BUILDING CAPACITY

Tim Callahan, MPH

People, Pipes, and Population Series—Part 2: Infrastructure Fragility: Digital Plans on Analog Pipes and Electrons

Editor's Note: A need exists within environmental health agencies to increase their capacity to perform in an environment of diminishing resources. With limited resources and increasing demands, we need to seek new approaches to the practice of environmental health. Acutely aware of these challenges, the *Journal* publishes the Building Capacity column to educate, reinforce, and build on successes within the profession using technology to improve efficiency and extend the impact of environmental health agencies.

Column contributors are guest authors. The conclusions of this column are those of the author(s) and do not necessarily represent the views or policies of NEHA.

Tim Callahan is a NEHA technical advisor for the Data & Technology section. Over the next year, we will publish a 4-part series authored by Callahan that explores environmental health modernization and the foundational support modernization requires.

Environmental health's modernization effort depends on systems that never appear in our budgets or dashboards: the electric grid and the water network. They power the servers that run our databases, the laboratories that test our samples, the facilities we inspect, and the homes and businesses we protect. Yet these foundations are old, expensive to maintain, and increasingly fragile.

The Overlooked Baseline

The U.S. built most of its power and water systems decades before digital public health was imaginable. Those assets are now past design life in many regions. The American Society of Civil Engineers (2025) gives the nation's overall infrastructure a C grade, with drinking water and wastewater in the C-range (i.e., mediocre and at risk). Meanwhile, the North American Electric Reliability Corporation (2025) warns that two thirds of the country faces elevated risk of electricity shortfalls during extreme heat, largely due to growth in demand and weather-related stress on transmission.

These numbers are not abstract. They describe the hidden operating environment for every environmental health program that is moving to software-as-a-service platforms or relying on cloud connectivity for inspections and records.

Recent Reminders

Each year offers a new case study of physical infrastructure failure that cascades into public health disruption.

- **Texas (2021):** A week-long freeze crippled the gas supply, halting one third of the state's power generation. Local health departments lost communication lines and digital access to inspection data while cold-chain vaccine storage became a statewide emergency.
- **Jackson, Mississippi (2022):** Flooding disabled the city's primary water treatment facility, leaving tens of thousands of people without potable water for weeks. Boil water advisories, distribution logistics, and public messaging consumed environmental health capacity for months.
- **Maui, Hawaii (2023):** Wildfires destroyed both water and power infrastructure across populated areas. Environmental health operations—from food safety oversight to vector control—were suspended as staff were reassigned to emergency response.

Each event had local causes but a national lesson: Digital modernization collapses when its physical foundation fails.

Why It Matters for Environmental Health

Environmental health professionals do not manage utilities, yet our mission depends on them. Grid failures interrupt inspection scheduling, electronic permitting, and laboratory workflows. Power loss halts cold-chain operations for samples and retail food. Water disruptions trigger boil advisories, facility closures, and disease control interventions.

Even brief outages can cascade. For example, a 2-hr network loss could delay reporting for a day, or a multiday water advisory could trigger hundreds of rescheduled inspections and increased public complaints. Most agencies lack redundant power or offline-ready applications. In an era where

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TABLE **1**

Selected National Infrastructure Indicators

Category	Indicator	Reported Value	Notes	Source
Power grid reliability	Regions with elevated summer shortfall risk	Approximately two thirds of U.S.	Driven by demand growth, extreme heat, and reduced firm generation. New resource growth (mainly solar/batteries) helps but doesn't offset all strain.	North American Electric Reliability Corporation, 2025
Power outages	Major outage events (1st quarter, 2024)	72 outages, 4,608,515 customers	Outages mainly caused by severe weather, wildfires, and aging infrastructure.	U.S. Department of Energy, n.d.
Water system quality	Overall U.S. drinking water grade	C grade	Indicates chronic underinvestment and age-related failures. Infrastructure grade plateaued at a C- grade.	American Society of Civil Engineers, 2025
Lead line replacement	Systems required to complete inventories by 2027	Approximately 67,000 systems	All U.S. water systems must inventory and plan for full lead service line replacement by 2027, with final replacement deadlines typically by 2037.	U.S. Environmental Protection Agency, 2024
Disaster recovery cost	Average FEMA public assistance obligation or incident (2020–2024)	Project average is $473,328 (nonpilot)	Rising costs reflect compounding infrastructure fragility and higher frequency and severity of events.	Federal Emergency Management Agency (FEMA), 2026

modernization projects assume "always on" connectivity, that assumption is now the weakest part of the plan.

