Intelligent Water

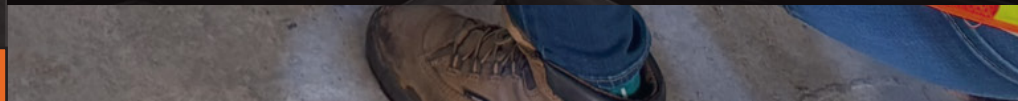
Water utilities are navigating unprecedented complexity. Aging infrastructure, climate variability, regulatory pressure, and workforce constraints are converging at a time when reliability and affordability are non-negotiable. Meeting these challenges requires more than incremental improvement, it requires intelligence embedded across planning, operations, and decision-making.

Intelligent Water is Arcadis' human-centric approach to applying digital twins, artificial intelligence (AI), and digital advisory services to help utilities transition from reactive management to proactive, outcome-driven performance. By combining engineering expertise, data, and analytics, Arcadis enables utilities to make confident, timely decisions that improve resilience and service to the communities that they anchor.

Does AI have a role to play in securing safe, reliable, sustainable drinking water? The International Monetary Fund's study on AI and the future of work found that almost 40 percent of global employment is exposed to AI, emphasizing how AI has permeated the workplace globally. Even before the rapid rise of AI in the workplace, recent research found about 60 percent of job functions today did not exist in 1940.

ARCADIS

While most utility leaders believe they know what needs to be done…only 11% strongly feel their utility is future ready.



Current Landscape & Trends

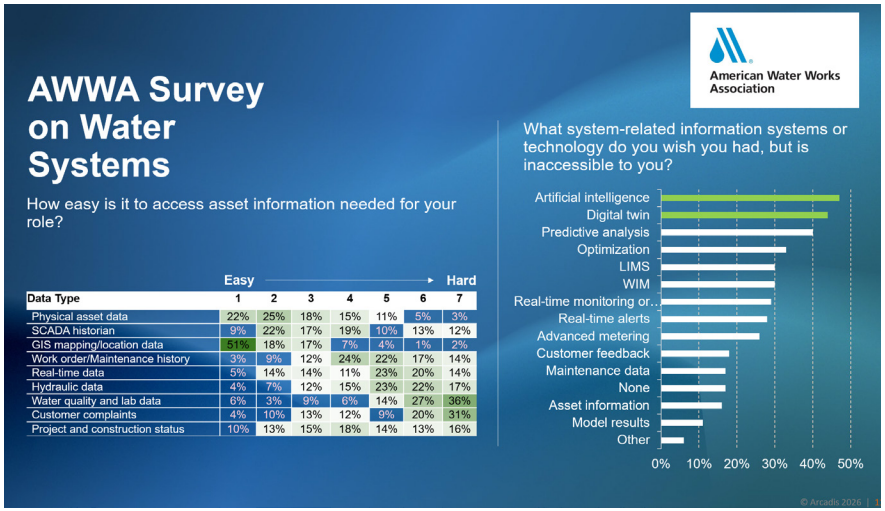
The adoption of AI, digital twins, and advanced analytics is accelerating, but many utilities face barriers such as resource constraints, data challenges, skill gaps, and organizational resistance. Industry frameworks like WRF Project 5189 guide utilities in advancing automation, analytics, and AI.

Across the water sector, the gap is widening between the data utilities collect and the insight they can apply. Many organizations rely on static models, disconnected systems, and manual analysis that limit their ability to anticipate risk and optimize performance.

Utilities have more data and less time

The gap between data and decisions

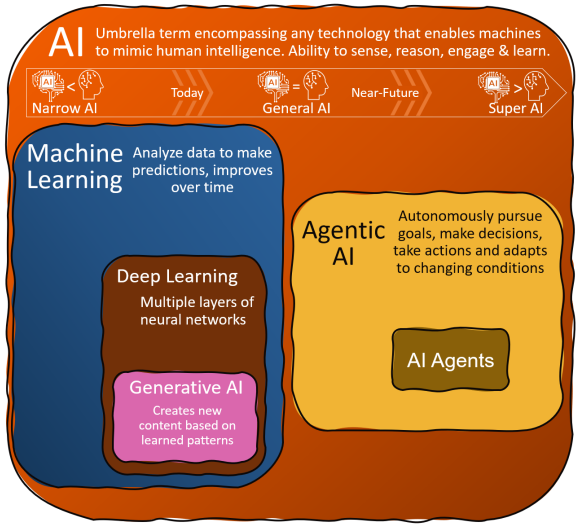
Many utilities collect large volumes of operational, asset, and customer data, yet still rely on fragmented systems, manual workflows, and static models. The result is delayed insight and inconsistent prioritization — particularly when conditions change quickly.



