2 mg/L; and
- Turbidity shall be equal to or less than 40 NTU (Mass.gov).

Deviance from these standards is outlined in the specific system's approval letter. Massachusetts uses NSF testing data (conducted under contract with MASSTC) to support system approvals.

Massachusetts Department of Environmental Protection and the local Board of Health review systems for approval. The designer of the system must be a registered professional engineer or a registered sanitarian and must prepare the plans for approval. After state approval, systems must be reviewed and approved for installation at a specific site; this is also the responsibility of Massachusetts DEP and the local Board of Health (Mass.gov – Innovative Tech and Title 5 Systems).

Rhode Island also has three tiers of approvals: Experimental Use, Class Two certification, and Class One certification. In order to be approved for Experimental Use, the manufacturer must demonstrate that the system works in practice or in theory. Experimental Use certification allows for up to 10 systems to be installed. For a Class Two certification, the technology must be supported by two years of performance data which must be collected at least quarterly. The technology must have been approved in Rhode Island or another jurisdiction for at least two years in order to be granted Class Two certification. Alternatively, a technology may receive Class Two certification if it is NSF certified and has testing results showing nitrogen reductions to 19 mg/L or less. Class Two certification must be renewed every five years. After four years of performance data that demonstrates that the nitrogen reduction standards have been met, the system may be approved for Class One approval, which does not require renewal. A technology may also be granted Class One approval if it has been approved for four consecutive years in three other jurisdictions. All approvals in Rhode Island require a full review by their Onsite Wastewater Treatment System Technical Review Committee. **Class One and Class Two systems fulfill the recommended criteria for rapid "general approval with conditions" under the proposed approval process (RIDEM, 2023).**

Long Island, New York's Suffolk County and **Nassau County** have similar approval processes. Both have four classes of approval: Experimental Use, Piloting Use, Provisional Use, And General Use. Acceptance for Provisional or General Use requires all performance testing results to yield an average total nitrogen concentration of 19 mg/L or less. For provisional approval, the technology must be piloted for at least 12 samples (monthly) and reach the required nitrogen concentration of 19 mg/L or less. To achieve General Use approval, at least 20 systems must be performance tested for at least 12 consecutive sampling events (monthly or bi-monthly) and average 19 mg/L or less of total nitrogen in the effluent. **Both Provisional and General Use approval in either county in Long Island, New York fulfills the recommended criteria for rapid "general approval with conditions" under the proposed approval process.**

Currently, only three technologies are approved at the recommended level in at least two of the three jurisdictions, all of which are already approved in New Hampshire. However, the lists of approved systems in these jurisdictions will grow as there are additional systems in approval pipelines in multiple jurisdictions. The list of approved systems will continue to grow as performance testing data is recorded and new technologies become available. For example, there are a number of systems approved in only one of the selected jurisdictions that may become approved in two or more if they reach performance standards for the given jurisdiction (Table 4).

5.2.2 Establish Inspection, Maintenance, and Monitoring Requirements for Advanced Septic Systems and/or all Systems in Nutrient Sensitive Areas

Summary: Currently, septic systems are installed with no required follow-up to ensure they are being maintained and operated correctly. An inspection program, maintenance documentation requirements, and for advanced systems a monitoring program, are recommended to ensure septic systems function well through time.

Expert Panel Votes: Endorsement (5)

Routine inspections and maintenance of septic systems can help ensure public sanitation and water quality protection, but presently there is no clear, enforced requirement in state rules for these. To be effective at protecting water quality from nutrient pollution, inspections must be sufficiently detailed to detect underground problems that are not visible from the ground surface, such as an inadequate vertical separation between the disposal field and groundwater or other limiting factors. Beyond identifying failing or underperforming systems, which can contribute nutrient-rich effluent to surface waters and pose a risk to public health, routine inspections can increase awareness around septic maintenance. The Expert Panel emphasized that mandating routine inspections would remind homeowners that their wastewater goes back into the environment and generally encourage greater stewardship. Such awareness can improve the participation in and support of different septic programs.

The Expert Panel strongly recommended that some form of inspection, maintenance, and monitoring program be instituted, especially within nutrient sensitive areas (see also Section 5.2.4 on establishing nutrient sensitive areas). Some panelists recommended an inspection requirement similar to those conducted by the municipality in Charlestown, Rhode Island. In Charlestown, the time between inspections is determined based on the findings of the previous inspection. Systems which are in good condition and show signs of adequate performance are inspected less frequently than systems which show signs of reduced performance, aging or obsolete materials (e.g., metal septic tanks), or other causes for concern. More generally, panelists suggested mandatory inspections approximately every three to five years in nutrient sensitive areas.

The Expert Panel discussed inspections required under Title 5 in Massachusetts and concluded that Title 5 inspections are too expensive and labor intensive to complete on a regular basis.

In areas without any centralized inspection data, the panelists generally agreed that an initial survey or inventory of septic systems is advisable, in which every system would be visited and briefly examined to determine (if possible) type, location, and general condition of the system. This initial inventory would involve less effort and detail than a full inspection of every system, but it would be a major step forward in managing and reducing nutrient (and pathogen) pollution by providing a watershed level overview of septic systems where no such data exist. The septic system inventory could then be used to prioritize and schedule future inspections, where systems that are the most likely sources of pollution (considering system type, condition, use, and location) are scheduled for inspection first.

As discussed in Section 5.2.1 above, New Hampshire should require operations and maintenance and performance testing as a condition of approval for all advanced nutrient reducing technologies.

5.2.3 Establish and Maintain a Database of System Inspection and/or Monitoring Results

Summary: The Expert Panel strongly agreed that a database of septic system inspections and/or monitoring results is essential in effectively managing advanced septic system technology. The only reservation was if inspections are not sufficiently rigorous to truly evaluate nutrient reductions, then the inspection data would have limited value.

Expert Panel Poll: "Incredibly Useful, Essential to Successful Management" (4), "Monitoring would be very useful, but inspections would only have limited value" (1)

Panelists emphasized several times over multiple meetings that real-world performance data is key to successful septic system management for nutrient reduction. A large dataset of real-world septic system performance data is maintained by MASSTC (separate from its National Sanitation Foundation certification data, which are confidential). Rhode Island (state level, and individual municipalities such as Charlestown) has septic system management programs which are heavily based on data. Suffolk and Nassau counties in New York are also collecting and publishing datasets on numbers and types of systems as well as results of their performance testing program for advanced wastewater technologies.

EPA proposed a standardized data collection and sharing initiative for New England and Long Island in 2016. This effort included a statistical analysis by Horsley Witten which determined how many systems and how many samples per system needed to be tested to be sure at a 90% confidence level that a given technology was effective. EPA also created a detailed testing program template. While the data sharing initiative was not ratified in a Memorandum of Cooperation (as was the case for six states in the Chesapeake Bay watershed), Suffolk and Nassau counties substantially adopted the proposed program. New Hampshire could join Suffolk and Nassau counties in adopting the program, which would be an important step toward cost-efficient regional data sharing. See also the discussion of data sharing in Section 5.2.1 on utilizing approvals from selected jurisdictions.

Panelists described and recommended features of some advanced septic system technologies which make monitoring feasible. These include pressurized shallow drainfields (see Section 5.4.2) which have a control panel that can easily record effluent pump activity to measure volume of effluent, and manufactured systems which have inspection ports which can be used for sample collection. In Charlestown, Rhode Island, site-built non-proprietary systems (e.g., layered soil treatment area, LSTA) are also being installed with features that allow effluent samples to be easily collected.

In discussions, panelists stipulated that the value of inspections depends heavily on exactly what is inspected. Massachusetts Title 5 inspections were mentioned as highly detailed and expensive, while other inspections focused only on sanitation issues may be completely inadequate to evaluate nutrient loading (see Section 5.5.1 on how to measure septic system performance). There was uniform agreement that an initial round of system inspections, even if not especially detailed or "perfect," can be extremely valuable in providing an initial inventory of systems in an area (see Section 5.2.2 on inspection programs). That inventory then helps plan a more thorough inspection program that strategically applies resources to vulnerable areas and septic systems whose performance appears questionable.

5.2.4 Map Nutrient Sensitive Areas and Require Adequate Wastewater Nutrient Treatment in those Areas

Summary: The Expert Panel agreed that advanced septic system technology should be applied where needed and not required where not needed. Massachusetts, Rhode Island, and the Long Island, New York counties have all implemented data-based nutrient sensitive zones. Those zones are the basis for requiring and/or prioritizing upgrades to advanced wastewater treatment. New Hampshire should also designate nutrient sensitive areas.

Advanced septic systems for nutrient reduction are expensive, and the resources to build, permit, inspect, and maintain them are limited. They also tend to be complex, requiring higher levels of maintenance than conventional systems, which makes them more sensitive to failure or poor performance due to forgetful or negligent homeowners. Advanced systems should ideally be built in areas where they are truly needed, and not required when other less expensive, less complex, and ultimately more reliable options are equally effective.

This policy recommendation was not voted on separately, but it is a prerequisite to other recommended actions and was discussed extensively by the Expert Panel. Mapping may have two tiers: a “highly sensitive area” with more stringent rules and criteria for nutrient reduction, and a “sensitive zone” with less stringent requirements. Areas outside of these two zones would be considered “not sensitive.”

Parameters discussed for assigning nutrient sensitive zones include:

- 303(d) impairment caused by nutrient pollution
- Proximity to any surface waters (ocean, pond, stream, ephemeral stream) and wetlands
- Shallow groundwater
- Coarse soils
- Sand and gravel aquifers
- Shallow to bedrock soils
- Density of existing septic systems
- Maximum buildout potential (or lot size)
- Water supply intake structures

Most of this information is publicly available through the USGS, the USDA Natural Resource Conservation Service, and municipal records. Watersheds currently listed as “impaired” due to nutrients on the 303(d) list are documented as having a nutrient loading issue, and critical water supplies are vulnerable to nutrient loading due to their use for drinking water. Areas with a large number of existing systems may be contributing large amounts of nutrients due to the sheer number of septic systems in the area. Similarly, areas that have a large maximum buildout potential (high density if completely developed) will face the threat of nutrient pollution as buildout occurs. Soil characteristics that can lead to inadequate nutrient removal (shallow groundwater/bedrock, coarse soils) or especially vulnerable groundwater resources such as sand and gravel aquifers should also be considered for the nutrient sensitive area.

