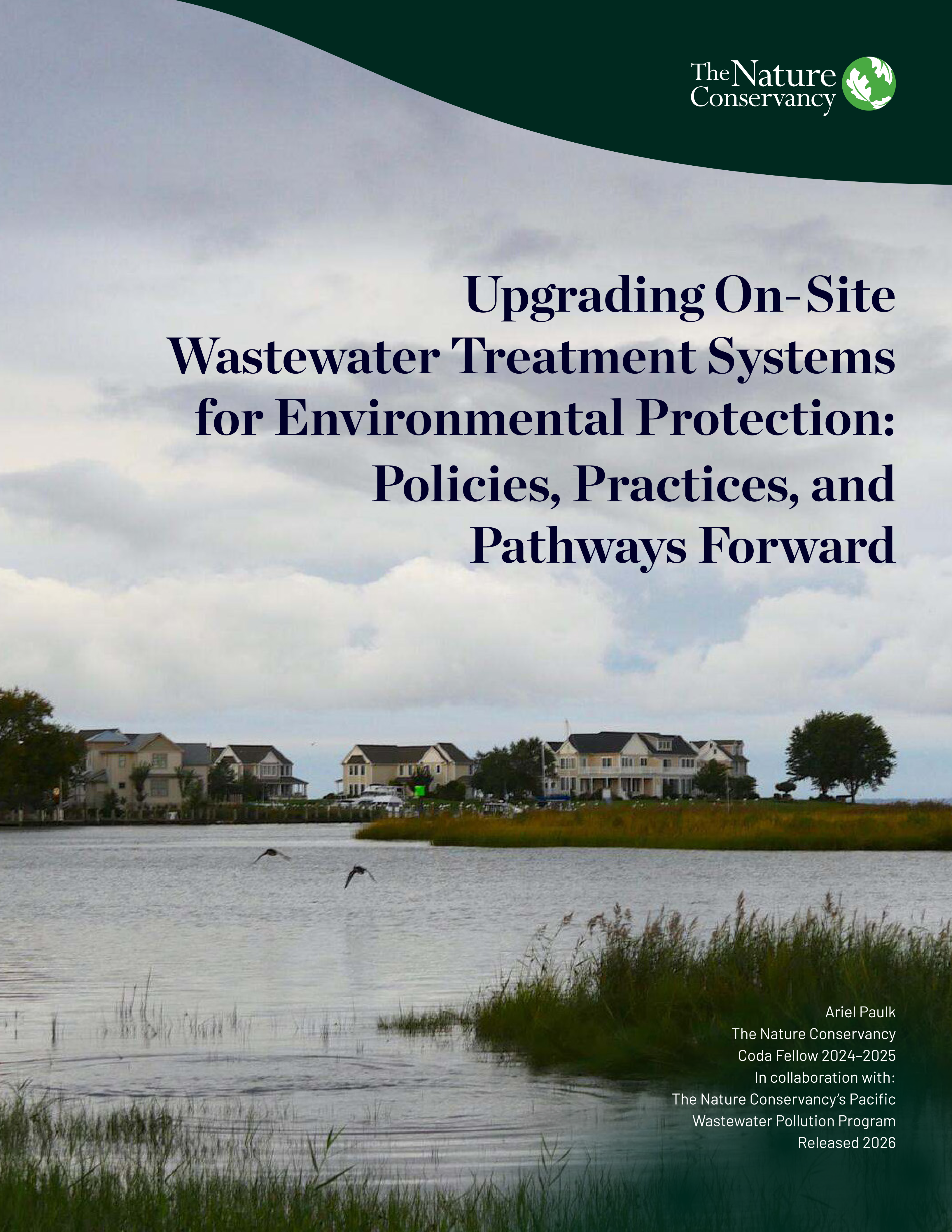

Upgrading On-Site Wastewater Treatment Systems for Environmental Protection: Policies, Practices, and Pathways Forward

Ariel Paulk
The Nature Conservancy
Coda Fellow 2024–2025
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SECTION I

Executive Summary

This report provides a comprehensive analysis of the environmental challenges associated with On-site Wastewater Treatment Systems (OWTS) due to inadequate nutrient removal, as well as potential solutions via policy and funding mechanisms in the United States. It aims to identify scalable, nature-based and community-supported solutions to reduce nutrient pollution and protect water quality, particularly in coastal and groundwater-dependent regions.

One in five U.S. households relies on OWTS, such as cesspools and septic systems, to manage wastewater.[1] Even when they are properly maintained, conventional OWTS systems have become antiquated, given modern demands and greater scientific understanding of wastewater management. These systems were not designed to remove harmful pollutants like nutrients, pathogens and pharmaceuticals—which consequently enter our groundwater and flow into our waterways. This issue is urgent, as climate change, sea-level rise and increasing coastal development further compromise OWTS performance, at the risk of both human and ecological health.

Addressing nutrient pollution through OWTS upgrades is an urgent environmental need, but also a policy opportunity. With the right mix of science, funding, communication and collaboration, communities can modernize wastewater infrastructure to better protect biodiversity and aquatic resources, while safeguarding public health and enhancing local economies.

To understand the feasibility of such policy and funding mechanisms within the United States, we interviewed nine individuals within The Nature Conservancy (TNC), as well as one external partner who has expertise in nature-based solutions (NbS) for wastewater treatment. Through these interviews, we explored the benefits and barriers of OWTS conversions and real-world applications of sustainable wastewater solutions.

Upgrading OWTS presents a unique opportunity to improve both environmental and human health, by:

- Innovating wastewater treatment through advanced and nature-based technologies.
- Enhancing environmental and public health by reducing nutrient pollution and improving conditions for aquatic recreation.
- Fostering collaboration among stakeholders, including governments, communities and conservation organizations.
- Creating green jobs and promoting community engagement in environmental stewardship.

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Salton sea algal bacterial bloom © Raindrift Wikimedia Commons CC BY-SA 3.0

Despite the benefits, several barriers hinder progress, particularly:

- High costs for homeowners and municipalities and limited access to funding.
- Fragmented regulations and lack of a universal federal septic code or centralized state requirements.
- Public skepticism and limited awareness of the environmental impacts of OWTS.
- Complex stakeholder coordination and logistical challenges during system upgrades.
- Insufficient policy support and technical capacity at the local and state government levels.

Policy remains a crucial area for improvement. Key barriers to improvement include:

- Lack of consistent regulatory frameworks across jurisdictions and local health department resistance to change.
- Unclear sequencing of implementation steps and funding mechanisms.
- Limited engineering expertise around incorporating green or gray infrastructure.
- Difficulty replicating successful models due to local variability in climate, infrastructure and governance.

TNC has demonstrated successes across the United States by forging strategic partnerships, investing in polling and other strategic communication strategies, working closely with local governments, and supporting innovative policy and NbS.

Case studies from New York, Hawai'i, Massachusetts and Arizona reveal that:

- Policy mandates, such as Hawai'i's cesspool ban, can drive large-scale change.
- Once the proper groundwork has been laid, ballot initiatives, like Proposition 2 in Suffolk County, New York, can unlock billions in funding.
- NbS, including innovative and alternative systems and wetland restoration, are effective but require tailored implementation.
- Community engagement and strategic communication are critical to building public and political support.

TNC's strategic recommendations are as follows:

- **Document the problem** by showing that current practice is ultimately harming drinking water and surrounding waterways.
- **Strengthen local coalitions** and build trust with key influencers within communities and counties.
- **Leverage diverse funding sources,** including state revolving funds and innovative financing models.
- **Advance NbS** or alternative advanced technologies tailored to local conditions that can filter nutrient pollution.
- **Develop strong communication strategies** to reach public officials and reporters.
- **Build internal capacity** for policy engagement and advocacy.
- Explore the Environmental Protection Agency's approach and regional models to **replicate and scale successful initiatives**.

