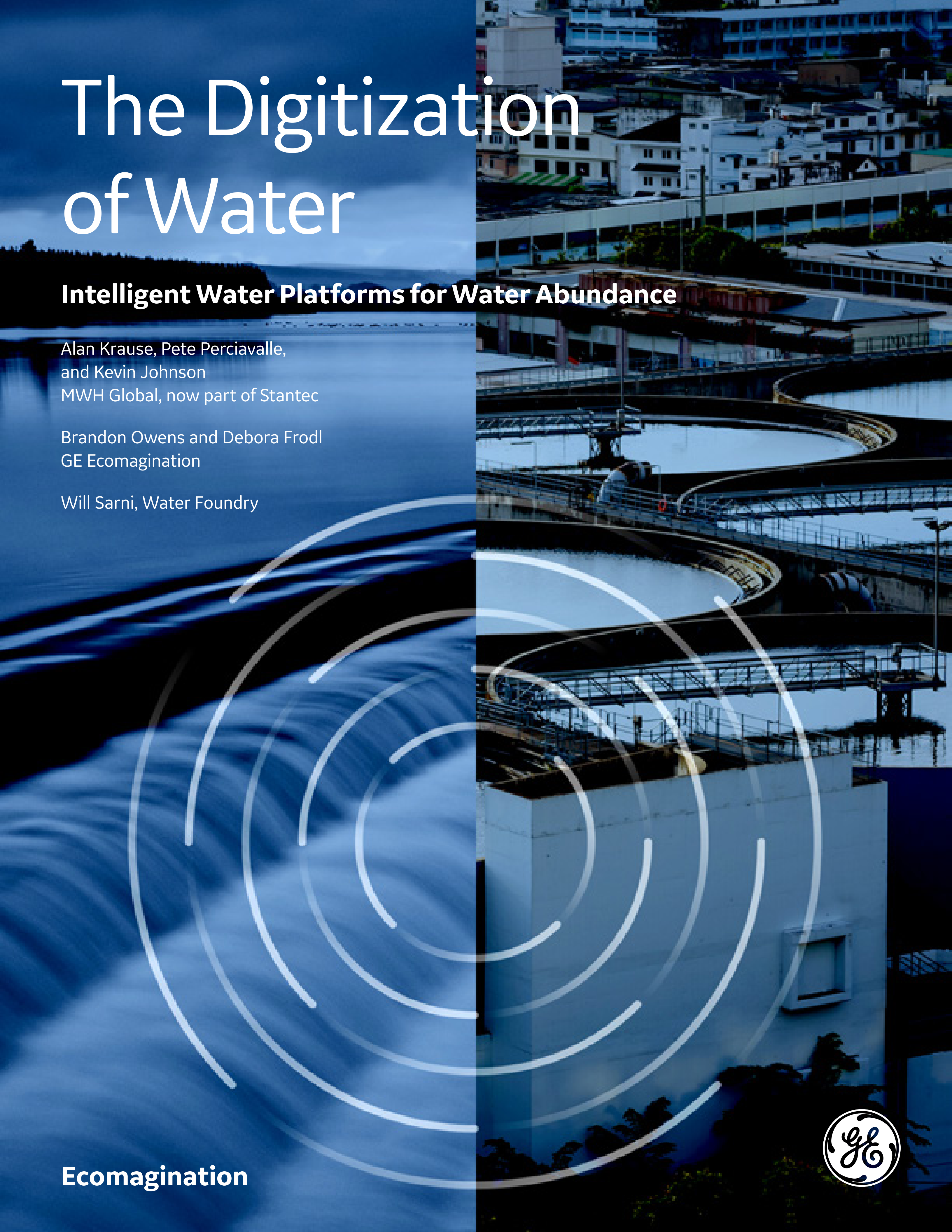

The Digitization of Water

Intelligent Water Platforms for Water Abundance

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FOREWORD

General Electric (GE) and MWH Global, now part of Stantec, have rich histories of working collaboratively to develop innovative solutions to complex problems. Both organizations believe in the application of sound science and smart technologies in support of more effective decision-making; and both organizations build on the best available data to have a positive impact on our world.

As a 125-year old technology company, GE has always believed in progress, investing, and taking risks to improve technology and build a brighter future for our customers and the world around us. From the invention of the first practical incandescent light bulb, to building America's first central power station, the GE tradition of life-changing innovation is unparalleled. Twelve years ago, with a vision to make a global impact on environmental outcomes and economic growth, GE decided to redefine what it means to be environmentally focused. In 2005 we launched GE Ecomagination (ecomagination.com) to provide advanced technology solutions that improve resource efficiency and economics for our customers, and improve efficiency in our own operations.

Likewise, since its founding in 1820, MWH Global has engaged in the engineering, construction, and management of some of the largest and most technically advanced water, hydropower, mining, and transportation projects for municipalities, governments, and multinational private corporations throughout the world. The role of MWH Global is to help manage water purity and availability in a sustainable fashion for the health, livelihood and security of people worldwide.

In partnership, GE and MWH Global hope to advance innovation in the global water industry through the application of digital technologies in order to increase global water abundance. Together, MWH Global and GE are committed to providing water utilities across the globe with end-to-end digital water solutions. Within this partnership, MWH Global offers extensive domain expertise and will act as integrators into core operations of water utilities by leveraging new digital technologies. GE will provide advanced digital solutions based on Predix,™ GE's Industrial Internet operating system.

New digital technologies are enabling water utilities and industries across the world to extract greater information and efficiencies from legacy water infrastructure to enhance decision-making, promote water conservation, build twenty-first century water infrastructure, and—perhaps most importantly—increase the value and benefits of the global water infrastructure network.

The potential for water conservation is vast. According to the United Nations Food and Agriculture Organization (FAO) Current global water consumption is around 4.5 cubic kilometers (km^3). Leakage rates in major cities range from 10 to 50 percent. If, on average, 25 percent of water leaks before it reaches its intended use, that means that 1 km^3 of water is lost every year as a result of aging and inefficient infrastructure. If digital tools can help water utilities detect and reduce water leakage by just 10 percent, this translates to an annual water savings of 0.1 km^3—or nearly 30 billion gallons.

"If digital tools can help water utilities detect and reduce water leakage by just 10 percent, this translates to an annual water savings of nearly 30 billion gallons."

MWH Global and GE are excited about the opportunity to play a role in helping to confront global water infrastructure challenges, and accelerate the pathway to a sustainable and productive water future that provides improved infrastructure and better water access to businesses and communities across the globe.

The future of water has just begun. Join us, and we'll get there together.

Alan J. Krause

Alan Krause
President, MWH Global, now part of Stantec

Deb Frodl

Debora Frodl
Global Executive Director, GE Ecomagination

INTRODUCTION

"The digitization of water will lead to improved infrastructure, less waste and greater water availability. The economic and social gains will be unprecedented for communities, businesses and the planet. Welcome to the future of water."

Alan Krause, CEO, MWH Global now part of Stantec

The same forces that unleashed the Industrial Internet are now leading the digitization of the global water business and public sector ecosystem. The lessons learned from the digitization of other sectors such as heavy industry, manufacturing, power, media, retail, communications, healthcare, and education are now being successfully applied to water infrastructure and commercial projects.

For example, the integration of industrial machines with information and communications technologies is being applied to water infrastructure around the world. This transformation will vastly improve the way water is collected, transported, treated and used efficiently in environments across the globe. The results will be beneficial to communities, businesses and natural ecosystems.