Massachusetts Department of Environmental Protection determined areas of nitrogen sensitivity to be:

1. Public and private water supply protection areas: public and private wells or wellfields and areas where both on-site septic systems and wells are not regulated by public water supplies; and
2. Natural resource areas: any watershed or embayment subject to a nitrogen Total Maximum Daily Load or the 208 Area Wide Water Quality Management Plan.

Prior to final Nitrogen Sensitive Area designation, Massachusetts Department of Environmental Protection put the identified zones through a public review process which included providing extensive public notice and holding public hearings (Massachusetts Title V Section 15.214). The finalized areas are mapped on the Nitrogen Sensitive Areas Address Lookup which allows residents to look up if they reside in the sensitive zone. Design flows in these areas are restricted to 440 gpd per acre. Massachusetts has only one tier for Nutrient Sensitive Zones.

Suffolk and Nassau counties in New York have established that their entire areas are nutrient sensitive zones where all septic systems must eventually provide advanced treatment for nitrogen attenuation or transition to public sewer. Although all areas in Suffolk and Nassau counties are nitrogen sensitive and will require nitrogen-reducing technologies, priority zones are used to develop implementation and system upgrade schedules. The prioritization was based in part on groundwater travel times according to studies by the USGS. For example, areas where the groundwater residence time was between 0-2 years warranted a higher priority than areas with a residence time of 2-25 years, meaning they are scheduled for system upgrades first. Critical drinking water supply areas are also included in Suffolk County's priority zones (Bellone, 2015; Jobin & Priolo, 2020). Information on Suffolk County's priority zones can be found in Section 8 of the Suffolk County Comprehensive Water Resources Management Plan and in the Suffolk County Subwatersheds Wastewater Plan.

Rhode Island Department of Environmental Management has designated two types of Critical Resource Areas—Narrow River watershed and Salt Ponds (estuaries) watersheds—where nitrogen-reducing septic systems are required. See Figure 6 for an example.

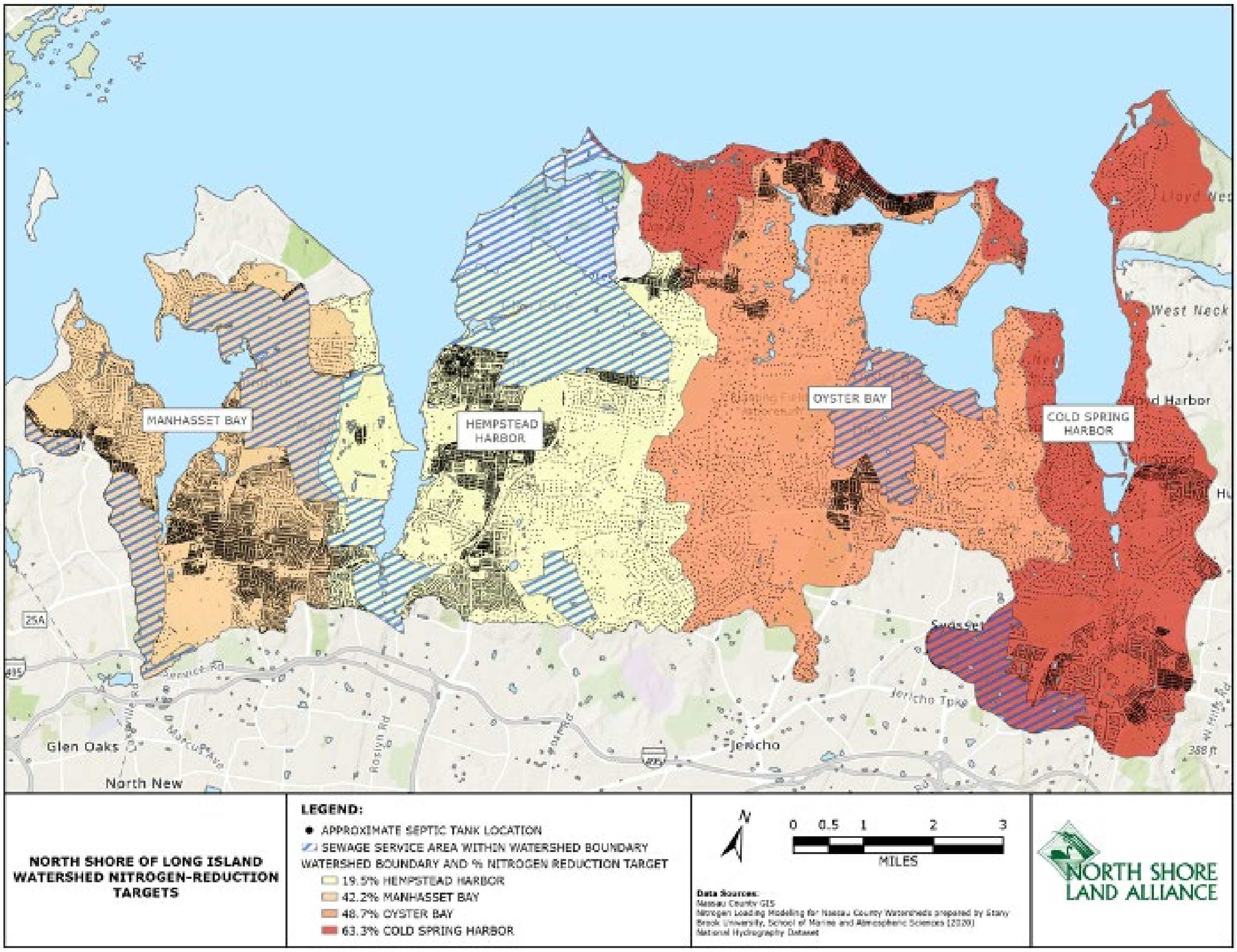

Figure 4. Priority nutrient-reduction areas on the North Shore of Long Island.

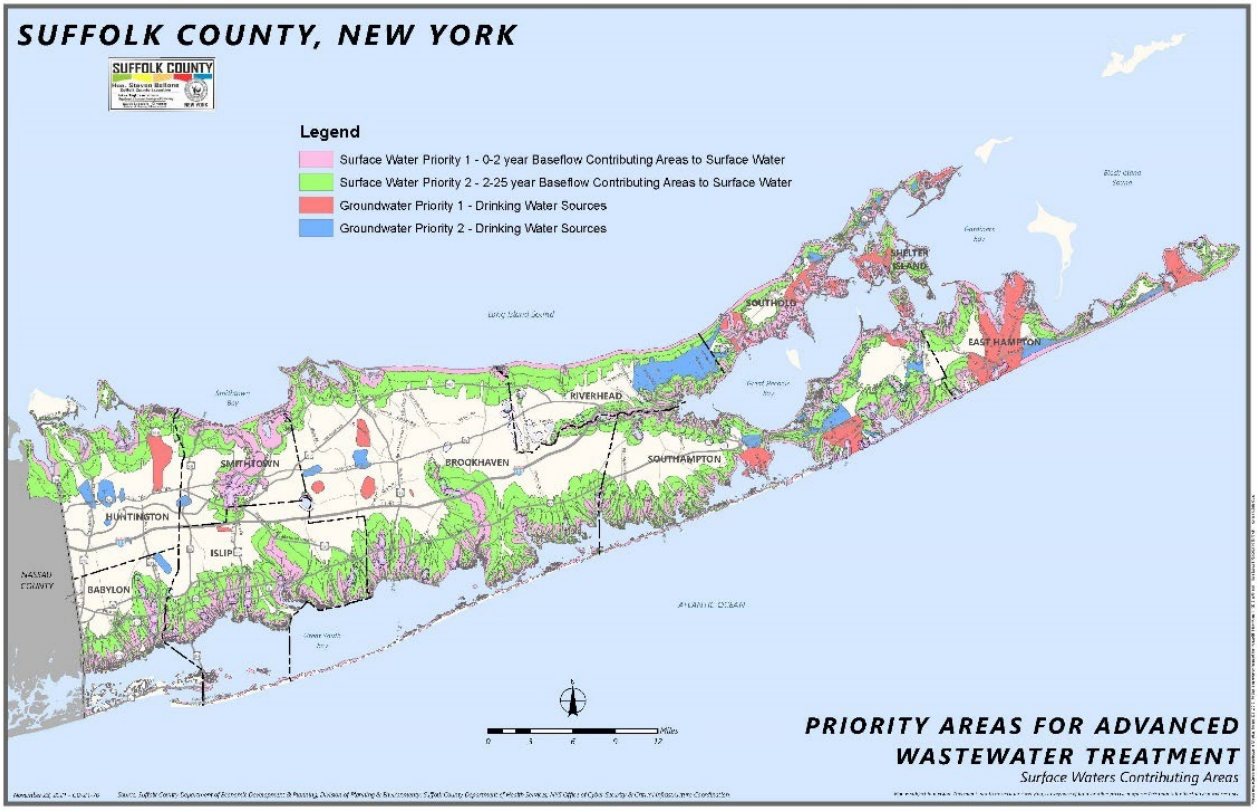

Figure 5. Priority nutrient-reduction areas in Suffolk County, New York. (Suffolk County Department of Economic Development & Planning, Division of Planning & Environment; Suffolk County Department of Health Services; NYS Office of Cyber Security & Critical Infrastructure Coordination, 2021).