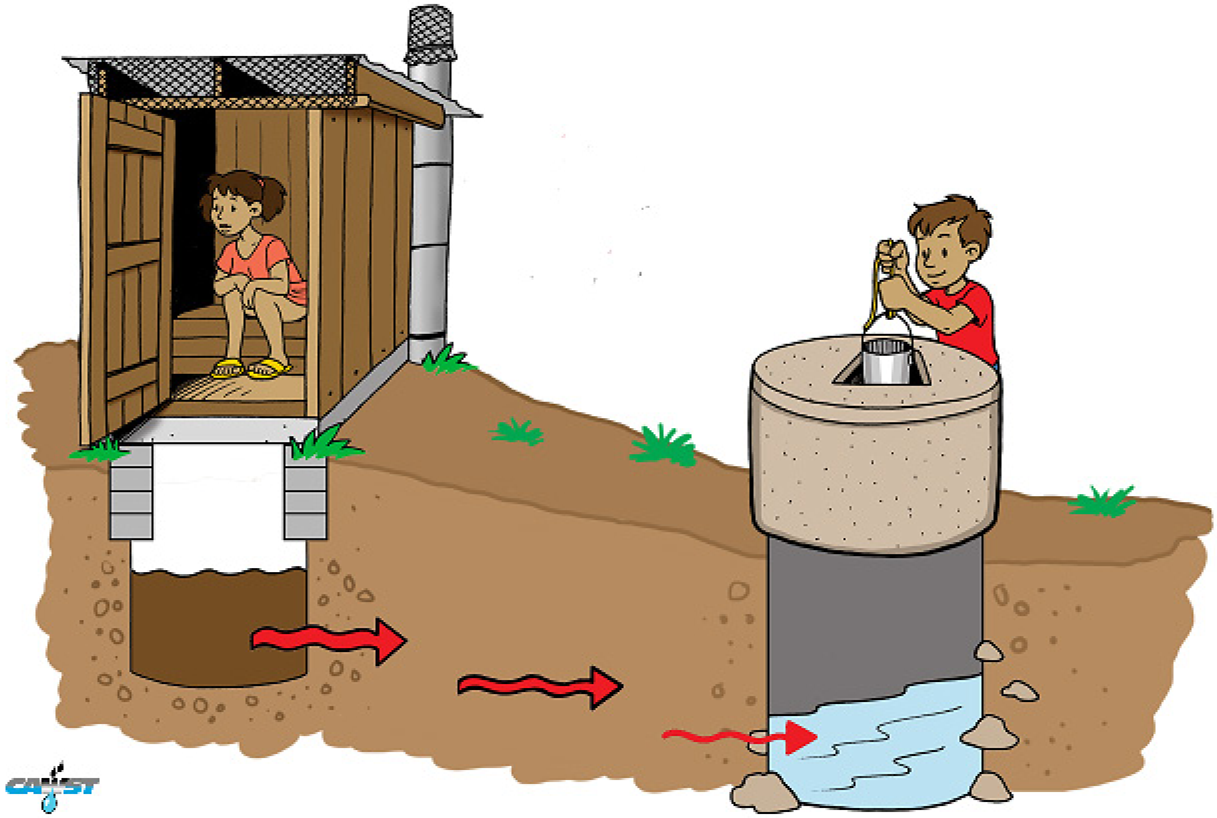
SECTION II

Introduction

On-site Wastewater Treatment Systems are defined as "multi-stage systems that collect, treat and disperse wastewater generated by a home or business."[2] Common types of OWTS include cesspools and septic systems. Cesspools are underground lined pits that collect wastewater, then disperse it back into the environment without treatment.[3] Septic systems typically consist of a septic tank that collects solids and a leach field that allows the wastewater to be naturally filtered by the surrounding soil.[4] When functioning properly, some OWTS, such as conventional septic systems, can effectively treat and remove pathogens and some chemicals from wastewater before the effluent reaches surrounding waterways. However, the performance of OWTS can be compromised by improper maintenance, poor siting, design limitations (e.g., conventional systems do not filter out nitrogen), natural disasters and proximity to other systems and water bodies.[5] These challenges have been exacerbated by climate change, particularly in coastal communities where increased storm events and sea-level rise lead to groundwater rise, saturating the soil treatment area under OWTS and ultimately reducing the systems' treatment effectiveness.[6]

Potential water quality and ecosystem health impacts can vary drastically from system to system, depending on the environmental conditions. In the United States, inadequate septic systems are failing to treat wastewater to safe levels, thereby allowing wastewater pollutants to spread through runoff and leach into groundwater. The decline in downstream water quality frequently coincides with the presence of poorly placed (hydrologically or geologically) OWTS, especially those near coastlines.[7] When wastewater is untreated or inadequately treated, it can contain pathogens, pharmaceuticals, microplastics, nutrients and heavy metals. These contaminants degrade the quality of drinking and surface water, posing significant health risks to humans, including risk of disease and infection from direct exposure to polluted waters or from consuming contaminated seafood.

Septic instal © royalty free



Groundwater Contamination Latin America © Sm CAWST Flickr CC BY 2.0

According to UNICEF, 1.4 million people die from inadequate water sanitation and hygiene each year.[8] In addition to these public health impacts, contaminants can travel from surface level to down-gradient waters, critically altering organisms' biological functions and disrupting ecological systems.[9,10,11,12,13] These pollutants are known to harm coral reefs, seagrass meadows, mangrove forests and salt marshes, as well as bivalve and finfish populations, with such impacts increasingly documented in recent years.[14] The inadequate treatment of wastewater by conventional OWTS can also be attributed to design—depending on the system type, nutrient removal can be minimal. (For example, OWTS can remove anywhere from 20% to 80% of total nitrogen.)[15,16] The extent of nutrient treatment can be affected by local precipitation trends and soil properties such as absorption, microbial activity and erodibility.[17] When these excess nutrients reach water bodies, they can cause harmful algal blooms and eutrophication, impacting aquatic biota and posing a public health hazard.[18]

There is an urgent need for policy to better address these ecosystem impacts and reflect today's environmental and demographic realities, including increasingly dense coastal populations and climate change. Globally, policy approaches vary. Some countries use command-and-control systems that regulate specific processes, while others, like the United States, focus more on outcomes, allowing for greater flexibility and innovation. TNC's Rob McDonald highlighted that countries like the United States are sometimes more open to market-based approaches, such as pollution trading and wetland banking, while regions in Europe tend to favor engineered solutions. In Africa, natural wetlands are sometimes used for primary treatment, which is often insufficient.

In the United States, state governments are the only form of government that have oversight on OWTS.[19] Through the Clean Water Act (CWA), states set water quality standards for each body of water within their jurisdiction, which can also help identify impaired areas where further pollution control is necessary.[20]

Each state has a different approach to setting their water quality standards, which has caused drastic disparities in water quality regulations and enforcement across the United States. Specifically in regard to septic systems, local health departments are often responsible for issuing and operating of permits while cooperating with state laws that oversee public health protection. [21] The differing septic codes between states, and even varying codes across a state's counties, have led to more untreated human waste pollution entering the environment.[22] For example, Michigan has no statewide septic code to standardize regulations for its more than 1.3 million septic systems.[23] There is also no clear anchor institution (like utility or city) to drive change; thus, it is critical that adequate, context-appropriate OWTS standards are enforced to protect waterways.

In addition, the responsibility for OWTS management typically falls on homeowners. It can cost $10,000 to $50,000 (or more) per property for a U.S. homeowner to upgrade from a cesspool to a septic system [24],and $5,000 to $20,000 (or more) to transition to an innovative/alternative (IA) septic system[25], which clearly shows the financial burden that comes with changing wastewater systems. There are also additional costs to properly maintain a septic system, such as regular pumping (typically every three to five years).[26] While cost-effective technologies do exist to help protect water quality, guidance around selecting an appropriate technology is sparse and highly context-dependent.

Through this report, we aim to:

- Synthesize case studies to identify replicable policy strategies and approaches that improve and protect coastal water quality from the impacts of OWTS.
- Identify and document instances where TNC and our partners have actively contributed to shaping policies reducing coastal pollutant loading from OWTS.
  Develop a roadmap to mobilize action. This will include key OWTS policy initiatives addressing new development near coastlines, conversions/ upgrades and funding support mechanisms (such as bonds and taxes), and areas that need improvement.

Grenada SoubiseShoreline © PinkReel

SECTION III

Benefits and Challenges

There are a number of benefits to OWTS upgrades and conversions, including protection of human health and nature, as well as challenges, as detailed below.

Benefits

A. Fewer excess nutrients entering the environment

When excess nitrogen, phosphorus and other nutrients enter the environment, they cause harmful algae growth and a reduction in oxygen levels, which leads to hypoxia.[27] Hypoxia can result in fish kills, eelgrass die-offs and the death of other aquatic organisms, ultimately damaging the health of the environment.[28] Repairing or upgrading failing OWTS helps prevent the excess nutrients from entering waterways, leading to fewer algae blooms and keeping other toxins from reaching drinking water that comes from wells.

B. Incentive to develop technological innovations

The environmental challenge of preventing excess nutrients from entering our waterways has catalyzed innovation within the wastewater sector, driving development of advanced technologies that not only remove nitrogen more effectively, but also prioritize ecological sustainability.

C. Job creation associated with NbS

Among the most promising approaches for wastewater treatment are nature-based solutions, which harness natural processes to filter wastewater. They offer a dual advantage: they mitigate pollution while creating green jobs and engaging folks in environmental stewardship. By working in harmony with nature, NbS can enhance the quality of life for both people and the ecosystems that surround them.[29] For example, treatment wetlands filter out nutrients through a variety of physical, chemical, and biological processes.[30] Another example is retired cranberry bogs that are being restored to functioning wetlands to provide wildlife habitat, water filtration and coastal resilience.[31]

Vertical Flow Constructed Wetland with Sludge Mineralisation © Florian Klingel and Pierre-Henri Dodane Flickr CC BY 2.0

Challenges

However, there are challenges to achieving OWTS upgrades and conversions. A primary difficulty is designing systems that can reliably reduce nitrogen levels to meet environmental standards established under the Clean Water Act, which aims to ensure that treated wastewater does not harm sensitive waterways.[32]

A. Ensuring public education and buy-in

The public needs access to financial incentives and information about upgrades. It is important to educate homeowners about how these upgrades will affect the costs, maintenance and functionality of their septic systems. In addition, explaining how the improvements will benefit not only their quality of life but that of the surrounding ecosystems and communities can increase buy-in.

B. Acquiring reliable and accessible funding streams

Securing adequate funding is also a major obstacle, as these projects often require substantial investment. To encourage broad adoption, it is vital to provide financial assistance through accessible and equitable programs and to establish a sustainable funding stream to subsidize these upgrades at scale. Without consistent financial support, it is difficult to maintain momentum and ensure that all homeowners have the resources needed to modernize their systems. In communities that have both centralized sewer systems and OWTS, there is a disparity between cost and maintenance burdens for homeowners with different treatment systems. Funding should equalize costs between homeowners with septic and sewer, recognizing that the benefits of improved wastewater treatment are communal rather than individual.[33]

C. Coordinating stakeholders

From a project planning and management perspective, it is difficult to coordinate efforts among a diverse group of stakeholders—including homeowners, contractors, environmental agencies and local municipalities—due to divergent goals and perspectives and limited capacity and time from all partners.

D. Navigating logistics and community disruptions

Physical disruptions, such as excavating private land or backyards for system installation or upgrades, may pose logistical hurdles and strain community relations.

E. Promoting policies that create an enabling environment

Lastly, supportive policy conditions are imperative to identifying OWTS-related pollution sources, prioritizing upgrades in the most vulnerable areas, establishing permitting codes that require adequate technology and creating sustainable funding sources for upgrades. Without strong policy backing and commitment, projects are less likely to receive the funding or regulatory support they need.

Senator Kings office OlympiaWA © Hannah Letinich

SECTION IV

Policy Barriers

There are a number of policy barriers that complicate the process of upgrading OWTS. Consequently, there is no clear action roadmap and efforts are often fragmented.

A. Lack of guidance on interventions and sequencing

One of the first questions policymakers face is whether to implement a legislative mandate requiring all systems to be upgraded by a certain date, or to take a more incremental approach by establishing pilot programs and offering funding opportunities. Each path has its own implications for feasibility, public acceptance and long-term success.

Another critical consideration is the sequencing of implementation steps. Should funding be publicized first to generate interest and demand, or should staff be hired in advance to ensure that there is adequate coverage to process applications and assist with upgrades? These logistical questions are closely tied to broader funding challenges. There is often ambiguity around who should bear the financial responsibility for OWTS upgrades—should it fall to individual homeowners, local or county governments, state agencies or even federal programs?