The digitization of water promises to help transform water infrastructure in both developed and emerging economies. In developed economies, many centralized water systems need upgrades and improvements to address system failures and chronic inefficiencies. Digital technologies are opening up new opportunities to improve water infrastructure capital and operating efficiency, enhance public safety and health via real-time monitoring, and early detection of major and minor asset failures at a much lower cost. In emerging and developed economies, digital technologies have the potential to not only improve centralized water infrastructure management and repair but also the adoption of distributed, decentralized, and off-grid water treatment technologies, improved water use in agriculture, and overall surface and groundwater management.

The ability of digital technologies to improve the efficiency of water use and increase the availability of water can lead to unprecedented economic development, business growth, and social well-being for a range of stakeholders. Water management is a critical issue nearly everywhere, and the digitization of water promises to deliver real, lasting solutions to solve one of the world's most pressing resource and infrastructure challenges while maximizing water quality and availability to consumers, businesses, and industries.

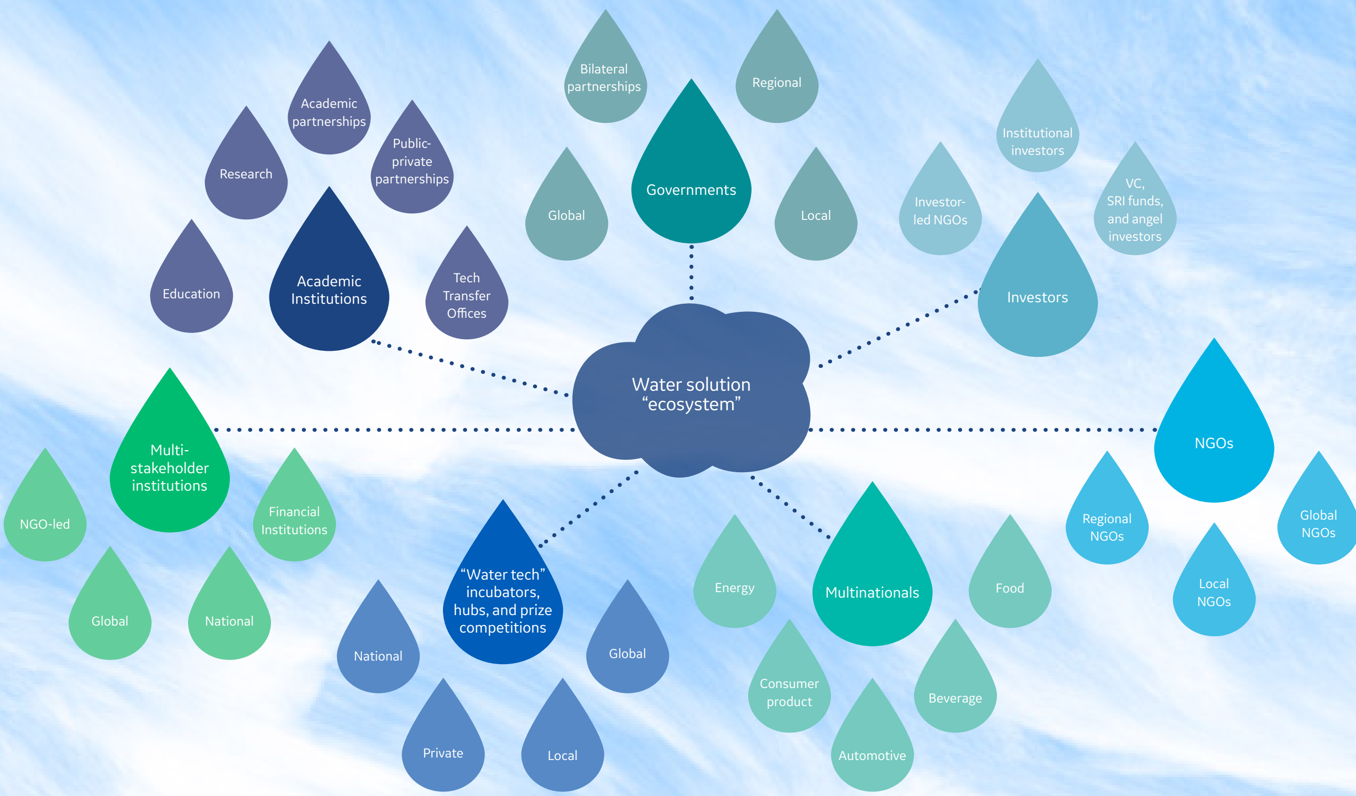
Success in addressing global water challenges through digitization will require not just innovative technologies but also innovative partnerships. These relationships will benefit from breaking out of siloed thinking, and will allow expansion into forward-looking business models, new funding strategies, and new collaborative partnerships.

We know from experience that innovative solutions can't evolve in a vacuum. They must attract resources, draw in capital, partners, suppliers, and customers to create cooperative networks. From our perspective, companies should be viewed not as a member of a single industry but as part of a business ecosystem that crosses a variety of industries. In a business ecosystem, companies co-evolve capabilities around new innovations. They work cooperatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations.

Further, it is not possible to integrate the water ecosystem into the digital water ecosystem overnight. It will require a large group of stakeholders—the public sector, academics, NGOs, and multinationals—to successfully digitize water. This business ecosystem is key to incentivizing people to install these devices to make water operations more efficient. Once water utilities demonstrate their ability to adapt their infrastructure and implement these smart technologies, others will follow as water efficiency and business productivity increases.

This is why MWH Global and GE have formed a strategic partnership to accelerate the development and deployment of digital water solutions. Since its founding in 1820, MWH Global has engaged in the engineering, construction, and management of some of the largest and most technically advanced water, hydropower, mining, and transportation projects for municipalities, governments and multinational private corporations throughout the world. The role of MWH Global is to help manage water purity and availability in a sustainable fashion for the health, livelihood and security of people worldwide. MWH

Figure 1: Generalized water innovation ecosystem



Source: Adapted from Kelly, Eamonn. 2015. *Business ecosystems come of age*. Deloitte University Press.

Global is a leader in driving new management means and methods such as "TOTEX," whereby capital and operating expenses are both considered in engineering options. We are leaders in research and development of water-related sciences; and we are leaders in water-related project delivery. We are now adding the digital sciences to all of these elements.

GE is a 125-year old technology company with a twenty-first century focus on the digitization of industry through its GE Digital business. GE's Industrial Internet operating system, Predix, provides the software foundation for the digitization of water. The Predix operating system provides clients with a broad digital canvas for innovation.

"GE and MWH Global are working together to transform the global water industry through new solutions and holistic engineering options. This will lead to greater water abundance, which is good for people and the planet. That's what GE Ecomagination is all about."

Debora Frodl, Global Executive Director, GE Ecomagination

Together, MWH Global and GE are committed to providing water utilities across the globe with end-to-end digital water solutions. Within this partnership, MWH Global offers extensive domain expertise and will act as integrators into core operations of water utilities by leveraging new digital technologies.