Data Type	1	2	3	4	5	6	7
Physical asset data	22%	25%	18%	15%	11%	5%	3%
SCADA historian	9%	22%	17%	19%	10%	13%	12%
GIS mapping/location data	51%	18%	17%	7%	4%	1%	2%
Work order/Maintenance history	3%	9%	12%	24%	22%	17%	14%
Real-time data	5%	14%	14%	11%	23%	20%	14%
Hydraulic data	4%	7%	12%	15%	23%	22%	17%
Water quality and lab data	6%	3%	9%	6%	14%	27%	36%
Customer complaints	4%	10%	13%	12%	9%	20%	31%
Project and construction status	10%	13%	15%	18%	14%	13%	16%

Agentic AI is moving from concept to capability

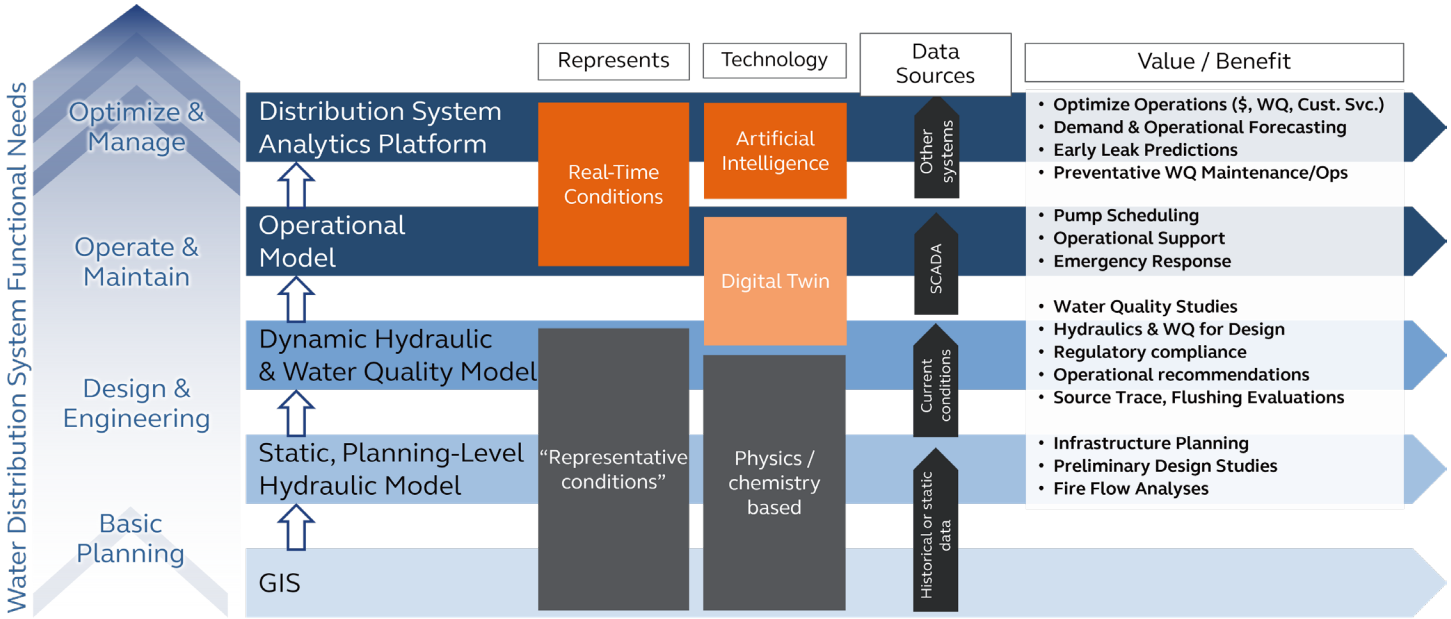
Across the sector, predictive AI is being used to forecast asset condition and operational risk. This is distinct from generative AI. Predictive AI focuses on forecasting and optimization based on data-driven insight, supporting practical use cases such as condition assessment, forecasting future system states, and optimizing resource utilization.