B. Lack of a universal septic code

A major structural issue is the lack of a universal septic code or the use of consistent federal regulations and standards across all septic systems, which complicates coordinated action across the United States. Regulations vary not only between states, but between cities within the same state in the case of Michigan, the only state without a statewide septic code. Efforts to pass a statewide code have repeatedly failed in Michigan due to political resistance and concerns about compliance burdens. Rich Bowman, director of external affairs for TNC's Michigan state chapter, suggests, however, that such codes are not always the most effective route. Although the other 49 states have statewide codes, many still struggle with water pollution linked to failing septic systems.[34]

The inconsistency in standards extends to water quality standards as well, which also vary across jurisdictions. Since states individually set water

River water sampling © iStock royalty free quality standards with the Environmental Protection Agency (EPA), each state, city and region has different parameters and measures that they must meet to remain in good standing for their water quality.[35] In the United States, this makes it especially difficult to pass a universal septic code, particularly if a state's water quality standards are already higher than the proposed universal code.

C. Lack of a streamlined permitting process

Another significant policy barrier to upgrading OWTS is the lack of a streamlined permitting process, which can include additional environmental reviews as part of the process. For example, in Tompkins County, New York, after a homeowner submits an OWTS construction permit application and fee, a site and soil investigation must be conducted before the construction permit is issued.[36] After the new OWTS system has been installed, the Health Department must inspect the system before it is concluded and covered. If multiple homeowners have submitted applications to upgrade their OWTS, the permitting system can get backlogged, and resources at the local health departments may be insufficient. The permitting process varies from state, county or even city depending on the water quality standards the municipality must follow.

Hawai'i presents a compelling case for the need to streamline permitting processes. The current requirements for converting cesspools to septic systems are restrictive and complex. For example, septic tanks are only approved if there is enough distance from the bottom of the proposed absorption trench to the seasonal high groundwater level, except under specific circumstances.[37] This regulation significantly slows down the pace of conversions, often requiring permits to be issued on a house-by-house basis rather than allowing for neighborhood-wide approvals that could accelerate progress.

However, Hawai'i has demonstrated success in streamlining permitting through its efforts to restore traditional Hawaii fishponds, or loko i'a. In 1995, the state passed Act 177, which provided exemptions from certain environmental review laws for projects aimed at reconstructing, restoring or utilizing fishponds, if a number of criteria were met.[38] Further progress came in 2015 when state and federal agencies adopted a more efficient permitting process for fishponds located on conservation-classified state lands.[39] This updated framework allows the Office of Conservation and Coastal Lands within the Department of Land and Natural Resources to review and approve restoration permits, while bypassing several state and federal regulatory requirements.

In addition to the required OWTS permit, a National Pollutant Discharge Elimination System permit may be required depending on the location of the upgrade. These permits limit what can be discharged, state how it will be monitored, and ensure that the discharge does not harm water quality or human health.[40]

D. Lack of septic engineering expertise

TNC's Rob McDonald noted that conservation and environmental organizations like TNC often lack in-house engineering expertise; therefore, partnerships with groups, like the International Water Association, are essential.[41] These collaborations allow engineers and policy experts to find common ground and shared values. Success often requires engaging with stakeholders through their pre-existing collaborative structures and spaces, while also encouraging them to engage beyond their traditional focus. There are also on-the-ground challenges. For example, in Massachusetts, the workforce for septic installers and inspectors is aging and getting closer to retirement. There are only a few individuals remaining who are familiar with advanced, nitrogen-removing systems design and maintenance.[42]

E. Lack of support for NbS for wastewater treatment

Local governments often prioritize measurable water quality improvements when evaluating NbS, focusing on outcomes such as pollutant reduction and stormwater management. Environmental advocates also value these measurable outcomes, but they place additional emphasis on the co-benefits of NbS, including habitat restoration, aesthetic enhancements and improved human well-being.

There is a general lack of knowledge among planners, developers and other stakeholders regarding NbS. This is often due to preconceived notions or a lack of understanding about the feasibility, cost and benefits of NbS compared with traditional gray infrastructure. Many perceive NbS to be more expensive or less reliable, specifically when considering up-front implementation and ongoing maintenance costs. Local authorities also tend to be less familiar with these approaches, which can slow down the permitting process if they require initial efficacy testing before giving approval. The performance of NbS can vary widely depending on environmental conditions, making them appear less predictable or attractive. Being able to identify the level of benefit a NbS can provide in a specific context requires technical capacity that is frequently missing and can be time consuming, further delaying efforts to determine which solutions are appropriate and effective for a specific region or ecosystem.

F. Difficulty in replicating efforts

Finally, while there are replicable techniques and transferable skills in this field, differences in climate, regulatory environments and transaction costs make it challenging to apply a one-size-fits-all approach. Replication must be tailored to local conditions, which requires flexibility, innovation and sustained collaboration.

SECTION V

Case Studies

A. Suffolk County, New York[43]

1. Project overview

Suffolk County, New York, is a success story that showcases the work, dedication and continuity of purpose that goes into passing conservation legislation to minimize the effects of wastewater pollution on the local environment. TNC's Stuart Lowrie remarked on the resilience of Long Island's shoreline ecosystems, which have continued to self regulate through periodic sea-level rise due to an increase in frequency of storms and sand movement.[44] However, his team noticed that salt marshes were disappearing at an alarming rate, including eelgrass and seagrass beds, and there was a massive decline in the shellfish population. Due to the loss of shellfish, such as clams, the Long Island waters were not being naturally filtered, resulting in brown tide events. TNC experimented by restocking the shellfish in pilot locations, which was a temporary fix to the issue, but another brown tide event soon canceled it out. TNC then hired an outside consultant to study the Great South Bay's water quality. The study found that 70% of the nutrient loading occurring in the Bay was a result of nitrogen pollution coming from cesspools and septic systems. As Suffolk County had some 380,000 systems in total, it was possibly the most well-populated place in the nation to rely on this decentralized form of wastewater treatment.[45]

Next, TNC's New York team examined what could be done through the Clean Water Act to initiate change. However, the CWA does not provide much guidance on tackling nonpoint source pollution sources, which include cesspools and septic systems.[46] The team then considered establishing a new standard for groundwater through state law; however, building, agricultural industry and water purveyor

Suffolk County NY © Stuart Lowrie

lobbyists blocked this effort.[47] This led the team to focus on the nonpoint sources and laying the groundwork to update the septic systems in Suffolk County to meet water quality standards.

On November 5, 2024, voters in Suffolk County approved Ballot Proposition 2 ("Prop 2"), the Suffolk County Water Quality Restoration Act. Prop 2 will generate $4 billion to modernize wastewater infrastructure and protect against nitrogen pollution and $2 billion to protect clean drinking water. Overall, Prop 2 will support restoration of Long Island's beaches, bays and harbors and will conserve open space and wildlife habitats. With this funding, it is hoped that Suffolk County and its 10 towns can incentivize and fund the replacement of all existing cesspools and septic systems to nitrogen-reducing systems over a period of 20 years.

2. Policy action

The initiative began with a fundamental challenge: replacing 380,000 septic systems that had been in place for over a century. The goal was ambitious, transitioning from outdated systems to nutrient-reducing, environmentally protective alternatives. The overarching question was whether a large-scale transformation was even feasible and which technologies could support it. TNC and coalition partners introduced new septic system technologies and conducted a series of pilot tests to validate those systems' effectiveness. These pilots not only demonstrated technical feasibility, but also helped establish a cost estimate of approximately $20,000–$24,000 per system—totaling around $8 billion for full implementation.

To address the financial burden, TNC and partners worked with Suffolk County legislators to introduce the ballot measure to secure $2.1 billion for septic system replacements over 35 years—not enough to fully cover the costs of the upgrades but enough to support the effort. An additional $2.1 billion was allocated for sewer installations in areas with high groundwater levels or dense populations, where sewer connections were more cost effective.[48] Multiple funding streams were mobilized to support the effort. The Community Preservation Fund, a real estate transfer fee that generates revenue and allocates 20% of the fund to water quality infrastructure improvements[49], enabled public financing, while the state contributed tens of millions of dollars to support the experimental phase. County governments also provided funding, and three towns contributed directly from their preservation funds. These efforts were complemented by smaller programs aimed at helping homeowners replace their systems. These financial avenues were critical in ensuring public buy-in and equitable implementation.

Regarding Suffolk County's community strategy, TNC's Kevin McDonald summarized the approach: "We made the political case privately. We made the science case publicly. We made the community case publicly." TNC's Marian Lindberg elaborated on the process, which began with a memo to the county citing its own research on harmful algae blooms caused by nitrogen loading.[50] This was supported by scientific studies conducted by TNC, health impact data, and advisories from the Suffolk County Water Authority. The communication strategy was also bolstered through collaboration with institutions like Stony Brook University, which helped translate complex scientific findings into accessible public messaging. This partnership played a key role in building trust and understanding among stakeholders. The Long Island Clean Water Partnership, a key partnership that spanned multiple organizations including TNC, three other environmental organizations and Stony Brook University, secured five years of funding at $100,000 per year.

3. Challenges

One of the major challenges in advancing the septic system replacement initiative was the political landscape. Previous attempts to pass the necessary legislation had failed, primarily due to internal disagreements within the county legislature, which did not approve placing it on the ballot. This political impasse stalled progress despite the urgency of the environmental issue. However, following another round of discussions with legislators, a legislative agreement was ultimately reached, allowing the proposition to be placed on the ballot.

Another challenge was bridging the gap between science and policy. TNC, a key player in the initiative, invested significant time and resources into scientific research. TNC also teamed up with Suffolk County to hire scientists from an outside partner, Woods Hole Oceanographic Institution.[51] However, translating science into actionable policy required a different set of skills and strategies. TNC had to learn how to effectively communicate complex scientific findings in a way that could influence policy decisions and gain public support. This process of conversion from data to policy was both time-consuming and critical to the initiative's eventual success. Kevin McDonald emphasized the importance of translating science into policy language.[52] Without this, local residents will not be able to interpret the metrics toward which the local lawmakers are working. Kevin McDonald noted that this was an opportunity for TNC to lean into—translating the science research we are conducting to meaningful policy language.