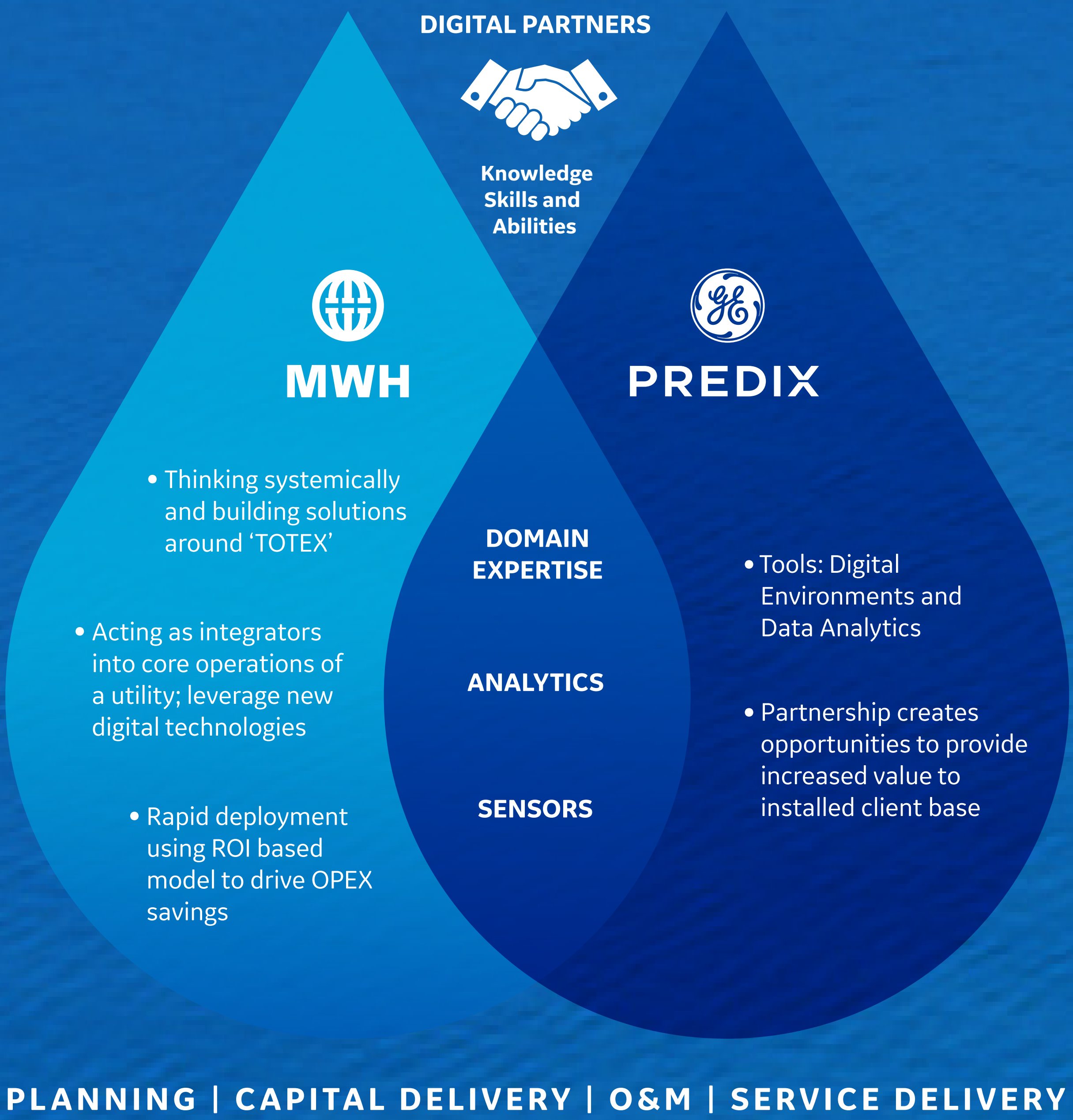
GLOBAL WATER CHALLENGES

Water resources, and the range of services they provide, underpin poverty reduction, economic and business growth, and environmental sustainability. From food and energy security to human and environmental health and economic development, water contributes to improvements in social well-being and inclusive growth, affecting the livelihoods of billions.

In the industrial sector, water is an essential resource in the production of many types of goods and services including food, energy, and manufacturing. Water supply must be reliable and consistent to support growing financially-sustainable investments in economic activities. Assuming business as usual, global water demand for the manufacturing industry alone is expected to increase by 400 percent from 2000 to 2050, leading all other sectors, with the bulk of this increase occurring in emerging economies and developing countries (The United Nations World Water Development Report, 2015).

Despite the extreme need for and reliance on water, the world's water infrastructure is not keeping pace with the growing demand. Modernization of water systems—both in developing countries as well as some of the world's most highly-developed economies—is urgently needed to ensure a safe, reliable water supply. In the United States alone, much of the drinking water infrastructure is nearing the end of its useful life. The American Society of Civil Engineers (ASCE) gave drinking water infrastructure a "D" rating in 2017. There are an estimated 240,000 water main breaks per year in the United States. Failures in drinking water infrastructure can result in water disruptions, impediments to emergency response, and damage to other types of infrastructure. Broken water mains can damage roadways and structures and hinder fire-control efforts while wasting trillions of gallons of water. Unscheduled repair work to address emergency pipe failures may cause additional disruptions to transportation and commerce (2013 Report Card for America's Infrastructure, 2013).

Figure 2: MWH Global-GE Strategic Water Partnership



Source: MWH Global and GE

Beyond water-related infrastructure problems, water security and water quality are also at risk. Water is a public health issue, as evidenced by Flint, Michigan as a water supply catastrophe, and the Charleston, West Virginia watershed contamination issue. With very little real-time monitoring of water quality parameters and/or surrogate indicators, a utility can have a contaminated source in production for several days.

PUBLIC WATER INFRASTRUCTURE CONCERNS GROW

This was according to a new survey released by MWH Global in 2015, more Americans are becoming concerned about aging water infrastructure in their communities than prior years and they're willing to spend more to make improvements (MWH now part of Stantec, 2016). Among the survey's key findings, nearly half of Americans (48 percent) feel that not having easy, low-cost access to water is an issue that U.S. communities are facing today—compared to 39 percent of Americans surveyed last year. In addition, 67 percent of U.S. consumers are worried about the amount of water used to make everyday products like food, clothing, and electronics.

The clock is ticking nationwide as confidence in centralized water infrastructure continues to decline. In 2015, Americans believed their community's water infrastructure would last an average of 16 more years. By 2016, that number dropped to 14 more years. Additionally, more than one in three (35 percent) Americans believe it will last less than five years.

GLOBAL WATER ACCESS

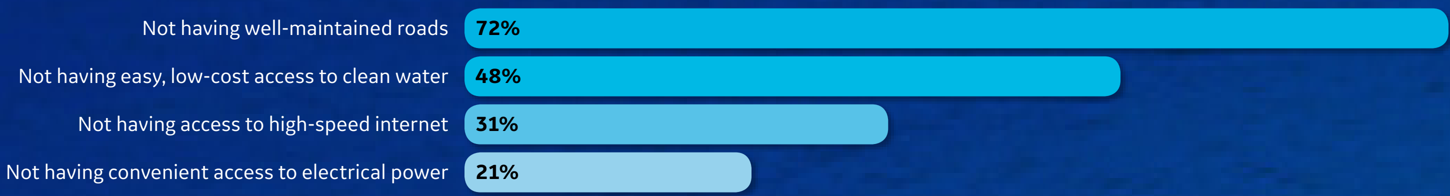
In the developing world, water access is the key issue. Many countries still face the challenges of eliminating poverty and promoting economic growth, ensuring health and sanitation, preventing land degradation and pollution, and advancing rural and urban development. Approximately 1.1 billion people in developing countries are currently living without adequate supply and access to water (The United Nations World Water Development Report, 2015). So accomplishing The United Nations Sustainable Development Goal of achieving universal and equitable access to safe and affordable drinking water by 2030 will require innovative approaches to water infrastructure. Emerging digital technologies have the potential to ensure that new systems deliver reliable, safe water in the most efficient manner.

