Jacobs Challenging today. Reinventing tomorrow.

The water of **our future** is the water of **our Past**

Nature reuses water endlessly, why don't we?

Water taps are running dry in India and South Africa. California is once again facing a drought; Australia survived the millennium drought; and in 2015, drought and inefficient infrastructure led to a severe water shortage crisis in Sao Paulo, Brazil. Rain falling across the Asia Pacific is causing severe flooding and some hurricane-ravaged Puerto Rican communities still do not have access to critical water and power supplies years after Hurricane Maria. Similarly, residents of Flint, Michigan, are still reeling from the effects of a contaminated drinking water system.

Each year, the natural and human made threats to our global water supply get more complex; while populations surge and the demand for water across industries increases. The crisis facing our water supply demands a new way of thinking to create integrated, smart and sustainable solutions that embrace the challenges facing our world today.

H_2O covers 70 percent of Earth; how is there a water crisis?

Water scarcity is not a new phenomenon; historical records note water shortages dating as far back as the 1800s[1]. Today, more than 2.1 billion people lack access to safe water around the world and year after year, the World Economic Forum lists[2] water scarcity as one of the top ten global risks.

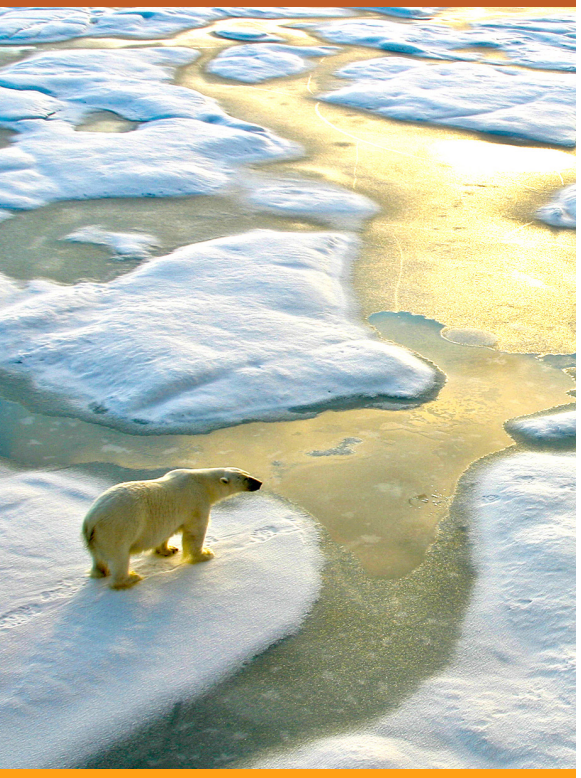
FRESH WATER < 3%
GLOBAL WATER

Understanding how we are facing a global water crisis, when the resource seems so readily available, is difficult to comprehend – especially given that water covers around 70 percent of our planet. Our freshwater resources are far less plentiful, however. More than 99 percent of Earth's freshwater is inaccessible, with much of it frozen in icecaps and glaciers or lying deep underground in aquifers.

Because there is so little freshwater accessible, the world relies on the natural water cycle to provide the water necessary to help communities thrive. The water we drink, bathe in and use to grow our food today is the same water dinosaurs used, thanks to nature – and for millions of years, the water cycle successfully provided what we needed.

In the last century though, changing climates and growing populations have created unsustainable levels of stress on the water cycle. If current usage trends don't change, **our world will have only 60 percent of the water it needs in 2030.**[3]

[1] https://www.worldvision.org/clean-water-news-stories/global-water-crisis-facts
[2] https://www.weforum.org/reports/the-global-risks-report-2018
[3] https://timedotcom.files.wordpress.com/2015/03/231823e.pdf



What's climate got to do with it?

Temperatures have crept higher for each decade since the mid-1800s. The changing average global temperature can lead to serious consequences, and future projections only point to accelerated warming, rising tides and a much more unpredictable hydrologic cycle.

We're already tapping into groundwater reserves at unsustainable rates to weather out these variating climate situations, such as recent droughts central in Europe or unseasonably dry winters lacking enough snowmelt to replenish the Colorado River, which is a major water supply to 30 million people in the western U.S. Worldwide, some 2.5 billion people rely on water from underground aquifers as their main source of freshwater and the state of our largest aquifers is bleak – that is why some agencies, such as the Woodland-Davis Clean Water Agency, have developed projects to move their systems' reliance from degrading groundwater supplies to surface water.

Variating climate will deepen the issues facing our safe water supply, triggering more shortages and droughts in some areas and floods in others – and already, water-related hazards account for nine out of 105 of recent natural disasters.