4. Successes

Prop 2 addresses one of the major challenges with fighting nitrogen pollution entering waterways: securing funding to update conventional OWTS. The measure secured $6 billion for Suffolk County over 20 years, enabling the eventual large-scale replacement and modernization of septic systems. In addition, Suffolk County was able to leverage additional billions of dollars in funding through matching programs at the state level and from state water quality improvement programs. Kevin McDonald noted, "It's not too far of a stretch to say our campaign catalyzed a major New York state infrastructure investment initiative."[53]

TNC's New York team played a pivotal role in shaping local policy and securing local funding, which streamlined the path toward OWTS upgrades. Their deep involvement in the policy process helped overcome bureaucratic hurdles and ensured that the initiative remained focused and effective. TNC's Stuart Lowrie emphasized the importance of persistence, stating that addressing nitrogen pollution is "a marathon, not a sprint. It is a process, not an event. If you do not have continuity of purpose, you will not succeed."[54]

Long Island's demographic profile also contributed to the initiative's success. With a highly educated and relatively affluent electorate, the region was well positioned to understand and support complex environmental policies. The community readiness created a favorable environment for passing ambitious measures like Prop 2.

Lastly, Kevin McDonald's leadership was instrumental in building political momentum alongside New York's government relations (GR) engagement team, which had relationships with government offices and state legislators and support from the overall county. His ability to connect with county executives and cultivate meaningful relationships helped elevate the issue to the highest levels of the government. His efforts culminated in a powerful public declaration by both the governor and the county officials, who jointly announced that "nitrogen pollution is clean water enemy number one." This high-level endorsement significantly boosted the initiative's visibility and credibility. Kevin also noted the ingredients of "GR Juice" are "relationships, great communication and follow through."[55]

5. Lessons learned

One of the most valuable takeaways from the success of Prop 2 is its potential to serve as a model for other states. The approval of legislation demonstrates that **when voters are given the opportunity to weigh in on critical environmental issues**, like water quality and infrastructure, **they are willing to support meaningful change**. Particularly in an area like Long Island where many residents appreciate and use the local waterways, it was crucial to receive public backing to get the legislation over the finish line. This sets a precedent for other regions that are considering similar ballot initiatives.

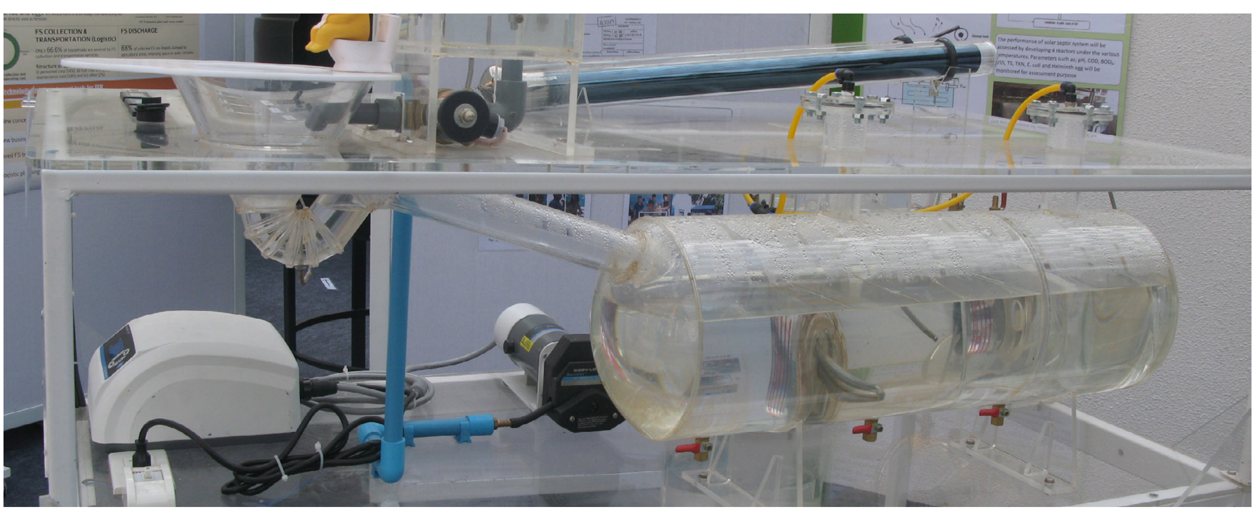
A key lesson from this effort is the importance of **building and maintaining strong local relationships**. The New York team collaborated closely with a wide network of partners, including TNC staff from Long Island and Connecticut, as well as New York's Governmental Relations team. These relationships extended to municipalities at the state, county and town levels, which proved essential in securing diverse funding sources and political support.

Strategic use of polling also played a critical role. Our public opinion research revealed that residents cared deeply about water quality and were willing to pay for improvements. These data helped shape the messaging and determine a realistic cost figure to present to voters. In addition, the Health Department required funding to test and approve new systems. TNC supported this need by advocating for and helping to establish a lottery program that offered free systems to selected residents across various county regions, an initiative that needed to be well-publicized to gain traction.

The campaign itself was a major undertaking, with a budget of $1 million. It brought together a coalition of contractors, municipal labor unions, environmental groups and other supporters. Interestingly, while environmental groups contributed 60% of the campaign budget and partners contributed 40%, the financial returns primarily benefited the partners, while environmentalists gained the long-term benefit of cleaner water.[56] This distinction shows that **environmentalists are willing to lobby and fund initiatives with long-term benefits to the environment, not just temporary solutions**, and that their investment can be critical to making progress.

Finally, the team learned from past experiences, particularly the Cape Cod case, where public skepticism undermined the credibility of environmental studies. To avoid this issue, TNC's Long Island team invested in a **"bulletproof" scientific foundation**. We hired the U.S. Geological Survey (USGS), as well as a top-tier modeling firm and additional experts through the county, to ensure that the data and projections were beyond reproach. This rigorous approach helped **build public trust and reinforce the legitimacy of the initiative**.

TNC's Marian Lindberg had the unique experience of using the grant fund opportunities she helped bring about to fund her own septic system upgrade. Lindberg received a total of $40,000 in financial assistance for the installation—$20,000 from the county, which included $10,000 in state funding, and another $20,000 from her town, as she resides in a high-priority watershed area. Despite the substantial support, the funding still did not cover the full cost of the installation, requiring her to contribute out-of-pocket. She candidly shared that the upgrade process was far from a walk in the park. During construction her yard was in a state of disarray, the upgrade was expensive, and delays from the county added to the frustration. Reflecting on her experience, she emphasized the importance of setting realistic expectations for homeowners. "We need to anticipate what people are going to experience," she noted, "and to be honest about the realities of the installation process."



Solar Septic Tank prototype © SuSanA Secretariat Flickr CC BY 2.0

Oahu cesspool © Shellie-Habel

B. Hawai'i

1. Project overview

Hawai'i's state legislature passed a law in 2017 banning the construction of new cesspools and requiring all cesspools to be converted by the year 2050, a total of 88,000.[58] As Hawai'i is an isolated archipelago that has uniquely challenging geology and site characteristics, the transition to advanced treatment systems is arduous.[59] However, transitioning to appropriate wastewater treatment is urgent, as Hawai'i's sea-level rise resulting from climate change is accelerating the rate at which untreated wastewater is reaching the state's waterways. This directly impacts Hawai'i's unique biodiversity, coastal ecosystems and human health.[60] Hawai'i's slow regulatory environment makes it challenging to reach the conversion deadline; furthermore, many homeowners are unable to finance the conversion on their own and need government assistance.

2. Policy action

Establishing a clear cesspool conversion mandate was a critical step in setting a definitive timeline for Hawai'i's transition away from outdated and ecologically detrimental wastewater systems. However, the pace of conversion has been hindered by lack of government capacity to implement the transition, which involves updating regulations, approving new technology and finding funding to support the conversions.

Another major policy challenge is that Hawai'i's wastewater regulations have not been updated in nearly a decade. For meaningful progress to be made, the Department of Health must be empowered to prioritize wastewater issues and must have the capacity to navigate the complex and often burdensome regulatory update process. TNC is taking a leadership role in this space, leveraging our scientific expertise to build the case and support prioritization efforts. Over the next few years, we will leverage our trusted reputation to guide policy development and provide on-the-ground support to advance legislative priorities.

TNC recently approved a new strategy to accelerate the pace and scale of conversion to sustainable wastewater infrastructure, particularly to limit environmental pollution and to increase policy advocacy in FY26. We have played a leadership role building the case for change and supporting prioritization efforts. We have also coordinated direct advocacy efforts, including setting up meetings with key legislators and providing testimony, technical input and on-the-ground support to advance legislative priorities.

In 2025, TNC provided light policy support, including scientific information and testimony, to advance three priorities:

a. adding Department of Health staff capacity (passed to add funding for one engineer)
b. requiring on-site systems less than 200 feet from the shoreline to use advanced denitrifying technology; the current state standard is 50 feet (did not pass)
c. adding funding capacity to the University of Hawai'i's Water Resources Research Center to accelerate review and approval processes for new technologies (passed)

One of our top legislative priorities was a proposed Environmental Stewardship Fee, a state-level policy designed to generate substantial revenue for natural resource restoration without increasing costs or taxes for Hawai'i residents. While advocacy for this fee was not focused on wastewater specifically, this innovative approach could provide a sustainable funding stream for wastewater upgrades.

Moving forward, there is a need for increased GR capacity to support this effort in Hawai'i and to support coordination with partners who are engaged in policy. This includes off-season planning and engagement of decision makers and staff to lay the groundwork for a legislative package that has legislative and community support.

3. Challenges

Funding remains one of the most significant challenges regarding Hawai'i's cesspool conversion. While the state's mandate provides a clear timeline and goal, securing the financial resources to support such a massive infrastructure shift has proven far more difficult. Although Hawai'i's unique landscape gives it an edge in qualifying for federal support, the actual funding received—such as from the Infrastructure Investment and Jobs Act—has fallen short of what's needed to make a meaningful impact. The scale of the task is daunting, with over 88,000 cesspools requiring conversion, each at a high cost and without a comprehensive financing framework in place.[61]

Hawai'i's inability to engage in deficit spending further complicates the issue. The state must carefully balance its budget, making it difficult to allocate sufficient resources for large-scale wastewater upgrades. In addition, the legislative process in Hawai'i presents its own set of hurdles. The pace, complexity and lack of transparency in the state legislature make it challenging to track and influence policy developments.