Providing water infrastructure in rapidly growing urban centers is another challenge. According to the United Nations Population Division, more than half of the world's population lives in urban areas today. This will rise to 60 percent of the population by 2030 (The United Nations World Water Development Report, 2015). Ninety percent of urban population growth will take place in African and Asian countries. Urbanization places huge demands on infrastructure, services, job creation, climate, and the environment. The development of urban water infrastructure is particularly important. With rapid urbanization becoming an inevitable fact, cities are facing increasing challenges to secure financially sustainable water and sanitation services for its citizens. However,

Figure 3: Worries about water infrastructure

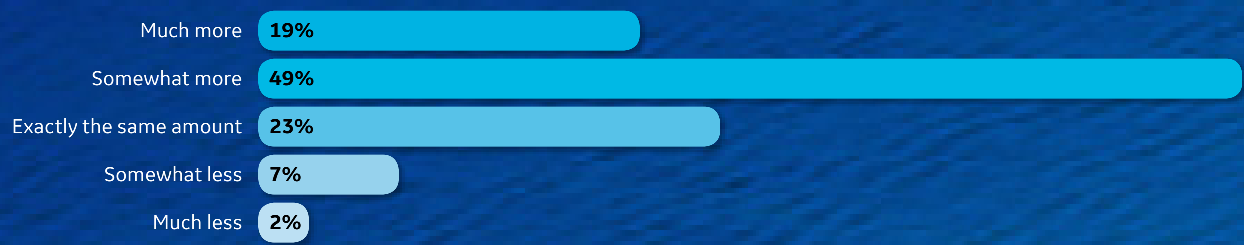
Infrastructure problems

Which of the following are issues that you feel communities in the U.S. are facing today?



Infrastructure spending

Should your community be spending more or less money to make sure its water infrastructure is well-maintained and properly functioning?



Infrastructure durability

Approximately how much longer do you think your community's current water infrastructure will last?

http://waterpolls.org/data/mwh-global-survey-infrastructure/
Source: MWH Global 2016 online survey of 1,005 nationally representative adults.
Margin of error is +/-3% in the 95% confidence interval.

if matched with appropriate and effective digital water solutions, water issues within cities can be properly addressed and managed.

Digital water solutions in cities can alleviate challenges facing urban water resources through the integration of information technologies and systems in areas of watershed management and sanitation. Such technologies may be adapted to continuously monitor water resources and diagnose problems in the urban water sector. This enables utilities to prioritize and manage maintenance issues more effectively, as well as to gather data needed to optimize all aspects of a city's water management system and feed information back to citizens, water operators, and technical service providers.

WATER SCARCITY

According to United Nations estimates, almost 1 billion people don't have access to safe water and over 2.5 billion don't have access to sanitation and hygiene. Why is it that there are so many globally that don't have access to safe water and sanitation? JPMorgan Global Equity Research framed the reasons for water scarcity in a report titled "Watching Water," published in 2008 (JPMorgan Global Equity Research, 2008):

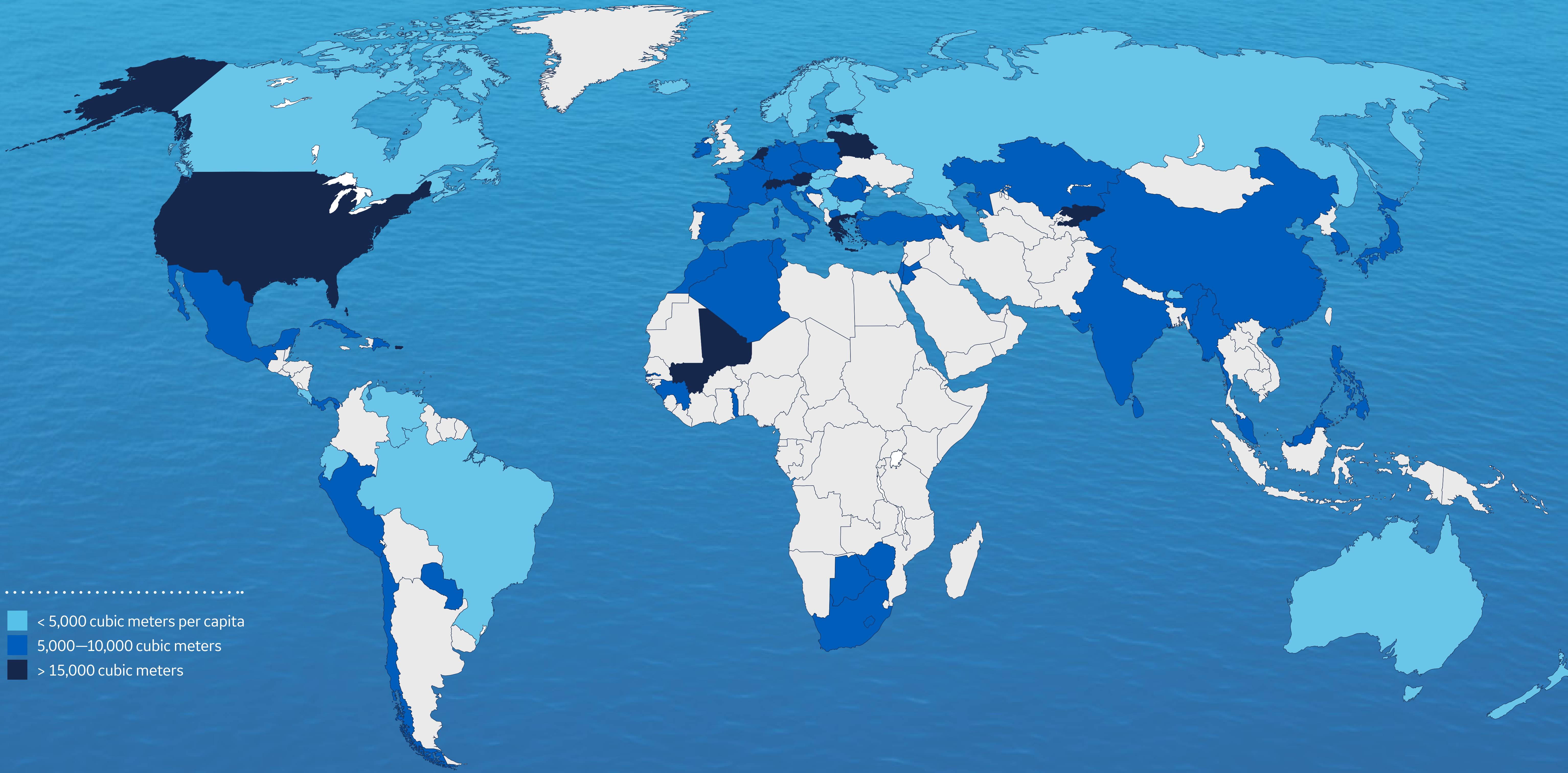
Population growth and increasing food needs (the rise of the middle class). The current global population recently crossed 7 billion (at the time of the JPMorgan report it was about 6.4 billion) and is increasing by about 70 million people per year, with most of the growth in emerging economies. The global population is expected to reach 8.1 billion by 2030 and 8.9 billion by 2050. While growth in OECD countries is expected to remain relatively flat, the population of the United States is expected to increase from 320 million at the end of 2014 to 370 million by 2030 (U.S. Census Bureau, 2014).