Digital twins are becoming the operating model

Digital twins provide dynamic representations of real-world systems by integrating models with current data. They support scenario testing, operational visibility, and planning decisions that adapt as the system changes.

As an example, let's focus on water distribution systems, beginning with the basics and functional needs. Every system needs a GIS and planning-level hydraulic model to support basic planning, design and engineering functional needs. These tools, while effective for their purpose, can be leveraged to obtain significantly more value by connecting to real-time data sources and sensors. This allows the investment in developing and calibrating a model to extend well beyond planning into operations and maintenance purposes. With the rapidly scaling capabilities of AI within water distribution system model, this further unlocks the value beyond operations into real-time optimization and management.



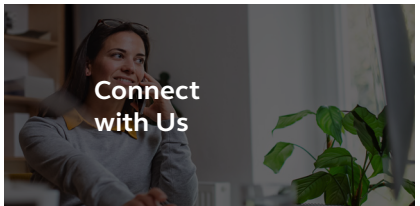
The City of Houston, Texas is currently implementing this Intelligent Water approach. **Satish Tripathi, Managing Engineer at Houston Water, said:** "Houston Water is currently developing a digital twin, aimed at improving decision-making and community service through updating the city's hydraulic model to align with modern AI-era modeling techniques. The Water Infrastructure Planning Group has chosen Arcadis as our partner in this endeavor. We are optimistic that this project will establish a new standard in modeling practices and expand the application of models within the framework of digital twins."

A people-centric shift

Utilities are also facing rising public scrutiny and expectations. Thought leadership emphasizes that utilities are evolving from silent service providers toward community anchors and that digital capability must be paired with community education, transparency, and trust. Arcadis is leading Water Research Foundation Project 5178, Preparing the Water Sector to Embrace Technology: Skillsets and Enterprise Management Approaches for the Digital Age. One finding from this research is that foundational skills shown below significantly vary across water utilities.

Arcadis thought leadership highlights a critical shift: artificial intelligence and digital twins are no longer experimental technologies. Predictive AI is being applied today to forecast asset condition, system performance, and operational risk. Digital twins are enabling utilities to move from retrospective analysis to forward-looking decision support, supporting both day-to-day operations and long-term capital planning.

Foundational Skill	Description
Digital & AI Literacy	Basic fluency in what AI tools do, how they work at a high level, and when human judgment is required.
Prompting & Instruction Design	The ability to ask clear questions, give context, and guide AI tools to produce accurate, useful outputs.
Verification & Safe Use	Checking, validating, and questioning AI recommendations before acting on them.
Data Awareness & Interpretation	Understanding where utility data comes from and how to interpret AI-generated summaries or insights.
Communication & Documentation with AI	Using AI to write, summarize, translate, and improve clarity in reports, logs, and customer communications.
Collaboration & Team-Based AI Use	Sharing AI-supported insights responsibly and working together across teams to interpret or verify outputs.
Cybersecurity & Safe Interaction Practices	Knowing what information must never be shared with AI tools and following safe login, access, and data practices.
Adaptability & Critical Thinking	Being open to learning new tools, questioning outputs, and adjusting workflows as AI capabilities evolve.



Enablers & Solutions

Digital twins are the foundation of Intelligent Water. They provide dynamic, continuously updated representations of physical water systems by integrating real-time data, engineering models, and analytics. Arcadis digital twins support scenario testing, operational optimization, and system-wide visibility across the asset lifecycle.

Artificial intelligence enhances these capabilities by identifying patterns, forecasting future states, and prioritizing actions. Arcadis emphasizes predictive AI applications that improve reliability, reduce risk, and support defensible decision-making. Digital Advisory services ensure that technology investments are aligned with organizational readiness, governance, and workforce capability—translating innovation into lasting value

Digital twins + AI + advisory: designed to work together

Digital twins: a shared operational picture

Arcadis' digital twin approach connects physical and digital worlds to model, manage, operate, and simulate real-world assets and systems. By integrating data sources and analytics, digital twins can enable continuous monitoring and "what-if" analysis across the lifecycle.

