

## AI GUARDRAILS #2

# /// THE ECONOMICS WON'T WAIT

Andy Bochman | Resilience Strategic Lead | West Yost

### TL;DR

*Water utilities face a convergence of crises — workforce retirement, aging infrastructure, capital backlogs measured in trillions, and intensifying climate extremes—that make GenAI adoption feel less like a choice and more like a necessity. Building an effective governance framework requires confronting how these pressures are shaping decisions; if you don't fully acknowledge the drivers, you can't make intentional choices about adoption.*

### INTRODUCTION

The first paper in this series explained why GenAI risks are categorically different from traditional cybersecurity threats and why existing frameworks are poorly equipped to address them. But before we can build governance structures adequate to those risks, we must reckon honestly with the forces that are driving GenAI adoption in water utilities.

For many utility leaders, GenAI adoption will not feel optional. The promised efficiencies are too compelling, the workforce crisis too acute, and the infrastructure backlog too deep for any responsible utility leader to simply sit this transformational moment out. That is not an argument for reckless deployment — it is an argument for urgency about governance. You cannot govern what you have not honestly confronted.

This paper examines the operational and economic pressures that are accelerating GenAI adoption across the water sector, the genuine capabilities GenAI offers, and the human factors that complicate any deployment. The third paper in this series will provide the governance framework utilities need to deploy GenAI safely.

### THE WORKFORCE CRISIS

Number one among the pressures driving GenAI adoption is the fact that an aging workforce is draining vital expertise from utilities with every passing year. It is a workforce that, while not necessarily taking its knowledge to the grave, is at least taking it to the golf course, the beach, or a retirement village. The brutal fact is that many

organizations see 30–40% of their workforce retiring in the next few years, compounded by significant hiring and retention challenges that mean similarly skilled or experienced replacements will be difficult to find. This convergence may portend:

- According to the EPA and Bookings, field inspection and operations capacity could fall by 30–50% as the retirement wave crests
- even as the amount of infrastructure requiring inspection is increasing due to its advanced age.
- Institutional knowledge evaporating as seasoned professionals walk out the door. The person who knows why an important pump station behaves oddly, or why a certain valve configuration exists, or what happened in the 1993 freeze that explains the current setup, is no longer accessible.
- With fewer qualified people diagnosing problems, outages linger longer — translating into the hard financial costs associated with emergency repair versus planned maintenance.

The Water Research Foundation's Project 5321 report, published in September 2024, had multiple callouts envisaging AI agents as a promising pathway for "preserving institutional knowledge." It also noted that in smaller utilities, "staff are already stretched thin, and vital knowledge often leaves with retiring employees." And this: "Early pilots show that Large Language Models (LLMs) can preserve institutional knowledge and enable real-time insights, helping even the smallest utilities modernize workflows and compete on a more level playing field."

Small and mid-size utilities will likely be more motivated to embrace GenAI solutions even more rapidly than their larger peers. If a high percentage of utilities serving 10,000 or fewer people can't afford formal security governance, the adoption pressure may hit them hardest while they enjoy the least protection. This asymmetry — maximum pressure, minimum capacity — deserves the water sector's focused attention.

## THE INFRASTRUCTURE BACKLOG

On top of the worrying personnel issues, there is the fact that infrastructure is getting older faster than it can be replaced or upgraded. Water systems with pipes from the 1920s–1960s, treatment plants now reaching their design capacity much earlier than originally projected, pump stations running around the clock that were meant for only intermittent use. As the capital backlog is measured in the trillions across US water infrastructure, when someone offers you an AI system that can:

- Monitor hundreds or thousands of sensors in real-time, versus monthly field checks
- Predict pipe failures six months out based on pressure transients, flow patterns, and water chemistry
- Optimize pump schedules to reduce energy costs 20–30%
- Flag anomalies that would take a 20-year veteran to notice
- Provide 24/7 “expert” guidance to junior operators

...not only will turning to GenAI feel like the biggest no-brainer, but utility directors who don’t adopt it may come to be seen as irresponsible to their ratepayers. That is the uncomfortable reality utility leaders must navigate: the pressure to adopt is real, and it is not coming only from vendors.

## THE CONTROL ROOM OF THE NEAR FUTURE

There is one more thing the AI salesman may tell you — and on this point, they may well be right. Your current control room relies on SCADA screens showing current state; when something looks odd, it triggers a call to a senior technician. Hopefully they are available. But here is what AI will enable in the near future:

- A view on not only current state, but a probabilistic six-hour forecast of system behavior.
- Something close to instant context: “This pressure drop pattern matches 23 previous incidents, where 18 were frozen services, 3 were main breaks, 2 were submerged meter vaults.”
- Access to a “digital twin” of a retired expert troubleshooter that can explain why the 1997 configuration prevents a certain failure mode.
- What-if scenarios: “If I switch to the backup pump now versus waiting two hours, what are the cascade risks?”
- Optimization and safety recommendations delivered with confidence intervals and risk scores — a genuine decision support tool for operators of every experience level.

These are not marketing fantasies. Early deployments in analogous sectors: aviation, healthcare, and large-scale manufacturing, have demonstrated similar capabilities. The water sector will get there too. The question is not whether these capabilities will arrive, but whether the governance structures to manage them responsibly will arrive first.

## THE REGULATORY ACCELERANT

One additional dynamic deserves mention. Some utilities have already attempted to ban GenAI from their operations. Their hands may be forced in time, as AI capabilities become embedded in newer versions of existing SCADA, asset management, and predictive maintenance systems they already use. The choice may not be whether to deploy AI, but whether to deploy it knowingly or unknowingly.

Moreover, if the Environmental Protection Agency (EPA) or the Department of Homeland Security (DHS) issue guidance that effectively discourages or restricts frontier cloud AI in OT-adjacent contexts — which sounds plausible given the current direction of critical infrastructure cyber policy — approaches that run customizable AIs locally on utility-controlled infrastructure may shift from a technical preference to a compliance requirement. Utilities that have done the governance work will be better positioned regardless of which regulatory direction the wind blows.

## THE HUMAN SIDE OF DEPLOYMENT

The economic and operational case for GenAI adoption is compelling. But do not forget the human side of new technology deployments. Adoption — fast or slow — requires gaining operator trust and significant retraining, amid resistance from some. Operators who have spent careers developing expertise will not automatically welcome systems that seem to second-guess their judgment.

This is not merely a change management problem. It has safety implications. The cognitive offloading risk — in which operators grow so reliant on AI guidance that their own situational awareness and manual skills atrophy — is well-documented in aviation, healthcare, and military contexts. Water utilities must learn from those sectors rather than repeat their mistakes. Maintaining genuine human expertise alongside AI assistance is not optional overhead; it is a core safety requirement.

## WHAT COMES NEXT

The economic case is strong. The operational pressures are real. The adoption trajectory is largely set. The only remaining question is whether water utilities will build the governance capacity to manage GenAI safely before or after something goes seriously wrong.

The third paper in this series provides the answer: a practical governance framework built on Cyber-Informed Engineering (CIE) principles — an emerging engineering discipline in the water sector— applied to AI safety challenges that cybersecurity was not designed to address. It covers foundational prerequisites, procurement strategy, engineered controls, design simplification, planned resilience, and the governance gaps that agentic AI is already beginning to open.

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Andy Bochman is Resilience Strategic Lead at West Yost. He previously served as Senior Grid Strategist at Idaho National Laboratory, where he co-developed the Cyber-informed Engineering (CIE) methodology. He is the co-author of *Countering Cyber Sabotage* (CRC Press, 2021).

Comments and questions: [resilience@westyost.com](mailto:resilience@westyost.com)