Urbanization. More than half of the global population now lives in cities, and increasing urbanization results in increased industrialization and increased water use.

Climate change. Climate change will alter hydrologic cycles on both a regional and local level. The long-term and short-term availability of freshwater will be altered along with changes in water quality, for instance water temperature, increased dissolved constituents, and others.

Figure 4: Long-term average renewable freshwater resources per capita (cubic meters)

Source: United Nations UNSD Environmental Indicators, release date December 2016.
Data available at: https://unstats.un.org/unsd/environment/qindicators.htm



A 2030 Water Resources Group (WRG) report, "Watching our Water Future," also provided a view of water scarcity, globally and within selected regions (2030 Water Resources Group, 2009). The WRG report lays out plausible scenarios for water supply, water demand and the "water gap" on a regional scale. This gap will play a critical role in how businesses address the risk and opportunities for their businesses. The report concludes that by 2030, assuming an average growth scenario, business as usual conditions, and if no efficiency gains are realized, global water requirements will grow from 4,500 billion cubic meters to 6,900 billion cubic meters—about 40 percent above current accessible and reliable supplies.

"Global water requirements will grow from 4.5 to 6.9 trillion cubic meters by 2030—40 percent above available supply."

Water Resources Group

The 40 percent gap is driven by global economic growth and development. Agriculture makes up the majority of this global water demand, with current use at about 71 percent of total demand. By 2030, the WRG expects agriculture's total water use will increase, but with faster population growth its share will decline slightly to 65 percent of total demand. Industrial demand is currently 16 percent, with a projected increase to 22 percent by 2030. Domestic water demand will decrease slightly from 14 percent to 12 percent by 2030.

The key concern in the WRG forecast is how to close the projected gap between business-as-usual and estimated increases in supply and water efficiency. For example, historical improvements in water efficiency in agriculture reveal only about 1 percent improvement between 1990 and 2004. There has been a similar rate of improvement in the industrial sector. If we project these rates of efficiency improvements to 2030, we would only meet about 20 percent of this 40 percent gap. If we assume a 20 percent increase in supply we would still have a remaining 60 percent of demand unmet.

Although currently it is only a small piece of the puzzle, digital water solutions have the potential to play an important role in helping to close the projected water gap. Digital technologies promote water resource management optimization, they can provide greater transparency to the underlying water system, and present new tools for managing and minimizing water leaks.

"Digital technologies can help close the water gap by promising water resource optimization, providing greater transparency, and minimizing water leaks."

GE developed the term “Industrial Internet” to refer to the Internet of Things (IoT) focused on industrial applications. The history of digital technologies in industrial applications can be traced back to 1959. That’s the year that Texaco’s Port Arthur refinery became the first chemical plant to use digital control. In the twenty-first century, Internet-enabled digital technologies are becoming ubiquitous across global industries. The digitization of water has just begun.

In the 1960s, the first generation of industrial software used large minicomputers with no connectivity to other systems. By the 1970s, second-generation software systems could be distributed across multiple connected stations. Network protocols were proprietary and not standardized during this period. By the 1990s, third-generation industrial control software was in use. These systems were distributed and networked, and could be spread across multiple local area networks and geographies, often with a single supervisor and historian.

The Internet was developed in parallel to the development of increasingly sophisticated industrial control software. The first nodes of what would become the Advanced Research Projects Agency Network (ARPANET) were established in 1969. ARPANET was the precursor to today’s Internet. In 1982, the Internet protocol (TCP/IP) was established. This standard enabled seamless communication between interconnected networks. The Internet grew to over 300,000 hosts by 1990. In 1991, after the ARPANET project was concluded, all commercial restrictions on the use of the Internet were removed.

The Internet blossomed into a global force for communications and retail commerce in the 1990s and 2000s. The world was transformed in a myriad of well-documented ways by the emergence of the Internet. By 2010, the number of Internet hosts exceeded 800 million. In 1994, the concept of the Internet of Things (IoT) was first developed. The basic idea was to affix sensors to common objects in order to connect these items to the Internet.

By 2010, improvements in information technologies enabled the IoT to be applied to industrial machinery. This led to the Industrial Internet, which is the fourth

Figure 5: Industrial Internet Timeline

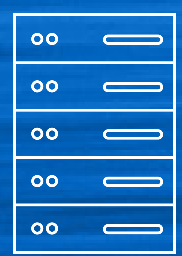
Industrial software systems have evolved over the last 50 years from monolithic systems that provided machine-level 014 control, to today's Industrial Internet, which facilitates resource optimization for global industrial networks.

1950s–1960s

Monolithic

Enabled Machine-Level Resource Optimization

The first generation of industrial control software used large mini-computers connected to industrial machines with no connectivity to other systems. They had limited security.



1950 1960

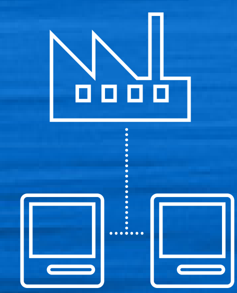
- **1959**
  Texaco's Port Arthur refinery becomes the first chemical plant to use digital control.
- **1969**
  The first nodes of what will become the Advanced Research Projects Agency Network (ARPANET) are established. ARPANET was the precursor to today's Internet.

1970s–1980s

Distributed

Enabled Facility-Level Resource Optimization

The second generation of industrial control software was distributed across multiple independent workstations connected through proprietary communications protocols. They had limited security.



1970 1980

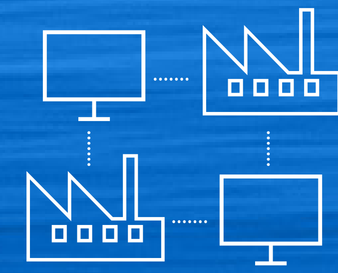
- **1982**
  The Internet protocol (TCP/IP) is established. This standard enabled seamless communication between interconnected networks.
- **1985**
  The number of hosts on the Internet (all TCP/IP interconnected networks) reaches 2,000.

1990s–2000s

Networked

Enabled Enterprise-Level Resource Optimization

The third generation of industrial control software was distributed and networked, and computers could be interconnected through a secure local area network (LAN). The systems spread across multiple LANs and across geographies.



1990 2000

- **1990**
  The Internet grows to over 300,000 hosts.
- **1991**
  After the ARPANET project was concluded, all commercial restrictions on the use of the Internet are removed.
- **1994**
  The concept of the Internet of Things (IoT) is first developed. The basic idea was to affix sensors to common objects in order to connect these items to the Internet.
- **1999**
  The Massachusetts Institute of Technology (MIT) establishes the Auto-ID Center to conduct research focused on IoT. During the same year, the world's first machine-to-machine protocol, MQ Telemetry Transport (MQTT), is developed.
- **2008**
  The first international IoT conference takes place in Zurich.