The Cost of Catching Up

The U.S. Environmental Protection Agency (2024) estimates that tens of billions of dollars will be required over the next decade to replace lead service lines under the Lead and Copper Rule Improvements that was finalized in 2024. Approximately 67,000 of small- and mid-sized systems will need technical assistance to complete inventories by 2027. Every inventory and replacement cycle produces new data, advisories, and public contacts that flow directly into local environmental health workloads.

For power, reliability investments lag behind the electrification trend. Extreme weather events that once happened once per decade have now occurred multiple times within a 5-year span (North American Electric Reliability Corporation, 2025). Recovery costs, as measured through the Federal Emergency Management Agency's (2026) public assistance obligations, show a steady rise in infrastructure-related declarations. These budget lines are not abstract; they are indirect drivers of environmental health workload and the demand for risk communication.

What the Data Suggest

Infrastructure fragility is not evenly distributed. Rural areas often have aging substations and single-feed power lines, and urban cores have water systems with century-old mains. Both can fail in different ways. The indicators in Table 1 summarize national benchmarks that, while approximate, frame the scale of the dependency problem.

Lessons Emerging

Environmental health has matured into a data-driven profession, but its infrastructure assumptions remain analog. The sector tends to plan for system upgrades, not system interruptions. The key lesson from recent disasters is that modernization and resilience must evolve together.

- **Modernization without resilience is brittle.** New platforms cannot function when connectivity, power, or water are unavailable.
- **Resilience without modernization is sightless.** Outages that disrupt paper-based operations erase visibility, consume workforce capacity, and delay recovery.
- **Environmental health sits at the intersection.** We depend on utilities, yet are accountable to the public when they fail.

Ignoring this interplay leads to unrealistic project timelines, false confidence in continuity plans, and staff left improvising with paper logs and personal devices when networks go down.

Building Capacity Means Building for Realities We Cannot Control

Capacity building is often framed as staffing, funding, or technology acquisition. It should also mean developing realistic expectations about the systems we rely on but do not control. The power grid and the water network are the quiet dependencies beneath every modernization effort. Recognizing their fragility is the first step toward designing systems that can ride through inevitable interruptions.

Be Aware/Prepare

Be Aware

- Two thirds of the U.S. face elevated grid reliability risk during peak demand seasons (North American Electric Reliability Corporation, 2025)
- Drinking-water infrastructure remains graded in the C- range nationally, signaling chronic underinvestment (American Society of Civil Engineers, 2025)
- Lead-service line replacement and advisory workloads will rise sharply through 2037 (U.S. Environmental Protection Agency, 2024)

Prepare

- Assume periodic power or water disruptions when planning modernization schedules
- Ensure critical operations can function offline for at least 72 hr
- Treat infrastructure metrics similar to grid alerts and water advisory frequency as operational indicators—they are not external trivia

Looking Ahead

Infrastructure is the second leg of the environmental health modernization platform. The first was people. The next will be population and addressing how climate-driven migration and demographic change redistribute both workload and vulnerability. Together, these themes define the real platform environmental health is building on: people, pipes, and population.

AI Disclaimer: The author used Chat GPT for review prior to final drafting of this column with the following prompt: "Act as an expert editor for an academic journal. Review the attached article for coherence, grammar, and engagement with environmental health professionals. Do not change any text and only make recommendations for edits. Before generating anything, ask questions to help produce the best result."

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