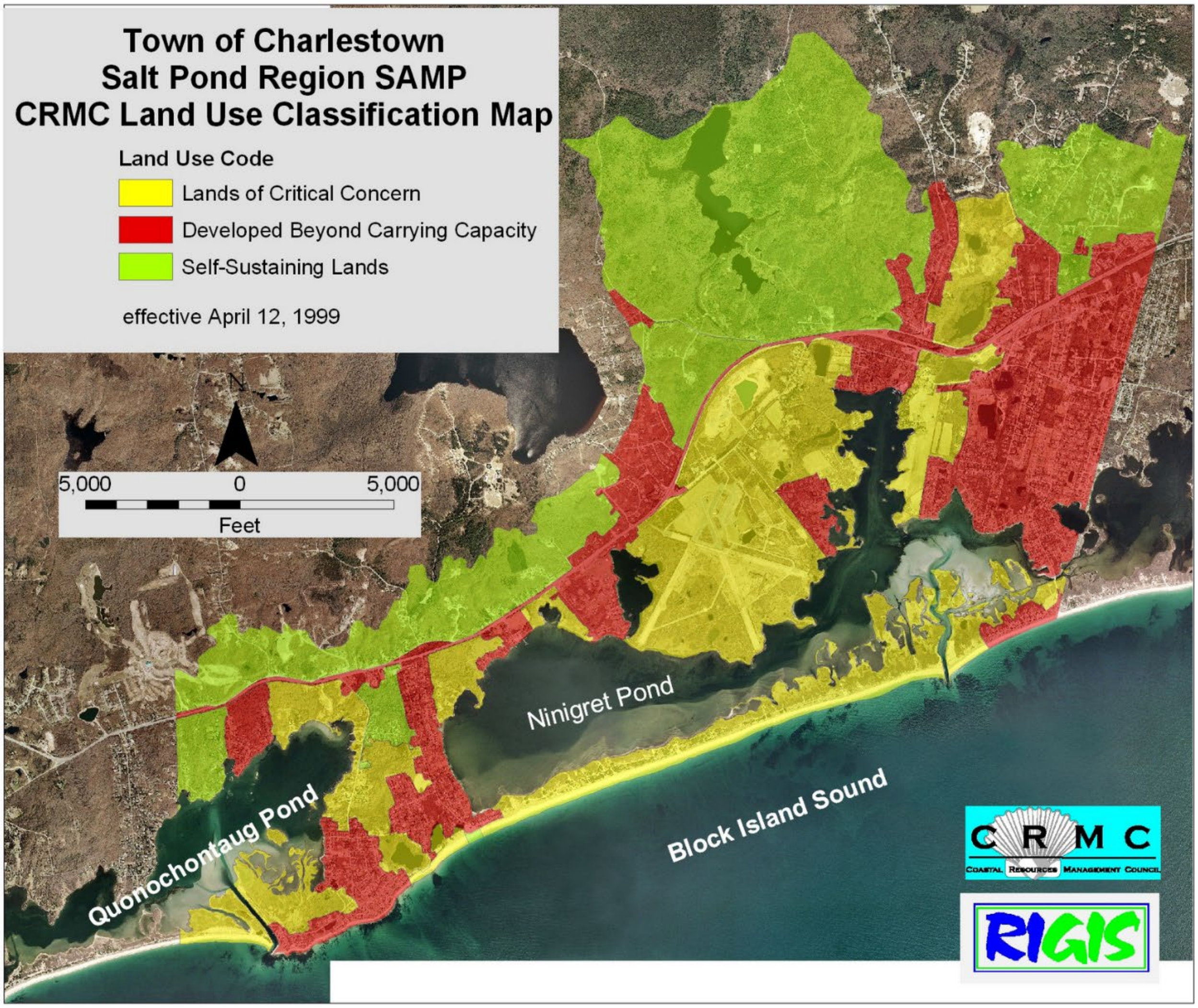

Figure 6. Rhode Island Department of Environmental Management designated Salt Pond Region within Charlestown. Shaded areas represent a state-designated Critical Resource Area within the Town of Charlestown within which advanced wastewater treatment technology is required. See Rhode Island's webpage on these designations. Source: http://www.crmc.ri.gov/maps.html.

The Advisory Committee indicated that impaired watersheds (303(d) listed) have been discussed as priority nutrient reduction areas in which advanced wastewater treatment would be required. The project team notes that this approach would not protect any currently high-quality waters which are sensitive to nutrient pollution. In addition, some impaired lake watersheds may have high density development ringing the lake, and low-density development in upper watershed areas. It would not make sense to require advanced nutrient treatment in portions of impaired watersheds with large lot sizes, long distances to waterbodies and wetlands, deep enough groundwater tables, and soils with demonstrably high nutrient retention capabilities.

Require Advanced Treatment in Highly Nutrient Sensitive Zones

Expert Panel Votes: Endorsement (4), Agreement with Reservations (1)

This policy recommendation assumes a two-tiered nutrient sensitive zone is developed in New Hampshire. Within the most nutrient sensitive zone, advanced treatment technology for nutrient removal should be required for new, expanded, and replacement systems. The proposal specifies "advanced technology" rather than solely full systems; therefore retrofits, inserts, comprehensive site designs which optimize for nutrient treatment, and/or other technologies such as shallow pressurized drainfields can be considered.

If a two-tiered nutrient sensitive map is adopted, lower cost and lower intensity efforts to reduce nutrient pollution from septic systems could be required in the less sensitive zone. For example, a comprehensive site assessment which considers phosphorus reduction as well as sanitary considerations could be required, allowing conventional septic systems, provided they are installed in ways which optimize for phosphorus reduction. In areas further from surface waterbodies with large lot sizes, this type of approach may be advisable given the ability to use a system with a larger footprint, which is arguably more reliable and resistant to neglect than a complex advanced treatment system.

Reservations

This topic was voted on without discussion.

Update Nutrient Sensitive Zone Maps Every 10 Years

Expert Panel Votes: Endorsement (4), Agreement with Reservations (1)

This policy recommendation assumes nutrient sensitive zone(s) are developed in New Hampshire. The proposal is to update those zones every 10 years based on the latest science, data, and experience with advanced septic system technology for nutrient treatment. Additionally, as climate change begins to affect sea level, precipitation rates, storm dynamics, and water table elevations, amending the nutrient sensitive zone to the most updated knowledge is essential to maintaining resilient communities.

Reservations

This topic was voted on without discussion.

5.2.5 Establish a Training Program / Policy for Advanced Wastewater Professionals

Summary: The Expert Panel agreed that a training program and/or policy for advanced wastewater professionals would promote the professional infrastructure necessary to support effective advanced wastewater treatment in New Hampshire.

Expert Panel Votes: Endorsement (2), Agreement with Reservations (3)

The Expert Panel recommended New Hampshire establish a policy and program to manage training of advanced wastewater professionals. These could include statewide training legislation or rules and regulations establishing protocols and continuing education requirements. Many panelists noted that a training program was much more feasible and flexible than a training "center." Panelists stated that Massachusetts does have a statewide certification program for soil evaluators and septic system inspectors; however, there is no statewide certification program for septic system installers (it is all done by towns with mixed results). Rhode Island has a statewide certification program, and Maine just adopted one. In the Rhode Island program, there are only exams, with no training requirement, which was seen as questionable. One panelist recommended that New Hampshire review training requirements and approve courses from whomever would like to have their courses approved.

Reservations

This topic was voted on without discussion.

5.3 Financing and Incentives

5.3.1 Pilot Advanced Treatment Installation Program

Summary: The Expert Panel strongly recommended some form of advanced septic system technology pilot program in New Hampshire.

Expert Panel Votes: Endorsement (5)

The Expert Panel recommended New Hampshire pursue a pilot program for advanced septic system technology installations. For example, NHDES, a watershed-focused organization like PREP, or municipalities could seek federal funding. An example is the EPA's Southeast New England Program Pilot Watershed Initiative grant received by the Town of Charlestown, Rhode Island, to plan, install, and monitor approximately 20 advanced septic systems as part of the Town's ongoing long-term onsite wastewater management program.

The pilot program should fund over 50% of the cost of each septic system installation, because panelists indicated in their experience that was the threshold for public interest in system upgrades or replacements. An example of funding sources for the pilot program is 50% federal, 5-10% municipal, 40-45% homeowner. The panelists suggested replacing or installing advanced technologies (not limited to whole septic systems) for 30 to 40 systems retrofits total, all within 3 to 4 target hotspot areas with strong local interest and clear, measurable pollution problems.

5.3.2 Establish / Maintain Low-Interest Revolving Loan Programs for Septic Systems

Summary: The Expert Panel recommended establishing a low-interest loan program capable of offering rapid support to homeowners facing the need to replace or upgrade their septic system. Rhode Island's State Revolving Loan program is a clear example.

Expert Panel Votes: Endorsement (5)

The Expert Panel recommended establishing and/or maintaining a low-interest revolving loan program which provides financing to those who need to replace or upgrade failing septic systems. Many states offer this type of program, which works as follows. The state manages a low or zero interest loan program (sometimes with Federally sourced funding) that municipalities can apply to. If awarded, the municipality receives the funds in advance in a municipal account. Municipalities use the financing to offer a low-interest loan to homeowners in need of system replacement, usually due to an unexpected system failure or underperformance. Panelists reported that this type of financing is not an effective incentive to adopt advanced technology but is often welcomed by those in need and allows the municipality to offer some form of assistance to facilitate and accelerate on-the-ground repair or replacement. When the municipality exhausts the available financing, they can reapply to the state to replenish their account.

Charlestown, Rhode Island offers septic system repair and replacement funds in the form of a low interest (1%) $25,000 loan to the homeowner. Repair and replacement funding ensures that failing systems are attended to and replaced by reducing financial barriers. Failures can cause public health and sanitation issues and nutrient loading to nearby waterbodies. Panelists also identified that similar funding or loan programs are excellent outreach and education opportunities to expand homeowner awareness of the environmental impact of septic systems.

Some Advisory Committee members noted that New Hampshire's current State Revolving Loan program required lengthy delays (sometimes 1-2 years) between application for financing and availability of those funds for on-the-ground implementation. Enabling legislation and/or rule changes may be necessary to realize this recommendation.

5.3.3 Seek Funding for Advanced Septic System Projects

Summary: The Expert Panel agreed New Hampshire should seek funding to support advanced septic system adoptions. This is longer term support than a pilot program, and ideally would reduce the cost to eligible homeowners of advanced systems to slightly less than conventional systems.