2010s–Today

Industrial Internet

Enables Global Network Resource Optimization

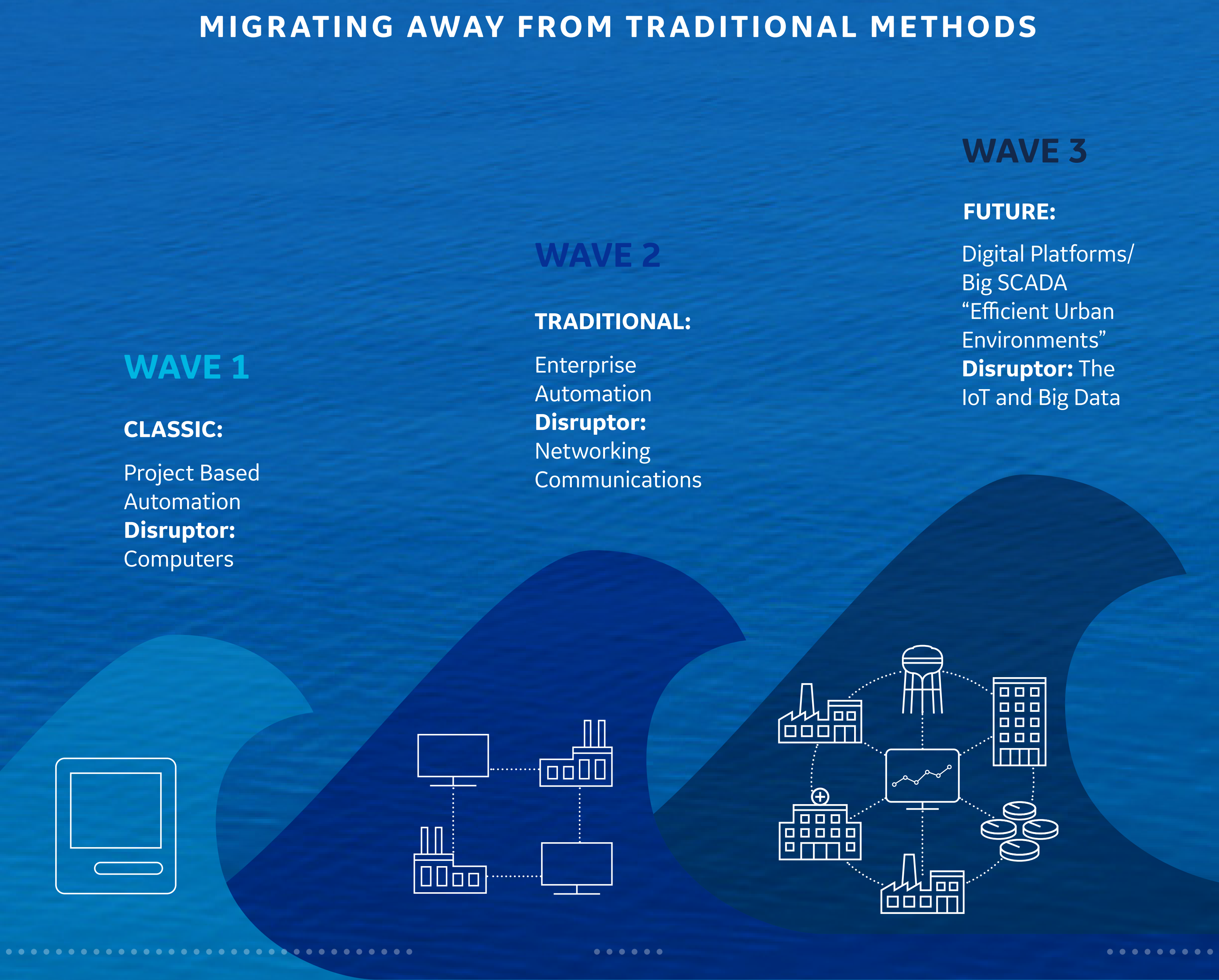
Over the last decade, cloud computing, network bandwidth increases, hardware improvements, and software advances have enabled the emergence of the Industrial Internet.

2010 2020

- **2010**
  The number of Internet hosts exceeds 800 million.
- Improvements in information technologies enable the IoT to be applied to industrial machinery.
- **2012**
  GE announces its commitment to a $1 billion investment in software and analytics and launches the Software and Analytical Center of Excellence in California.
- **2013**
  GE develops Predix™, the first software platform for the Industrial Internet.
- **2014**
  GE's portfolio grows to 31 Industrial Internet applications within its Predictivity suite of solutions using the Predix™ platform. The Industrial Internet Consortium is established to further the development, adoption, and widespread use of the Industrial Internet.
- **2015**
  GE releases Predix™, the operating system of the Industrial Internet. Predix™ is a cloud-based platform designed for building and powering industrial-strength applications.
- **2015**
  GE and Intel joined forces in order to leverage the power of ICT to help solve the world's toughest global natural resource challenges.
- **2016**
  GE releases the Digital Hydro Plant, a nimble suite of end-to-end apps that seamlessly integrates software intelligence into hardware assets and control systems to enable new economic outcomes and opportunities.
- **2017**
  GE and MWH Global partner to provide digital solutions for water infrastructure.

Source: (Owens, 2014)

Figure 6: Three Phases of Digital Water Infrastructure



"Technology is driving this change more rapidly than ever."

Source: MWH Global

generation of industrial software systems. Technology advances include falling computing prices, the miniaturization of computers, increasing bandwidth, and the emergence of cloud computing and mobility solutions. All of these technology trends together provided the tailwinds necessary to launch the Industrial Internet.

The phases of the evolution of digital technologies for use in industrial operations and the emergence of the Industrial Internet correspond to the three phases in the application of digital technologies to water infrastructure. In the first phase, in the 1980s and 1990s, digital technologies were applied to water infrastructure on a project-specific basis using automation and the best available digital technologies. Starting around the turn of the century, network technologies were applied to automate the water infrastructure enterprise. Today, the Industrial Internet is being leveraged to implement intelligent water platforms.

THE DIGITAL WATER OPPORTUNITY FOR UTILITIES

Water and watershed utility directors and leaders have a nearly impossible and thankless job. On a daily basis they face political pressure in 4-year cycles on 20–50-year infrastructure plans, local/state/federal regulators, public perception, do-more-with-less budget cycles and staffing/pay restrictions. They need to make decisions today, for extended planning horizons, for tomorrow, based on limited data from the past.

The business strategy of water is indeed changing and shifting to a more comprehensive TOTEX approach. Considering the mid-to-long term operational costs of water assets in the planning of capital is a major change. No matter if TOTEX is addressed from the top-down in a rate or affordability study, or from bottom-up in an asset management centric approach, this represents a change in business process in the utility.

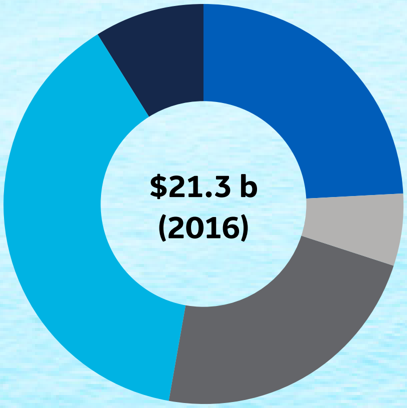
The inventory of skill sets is also changing—millennials entering the work force use mobility-based solutions with much more savvy than previous generations. The training of a multi-generational work force to exploit the power of digital solutions that support the "new" business strategy must be profoundly addressed.

In many projects, much of the data to be used in decision making is locked-up in systems clients already have. In years past, it was a daunting task to build very structured "data-warehouses," integrating these legacy systems and building dashboards. This was not only expensive to build, but more expensive to maintain. The new "digital wave" makes it cost-effective and fast to build and execute these digital solutions by leveraging much of the existing legacy data clients already have.