AI: decision support grounded in engineering context

AI can process large datasets quickly, identify patterns, and make predictions. In water, the most durable value often comes from predictive applications that improve reliability and reduce risk while keeping professional judgment with utility teams.

Digital Advisory: turning technology into adoption

Digital transformation fails when it is treated as a software rollout. Digital Advisory services align use cases, governance, workflows, and workforce capability so utilities can move from pilots to scaled impact. The goal is measurable outcomes not technology deployment for its own sake.

Secure and scalable foundations

Arcadis' digital twin platform is described as scalable and secure, developed in partnership with Microsoft, with flexibility to deploy in client environments or as a managed service.

Implementation Strategies

Successful Intelligent Water programs are purpose-led and incremental. Arcadis works with utilities to assess readiness, define high-value use cases, and deploy solutions that deliver early value while establishing a scalable foundation.

A practical path from pilot to scale

Start with a business case, not a platform

Utilities adopting AI successfully start by clarifying objectives and selecting use cases where improved decision quality directly affects outcomes. Common motivators include compliance deadlines, workforce shortages, and operational efficiency, including early leak detection and automation of complex systems.

Address barriers head-on

Industry thought leadership highlights recurring barriers: skills and capacity, uncertainty about ROI and payback, and funding constraints. A phased roadmap helps reduce risk by proving value early and building capability in parallel.

Deliver in phases

Arcadis implementation programs typically sequence: (1) readiness assessment, (2) priority use cases and data foundation, (3) prototype/ pilot, (4) operationalization with governance and workflow integration, and (5) scale across functions.

Governance and trust are non-negotiable

Responsible AI use requires transparency, clear accountability, and documented human review, especially where decisions affect compliance, safety, and service levels.

Digital twins often begin as targeted planning or operational tools and evolve into enterprise platforms supporting multiple business functions. Consistent across Arcadis engagements is the importance of leadership alignment, cross-functional collaboration, and clear measures of success.

Data Proliferation

Without proper management of this seemingly endless data accumulation, it can quickly become unmanageable and unworkable.

Data proliferation requires strong management

Keep Your Data Accurate

Inaccuracies in data can often be overlooked, only revealing themselves when it's too late.

Data Governance allows organizations to stay on top of their data and therefore maintain high consumer confidence.

Builds confidence and avoid mistakes

Accessibility to More Powerful Data Analytics

By forming analytics into your data governance framework, it opens doors to data-discovery into social network, machine - generated, and internal data environments.

A stronger understanding of data leads to stronger results

Increased Regulations

Regulatory requirements for data have become more demanding in terms of data privacy, protections, and accessibility.

Ensure your data is safe, secure, and compliant.

Maintain compliance to gain trust in public, private & government spheres

01

Preparing for the journey - building the case for change

02

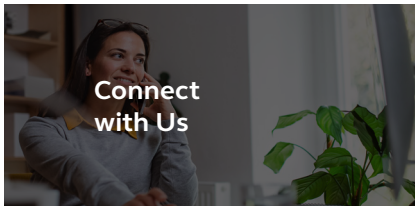
Setting off on the journey - recognizing the organizational impacts

03

Taking others on the journey - aligning the whole business

04

Choosing interchanges on the journey - the route to success



> Utilities that realize the greatest value from Intelligent Water focus on decisions, not tools. They prioritize use cases where improved insight directly affects outcomes such as service reliability, capital efficiency, and risk management.

Five moves utilities can make this quarter:

1) Define “decision moments”
Identify the 10–20 recurring decisions where uncertainty is costly, e.g., which pipes to replace, how to tune operations during extremes, how to prioritize inspections, or how to target field work. Build Intelligent Water use cases around these decision moments.