Expert Panel Votes: Endorsement (3), Agreement with Reservations (2)

The panel agreed that New Hampshire should pursue funding at all levels (federal, state, county, local, other) to support advanced septic system installations. This policy idea was voted on with minimal discussion; however, panelists emphasized that using funding to reduce the cost to the homeowner of an alternative system to be equal or somewhat less than a conventional system serves as a reliable incentive to promote the use of nitrogen-reducing technology.

While Charlestown, Rhode Island is currently implementing a pilot program (shorter term funding), the Town has worked consistently over many years to obtain multiple rounds of funding. The series of successful grant-funded programs could be seen as a form of long-term funding support.

Reservations

This topic was voted on without discussion.

After the Expert Panel's work concluded, the FB Environmental project team followed up with panelist Justin Jobin of Coastal Wastewaters Solutions to present the following example of longer term funding support for advanced septic systems in Long Island, New York counties.

Overview of Nitrogen-Reducing Septic System Grant Programs on Long Island

Both Nassau and Suffolk counties on Long Island have created advanced septic system grant programs by layering state and county incentives and greatly streamlining the grant payment process. In 2014, Suffolk County established the Reclaim Our Water (ROW) initiative, a science-based framework for replacing cesspools and conventional deep leaching structures with nitrogen-reducing systems. In 2017, Suffolk County launched their Septic Improvement Program (SIP) which initially utilized county funds to provide grants of up to $10,000 to incentivize homeowners to install nitrogen-reducing septic systems (SCDHS, 2017).

In 2018, The New York State Department of Environmental Conservation in cooperation with the New York State Environmental Facilities Corporation (EFC) established the New York State Septic System Replacement Program (SSRP) which established awards to participating counties to make grants of $10,000.00 available to qualified property owners looking to upgrade their septic systems.

The SSRP allocated $75 million to support a multi-year program that resulted in five (5) allocations of $15 million dollars. Over 70% of the first $15 million allocation, made in 2018, was awarded to Long Island. Suffolk County received $10 million, and Nassau County received $1 million. A second allocation of the same amount was made in 2021, and the third and fourth allocations were announced in April of 2022. As of August 31, 2022, Nassau County has been allocated $4 million in SSRP funds and Suffolk County has been allocated $30 million. Although the SSRP funding can be used to upgrade failing systems with conventional systems in other parts of New York State, Nassau and Suffolk decided to limit the use of the grant to nitrogen-reducing septic systems.

Once these State programs were in place, Suffolk County coupled county and state funding to better offset the increased cost of nitrogen-reducing systems. Suffolk County also used an Assignment of Payment (AOP) process which was modeled on the State of Maryland's program to allow the property owner to instruct the County to directly pay the contractor on the property owner's behalf. The AOP process allowed the program to function more as a guided program with step-by-step assistance from the County than a simple reimbursement program, which many potential applicants find burdensome. As of August 31, 2022, Suffolk County's SIP was in its fifth year with over 1,000 installations.

In addition, Suffolk County offers additional grants for low to moderate income applicants and when a pressurized shallow drainfield is required. This is important for New Hampshire to consider when designing any grant program, because low to moderate income homeowners face a disproportionate financial burden when replacing a septic system.

In 2021, after delegating the Nassau County Soil and Water Conservation District (District) as the administrative entity for the grant program, Nassau County launched the Septic Environmental Program to Improve Cleanliness (S.E.P.T.I.C.) which provides grant funding to eligible homeowners, not-for-profits, and small businesses to replace conventional septic systems and cesspools with a nitrogen-reducing system. The S.E.P.T.I.C. grant program models the Suffolk County program, combining state and county grants for up to $20,000 per tax parcel to eligible property owners (Nassau County, n.d.).

5.3.4 Allow Manufacturers to Fund Engineering Review of Advanced Technologies Using NHDES Selected Contractors

Summary: The Expert Panel agreed that manufacturer's funding of NHDES selected engineering review was a valid option to accelerate the approval process for new technologies that had not been approved elsewhere.

Expert Panel Votes: Endorsement (2), Agreement with Reservations (3)

This policy idea is intended to provide an option for manufacturers (or prospective users) of advanced treatment septic systems to accelerate the evaluation process by funding the engineering review required using contracted reviewers selected independently by NHDES. This proposal would likely apply to technologies that have not been approved in other jurisdictions, and thus complements the recommendation in Section 5.2.1. This point was voted on without much panel discussion.

5.4 Noteworthy Suggestions

The following ideas were discussed in detail by the panel and were met with general agreement but were not explicitly voted on due to time constraints. With additional time and effort by New Hampshire stakeholders, policy recommendations could be developed from these suggestions.

5.4.1 Utilize Undisturbed Native Soils and Upper Soil Horizons

Summary: The Expert Panel generally agreed that the upper layers of native, undisturbed soils usually offer excellent nutrient retention characteristics. When possible, these soil horizons should be used in septic system designs, especially in sandy or gravelly soils.

Panelists generally agreed that native topsoil and upper soil horizons with intact structure (e.g., not compacted, not smeared, not recently disturbed) typically offered valuable nutrient treatment capacities that, when possible, should be utilized for wastewater treatment. These upper soil layers are biologically active; therefore, plants and microbes can directly take up nutrients. Soils have structure including capillary pores—tiny voids created by the decomposition of organic matter over many decades—which cause wastewater effluent to diffuse horizontally rather than drain downward due to gravity. Horizontal diffusion effectively expands the treatment area, allows additional nutrient uptake and/or mineralization of phosphorus, and keeps effluent away from groundwater which is a conduit to surface waters. Previously excavated soils (fill) lose this structure (David Rocque, personal communication).

Panelists agreed that undisturbed native soils (except for scarification to prevent a hydraulic discontinuity) should be preserved, and that placing fill on top of intact native soils to create a mounded system was generally a valid approach. Using topsoil layers was seen as beneficial in all cases but is most important for sandy, gravelly, or shallow soils because upper soil layers are finer-textured and have higher nutrient retention capacities than deeper layers. Disposal fields with fine-textured soils have ion exchange capacity in all layers and usually require shallow installation of septic systems due to groundwater table depths or a hardpan. Utilizing native upper soil horizons (where site conditions allow) will tend to be inherently less expensive, less complex, lower maintenance, and therefore more reliable than mechanical and electrical technologies which could be installed in their place.

Currently, Subsurface Rule Env-Wq 1014.04 allows fill to be used to achieve adequate vertical separation distance. The Expert Panel discussed disallowing fill in this case and voted two "endorsement," two "agreement with reservations," and one "hold." Discussion centered around the seemingly inadequate two-foot separation distance mentioned in this rule, as well as the many possible soil types. Incentivizing (or requiring) the use of undisturbed native soils for wastewater treatment was generally agreed on.

5.4.2 Pressurized Shallow Drainfields

Summary: The Expert Panel repeatedly mentioned the benefits of pressurized shallow drainfields, which typically are installed downstream of nitrogen-reducing septic tank technologies. Their benefits include steady and even time-dosing of pre-treated wastewater; relatively compact and shallow installations which utilize upper soil horizons to provide additional nutrient removal; evenly spreading effluent across the disposal field; and ease of performance monitoring.

Pressurized Shallow Drainfields (PSDs) were mentioned repeatedly through Expert Panel meetings. PSDs were highly recommended by panelists and are required as part of advanced treatment systems in Charlestown, Rhode Island. In Suffolk County, New York, they are eligible for additional funding incentives and are usually used in conjunction with a nitrogen-reducing system.

There are several advantages to PSDs. First, low pressure pumps tend to distribute effluent more evenly and reliably across the entire disposal field compared to conventional systems. Pumps are timed to feed pre-treated wastewater to the drainfield evenly throughout the day, rather than in pulses based on homeowner water use. Both these factors maximize the treatment efficiency and service life of the drainfield. PSDs are also capable of recording pump on/off times, which allows effluent volumes to be accurately calculated. Nutrient concentrations in the effluent can also be sampled, thus nutrient loads to the environment and system performance can be calculated. Since PSDs are located within the upper soil horizons, they take advantage of several mechanisms to treat nutrients, including nutrient uptake by plants and microbes and horizontal dispersion of wastewater through capillary pores in undisturbed soil which effectively expands the treatment area. PSDs also tend to maximize vertical separation from groundwater. Finer-textured topsoil layers tend to have higher levels of iron, aluminum, and calcium than deeper horizons, meaning they are more well-suited for nutrient removal (including phosphorus) than coarser parent material (RIDEM, 2013). Panelists cited an additional 30% nitrogen removal from PSDs (though published research shows a wide range of additional nutrient removal, see this project's literature review). Finally, while mounded systems and PSDs both utilize native topsoil and upper soil horizons to maximize nutrient reduction, PSDs are less vulnerable to damage from moving flood waters (e.g., storm surge, river flooding) because they are flush to the ground, whereas mounded systems are more prone to being washed away.

Research supports pairing PSDs with septic system nitrogen treatment technologies. These advanced treatment units often oxidize most of the dissolved organic carbon (DOC) before final dispersal to the disposal field, meaning there may be less denitrification in the disposal field as DOC is an important ingredient for denitrification (Cooper et al., 2016), and the formation of the biomat may be slowed or absent (Gill et al., 2009). The biomat is a layer directly under the disposal pipes containing anaerobic microbes and suspended particles from the wastewater. Typically, the biomat plays an integral role in evenly spreading effluent across the disposal field and increasing residence time in the unsaturated zone (Beach et al., 2005). The biomat is less likely to form with nitrogen-reducing septic systems because they also treat biological oxygen demand (BOD) and remove total suspended solids (TSS), which are important factors influencing the development of the biomat (Beal et al., 2005). Therefore, the ability of the PSD to spread effluent evenly across the disposal field is critical for these systems, especially if biomat formation is slowed or absent altogether.