In 2050

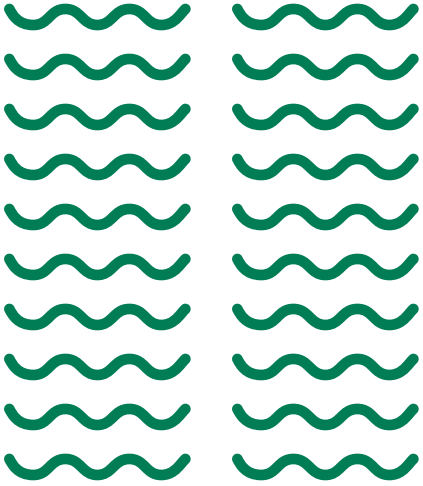
5x as much land is likely to be under "extreme drought" than today.[4]

1/3 of the world's largest aquifers are considered significantly distressed.
https://www.nasa.gov/jpl/grace/study-third-of-big-groundwater-basins-in-distress

[4] Smart Green Cities: Toward a Carbon Neutral World By Woodrow Clark II, Grant Cooke
[5] http://www.worldbank.org/en/topic/water/overview

More money, more people, more problems?

Satisfying the thirst created by growing populations extends beyond just having enough water to drink and bathe in, although that too is a challenge. When populations boom, there are more mouths to feed, crops to grow and more houses and businesses to power.



1 TRILLION CUBIC METERS

= 20 Nile River ANNUAL FLOWS

In the next two decades, global middle class is expected to surge by more than 2 billion, increasing stress on freshwater supplies.

As people move up in class, demand increases for higher quality products that require more water than crop-based agriculture, which today accounts for 70 percent of global freshwater consumption[6]. More demands and stress on our water and land resources will drive food costs higher. In the next five years, it is estimated that agriculture requirements alone will require us to use one trillion cubic meters of freshwater per year[7].

Energy production is the second largest consumer of freshwater, and at the current pace, we will not have enough freshwater available to meet global energy demands in the upcoming decades. In fact, limited freshwater supplies are already directly impacting the location of power plant sites in water constrained areas. Additional impacts from urbanization and agriculture are limiting natural infrastructure in our ecosystems, and in turn minimizing crucial replenishing activities in the water cycle.

[6] https://blogs.worldbank.org/opendata/chart-globally-70-freshwater-used-agriculture

[7] http://inweh.unu.edu/wp-content/uploads/2015/06/Water-Security-Global-Crisis.pdf

Can we still flip the switch?

In the past 30 years, major wastewater treatment system investments have improved water quality in many developed countries and in 2000, the U.N. member states set a 2015 target to halve the number of people without sustainable access to safe drinking water. Globally, we reached that goal five years ahead of time, bringing water to more than 2 billion people in total since 1990.[8]

It is an achievement achieved with aid from organizations such as Water For People. Water For People focuses on helping people in developing countries gain access to safe drinking water and improved sanitation – via a sustainable program that creates capacity-building of strong businesses, communities and governments to help carry on the services for generations to come.

But, one in nine people still do not have consistent, safe access to this precious resource.

To deliver on the next phase of U.N. goals to provide clean water and sanitation for all by 2030, we need to flip the switch. It is time to make global changes to how we view and manage this vital resource, before it is too late – **and that's where potable reuse, or purifying wastewater effluent to create drinking water – can make an impact.**

[8] https://www.un.org/sustainabledevelopment/water-and-sanitation/

The water we use today is the **same water the dinosaurs drank** millions of years ago.

Potable reuse, what's that?

Since there is no new water on Earth, it's true that all water goes through a natural cycle and is essentially recycled water before it is treated and returned to homes and businesses as drinking water.

In recent decades though, forward-thinking organizations have looked to replicate nature more closely and on a more rapid scale, reclaiming water once viewed as waste and recycling it to augment water supplies.

There are two types of potable reuse making a splash for communities and utilities around the globe. The first, indirect potable reuse, is when reclaimed community wastewater is purified with advanced treatment and recycled into water supplies through environmental buffers, such as lakes and groundwater aquifers. The second type, direct potable reuse (DPR), introduces highly purified recycled water directly into a public water system's drinking water or raw water supply.

In some cases, **reuse water is so pure** that minerals must be added back in for stabilization and pH adjustment.

What's so great about reuse?