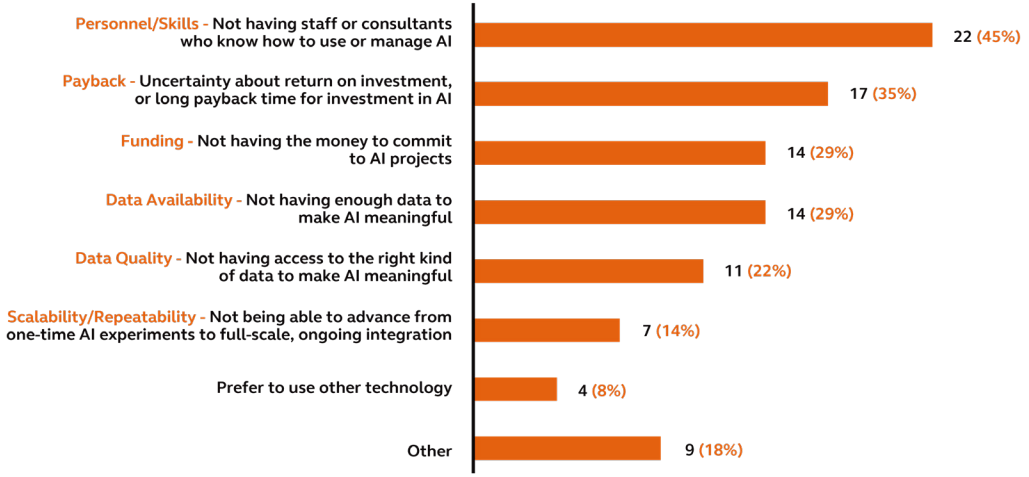
2) Use what you already have
Many organizations have underused historical data that can yield insight through thoughtful analysis. Start by improving data accessibility, quality, and linkage across systems that already exist.

3) Prioritize predictive value
Favor predictive use cases that improve reliability, reduce disruptions, and strengthen capital efficiency. Predictive AI is described as mature and practical for utilities because it focuses on forecasting and optimizing system performance.

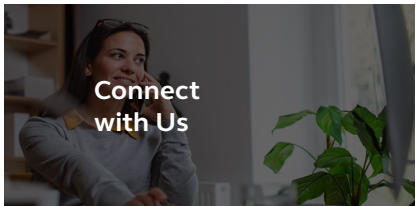
4) Invest in people and change
Adoption depends on workflow redesign, training, and role clarity. Digital transformation requires a mindset and behavioral shift, not just automation.

5) Build trust through transparency
Put transparency into the process: define what AI is (and is not) doing, document review responsibilities, and communicate how decisions are made.

Barriers and concerns regarding AI implementation: industry view



Arcadis recommends that utilities clarify decision objectives, leverage existing data more effectively, invest in workforce capability alongside technology, and govern AI transparently to build trust internally and with stakeholders. Intelligent Water succeeds when people, process, and technology advance together.



Connect With Us

Arcadis brings together global expertise in digital twins, artificial intelligence, advisory services, and change management. Our Intelligent Water specialists work alongside utility leaders, planners, and operators to deliver practical, scalable solutions grounded in engineering excellence and informed by data. The focus remains human-centric: empowering teams to make better decisions at the right time.

Follow the latest resilience strategies and stories on LinkedIn and connect with our Subject Matter Experts:

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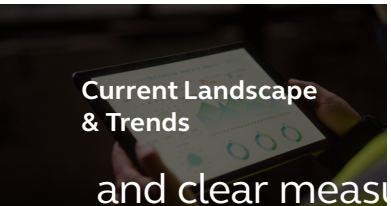

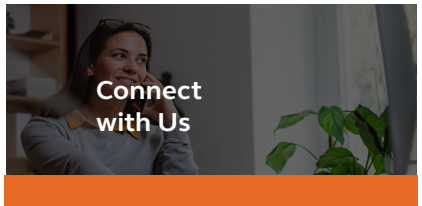

Arcadis is a leading researcher for the application of AI within the water sector

01 **Water Research Foundation 5178: Preparing the Water Sector to Embrace Technology**
Lead by Arcadis

02 **Water Research Foundation 5189: Artificial Intelligence Adoption Framework for W/WW Utilities**
Lead by Arcadis

03 **AI for Water: Evaluating Impact on the Water Workforce**
Collaboration between Bluefield Research & Arcadis

04 **US Regulatory Survey on use of AI in public water systems**
Performed by Arcadis

05 **AWWA Survey on Water Distribution System Technology, Including Digital Twins, AI, Modeling**
Lead by Arcadis' AWWA Committee Chairs

06 **Water Research Foundation 5294: Data Management Best Practices: Integrating Data Sources**
Lead by Arcadis

07 **Water Research Foundation 5189: Quantifying the Impact of Artificial Intelligence/Machine Learning-Based Approaches to Utility Performance** | Lead by Arcadis