Some studies have examined additional nitrogen removal occurring within PSDs. One study suggests that typically 33–73% of nitrogen may be removed in a PSD beyond the nitrogen already removed by an advanced septic system (Holden et al., 2004). The authors attribute the robust nitrogen removal primarily to denitrification, and evidence suggests that autotrophic denitrification and anammox processes may be active in PSDs in the absence of DOC (Cooper et al., 2016). Conversely, another study found only 4.8% nitrogen removal in a PSD beyond what had already been removed by an advanced system, though cumulative nitrogen removal from the entire system outperformed that of a conventional septic system (Cooper et al., 2015). Enhanced nitrogen removal observed in PSDs may depend on soil characteristics. In a study of eight PSDs and eleven conventional systems installed in sandy, well-drained soil, Bunnell et al. (1999) found no significant differences in nitrogen removal between the two technologies. While the authors acknowledge that other studies have observed enhanced nitrogen removal in PSDs, they discuss that PSDs are likely most efficient in areas with low permeability soil, high or seasonally perched water table, or shallow bedrock, and may not be as applicable for nitrogen removal in more well-drained areas when not used in conjunction with a nitrogen-reducing technology (Bunnell et al., 1999).

PSDs may also provide enhanced phosphorus removal by utilizing upper soil horizons which often contain more iron, aluminum, and calcium than deeper soil horizons. However, this may not always be the case. For example, Cooper et al. (2015) found no differences between phosphorus removal in PSDs and conventional systems because the low pH and high amounts of iron and aluminum oxides in the disposal areas led to near-complete phosphorus retention in all test systems. Alternatively, if an advanced nitrogen-reducing technology is used, PSDs may promote more robust phosphorus retention in the absence of a biomat by evenly spreading effluent across the disposal field, since the absence of the biomat (common in nitrogen-reducing systems) may otherwise contribute to lower phosphorus retention (Gill et al., 2009). In coarse-textured, highly permeable soils such as sand and gravel, pressure-dosing (used in PSDs) may increase phosphorus retention compared to conventional systems. In a conventional system, effluent is likely to only percolate through the soil directly beneath the disposal pipes, with little spreading across the disposal field surface. By contrast, even in sands and gravels, pressure-dosing more evenly spreads the effluent across the full infiltrative surface, utilizing a greater soil volume in wastewater treatment (David Rocque, personal communication).

The Advisory Committee expressed concerns about the similarity between PSDs and pressure-dosed systems that were used in New Hampshire and Vermont in the 1980s. According to some committee members, the systems tended to fail after they were installed; however, these systems were likely a type of mounded sand filter which used the drainfield both for treatment and for final dispersal. There are a few key differences between PSDs and older mounded sand filters. The main difference is that PSDs are most commonly used for final effluent dispersal after pre-treatment (including nitrogen attenuation) in an advanced treatment unit. Pre-treatment considerably reduces the amount of TSS and BOD in the wastewater. Because these two qualities strongly influence the formation of a biomat and soil clogging, the system is less likely to fail because of clogging since the TSS and BOD are removed during pre-treatment. The pressure-dosed sand filter systems in the 1980s were likely not used in conjunction with advanced treatment units, meaning there were elevated levels of TSS and BOD that could lead to system failure as the biomat grew and eventually caused clogging. Moreover, detailed guidelines for PSD design and installation have been developed in recent years which provide well-established loading rates for PSDs given the soil characteristics and performance of the alternative septic system.

5.4.3 Make Nutrient Reduction a Factor in Site Evaluation and System Design

Summary: Some panelists noted that nutrient treatment was not a requirement or even a design factor in conventional septic systems in many jurisdictions (including New Hampshire and Maine). In many instances, conventional systems can be designed and sited to achieve greater nutrient treatment, especially for phosphorus, if the rules require it and design guidelines incorporate it.

Research indicates that one of the most promising approaches to reducing phosphorus pollution is comprehensive site assessments that optimize conventional septic system installations for phosphorus reduction rather than considering only sanitation-related factors (Stone Environmental, 2005). Other research found that long wastewater flow paths through unsaturated soils tend to result in extremely high phosphorus attenuation (Robertson et al., 2019). Therefore, placing a septic system further away from surface water (even when not otherwise required) would likely result in meaningful improvements to phosphorus retention. Reddish soil color can also indicate the presence of iron, which is involved in many processes that retain phosphorus. Other soil characteristics that would suggest more complete nutrient removal capabilities are a large vertical separation distance from groundwater and a finer soil texture. Although soils on a given lot (especially a small lot) can appear uniform, there are often small amounts of variability that can lead to some portions of the lot being more well suited for phosphorus removal than others.

A relatively simple change to the Design Rules would be to require Permitted Designers to include phosphorus removal as a factor when planning conventional septic systems in phosphorus sensitive areas, as all of the information needed for a qualitative assessment of phosphorus reduction potential is already collected during site evaluation. Including phosphorus treatment as a criterion for site evaluation and design can help identify if other nutrient reduction strategies are needed. Even though there are essentially no approved phosphorus reducing systems in any state, reduction strategies such as composting toilets or design options such as a mounded system or nitrogen-reducing inserts paired with pressurized shallow drainfields may be recommended.

Although choosing a specified amount or percentage for nutrient reduction as a criteria may be difficult, a semi-qualitative and semi-quantitative approach may be used, such as that in Table 2-19 from Stone Environmental (2005), which could be further expanded upon to include additional criteria for soil texture and vertical separation distance.

5.4.4 Change Terminology from "Disposal Field" to "Dispersal Field"

Summary: The Expert Panel briefly discussed the importance of word choice in promoting more accurate ways of thinking about septic systems among practitioners and the general public. Generally, words should be chosen which connotate wastewater recycling.

Using the term “disposal field” connotates that wastewater and any associated issues (including nutrient pollution) disappear as a homeowner or public concern. A panelist recommended changing the term to “dispersal field” which is more accurate and promotes the idea that wastewater flows through to the environment, thereby nudging people toward some concern for wastewater treatment. Panelists also recommended changing the terminology from “Individual Sewage Disposal System” (ISDS) to “On-site Wastewater Treatment System” (OWTS). Improving the language used to refer to septic systems to be more environmentally focused promotes stewardship of water resources; emphasizing that the purpose of a septic system is to treat wastewater rather than dispose of it helps to redefine how people view their septic system.

5.5 Item for Further Research

5.5.1 How to Measure Septic System Performance

Summary: The Expert Panel discussed and was polled on the best approach to monitoring septic system performance. Calculating nutrient loads from real-world septic systems was overwhelmingly preferred. Note also that a well-developed, data-based septic system technology testing protocol was developed in 2016 when EPA worked with all five New England states and Long Island towards a regional data sharing agreement.

There are several ways to measure septic system performance regarding nutrient attenuation. Which methods are used can be the basis for approving or rejecting a septic system technology or determining that a specific system is performing adequately, underperforming, or failing. Some approaches to quantifying nutrient reduction are:

- Nutrient concentration of effluent leaving the system (or system component). A threshold used in many states for advanced nitrogen treatment is 19 mg/L of nitrogen.
- Percent reduction of nutrients. For example, a septic system technology is found to reduce nitrogen by 50% (or other percentage). Wastewater effluent flowing out of the system has half the nitrogen concentration as wastewater flowing in.
- Modeled nutrient reduction for a given technology. For example, System X has undergone a testing program and was found to provide a given percent reduction or maintain a concentration below a given threshold. Therefore, all future installations of System X’s are assumed to meet that performance level.
- Monitored nutrient loads. In this case, samples are taken from each installed system (e.g., bi-annually or quarterly), and the samples show the real-world performance of that specific system.

The Expert Panel discussed the topic of which criteria to use to measure septic system performance and was then polled prior to its second meeting. The most votes (80% in favor) went to monitoring nutrient loads from real-world septic systems.

Significant efforts have been made to establish regional septic system performance data sharing over the past 10 years. In 2015, EPA supported Delaware, Maryland, Pennsylvania, Virginia, and West Virginia in signing a Memorandum of Cooperation to share performance data from nitrogen-reducing septic systems. They developed standard protocols for provisional and final field testing of nitrogen-reducing pretreatment units, without superseding any state laws or rules on septic systems. In 2016, EPA pursued a similar sharing agreement in New England and Long Island, and all five states plus Long Island participated. A statistical analysis of Massachusetts real-world advanced septic system performance data was conducted to determine a minimum testing regime. Furthermore, a Test Plan Application Template was developed, which provided a detailed standard procedure to evaluate new technologies. No memorandum of cooperation has yet been approved, though two Long Island counties have adopted the data sharing recommendations. See Section 5.2.1 for more details about the data sharing project.

5.5.2 Responsible Management Entity (RME) for System Maintenance (and Insurance)

Summary: Several panelists noted that the Responsible Management Entity (RME) approach was being used in other states to ensure septic systems were professionally inspected and maintained. They recommended New Hampshire study RMEs as an option.

A Responsible Management Entity (RME) is an organization which provides septic system maintenance, and in some cases replacement, to homeowners for a recurring fee. The main advantage of an RME is professional management of onsite wastewater systems which takes the burden (and potential for neglect) off the shoulders of individual homeowners. An RME's management of many individual septic systems makes onsite wastewater management more like a utility. Resources are thus strategically allocated to provide the greatest benefit to the community as a whole. An additional advantage (when implemented) occurs when RME fees also cover replacement or repair of septic systems when needed. In this case, the RME also functions as septic system insurance. RMEs were discussed favorably by the panel but not voted on.

The panel was not aware of RMEs in use within New England at present; however, several panelists noted that the Town of Charlestown, Rhode Island essentially functions as an RME in that the municipality maintains a robust inventory and inspection program of every system within its municipal borders and has received grant funding to partially fund replacement of the highest priority systems (typically the worst performing in the most pollution sensitive areas). MASSTC recently published a detailed article on RMEs and is the designated RME for Barnstable County, Massachusetts (though apparently not yet fully implemented).

EPA published detailed guidance on RMEs in 2015 (see Appendix A in the linked document) in which they describe five different management models. Some forms of RMEs require supporting or enabling state statutes, and some benefit from EPA or USDA funding. Participation in an RME may be mandatory or optional. EPA describes two different models which specifically address establishing and operating an

RME for septic systems. These two models are reserved for septic system management in environmentally sensitive areas. The first model is called "The Responsible Management Entity (RME) Operation and Maintenance Model" in which the operating permit for the septic system is issued to the RME. The second model is called "The Responsible Management Entity (RME) Ownership Model" in which the RME owns, maintains, and manages the septic system instead of the property owner. The EPA emphasizes that a regulatory structure similar to a public utility may be necessary for the ownership model because of a lack of competition for the RME. The following is a summary of Appendix A of the EPA's "Volunteer National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems" in which these two management models are described (EPA, 2003).