The digitization of water provides a clear pathway toward a more productive and sustainable water future. As water infrastructure is improved or replaced, ongoing maintenance of these systems—including pipelines, pumping stations and sewers—will be crucial to ensuring the same issues do not arise again 20, 50 or even 100 years from now. This is where digital solutions shine. By utilizing technologies that monitor and collect data into a single platform, utilities can begin to use these data to shift away from their traditional reactive approach to operate in a more predictive manner.

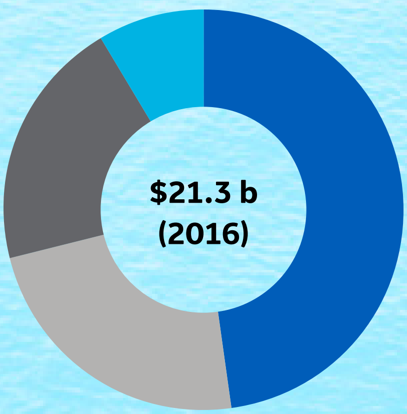
Figure 7: Global water utility market for digital solutions (2016-2021)

The estimated global market for control and monitoring solutions was **$21.3 billion** in 2016. By 2021, Global Water Intelligence (GWI) estimates that the market will grow to **$30.1 billion.** That's a 7.2% average annual rate of growth.



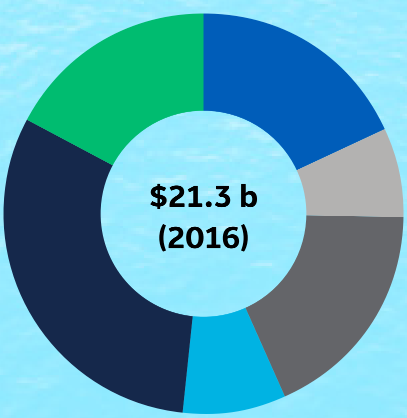
Total spend by region

- North America **$5.2 billion**
- Latin America/Caribbean **$1.2 billion**
- Europe & Central Asia **$4.9 billion**
- Asia Pacific **$8.2 billion**
- Middle East/Africa **$1.8 billion**



Total spend by application

- Networks **$10.2 billion**
- Water Treatment **$5.0 billion**
- Wastewater Treatment **$4.3 billion**
- Industry Processes **$1.8 billion**



Total spend by application product category

- Physical Parameters **$3.9 billion**
- Water Quality Seminars **$1.5 billion**
- Customer Meters **$3.8 billion**
- Labfield Testing **$1.8 billion**
- Other Automation & Control **$6.6 billion**
- Data Management/Analysis **$3.6 billion**

Source: Global Water Intelligence (GWI 2016). Water's Digital Future

For example, by mapping and monitoring sewer systems, a utility could identify an emerging system failure before it surfaces and deploy resources to fix the problem. While this is just one example, the possibilities are endless.

A less obvious problem at the heart of water infrastructure issues lies at a crucial point in the distribution system—the consumer. As with any service provider, water utilities strive to maintain mutually beneficial relationships with consumers at the household or institutional level. Digital communication and engagement tools that deliver billing information, leak identification, remote valve control, resolution notifications, and water usage insight can make it easier for consumers to understand their water consumption habits, save money and protect their property from costly water damage. For utilities, these customer self-service applications can also reduce the cost to service consumer accounts by proactively addressing customer concerns, minimizing the need for on-site visits, and improving payment performance.

These opportunities address some of the most pressing concerns for water utilities, but the growth of digital water technologies is not limited to these alone. There are untapped opportunities for utilities to save money, increase revenue, increase public safety, comply with regulators by using intelligent technologies to improve asset management, process optimization, improve water quality, and enhance interaction with consumers. The growth of digital technologies and applications in these critical segments is being driven by the need to improve efficiency and reduce business costs in order to maintain competitiveness. In addition, tightening regulations around the world are driving utilities and industries to implement digital solutions to maintain compliance.

The total global size of this opportunity in the global water utility sector is significant. According to Global Water Intelligence (GWI), a leading authority on market intelligence, news and analysis on the international water industry, the 2016 market for digital solutions for water utilities was $17.7 billion in 2016. GWI expects the market to grow to $25 billion by 2021. This represents an average annual growth rate of 7.2 percent between 2016 and 2021.

To fully understand the future of water and the importance of digitization, it's critical to gather perspectives from water industry experts around the world. In the same way that GE and MWH Global have partnered to develop commercial digital water solutions for utilities, we recognize the need to partner with global water thinkers to understand the challenges and opportunities surrounding digital water. Global water strategist Will Sarni of Water Foundry, LLC, connected with three global experts to get their insights on the digitization of water.

Piers Clark

An interview with Piers Clark, Founder and CEO of the Isle Group, provided insight into digital applications in the water utility sector and how to address infrastructure needs. In general, customers won't care about digital systems (unless on a smart city scale) to conserve water usage. However, those who will care are the big industrial companies who use enough water so that they can save significant amounts of money if they limit water use. The bill actually matters in commercial organizations due to the scale. The other realm is wholesale (reservoirs, pipes, and treatment centers) where digitization can impact leakage, pressure control, and provide an understanding of dynamic networks/dynamic control in real-time. Clark believes the journey to digitization will take another generation but says that five years ago people didn't even use the term "digitization of water."

"Large commercial and industrial water consumers can save a significant amount of money using digital solutions."

Dave Henderson

An interview with Dave Henderson, Managing Partner of XPV Water Partners, provided valuable insight on the current trends and challenges in digital water.

Henderson believes the world is at an inflection point in the adoption of digital water solutions. The growth trend in adoption is driven by externalities outside the water sector. These externalities include: inexpensive sensors, consumer preference (i.e. the widespread use of smart phones), increased need by the industrial sector to streamline operations and reduce costs, increased adoption of cloud-based data solutions, and increased sales of software solutions to small and mid-sized companies. According to Henderson, there isn't a market failure, per se, to adopt digital water solutions. Instead we are witnessing the early stages of adoption of digital solutions in a sector that lags decades behind the energy sector in the use of data and analytics.

Henderson believes that there are several challenges confronting the adoption of digital water solutions. These include the need for standard protocols, disparate water data sources, and historical challenges in generating big value and financial returns in the sector. In Henderson's view, the most encouraging signal that digital water applications will continue to accelerate is that, in general, the public and private sectors currently make decisions on poor data sets—incomplete data and less than robust analytics. For the first time we are seeing the emergence of real time data and analytics to inform public policy and business decisions. The winners in digital water will be those companies that address very specific applications such as customer information systems, environmental data management, stormwater runoff, chemical management, etc. The adoption of digital solutions will significantly reduce the need for infrastructure spending—better data and analytics equals better allocation of investment dollars and workforce resources.

"The adoption of digital technologies will significantly reduce the need for water infrastructure spending."

Amir Peleg

Amir Peleg is "Israel's Water Ninja" and the Chairman of SWAN, was interviewed about the trends in digital applications in water. He is the founder of TAKADU, an event management system that is already in 11 countries. This "event management system" utilizes data for predictive analytics—detecting systems failures and providing a cloud-based solution to manage those incidents and optimize decision making.

Peleg emphasizes thinking about digital application through a people, process and technology paradigm. He believes that people are both a problem and the solution. If systems are run with people who haven't changed operations in 30 years, then they are not open to changes. An infusion of people recruited from the computer science field along with industrial engineers or customer service representatives would shift the dynamic and facilitate the adjustment to new digital technologies. The dynamic would change from response mode (i.e., "fire fighting") to data-driven decision making and improved planning so response is not necessary, and quality customer relationship management could then be emphasized. Peleg notes the technology is already there with sensors, communications, and data gathering, but cannot be implemented efficiently if people are not open to new processes or technology.