Compounding this is the limited capacity within state agencies to adopt new codes, evaluate and update permitting rules for emerging technologies (including those that are critical to add denitrification elements to limit nitrogen pollution), and implement the necessary changes to meet both conversion and water quality goals.

Paul Sturm, director of the nonprofit Ridge to Reefs, highlighted additional regulatory challenges. He noted that Hawai'i's permitting process is notoriously slow and often counterintuitive.[62] For example, outdated systems are sometimes replaced with basic septic systems rather than more advanced technologies, which prolongs environmental issues by failing to incorporate features such as denitrification technology to protect vulnerable ecosystems and groundwater supplies. While states like Virginia provide permit decisions within 15 days, Hawai'i's process can take up to six months.[63] This delay discourages progress and frustrates stakeholders. Sturm also pointed out that many regulators lack the technical background to confidently evaluate new systems, which further slows decision-making. To accelerate change, he emphasized the importance of building coalitions and collaborating with engineers, who often have deeper on-the-ground experience.

Finally, the state's investment in wastewater solutions remains limited; only about 5–15% of the budget is allocated to this issue. However, partnerships with institutions like the University of Hawai'i and Louisiana State University are helping to fill research gaps and support evidence-based policy development. These collaborations are essential for building the knowledge base and momentum needed to overcome the many challenges facing Hawai'i's wastewater transformation.

4. Successes

There is strong support for environmental initiatives among Hawai'i residents. A poll of Hawai'i's voters showed that they would like tourists to pay $50 per person to raise funds to protect and restore land, water and wildlife.[64]

In addition, in 2025, there were several notable legislative achievements. The state passed a bill to expand capacity within the Department of Health. However, the change enabled the addition of only one engineer-level staff member, offering limited capacity gains. A key challenge moving forward will be identifying a qualified candidate for this role, given the constraints of the available salary. Another significant success was the passage of a bill establishing a pilot program at the University of Hawai'i Water Resources Research Center. This initiative—Wastewater System Testing; Pilot Program; Appropriation—allocates funding for fiscal year 2025–2026 to support a three-year pilot focused on testing new wastewater and individual wastewater system technologies. The program includes requirements for interim and final reports to be submitted to the Legislature.

A key lesson from this session is the importance of building stronger collaboration between scientists and GR staff to ensure coordinated and effective messaging. Aligning technical insights with policy strategy can significantly enhance advocacy outcomes. A second lesson for the Hawai'i policy team was that specific bills with smaller funding tasks were prioritized by a state legislature in crisis, and so it is worth thinking about the portfolio of bills submitted to offer both technical and financial choice for decision makers.

Looking ahead, there are promising opportunities to collaborate with other organizations in this space to refine policy priorities and advocate collectively. TNC Hawai'i is initiating conversations with partners in preparation for the FY26 legislative session. In addition, we are working closely with the Coral Reef Alliance, which is forming a statewide coalition of NGOs, government agencies and other stakeholders. This coalition presents a valuable opportunity to enhance coordination, streamline communication and strengthen collective impact across the sector.

5. Lessons learned

One of the key takeaways from Hawai'i's experience is the importance of building strong relationships with congressional delegations. As Kainan Miranda, director of external affairs for TNC's Hawai'i GR team, advised, chapters in other states should **proactively engage with their federal representatives** by providing them with relevant information and updates. These relationships can be instrumental in securing funding and advancing legislative priorities.

For chapters without a designated GR staff member, there are still effective ways to engage in policy work. Miranda emphasized the value of leaning in through technical expertise and strategic planning. By **organizing meetings, setting priorities and demonstrating subject matter knowledge**, technical staff can play a vital role in policy advocacy. Building credibility through expertise is a powerful way to influence decision making and gain the trust of policymakers.

Partnerships have also proven to be a cornerstone of the Hawai'i chapter's approach. We have prioritized working closely with local communities, not just as stakeholders but as active participants in shaping solutions. By leading conversations, offering capacity and leadership where possible, and genuinely incorporating community input into decision-making, TNC has strengthened our role as a trusted and effective partner.

Another important lesson is the value of **collaboration across disciplines**. Engaging conservation and subject matter experts in direct policy work helps ensure that advocacy efforts are grounded in science and practical knowledge. Building connections with like-minded organizations and individuals within the community

Volunteer citizen scientists from Hui O Ka Wai Ola monitor water quality in Maui © Bruce Forrester

broadens the base of support and enhances the impact of advocacy. While every strategy must align with the local political context, having GR support—whether formal or informal—can significantly enhance a chapter's ability to move policy forward.

Lastly, **having good data about where OWTS are located, and knowing the implications of on-site systems for water quality**, have been invaluable when building the case to upgrade. Partnerships in science have been just as valuable as partnerships with local communities. The Hawai'i team has helped to guide efforts to prioritize cesspool upgrades, building a map that designates three different prioritization ranks and that is approved by the Department of Health. Maintaining a database of the locations of on-site systems and where county governments and community organizations plan on sewering next is key to giving decision makers and homeowners confidence that they are upgrading at the right time for the right reason.

In addition to targeting the worst, most polluting on-site systems, the team also built the case for conversions based on which ecosystems were impacted and whether they were damaged directly by wastewater. A key collaboration piece submitted to the journal Nature used a comprehensive large-scale study of reefs to show that wastewater was one of the most important stressors hindering reef recovery after a bleaching event. This type of multi-institution large spatial-scale science has been important to communicate with everyone involved in designing policy and communications.

C. Cape Cod, Massachusetts[65]

1. Project overview

In January 2013, after a decade of research conducted by the Massachusetts Department of Environmental Protection (MassDEP), the Cape Cod Commission and the Massachusetts Estuaries Project, the Commonwealth of Massachusetts used the Clean Water Act to direct the Cape Cod Commission to update the 1978 Section 208 plan for Cape Cod.[66] Section 208 of the CWA establishes policies and program requirements for water quality management and planning to control water pollution from point and nonpoint sources.[67] Cape Cod's Area Wide Water Quality Management Plan Update, a 208 Plan, is an important framework that is working to restore embayment water quality on the Cape.[68] The plan recognized that 80% of the nitrogen entering the Cape's watersheds was coming from septic systems.[69]

In the summer of 2023, the Commonwealth of Massachusetts set its own goals to increase permanent conservation to at least 30% of the state by 2030 and at least 40% by 2050.[70] Through this initiative, the state outlines water use laws and regulations that are designed to protect and enhance aquatic and wetland habitats.[71] One in particular addresses the pervasiveness of nitrogen pollution: Title 5, which details how to install, use and maintain septic systems with updates to the rules designed to mitigate the effects of nutrient pollution on Cape Cod, recognizing the water quality is significantly impaired.[72]

Momentum increased significantly when the Conservation Law Foundation filed a lawsuit against the state of Massachusetts, pushing for faster action on wastewater management.[73] TNC joined other partners to actively contribute to the state regulatory update process by submitting comments and engaging in policy discussions in both formal and informal avenues, supported by a long track record of collaboration with MassDEP. This collaboration helped elevate the urgency of the issue and brought more voices to the table in support of meaningful regulatory change to upgrade outdated OWTS in the Cape. They specifically pushed for updates to the Title 5 regulations, which towns may adopt through watershed permits, providing a flexible pathway to meet nitrogen reduction requirements, including IA septic upgrades (enhanced and innovative/alternative septic systems).[74]

TNC in Massachusetts has taken proactive steps to combat the nitrogen pollution affecting the Cape's biodiversity and water quality health through exploring and implementing advanced septic technologies, including IA systems. These systems are a NbS because they use natural materials, including limestone and wood chips, to naturally filter and remove nitrogen from wastewater. The Massachusetts chapter collaborated closely with local environmental organizations, including a regional watershed association, to pilot and fund these systems, specifically working toward Massachusetts' 2030 goal of "advancing the use of nature-based solutions and new septic system technologies to reduce land-based nutrient pollution for cleaner water."[75] We also brought together key stakeholders, including the EPA, USGS, local and regional governments and local homeowners, to advance solutions to nitrogen pollution on Cape Cod. The primary goal was to expand the available toolbox of solutions to nitrogen pollution on Cape Cod, including through IA septic system upgrades.

As part of this effort, the collaborative team developed a pilot program in the Shubael Pond neighborhood of Barnstable, Massachusetts, to install a number of IA systems across the region and begin monitoring their effectiveness in reducing nitrogen pollution. This effort marks a significant step forward in protecting the state's water resources through sustainable, science-driven innovation. Once the Shubael Pond pilot was installed and was being monitored, TNC moved on to tackle another pressing challenge facing septic system adoption: long-term financing, operations and maintenance of the systems. With support from the TNC NatureVest team, TNC and our partners identified that a centralized utility structure, known as a Responsible Management Entity (RME), was needed to bring together funding sources and systems maintenance and management expertise to facilitate long-term implementation and successful operation of these systems.[76] Since 2022, TNC has been supporting the Massachusetts Alternative Septic System Test Center in developing a pilot RME program, now known as the [Septic Utility Program](), to meet these needs. To address the long-term financial needs, TNC and NatureVest developed a [financial analysis model]() to help municipalities evaluate the costs of various wastewater treatment upgrade scenarios.

2. Policy action

In 2023, MassDEP introduced an updated regulatory framework aimed at accelerating action on wastewater management. The new regulations require timely implementation of upgraded septic systems or the development of watershed-based plans to effectively reduce nitrogen pollution to meet the CWA's Total Maximum Daily Loads (TMDLs). Nitrogen reduction thresholds have been established based on watershed-specific, data-informed needs.[77]

The 2023 updates to Massachusetts' Title 5 regulations established Nitrogen Sensitive Areas within which municipalities had to take one of two actions: upgrade all septic systems older than 10 years to systems with [Best Available Nitrogen Reducing Technology (BANRT)]() or establish watershed permits that use a suite of tools to reduce nitrogen loading to meet the nitrogen TMDLs for the watershed.