5.5.2.1 RME Operation and Maintenance Model

"RME Operation and Maintenance Model" details the responsibilities of the RME compared to those of the regulatory authority and the homeowner in this framework. In this circumstance, the RME would have a role in:

- Public education and participation
- Planning
- Performance
- Training and certification / licensing
- Operation & maintenance
- Residuals management
- Compliance inspections / monitoring
- Corrective actions
- Record keeping, inventory, & reporting
- Financial assistance & funding

In terms of **public education and participation**, the RME is responsible for educating property owners on how to care for and use their septic system. They would also inform property owners on requirements set forth by the RME (such as fee schedules or other prerequisites for participation in the RME).

Planning involves the development of criteria for acceptance into the RME. For example, the RME can require a certain type of septic system design for the property owners they serve, or at a minimum require the proper site evaluations and design documentation. This is similar to how the MASSTC services solely I/A systems as part of the RME. The RME must also consider future demand for operations and maintenance. For example, the entity must be aware of property owners' interest in joining the RME and which I/A technologies are most popular in the area.

In terms of **performance,** the RME is responsible for complying with performance criteria for each system. For example, the RME must ensure that each septic system meets public health requirements set forth by each jurisdiction. Should a jurisdiction define system failure to include inadequate treatment of nutrients or establish criteria for the nutrient reduction efficiency of I/A systems, the RME would be responsible for meeting those performance criteria as well.

Training and certification / licensing are integral to the validity and reliability of an RME. The entity must ensure that its staff have the appropriate certifications and licenses to work with septic systems. It must also ensure its staff receive additional training required by the state, especially if specialized knowledge is necessary for certain types of septic systems. If the RME contracts others to perform work on a septic system, it must ensure that it chooses contractors who have the appropriate certifications / licenses.

The RME's main responsibility under this management model is the **operation and maintenance** of septic systems. The RME must operate and maintain the system following the guidelines of the operating permit. This includes **residuals management** and **compliance inspections / monitoring**. The framework provided by the EPA states that the RME is responsible for hiring licensed septic system pumpers, haulers, and inspectors to meet requirements set forth by the respective jurisdiction. After any maintenance or inspection is performed, the RME must submit the proper compliance reports to the regulatory authority.

If violations occur, the RME is not responsible for **corrective actions** to fix the violation, according to the EPA's framework. However, the RME is responsible for negotiating and meeting compliance schedules set forth by the state. If an RME were to be established in New Hampshire, the RME could choose whether or not to be responsible for providing corrective services.

The RME has important administrative responsibilities such as **record keeping, inventory, and reporting** and helping with **financial assistance & funding**. Beyond managing its employees or contractors and working with property owners, the RME must keep records of all services provided, as well as create an inventory of all permit information. Maintaining an inventory of all septic systems serviced by the RME is important public knowledge that should be shared with the state or other jurisdictions. The RME can also be a bridge between property owners and the regulatory authority to optimize permitting, funding applications, and other operations.

5.5.2.2 RME Ownership Model

EPA also describes the "RME Ownership" model, in which the RME takes on additional duties and responsibilities beyond operations and maintenance. In this framework, the RME would be the owner of each septic system it serves, rather than the property owner. In the EPA's model for RME ownership, the RME has the same responsibilities as the "Operations and Maintenance Model," with heightened responsibilities in:

- Planning
- Training and certification / licensing
- Site evaluation
- Design
- Construction
- Corrective actions

As the owner of the septic system rather than the property owner, **planning** takes on a larger importance, and it is the RME's responsibility to work with developers to ensure that subdivision plans meet RME requirements. The RME must also determine the most cost-effective form of wastewater treatment for a given area, whether it be installing sewer, a community system, or individual septic systems.

Through septic system ownership, this form of RME is similar to a utility, and is responsible for oversight of the full lifespan of a septic system, including **site evaluation**, **design**, and **construction**. The RME must hire or contract certified / licensed Permitted Designers and installers to ensure each septic system will adequately address public health and nutrient reduction concerns. It is the RME's responsibility to make sure each contractor has the proper **training, certification, and licensing** to be working with septic systems. Alongside this, the RME is also responsible for hiring the proper personnel to perform **corrective actions** if a violation were to occur.

With the additional responsibilities, the RME's administrative needs increase, and the RME must accurately maintain permits, files, designs, and records of maintenance. Having an inventory of systems as well as their designs and site evaluations provides an increased amount of knowledge for all stakeholders. For example, this type of inventory can map the distribution of various types of septic systems throughout an area and can provide site-specific soils information that is typically difficult to access or nonexistent. Soil characteristics such as texture, structure, color, and vertical separation distance are all essential factors that help determine septic system nutrient loading to groundwater and surface waters.

5.5.2.3 RME Case Studies

Many jurisdictions utilize RMEs in areas where environmental protection is a priority. These communities have largely seen great success on a variety of scales. The following examples of RMEs established in various jurisdictions are summarized from the EPA's "Case Studies of Individual and Clustered (Decentralized) Wastewater Management Programs." Most jurisdictions opt to use a hybrid of various approaches that is tailored to the level of oversight necessary for the community (EPA, 2012). Jurisdictions have adopted a range of management models, incorporating various levels of oversight.

Many jurisdictions utilize RMEs in areas where environmental protection is a priority. These communities have largely seen great success on a variety of scales. The Otter Tail County Water Management District near Otter Tail Lake in Minnesota formed an RME, assuming responsibility for 1,640 septic systems in the district. They became responsible for planning, design, construction, operation, and maintenance of these systems. They enforce semi-annual inspections, with different standards for seasonally used homes than year-round homes. Groundwater and surface water monitoring is also part of their program. Their efforts to manage septic systems have led to tangible improvements in water quality, such as decreasing nitrogen and phosphorus levels and increasing water clarity.

Peña Blanca, New Mexico achieved similar improvements to groundwater quality by establishing an RME. The Peña Blanca Water and Sanitation District is responsible for meeting operations and maintenance requirements, semi-annual pumping, and maintaining records of each system under their jurisdiction. Naturally, this created an inventory of all septic systems. A key takeaway from Peña Blanca is that the program costs less than half of the estimated cost of a sewer system for the area. Residents pay a monthly fee of $9-20.

On a very small scale of about 71 systems, Shannon City, Iowa established an RME that owns, designs, and maintains septic systems within the town. In order for a property owner to build a home, they must sign an easement that allows the RME to own, construct, and operate their septic system. The operations and maintenance fee is $18 per month here.

Most RMEs, such as the case studies above, take advantage of federal funding opportunities through the EPA or USDA to help upgrade existing systems to nutrient-reducing technologies. They also often require easements from property owners so that the RME can access their property to install, inspect, or maintain their septic system. Areas that form RMEs through a regional water district or municipality are able to do so based on state statute. RMEs also work closely with septic regulations because regulatory authorities create installation, design, operations, and maintenance guidelines that RMEs help property owners attain.

5.5.3 Soil Color as Proxy for Soil Minerals and Nutrient Retention Capacity

Summary: Certain unsaturated native soil horizons can provide significant phosphorus retention without the need for advanced technology; however, there is no consideration of this within the Design Rules. One option would be to use soil color analysis to identify these soils and develop a way to incorporate phosphorus reduction requirements in the Design Rules.

Expert Panel Votes: Endorsement (4), Agreement with Reservations (1)

While the Expert Panel voted in agreement with this concept, the proposal as drafted by the project team contained multiple parts and did not articulate a well-defined policy option. For this reason, despite general agreement by the panel, it is presented as an item for further research.

Certain soil minerals (including iron and aluminum) are associated with high levels of phosphorus retention. Lab analyses that determine the breakdown of the soil mineralogy can be time and resource intensive, yet simply analyzing the color of the soil may provide an indication of what minerals are present. Generally, soil horizons that are red or orange in color indicate that the soil is high in iron (Singer & Munns, 2006). In particular, soils with a Munsell color of 7.5YR or redder are well-suited for phosphorus removal (Stone Environmental, 2005). Munsell color is information already collected for each soil horizon during a standard soil evaluation.

The Design Rules may be revised to explicitly incorporate this fact for the purpose of enhancing soil evaluation and septic system design for phosphorus retention where appropriate (see Section 5.2.4, Map Nutrient Sensitive Areas).

The Expert Panel did not recommend a specific method of incorporating soil color into the rules, though Table 2-19 from Stone Environmental (2005) provides an example scoring system for assessing the potential for phosphorus retention in a septic drainfield based on soil characteristics such as color. The semi-qualitative approach assigns a score for each soil horizon and assigns a weight to each one based on the total depth of the horizon. In their framework, the scoring system would help identify whether the native soil would provide enough phosphorus removal or if other nutrient reduction measures are necessary.

NHDES could adopt a similar scoring systems within nutrient senstive areas to determine whether adequate phosphorus reductions will occur throughout the disposal area, while nitrogen reductions can be accomplished through nitrogen-specific septic system technologies, if necessary. Designing a scoring system for New Hampshire would involve determining which soil characteristics and colors indicate that a soil horizon may have heightened retention capacity.

Reservations

David Rocque provided the following written comment:

> "I have some reservations about this recommendation because of soil testing done by URI Soil Science Professor, Mark Stolts. He was a member of the New England Hydric Soils Technical Committee. Mark collected soil samples from some very red B horizons

in Maine that had very little iron in them. The red color was due to organic matter content. Some of these horizons probably do have elevated aluminum in them which will also tie up P (especially if the soil is or was a spodosol)…. This is usually the "B" horizon in most soils which is also quite biologically active with plant roots to take up nutrients."

David Rocque, panelist and Maine State Soil Scientist (retired)

Figure 7. Reddish soil colors are associated with weathered soils that are high in iron. Photo Credit: NRCS-USDA.