Peleg ties in the idea that there is not one specific trend and people are confusing IoT/Digital/Smart/Data, etc. He states, "In most cases, if you ask people at the utility, they will say they're advanced since they just bought a few smart meters. People think they're digital, but that's not true." It is not enough to have a sensor to measure something specific because they are not necessarily utilizing/analyzing/communicating the gathered data with other smart technologies. Talking about the U.S. market, Peleg stated that the U.S. is a few years behind the rest of the developed world with one of the biggest drivers of improvement being regulation and necessity. But things are moving in several states and one would assume that this gap will close fast.

"Digital water technologies are already here, but cannot be implemented if people are not open to new processes and technologies."

THE INTELLIGENT WATER PLATFORM

Water utilities are faced with very complex decisions on investment strategies that are influenced by elected officials, staff, the public, NGOs, and local, state and federal regulators. The public sees the outcomes of these investments in the form of visible capital projects, service level changes and rates. Digital solutions are invisible to the public but typically seen as an expense versus an investment. Consequently, many utility directors do not want to be in the public eye implementing multi-million dollar digital solutions while their infrastructure is in need of repairs or replacement. The digital solutions and implementation methods of the 1990s and early 2000s are still widely practiced and they can draw a heavy burden on utility budgets, thus cementing the view that digital technology is simply a cost and not a highly effective investment.

In addition, utility directors and their staff are challenged and at times overwhelmed with applying new technologies and approaches like IoT, mobility, Big Data, and business analytics. Although these challenges are real in terms of placing them in the proper context, the opportunities for leveraging new digital technologies to achieve optimum performance are considerable and can deliver more immediate results. Today's solutions to these challenges can be deployed in weeks, not years, and produce financially tangible and visible outcomes. For example, digital technology can be deployed to unlock the data that a utility already has in many systems, correlate that data and arrange it in such a way that allows scarce capital to be focused on assets most at risk, and to re-focus a utility on a pro-active maintenance cycle. To help utilities achieve these results, MWH Global and GE have formed a strategic partnership to accelerate the development and deployment of digital water solutions. This pairing provides water utilities across the globe with the opportunity to engage with MWH Global and GE to receive end-to-end digital water solutions.

In addition to its role as the premier global provider of water infrastructure, MWH Global brings:

- Customer service and TOTEX focus;
- Applications and outcome-based mindset;
- Content expertise in all water-related matters; and
- Dedicated team of water scientists, data scientists, engineers, and operators.

GE Digital's role is to provide the digital tools and technologies to enable MWH Global water hardware to digitize. In addition to its role as the provider of digital infrastructure, GE brings:

- Product and platform focus;
- An asset performance focus;
- Multi-sector installed solutions;
- Content expertise; and
- A full commitment to investment in digital solutions.

"Our goal is to develop digital solutions on a platform that is affordable, sustainable, and will be supported by multiple industry stakeholders. GE's Predix allows us to do that."

Pete Perciavalle, Vice President —
Director of Client Enterprise Systems and Optimization,
MWH Global now part of Stantec

The ultimate goal of the MWH Global-GE strategic partnership is to drive a step change in the performance of customer water assets. The MWH Global-GE partnership is based on a "Water Intelligence Platform" that connects legacy systems to an analytics platform to drive insight and outcomes for clients. The Water Intelligence Platform combines MWH Global content knowledge with GE Digital applications to produce an optimized water system. GE and MWH Global are currently working together with several leading water companies to demonstrate the Water Intelligence Platform.

Figure 8: The Water Intelligence Platform

Source: MWH Global and GE

MWH Global has been a pioneer in the digitization of water over the last decade and its strategic partnership with GE Digital makes our capabilities even more formidable. With GE as a reliable and proven partner, the Intelligent Water Platform is positioned to be scaled for use in diverse water utility environments across the globe.

MWH Global has been implementing digital solutions for water utilities across the information technology spectrum for years. With today's tools, workforce, and communications infrastructure, we can now do it for a fraction of the cost and produce real outcomes in the same business quarter. Current implementations to date have provided promising results. MWH Global has launched the Intelligent Water Platform in utility environments as diverse as San Diego and Atlanta. These projects have returned a value of 1 to 10 times the investment cost in as little as four months. The combination of reduced capital spending and operational savings is a powerful driver for digital water systems.

Case Study—City of San Diego

During San Diego's Clean Water program in the late 1990s, the city was faced with implementing $2B in new infrastructure, and a 5-fold increase in operating assets. The net effect on operating expenses was projected to nearly triple. The capital story is well known in the industry—MWH Global delivered the new infrastructure for 25 percent less cost. To address the operating cost issues, a first-of-its-kind digital solution was deployed, along with a comprehensive employee training/upgrading program, and a re-building of operating strategy.

Case Study—City of Atlanta

MWH Global is currently working with the City of Atlanta Department of Watershed Management operator, which includes the wastewater and combined sewer system. As part of this management effort, the city engaged MWH Global in the implementation of an intelligent data platform to track consent decree data and expand its use to other functional areas of the department. MWH Global delivered a state-of-the-art analytics platform that receives near-time unstructured information from their SCADA, CMMS, GIS, and other business systems and disseminates useful and meaningful information through enterprise-wide dashboards. Atlanta was able to see immediate benefits in just a few weeks of the launch. Since the launch of this system, the city has been able to reduce overflows by more than 30 percent and is using the data to make more informed capital planning decisions.

CONCLUSION

New digital technologies are enabling water utilities and industries across the world to extract greater information and efficiencies from legacy water infrastructure to enhance decision-making, promote water conservation, build twenty-first century water infrastructure, and—perhaps most importantly—increase the value and benefits of the global water infrastructure network. Yet, the digital water journey has just begun. A new world of possibilities is being unlocked through the Industrial Internet.

MWH Global and GE are excited about the opportunity to play a role in helping to confront global water infrastructure challenges, and accelerate the pathway to a sustainable and productive water future that provides improved infrastructure and better water access to businesses and communities across the globe.

REFERENCES

American Society of Civil Engineers. (2013). *2013 Report Card for America's Infrastructure*. American Society of Civil Engineers.

2030 Water Resources Group. (2009). *Charting Our Water Future: Economic frameworks to inform decision-making*. Retrieved from http://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/charting-our-water-future

JPMorgan Global Equity Research. (2008). *Watching water: a guide to evaluating corporate risk in a thirsty world*. JPMorgan Environmental, Social, and Governance. Retrieved from http://pdf.wri.org/jpmorgan_watching_water.pdf

Kelly, Eamonn. (2015). *Business ecosystems come of age*. Deloitte University Press.

Kumar, Gautam. (2016, July 15). *Leaking Cities & Wasted Water.* Progress.com. Accessed September 15, 2017. https://progress.com/sustainability/20160715/in-charts-leaking-cities-wasted-water/.

MWH now part of Stantec. (2016, July 5). Survey Says More Americans Worried About Water Infrastructure, Willing to Pay More. Broomfield, Colo., U.S.A.

Owens, B. (2014). *Digital Resource Productivity*. Boston, Mass.: General Electric.

The United Nations World Water Development Report. (2015). *Water for a Sustainable World*. Paris, France: United Nations Educational, Scientific and Cultural Organization (UNESCO) on Behalf of UN-Water.

U.S. Census Bureau. (2014). *U.S. Population Projections: 2014–2060.* Washington, D.C.: U.S. Census Bureau.