TNC's Massachusetts chapter, including our conservation and policy staff, played an active role in shaping this policy by submitting formal comments on the proposed updates, collaborating with partners, speaking at public hearings and developing communication tools to ensure that the public, especially homeowners, had access to clear, accurate information.[78] To amplify public understanding, the chapter partnered with *The New York Times* to tell a relatable, human-centered story that brought the issue to life for a broader audience.[79]

An example of how Cape Cod is putting policy into action is through an aquifund. The Cape Cod Aquifund (formerly known as the Community Septic Management Loan Program) is a financial assistance program designed to help homeowners upgrade failing residential septic systems to meet Title 5 Standards.[80] The program was made possible by the Open Space Bond Bill of 1996, which allocated $30 million to MassDEP. MassDEP used these funds to support loans administered through the Massachusetts Clean Water Trust, helping eligible homeowners offset the costs of Title 5 compliance. The aquifund offers low-interest betterment loans to Cape Cod homeowners to help cover the costs of repairing or replacing failed septic systems, upgrading to advanced septic technologies or connecting to municipal sewer systems.[81] It provides residents with fair and accessible financial support to achieve the region's clean water goals, paving the way to allow residents from all backgrounds to receive financial assistance to improve their septic systems.

3. Challenges

Since the policy went into effect on July 3, 2023, progress in upgrading septic systems has been slow, and any resulting improvements in water quality are expected to take even longer to materialize. This delay underscores the urgency of addressing the root cause of nitrogen pollution more effectively and at scale.

One of the major barriers to progress is insufficient financial support options for homeowners. Septic system upgrades are not eligible for infrastructure grants, which places the full financial burden on individual property owners. For many people, the cost of these upgrades is simply unaffordable, creating a significant obstacle to widespread adoption. Homeowners are required to upgrade their systems by a specific date set by the Title 5 regulation but may not have to upgrade depending on what their town puts into the watershed permit.

Emma Gildesgame, climate adaptation scientist for TNC in Massachusetts, highlighted the gravity of the situation by stating, "One of the biggest challenges that we're facing is that none of our habitat protection or restoration work along the coast is going to stick or work unless we address the nitrogen pollution that is really, really pervasive across our coast. And on Cape Cod, about 80% of the nitrogen pollution is from on-site wastewater treatment systems."[82] The Massachusetts chapter has worked with partners restoring retired cranberry bogs to remove nitrogen, for example, which is now managed through Massachusetts' Division of Ecological Restoration (DER) department.[83] The chapter has also focused on restoring eelgrass, salt marsh and oyster reefs. However, even with these efforts to remove nitrogen from waterways, there is still a need for systemic solutions that address both environmental and economic realities.

4. Successes

Public outreach and education have played a pivotal role in shifting public perception around septic system upgrades. As awareness grows about the environmental and health impacts of nitrogen pollution, more homeowners are becoming open to upgrading their systems—especially when they understand the long-term benefits for their communities and local ecosystems.

In addition to policy advocacy on upgrading septic systems, TNC and our partners have been working on innovative NbS to reduce nitrogen pollution. One such effort involves restoring retired cranberry bogs by reestablishing historic wetlands. These restored wetlands are carefully graded and planted to promote the natural denitrification process, which helps remove nitrogen before it reaches aquifers and waterways. Massachusetts' DER manages the cranberry program and partners with other entities to make this work possible. DER works with the U.S. Department of Agriculture's Natural Resources Conservation Service through their Wetland Reserve Easement Program.[84] This program offers landowners direct compensation for permanent conservation easements. However, it has limited resources, and not every landowner will receive technical assistance or financial support.[85] DER prioritizes funding and assistance for high-priority sites, such as flow-through bogs, fields underlain by deep peat and low-lying properties that are subject to inland or coastal flooding.[86] TNC's policy team has been instrumental in advocating for funding and raising awareness about the ecological value of these projects, focusing on IA septic systems and cranberry bog restoration after a 2019 study indicated that they were more cost effective than sewering.[87]

Barnstable Cranberry Bog restoration site © Emma Gildesgame

Today, DER leads these restoration efforts, building on the groundwork laid by TNC and its collaborators. As Gildesgame noted, "The goal behind nature-based solutions is to add more tools to the toolbox, because if we only rely on sewers, then it's going to take decades and billions of dollars to upgrade all of the outdated systems."[88] Her statement underscores the importance of integrating natural infrastructure into broader water quality strategies—offering cost-effective, scalable solutions that complement traditional approaches.

5. Lessons learned

TNC in Massachusetts has learned numerous lessons through this work. To operationalize this concept, the Massachusetts Alternative Septic System Technology Center launched the Septic Utility Program in its pilot phase, with funding support from TNC.[89] In partnership with NatureVest, the team is analyzing the full cost of septic system upgrades, the operational expenses of running the Septic Utility Program and the long-term financial implications of acting now versus delaying improvements. This analysis is helping to shape **a scalable, sustainable model for decentralized wastewater management**.

TNC has built strong **partnerships** with organizations such as the Barnstable Clean Water Coalition, the Town of Barnstable, U.S. EPA and the Massachusetts Alternative Septic System Test Center. These collaborations have been essential in aligning local, state and federal efforts and ensuring that solutions are grounded in both science and community needs.

Public communication has been a critical component of success. Through targeted outreach and media engagement, the conversation around septic systems and nitrogen pollution has evolved. TNC's Marketing and Communications team in Massachusetts developed a media strategy, including a high-impact collaboration with *The New York Times* to raise public awareness. Gildesgame worked closely with the *Times* reporter on framing and messaging, using her subject matter expertise to help tell the story of nitrogen pollution in the Cape. A long-term media consultant in Massachusetts also supported these efforts, helping to maintain momentum and visibility.

The EPA's Southeast New England Program played a crucial role in providing grants for IA systems, particularly in Massachusetts.[90] TNC has contributed more than $600,000 since 2022 to support nature-based wastewater treatment alternatives in Massachusetts. Meanwhile, the EPA has continued to match and expand upon these investments, mobilizing full-time staff and resources to scale these programs regionally. Though the dedication of these funds marks a huge step in the effort to upgrade septic systems in Massachusetts, much more **financial support** is still needed to restore water quality in the region.

Community engagement © Alan Cressler

D. Arizona

1. Project overview

In Arizona, the challenge of addressing water quality comes with a twist: the region's watersheds must work with limited water availability. With groundwater serving as the primary source of drinking water for many communities, the state has turned its focus to maximizing the benefits of wastewater through recharge projects that replenish aquifers.[91] However, ensuring the quality of this water in surface and groundwater systems remains a critical concern. One focus area is the Yavapai-Apache Nation, a tribal community within the Verde watershed. Sewage lagoons were constructed in 2019 to treat wastewater and address immediate sanitation needs, but these facilities are located close to the Verde River, raising concerns about long-term water quality. The Yavapai-Apache Nation has led efforts to secure funding for improved water infrastructure policies, and funding has also been secured for a modern wastewater treatment plant to improve overall health, sanitation and water security for the Nation.

2. Policy action

One of the most significant policy challenges is building and funding wastewater treatment facilities. Public acceptance remains a major hurdle, often due to lack of understanding that upgrading OWTS will ultimately protect water drinking sources. In addition, the scale of required funding is daunting. The planning phase alone for an on-site facility can cost more than $200,000, not including preliminary design work. These financial and social barriers make it difficult to move forward, even when the need is urgent. For example, the Yavapai-Apache Nation has identified a new wastewater treatment plant as its top infrastructure priority, yet progress has been constrained by these very issues.

Understanding and effectively applying the CWA is another critical area of focus. Policymakers and practitioners are working to strike a balance between regulatory compliance and practical effectiveness. Options under consideration include establishing active waste management areas, evaporating effluent and managing large-lot, unregulated sub-developments that rely on individual wells and septic tanks. Each of these approaches carries water quality implications that must be carefully evaluated.

To navigate these complexities, Kim Schonek, Water Program director for TNC in Arizona, shared that legal expertise has been essential. Her team worked with Joan Card, a legal advisor who has been instrumental in helping stakeholders understand the nuances of the CWA, including TMDLs, nutrient standards and the potential for regulatory variances.[92] This legal grounding is helping to educate practitioners and inform smarter, more flexible updated wastewater treatment systems.

Another area of policy exploration involves water quality trading platforms. These market-based mechanisms could offer a more flexible and cost-effective way to meet water quality goals by allowing entities to trade pollution reduction credits. Understanding how these platforms work and how they can be integrated into existing regulatory frameworks is a potential step forward.

Finally, a forward-looking approach is essential. Policymakers are asking tough questions about how to overcome the water quality and infrastructure challenges Arizona is likely to face in the next 25 years. Being practical about the realities of municipal and domestic water supplies—especially in the face of climate change and population growth—is critical. Long-term planning must be grounded in both environmental science and economic feasibility to ensure sustainable outcomes.

3. Challenges

Working within Tribal communities brings both opportunities and challenges. While federal infrastructure funding during the Biden Administration and the Justice40 initiative (terminated in 2025) offered critical support, they also came with additional layers of review and approval. These extended processes can significantly delay progress. For example, one Tribal wastewater treatment project is currently facing a $14 million funding shortfall. Although partial funding has been secured from sources like the America Rescue Plan Act (ARPA), the Army Corps of Engineers and state-based programs, returning to the federal funding cycle and potentially having to wait another year could drive costs even higher due to inflation and rising construction expenses. There is an urgent need to move into the construction phase as soon as possible.

Securing funding is only part of the challenge; understanding the scope and scale of the solution is equally important. Determining where a wastewater treatment plant is needed, how large it should be, and what infrastructure is required takes time and expertise. Even with federal assistance, it is difficult to obtain implementation funding. Cost estimates often fall short of actual expenses, making it hard to plan effectively and increasing the risk of budget overruns.

Advocating for funding requires not only technical knowledge but also strategic communication. One key message is that transitioning from septic to sewer systems protects both human and environmental health, especially when it involves upgrading water lines and improving water quality. We must engage with legislators to help them understand the importance of these investments and to build broad support for modernizing aging infrastructure. Collaborative efforts are needed to ensure that everyone is working together toward sustainable, long-term solutions.