Figure 8. Screenshots of experimental Layered Soil Treatment Area septic system installations in Charlestown, Rhode Island. Four systems are being installed under an EPA Southeast New England (SNEP) funded pilot project. This is a non-proprietary system with design features allowing easy performance monitoring and inspection. A. standard septic tank b. effluent sample collection to measure nitrogen concentration; c. excavation for disposal field showing pan lysimeters which facilitate monitoring; d. pressurized shallow drainfield (PSD). Source: Video by the Town of Charlestown, available at https://www.youtube.com/watch?v=KJ6oGT1VaU8.

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Appendix A: Expert Panelists

Marcel Belaval, Deputy Director of the United States Geological Survey, New England Water Science Center, New Hampshire Licensed Professional Geologist

Marcel has extensive experience in geology and hydrology as it relates to septic system impacts, particularly in coastal neighborhoods. Marcel worked for the Environmental Protection Agency Region 1 as an environmental scientist then hydrologist for eighteen years before becoming the Deputy Director of the New England Water Science Center at the United States Geological Survey. His work focuses on contaminant hydrogeology, surface water and groundwater interaction, and watershed nutrient management.

Alissa Cox, Director, University of Rhode Island New England Onsite Wastewater Training Program

Alissa earned her PhD at University of Rhode Island's (URI) Laboratory of Soil Ecology and Microbiology, and in addition to her position with the New England Onsite Wastewater Training Program, she is the Program Director at URI's Coastal Institute and a Clinical Assistant Professor in the Natural Resources Science department. Alissa's research focuses on understanding coastal groundwater dynamics to assess how they may impact current and future onsite wastewater treatment systems as well as the effect climate change has on these dynamics. She currently serves as the coordinator of the USDA Hatch Multi-state Research Project NE2045 related to onsite wastewater treatment and climate change.

Matthew Dowling, Onsite Wastewater Manager, Town of Charlestown, Rhode Island

Matthew has over 23 years of experience in onsite wastewater systems and watershed management. Under Charlestown Municipal Code, he currently oversees the individual management of over 5,000 OWTS (including over 600 nitrogen-reducing OWTS), many of which are within Rhode Island designated Salt Pond Watersheds. The municipal program he oversees includes regularly scheduled inspections of every OWTS within its borders and has removed 99% of cesspools. He develops policies, meta-analyses, datasets, publications, and maps that quantify nutrient impacts to the watershed. Under Matthew's direction, Charlestown's Onsite Wastewater Program has obtained four major Federal and State assistance awards since 2017 to install and evaluate advanced nitrogen-reducing OWTS, including an ongoing 5 year pilot project funded by EPA's Southeast New England Program (SNEP), all of which have been managed by municipal staff.

Michelle Jenkins, Information Officer, New England Interstate Water Pollution Control Commission

Michelle coordinates the Massachusetts Certification and Renewal Programs for Wastewater Treatment Plant Operators and Title 5 System Inspectors and Soil Evaluators on behalf of the Massachusetts Department of Environmental Protection. In addition, she is a member of the Yankee Onsite Wastewater Association's Board, the Massachusetts Onsite Advisory Committee, the New York State Wastewater Operator Certification Governance Council, the steering committee of the New England Onsite Wastewater Training Program at the University of Rhode Island and participates in the US EPA MOU Partnership for Decentralized Wastewater Management. Moreover, Michelle leads an Onsite Wastewater workgroup, bringing together regulators from New England and New York along with US EPA Region 1 representatives.

Justin Jobin, Environmental Scientist, Coastal Wastewater Solutions, LLC

Justin is an environmental scientist with over two decades of decentralized wastewater experience which started at the New England Onsite Wastewater Training Program at the University of Rhode Island, where he co-authored many publications and assisted in industry training. He also served 15 years as the Wastewater Management Specialist and GIS Coordinator for the Town of Jamestown, RI where he implemented and ran the town's Wastewater Management District and used GIS analysis to inform science-based regulations to address the cumulative impact of nonpoint source pollution in environmentally sensitive areas. Mr. Jobin recently served over six years as the Environmental Projects Coordinator for the Suffolk County NY, Department of Health Services and currently serves as the Wastewater Management Consultant for Nassau County's Soil and Water Conservation District where he continues to address the region's nitrogen pollution crisis by advancing several key elements of the Long Island Nitrogen Action Plan (LINAP), including his work as a lead architect and project manager of the nitrogen-reducing septic system grant programs on Long Island, which have received over $60M in Federal, State, and County Funding to date.

David Rocque, Maine State Soil Scientist (Retired)

David retired from Maine State Government in 2021 after 33 years of being the State Soil Scientist. Prior to that position, David was the State Site Evaluator, a position under which he was responsible for licensing Site Evaluators in Maine and performing field check of their work. David was also responsible for evaluating any proposed products to be used in septic systems in Maine. In his position as State Soil Scientist, David was intimately involved with the State Subsurface Wastewater Disposal Program and helped write a number of sections in the Maine Subsurface Wastewater Disposal Rules including the drainage key. David also provided invaluable technical assistance when sought (he was the lead investigator on why peat disposal systems were failing at an unusually high rate). David began a training program in 1987 for site evaluators, contractors, and local plumbing inspectors and continues those training workshops though retired from the State Government. David has been a member of the Maine Association of Site Evaluators since it was formed, also serving on the Technical Review Committee which is charged with providing professional advice to the State Septic System Program when changes are proposed to the rules or new products are proposed. David has been a licensed Site Evaluator since 1977. David developed guidelines for the disposal of wastewater from agricultural operations, including slaughterhouses, and continues to assist the Maine Department of Agriculture with the design of such systems. David has a BS in Forest Management and Minor in Soils from the University of Maine.

Appendix B: Maine Soil Key

KEY FOR DETERMINING DEPTH TO SEASONAL GROUNDWATER TABLE – STATE OF MAINE

In a field area or a forest area with an A or Ap horizon:

If the A or Ap horizon is not dark (value more than 3 and/or chroma more than 2, moist) and is any thickness, measure the depth to where 2% or more redoximorphic features are first encountered or to the top of a subsoil horizon with 2 or more colors in a streaked pattern or with differential organic matter accumulation to determine depth to seasonal groundwater table. If the A or Ap horizon of any thickness is dark (value 3 or less and chroma 2 or less, moist), measure the depth to where you first encounter 2% or more redoximorphic features or oxidized rhizospheres in it for the depth to seasonal groundwater table. If there are no redoximorphic features or oxidized rhizospheres in the A or Ap horizon, look at the horizon that immediately underlies it. The soil is Drainage Condition E (poorly drained with a groundwater table within or at the top of the A or Ap), if the upper part of the horizon immediately below the dark A or Ap horizon (for design purposes, the SWT is assumed to be at the top of the A or Ap, unless monitoring data is available that proves otherwise):

a. has 2% or more of any kind of redoximorphic features if the soil is loamy very fine sand or coarser or redox depletions or a reduced or depleted matrix for soils that are loamy very fine sand or finer; or
b. has 2 or more colors in a streaked pattern or with differential organic matter accumulation where one or more of the colors is dark (value of 3 or less and chroma 2 or less, moist); or
c. has an E horizon with 2% or more redoximorphic features or organic streaking overlying a *2” thick or thicker dark (value 3 or less and chroma 2 or less, moist) Bh or Bhs horizon that is continuous (unless altered by tree throw or human activity); or
d. has a 2” thick or thicker* dark (value 3 or less and chroma 2 or less, moist) Bh or Bhs horizon that is continuous (unless altered by tree throw or human activity)

If the A or Ap horizon is dark (value of 3 or less and chroma 2 or less, moist) and the horizon immediately underlying it does not meet a-d above, measure the depth to where you first encounter 2% or more redoximorphic features or to the top of a subsoil horizon with 2 or more colors in a streaked pattern or with differential organic matter accumulation to determine depth to seasonal groundwater table.

In a forested area where there is no A or Ap horizon:

The soil is Drainage Condition E (poorly drained) if the upper part of the first mineral soil horizon immediately below the organic duff layer:

- has 2% or more redoximorphic features or organic streaking in the E horizon which is immediately underlain by a 2” thick or thicker* dark (value 3 or less and chroma 2 or less, moist) Bh or Bhs horizon that is continuous (unless altered by tree throw or human activity); or
- has a two or more colors in a streaked pattern or with differential organic matter accumulation where one or more of the colors is dark (value 3 or less and chroma 2 or less, moist

If the soil does not meet a or b above, measure the depth to where you encounter 2% or more redoximorphic features or to the top of a horizon with two or more colors in a streaked pattern or with differential organic matter accumulation to determine depth to seasonal groundwater table.

* A 2-inch thick or thicker Bh or Bhs horizon can form under thick organic accumulations due to cold temperatures (not wetness) such as in higher elevations, in the northern part of the state or downeast coastal areas. These indicators should only be used when the organic accumulation and the thick Bh or Bhs horizon development is due to wetness. [Source: 10-144 CMR 241, Section 4, p 35]

Appendix C: Tables of Approved System Types in Selected Jurisdictions

Table 4: Systems approved in at least one of the three selected jurisdictions. NHDES should cross-reference this list with their internal list of approved systems in New Hampshire because some companies / technologies have changed names since they were approved, and specific design flows or models are not mentioned on the New Hampshire Approval List for certain technologies.

Company	System	Model	Approval States	Certified in NH*
Aquapoint.3 LLC	Bioclere	16, 24, 30, 36 Series	MA, RI	X
Bio-Microbics, Inc.	HighStrengthFAST	1.0, 1.5, 3.0, 4.5, 9.0	MA	
Bio-Microbics, Inc.	MicroFAST	3.0, 4.5, 9.0	MA	X
Bio-Microbics, Inc.	NitriFAST	0.5, 0.75, 1.0, 1.5, 3.0, 4.5, 9.0	MA	
Bio-Microbics, Inc.	MicroFAST	1.5	MA	X
Bio-Microbics, Inc.	MicroFAST	0.5, 0.75, 0.9	MA, RI	X
Bio-Microbics, Inc.	BioBarrier	0.5N, 1.0N, 1.5N	RI	
Bio-Microbics, Inc.	MicroFAST	0.625	RI	X
Bio-Microbics/ SeptiTech	SeptiTech Treatment Systems	M400N, M550N, M1200N, M1500N, M2500N, M3000N	MA	X
Bio-Microbics/ SeptiTech	Smart Trickling Anaerobic/Aerobic Recirculating (STAAR) Media Filter	0.5D, 0.75D, 1.0D, 1.2D, 1.5D, 3.0D, 4.5D, 6.0D, 9.0D, 13.5D, 18D, 24D	RI, NY	X
Center for Clean Water Technology	Nitrogen Reducing Biofilters (NRBs)		NY	
F.R. Mahony & Associates, Inc.	Amphidrome	All Design Flows	MA, RI	X
Fuji Clean USA, LLC	FujiClean	CEN5, CEN7, CEN10	MA, RI, NY	X
Hydro-Action	Hydro-Action	AN Series	NY	
Innovative RUCK Systems, Inc.	RUCK		MA	
KleanTu, LLC.	NitROE	2KS, 2KM	MA	
Norweco, Inc.	Singulair 960 DN	500	MA	X
Norweco, Inc.	Singulair 960 DN Green	600	MA	
Norweco, Inc.	Singulair 960 DN	500, 750, 1000, 1250, 1500	MA, RI	X
Norweco, Inc.	Singulair Green TNT	500, 600, 750, 1000, 1250, 1500	MA	X
Norweco, Inc.	Hydro-Kinetic	600 FEU	NY	X
Norweco, Inc.	Singulair TNT	500, 600, 750, 1000, 1250, 1500	MA, NY	X
Orenco Systems, Inc.	AdvanTex Treatment Systems	AX20-RT, AX25-RT	MA	X

Company	System	Model	Approval States	Certified in NH*
Orenco Systems, Inc.	AdvanTex Treatment Systems	AX 20, AX100	MA, RI, NY	X
Smith & Loveless, Inc.	Smith & Loveless Modular FAST	All Design Flows	MA	
Waterloo Biofilter System, Inc.	Waterloo Biofilter	All Design Flows	MA	

Table 5: Systems approved in at least two of the three jurisdictions. NHDES should cross-reference this list with their internal list of approved systems in New Hampshire because some companies / technologies have changed names since they were approved, and no specific design flows or models are mentioned on the New Hampshire Approval List.

Company	System	Model	Approval States	Certified in NH*
Aquapoint.3 LLC	Bioclere	16, 24, 30, 36 Series	MA, RI	X
Bio-Microbics, Inc.	MicroFAST	0.5, 0.75, 0.9	MA, RI	X
Bio-Microbics/ SeptiTech	Smart Trickling Anaerobic/Aerobic Recirculating (STAAR) Media Filter	0.5D, 0.75D, 1.0D, 1.2D, 1.5D, 3.0D, 4.5D, 6.0D, 9.0D, 13.5D, 18D, 24D	RI, NY	X
F.R. Mahony & Associates, Inc.	Amphidrome	All Design Flows	MA, RI	X
Fuji Clean USA, LLC	FujiClean	CEN5, CEN7, CEN10	MA, RI, NY	X
Norweco, Inc.	Singulair 960 DN	500, 750, 1000, 1250, 1500	MA, RI	X
Norweco, Inc.	Singulair TNT	500, 600, 750, 1000, 1250, 1500	MA, NY	X
Orenco Systems, Inc.	AdvanTex Treatment Systems	AX 20, AX100	MA, RI, NY	X

Appendix D: New England/Long Island Advanced Septic System Installations and Performance Data

Several sources of real-world advanced septic system performance data are available. While MASSTC does not publicly release National Sanitation Foundation testing data, they do maintain a publicly available database of monitoring data of installed systems.

Suffolk County, New York provided a review of available data from various states as part of the 2019 *Suffolk County Report on the Performance of Innovative and Alternative Onsite Wastewater Treatment Systems* (Jobin and Priolo, 2020). Technologies varied in performance across states, with many achieving nitrogen reductions below 19 mg/L in more than one state (Table 6). All five technologies that reduced total nitrogen levels below 19 mg/L during performance testing in two or more states are already approved for use in New Hampshire.

Data on nitrogen-reducing septic system performance is also available through the Massachusetts Alternative Septic System Testing Center (MAASTC) technologies page in the form of box plots presenting median total nitrogen values for each technology. Summary data was collated from the website and presented below to demonstrate real-world performance testing results for each system (Table 7). The percentage of systems that achieve nitrogen reduction below 19 mg/L is also included to display the possible variability in advanced septic system performance. Only technologies with 20 installed systems or greater were included in the chart.

Table 6. Summary of data from the 2019 Suffolk County Report on the Performance of Innovative and Alternative Onsite Wastewater Treatment Systems. Technologies were ordered based on the number of states where performance testing found a mean (New York, Massachusetts, Maryland) or median (Rhode Island, New Jersey) total nitrogen (TN) concentration of 19 mg/L or less for the given technology. Note that technologies are not necessarily approved in each state they were tested in.

Company	Technology	Number of States Tested	States where TN ≤19 mg/L	Approved in NH
Orenco Systems, Inc.	AdvanTex AX-20	4	NY, MD, RI	X
Bio-Microbics/SeptiTech	Smart Trickling Anaerobic/Aerobic Recirculating (STAAR) Media Filter	5	NY, NJ, RI	X
Fuji Clean USA, LLC	FujiClean CEN Series	2	NY, MD	X
F.R. Mahony & Associates	Amphidrome	3	NY, NJ	X
Bio-Microbics, Inc.	MicroFAST	4	NJ, RI	X
Adelante Consulting, Inc.	Pugo System	1	NY	
Premier Tech	EcoFlo Coco Filter + Denite	1	NY	
Bio-Microbics, Inc.	Bio-Barrier	2	NY	
Hydro-Action	Hydro-Action AN Series	2	NY	
Aquapoint.3 LLC	Bioclere	2	NJ	X
Orenco Systems, Inc.	AdvanTex RT	3	MD	X
Norweco, Inc.	Hydro-Kinetic	1		
Busse GmbH	BusseGT	1		X
AquaKlear Inc.	AquaKlear	1		
Premier Tech	EcoFlo Coco Filter	1		
Hoot Systems, LLC.	Hoot ANR	1		
Hoot Systems, LLC.	Hoot BNR	1		
Waterloo Biofilter	Waterloo Biofilter	2		
Norweco, Inc.	Singulair	3		X

Table 7. Summary of data from the Massachusetts Alternative Septic System Testing Center technologies page. Technologies were ordered based on "median of medians" total nitrogen concentration, where the median of the median value for each individual system was recorded.

Company	Technology	Median of Medians TN (mg/L)	Percent ≤19 mg/L	Number of Systems	Approved in NH
KleanTu, LLC.	NitROE	3.76	96.7 %	30	
Bio-Microbics/SeptiTech	Smart Trickling Anaerobic/Aerobic Recirculating (STAAR) Media Filter	8.85	91.4 %	245	X
F.R. Mahony & Associates	Amphidrome	12.84	69.2 %	26	X
Orenco Systems, Inc.	Advantex AX and AX-RT Series	14	72.6 %	168	X
Aquapoint.3, LLC.	Bioclere	15.04	70.9 %	151	
Bio-Microbics, Inc.	MicroFAST	21	42.8 %	425	X
Waterloo Biofilter System, Inc.	Waterloo Biofilter	22.85	42.9 %	28	
Hoot Systems	Hoot ANR and BNR	25.13	40 %	20	

The panelists chose not to comment on the performance of specific technologies. However, they suggested that a list of the systems most commonly used in other jurisdictions is likely a useful surrogate for how well-trusted a system may be in a given area. Information on the total number of advanced systems in each jurisdiction is available for Charlestown, Rhode Island (2023), Suffolk County, New York (2019), Nassau County, New York (2023), and Barnstable County, Massachusetts. In Charlestown, Rhode Island, AdvanTex by Orenco Systems, Inc. Is the most common system, making up nearly 67% of all innovative / alternative septic systems in the town. Fuji Clean is the most common technology in Suffolk County with 485 total systems (42%). Other popular technologies between the two jurisdictions are the Hydro-Action AN Series, Singulair by Norweco, Inc., and MicroFAST by Bio-Microbics, Inc. The most popular technology in Barnstable County is MicroFAST by BioMicrobics, Inc. / SeptiTECH, making up 55% of the systems installed in the area. A breakdown of the most common systems provided by the respective reports for each jurisdiction is included in Table 8.

Table 8. Summary of the six most commonly used advanced septic system technologies in selected jurisdictions with well-developed advanced and innovative septic (A/I) system management programs. Data is from the Town of Charlestown Onsite Wastewater Management Program 2023 Interim Summary (Dowling, 2023), the 2019 Suffolk County Report on the Performance of Innovative and Alternative Onsite Wastewater Treatment Systems (Jobin & Priolo, 2020), the 2023 Annual Report to NYS Environmental Facilities Corporation (NYS EFC) on Nassau County's S.E.P.T.I.C. Grant Program (Nassau County Soil and Water Conservation District and Jobin, 2023), and Barnstable County. Technologies already approved for use in New Hampshire are marked with an "X."

Technology	Number in Charlestown (2023)	Number in Suffolk County (2019)	Number in Nassau County (2023)	Number in Barnstable County (2023)	Total	% of total	Approved in NH
BioMicrobics, Inc. MicroFAST	109	0	0	2135	2244	37.6 %	X
Norweco, Inc. Singulair	104	220	6	419	749	12.6 %	X
Orenco Systems, Inc. AdvanTex AX20	577	33	0	6	616	10.3 %	X
BioMicrobics, Inc. / SeptiTech, Smart Trickling Anaerobic/Aerobic Recirculating (STAAR) Media Filter	6	48	1	494	549	9.2 %	X
FujiClean USA, LLC, FujiClean CEN Series	5	485	38	5	533	8.9 %	X
Hydro-Action, Hydro-Action AN Series	0	372	7	0	379	6.4 %	
Aquapoint.3, LLC, Bioclere	0	0	0	0	324	5.4 %	X