Environmental conditions also pose significant challenges. In some areas, treatment wetlands are difficult to implement due to high evaporation rates. For example, some recharge projects divert treated effluent into constructed wetlands rather than returning it directly to the river. As a result, a substantial portion of that water is lost to evaporation or infiltration—meaning only about half may ultimately make its way back to the river system. This creates an important trade-off. On one hand, constructed wetlands can provide ecological benefits, such as supporting habitat and improving water quality, which aligns with broader goals to restore freshwater ecosystems. On the other hand, reducing the volume of water that returns to the river can limit flows needed to sustain downstream habitats, an important concern in water-scarce regions like Arizona, where maintaining river and groundwater levels is a priority for ecosystem health.

Water quality requirements further complicate these systems. In particular, phosphorus must often be reduced to meet regulatory standards before water can be discharged or reused. While wetlands can help remove nutrients, achieving sufficiently low phosphorus levels can be technically challenging and may require additional treatment or careful system design. Balancing the ecological benefits of wetlands treatment with the need to meet strict water quality standards—and maintain river flows—remains a complex and ongoing challenge.

4. Successes

Though the use of treatment wetlands in Arizona is challenging due to high evaporation rates, they are still a good option for the state. With this method, water returning to the river is first routed through artificial wetlands, which benefits the health of the river ecosystem.[93]

In June 2024, the Water Infrastructure Finance Authority of Arizona closed a $16.3 million loan with the Yavapai-Apache Nation.[94] Through this federally funded Clean Water State Revolving Fund loan, the Tribal community will be able to finance a wastewater treatment facility to replace the outdated sewage lagoon system that currently serves 176 connections within the Reservation.[95] The Nation also plans to integrate the reclaimed water generated by the wastewater treatment facility into their agricultural operations for irrigation. This marks a huge win for the Nation and for all communities that rely on the Verde River.

5. Lessons learned

A key lesson has been the importance of **active involvement in water infrastructure policy**. Last year, participation in the State Water Conservation Grant Fund Committee helped secure $200 million in ARPA funding. Advocates successfully pushed for a balanced approach that includes both traditional infrastructure and NbS. This dual strategy has proven essential for addressing diverse water management needs across the state.

Partnerships have also played a critical role. The Audubon Society, along with other organizations, has helped raise awareness and build momentum for water security efforts in Arizona.[96] At the regional level, six cities in the Verde Valley have come together to coordinate a comprehensive wastewater management and effluent reuse plan. This kind of regional collaboration is vital for creating scalable, sustainable solutions.

Communities are facing tough decisions. One Arizona community with failing septic systems that were leaking into the Colorado River had no choice but to mandate a sewer solution, resulting in a $200 monthly increase in sewer bills for residents. This case highlights the **urgency of addressing failing infrastructure and the real costs of inaction**.

There is hope that the Yavapai-Apache Nation will become a model success story. With $800,000 in corporate and foundation funding secured, as well as the $16.3 million loan from the Water Infrastructure Finance Authority of Arizona, the project is well positioned to demonstrate how targeted investment can lead to meaningful outcomes. This success could serve as **a blueprint for other Tribal and rural communities** facing similar challenges.

The City of Sierra Vista in southern Arizona is working on advanced water reuse through the Cochise Conservation and Recharge Network. The city treats water to A+ quality standards and uses it to recharge the river, benefiting both the environment and the local economy. This project illustrates how high-quality treatment and strategic reuse can align ecological goals with community development.

Cienega Los Fresnos © Peter Warren TNC

SECTION VI

Legislative Framework and Enabling Policy Conditions

Upgrading OWTS is more effective when it is supported by a strong legislative framework and enabling policy conditions. The following approaches can set up the conditions for success.

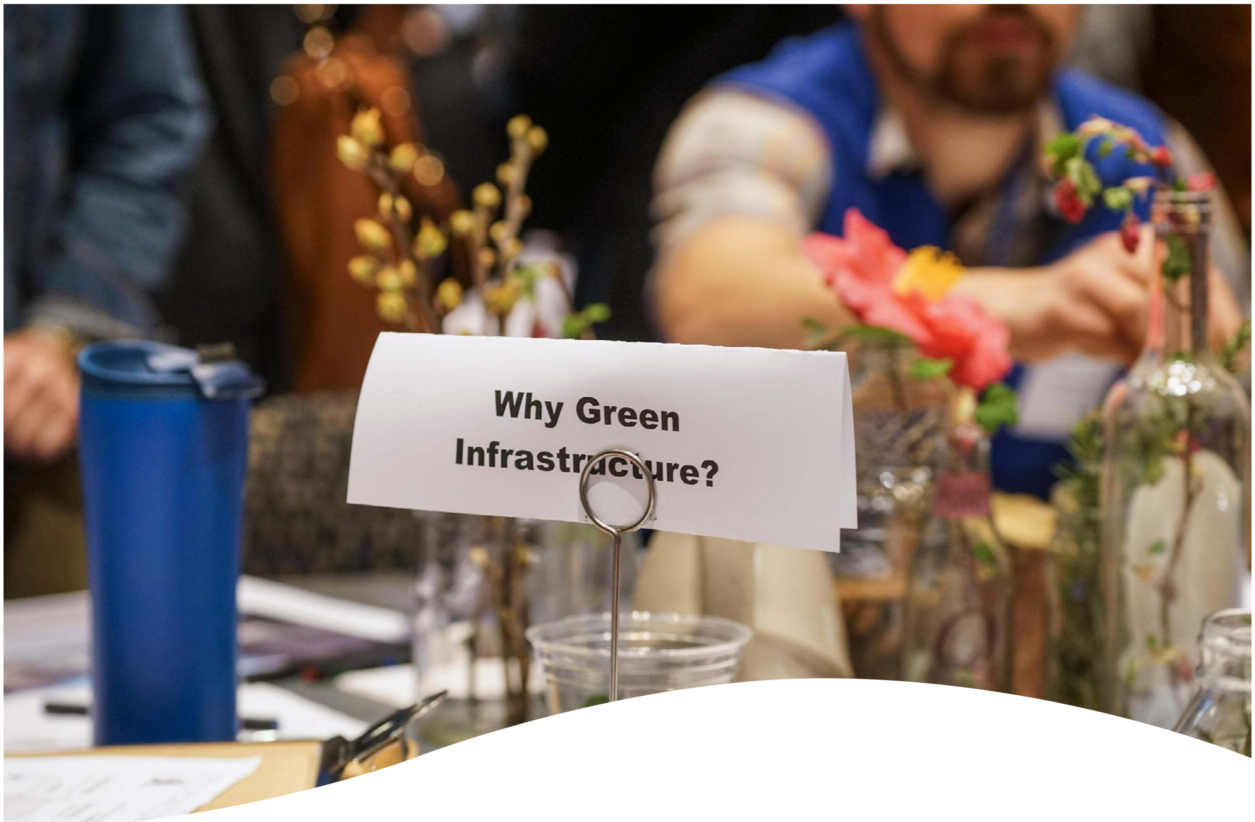
Develop a coordinated policy strategy.

Effective policy change in the realm of OWTS upgrades and NbS requires a coordinated strategy that bridges science, communication and legislative action. One of the most important principles is ensuring that policy and legislative staff work closely with GR teams. We recommend that scientific experts always go with a GR representative to meetings with legislators. GR professionals are trained to translate complex technical information into compelling, accessible narratives that resonate with both the public and elected officials. As Kevin McDonald with TNC's New York GR team aptly stated, "This is a tandem strategy. You need good science, you need great communication, and you need great communication with the policymakers whose lives you want to change."[97] It is important to note that the science needs to support the questions and concerns of the legislative staff. This coordinated effort can lead to the creation of reports that assist local, state or federal legislation to pass.

Access funding streams.

A critical enabling condition for implementing system upgrades, particularly those involving NbS and blended infrastructure, is access to sustainable and scalable funding. This section highlights how existing financial mechanisms, such as the EPA's Clean Water State Revolving Fund (CWSRF), serve as foundational tools for communities to invest in water quality improvements. It also underscores the importance of collaborative advocacy and enabling legislation to unlock these resources and deploy solutions at scale.

Rob McDonald emphasized that the United States is investing in NbS through mechanisms like state water revolving funds.[98] The CWSRF is a federal-state partnership that offers low-cost financing to communities for a wide range of water quality infrastructure projects.[99] According to the EPA website, "[t]he 51 CWSRF programs function like environmental infrastructure banks by providing low interest loans to eligible recipients for water infrastructure projects. As money is paid back into the state's revolving loan fund, the state makes new loans to other recipients for high priority, water quality activities."[100] This is a funding opportunity that can be leveraged to support blended infrastructure strategies that reduce stormwater volume and improve wastewater treatment outcomes. Homeowners who are interested in accessing CWSRF assistance should reach out to their state representatives to learn more about the application process and eligibility requirements and reference the EPA's resources for guidance.[101] Delaware is currently the only state that provides CWSRF assistance directly to homeowners.[102] However, 15 other states provide funding indirectly



The Green Infrastructure Summit, held at Cascadia College in Bothell, WA, convened diverse leaders from Puget Sound cities and towns to map the strategic role of green infrastructure for a shared clean water future. © Courtney Baxter TNC

for individual septic projects through sponsorship, loans or deposits to intermediaries like utilities, municipalities or financial institutions that then finance the projects.[103]

Another way to access additional funding streams is to submit funding requests through a coalition. Marian Lindberg of TNC in New York remarked that state and local legislators like to see like-minded groups working together on an issue, which is one of the reasons that the Long Island Clean Water Partnership was created and that TNC became involved in it.[104] However, to unlock these funds and implement solutions at scale, enabling legislation is often required.

Advocate to help legislation pass.

Passing legislation is a complex, multi-step process. Stuart Lowrie, former director of TNC's New York Division Water team and current senior learning consultant for TNC's HR Learning and Development department, explained that environmental funding measures typically require enabling laws to be passed at the state level before they can be placed on local ballots for public vote.[105] In New York, for example, the state assembly, senate and governor had to agree to place a measure on the ballot in Suffolk County. The county legislature then had to draft ballot language and ensure it was submitted 180 days before the vote.[106] This process demands constant vigilance to ensure the original intent of the legislation is preserved and a commitment to playing the long game to get legislation passed.

As an example of long-term commitment paying off, Kevin McDonald recalled that in 2015 the TNC New York team decided to embark on the Long Island Nitrogen Action Plan as one of the Business Division's initiatives.[107] This initiative has seen success over the previous 10 years and is a great example of collaboration between multiple stakeholders: the Department of Environment Conservation, the Long Island Regional Planning

Council, Suffolk and Nassau counties, and other partners.[108] Stuart cited a 15-year history of TNC staff on Long Island grappling with challenges related to the shore environment on the island, again demonstrating the commitment by both the team and by TNC as a whole to protecting Long Island's biodiversity and ecosystems.[109]

Advocacy also paid off when the European Commission adopted the Nature Restoration Regulation as law.[110] The Nature Restoration Regulation is the European Union's first continent-wide law that focuses on restoring ecosystems, habitats and species across the countries that make up the union.

Build a coalition.

Coalition-building has proven to be a powerful tool in advancing these efforts. In New York, TNC played a leading role in creating the Long Island Clean Water Partnership with three other environmental groups and Stony Brook University, which employed one of the leading academic experts on algae blooms in the world. A local foundation funded the Partnership's five groups, which came together to submit fundraising pitches and reports.[111] They developed a shared website, conducted joint fundraising and coordinated messaging. Their communication strategy was highly targeted, focusing on county legislators and emphasizing the direct link between nitrogen pollution and quality of life. A central message was: "Nitrogen pollution from cesspools and septic systems is destroying our quality of life and our economy, and we have to fix it now." This messaging was tested in focus groups and adopted across all partner organizations.

Long Island Clean Water Partnership © LICWP

TNC Long Island coms © TNC

Develop a coordinated communication strategy.

Strategic communication is key to achieving successful policy reform. For example, the Long Island Clean Water Partnership coalition invested $400,000 in early advertising and polling, which caught the attention of the New York governor and catalyzed a partnership with TNC.[112] This public pressure created a political imperative: either act on the issue or risk litigation from non-TNC NGOs and further public scrutiny. The campaign emphasized the interconnectedness of water systems, groundwater, surface water and drinking water, framing the issue as one of public health and environmental integrity. Attention-grabbing examples, such as a dog dying from toxic algae exposure, helped personalize the risks and drive urgency. However, public opinion research shows that education campaigns are often ineffective unless they are paired with strong policy and funding mechanisms.

Ultimately, successful policy change requires a blend of science, strategic communication, coalition-building and legislative action. It also requires tailoring approaches to local contexts, considering factors like climate, regulatory frameworks and public sentiment, to ensure that solutions are both effective and scalable.

SECTION VII

Recommendations

Based on the research and interviews described here, TNC offers the following recommendations for effectively upgrading OWTS across the United States to enhance environmental protection:

1. Strengthen local relationships and coalitions.

Building and maintaining strong local relationships is essential for water infrastructure projects to succeed. Collaboration with local governments, community groups and regional coalitions ensures that projects are grounded in community needs and have the support necessary for implementation. Working with coalitions to submit funding requests also demonstrates unity and shared purpose, and it is something major funders increasingly look for when evaluating proposals. By learning from one another and building on collective experience, we can accelerate progress and implement more effective, scalable solutions worldwide.

2. Leverage diverse funding sources.

Utilizing all available funding streams—local, state and federal—is critical. A strong example is New York's Community Preservation Fund, established in 1998, which uses a 2% real estate transfer tax paid by buyers to support conservation efforts.[113] The fund, extended through 2060, now allows up to 20% of its annual revenue to be used for water quality infrastructure and improvements. This model shows how expanding the scope of existing funds can unlock new opportunities. In addition, programs like EPA's Southeast New England Program and state revolving funds (SRFs) should be fully explored for grant and loan opportunities.

3. Pursue innovative financing models.

Creative financing mechanisms can help overcome cost barriers. Michigan proposed an on-bill financing model that uses loans from SRFs to upgrade septic systems, with repayment structured as a special assessment on property tax bills over 10 years.[114] SRF are dedicated revolving loan funds that can serve as repositories for states to place grant funds. They can provide loans and other authorized assistance to water systems for eligible infrastructure projects. As the loans are repaid, the repayment money and interest flows back into the dedicated revolving fund, after which it can be used to make additional loans.[115] This approach could be paired with bulk purchasing strategies to reduce costs and manage inflation, while giving contractors a clear long-term vision for resource planning.

4. Develop a strong communication strategy.

Public support for infrastructure improvements is vital. A well-crafted communication strategy can help communities understand the importance of investing in their water infrastructure. It should address concerns about costs, maintenance and long-term performance. Educational tools, like short videos explaining the process, can demystify complex systems for both the public and decision makers.[116] Engaging media partners and leveraging local voices can further amplify outreach.

5. Advance nature-based solutions.

NbS offer sustainable, cost-effective alternatives to traditional infrastructure. Examples include kelp farming to absorb nitrogen, denitrifying wetlands, bioreactors and bioretention systems.[117] TNC has supported projects like the installation of a nitrogen-reducing wetland system at Cold Spring Harbor and kelp farming with the Shinnecock Nation. Another organization, Ridge to Reefs, has been able to reduce leach field impacts by up to 80% and is exploring pay-for-performance models to lower compliance costs in states like Virginia.[118]

6. Tailor nature-based solutions to local conditions.

Implementing NbS requires careful planning and stakeholder alignment. Factors such as available space, wastewater volume, climate and soil health must be considered. NbS are most feasible in locations with sufficient space, warm temperatures and clear regulatory incentives.[119] Pre-development planning, including site assessments and soil testing, is essential. Overcoming community skepticism and clarifying long-term maintenance responsibilities are also key to success.

7. Build capacity and policy engagement.

To sustain momentum, conservation staff must be organized and proactive in engaging with policy. This work includes prioritizing bills, drafting testimony and coordinating advocacy efforts. Kainan Miranda emphasized the need for structured capacity and planning,[120] while Paul Sturm highlighted the importance of education, both for the public and for regulators and engineers.[121] Real-time data and scalable models will be crucial for expanding NbS beyond small-scale applications.

8. Find innovative ways to streamline permitting.

There is a strong need to look at different ways to streamline the permitting process in order to meet the demand and scale states require, ultimately allowing them to meet their water quality and environmental standards.

For example, two bills passed by California's legislative session in June 2025 improved the permitting process. These bills, AB 130 and SB 131, accelerated the permit review process and boosted affordability for Californians.[122] They aimed to streamline the California Environmental Quality Act (CEQA) review on housing and infrastructure to accelerate the delivery of these projects. In addition, the bills expand the Permit Streamlining Act to speed up housing permitting and approvals, limit certain housing appeals and make permanent key provisions of the Housing Accountability Act and Housing Crisis Act. The bills also provide regulatory stability to control costs by freezing new residential building standards through 2031 and creating innovative mechanisms to unlock long-term investment opportunities. Some of the sustainable financing tools in the bills are a "revolving fund to reinvest equity from stabilized affordable housing into new developments" and a statewide CEQA mitigation bank to allow developers to meet their existing CEQA mitigation requirements through funding affordable, location-efficient housing and infrastructure projects.[123]

California's AB 130 and SB 131 laws are an example of how states can streamline their environmental review process. Streamlining the environmental review across an area or offering exemptions based on meeting certain standards could increase the efficiency in this process.

SECTION VIII

Conclusion

Upgrading OWTS is not just a technical challenge, it is a critical environmental and public health imperative. Across the United States, nutrient pollution from failing or inadequate OWTS continues to degrade water quality, threaten biodiversity, impact local economies and endanger human well-being. As climate change intensifies and coastal populations grow, the urgency to modernize these systems becomes even more pronounced.

Our research shows that while the path to large-scale and replicable OWTS reform is complex, it is also achievable. Case studies from New York, Hawai'i, Massachusetts, and Arizona demonstrate that success hinges on a combination of strong policy frameworks, innovative financing, community engagement and nature-based solutions. These examples also highlight the importance of tailoring strategies to local conditions, whether that means leveraging ballot initiatives, restoring wetlands or advocating for Tribal infrastructure funding.

However, systemic barriers remain. Fragmented regulations, inconsistent water quality standards, limited funding and a lack of public awareness continue to slow progress. Overcoming these challenges will require coordinated action across sectors and levels of government, as well as sustained investment in both infrastructure and education.

TNC is committed to advancing this work by supporting science-based policy, fostering cross-sector partnerships and promoting scalable, nature-based solutions. By aligning environmental goals with community needs and economic realities, we can build a future where clean water is not a privilege, but a guarantee for people and nature alike.

IX APPENDIX

Survey Methodology and Findings

To comprehensively understand the landscape of on-site water treatment system policy across TNC's programs and other external partners, we completed structured research and outreach. This work included a qualitative survey with a series of in-depth interviews conducted across internal teams and one external partner. These interviews were conducted via the interview platform Riverside.fm, which enabled both audio recording and real-time transcription.

The survey instrument, designed for both TNC members and external partners, aimed to capture background context regarding the need for improvements to on-site water treatment systems in each geographic location, as well as in the policy landscape. The following themes were discussed in detail: funding gaps, policy landscape around shaping water quality policies, sequencing of policy, the use of policy and regulatory levers and the communication strategy.

This mixed-methods approach allowed for both qualitative insights and comparative analysis of policy frameworks, technical innovations and financing opportunities for homeowners in the four different locations. We gave particular attention to challenges around the state policy landscape, how to secure funding for system upgrade projects and understanding the permitting process.

List of Respondents

Name	Affiliation	Role
Richard Bowman	TNC - Michigan	Director of External Affairs
Emma Gildesgame	TNC - Massachusetts	Climate Adaptation Director
Marian Lindberg	TNC - New York	Conservation Projects Manager (Retired)
Stuart Lowrie	TNC - People Team	Water Quality Program Director (Retired)
Kevin McDonald	TNC - New York	Senior Policy Advisor
Robert McDonald	TNC - Europe	Lead Scientist, Nature-based Solutions
Kainan Miranda	TNC - Hawai'i	Director of External Affairs
Kim Schonek	TNC - Arizona	Water Program Director
Paul Sturm	External - Ridge to Reefs	Director

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