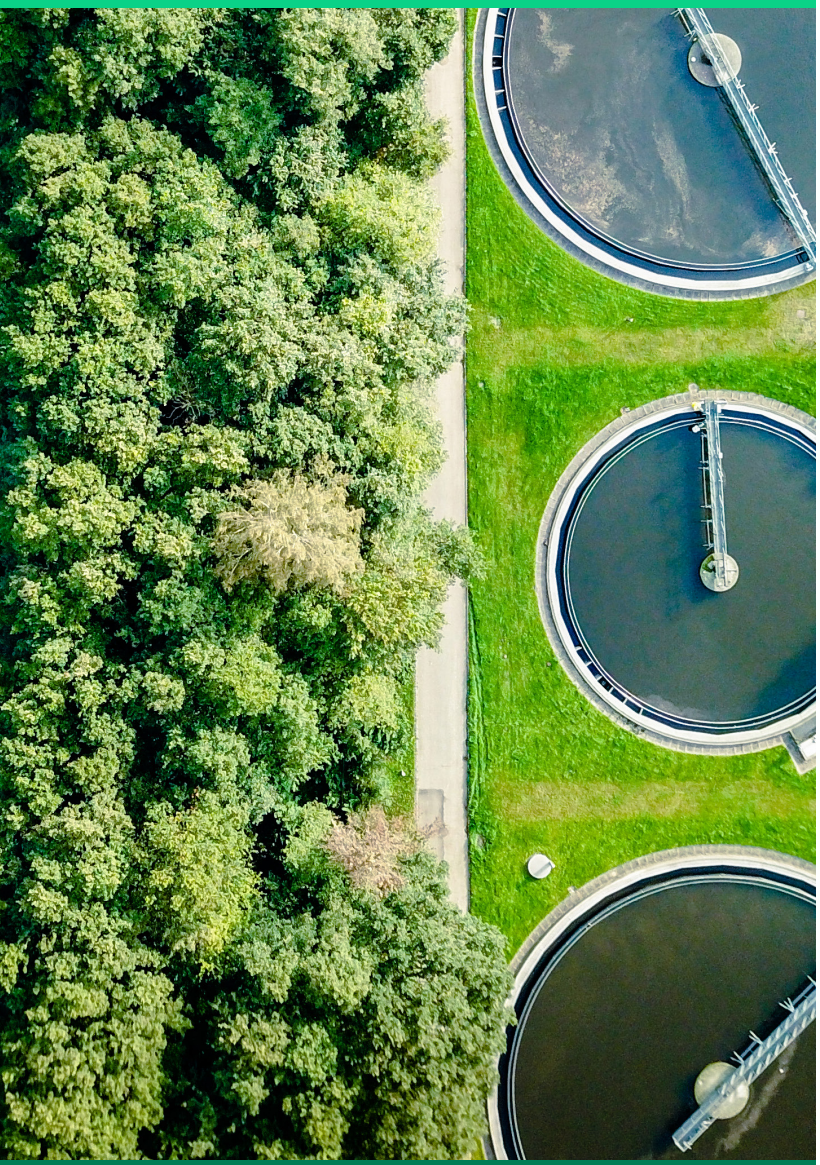
With drought conditions worsening in many global locations and record population growth exacerbating issues, addressing water supply demand in the next decade will be critical to meeting needs. With future variability in both areas expected, many communities are looking for a safe, sustainable additional water source and reuse technology offers just that.

Safe, drinkable water is top of mind for most utility owners and the public when it comes to drinking water treatment – and potable reuse is a completely safe option. All water purified by potable reuse systems is regulated and continuously monitored to ensure safety. Purified water is treated to extremely high standards before returning to drinking water taps. You might not realize it, but the water purification process produces water that is more pure than much of the water we currently drink. In fact, the purified water from some potable reuse systems is so pure that minerals must be added back in to ensure the water is compatible with our existing water distribution systems.

Not only is potable reuse a safe solution, it is also a future-proof and environmentally-friendly one. Reuse provides a locally-controlled, drought-proof water supply, eliminates the need for dedicated conveyance systems and reduces storage needs because water stays within the system – providing the water where it is needed and producing a strong water supply for resilient cities.

Reuse requires less energy to turn wastewater into drinking water than other options such as desalination, and reuse produces less greenhouse gas emissions than desalination as well, a win-win as more cities look to step-up their sustainability efforts.

In addition, in some locations it may eliminate the need to expand collection and conveyance of additional surface water supplies, which can be costly and may have negative environmental impacts.



What's holding us back from endless reuse?

Water reuse is already disrupting the water supply management market and innovators and early adopters in Singapore, Australia, the U.S. and other global locations led the way to develop full-scale projects during the past four decades. Despite the success stories and the widely-acknowledged technologies currently available to implement water reuse projects, the growth of reuse is increasing, but still relatively uneven.

One of main aspects holding back wide implementation of reuse is public acceptance. It likely comes as no surprise that the idea of recycling wastewater to our drinking water taps is often greeted with a bit of hesitance. In fact, much of the world still prefers more expensive,less environmentally-friendly techniques such as desalination to recycle water for drinking and bathing simply because it does not have the same negative connotations as reuse.

Building public support, while eliminating stigmas around the use of recycled water, is critical to successful reuse programs, yet easier defined than done. Just consider the example of Toowoomba, a small town in Queensland where Australians voted against developing a water reuse plant, in part due to the "yuck factor" dominating media coverage instead of highlights on the benefits water reuse could bring to the community.

Additionally, regulations and governmental guidance and support still lag behind. For example, there are no national standards for potable reuse in the U.S. Instead, the U.S. allows states to regulate how, when and where recycled water is used to supplement water supplies. Several states have indirect potable reuse regulations in place and others are exploring the possibilities.

In early 2018, Arizona became the first state to adopt a complete regulatory approach to DPR, following a lead by Texas, where case-by-case permits can be awarded to allow distribution of treated wastewater directly into potable water systems during drought conditions.[9] In 2016, California led a statewide DPR experts panel to support the feasibility of DPR in the state and now the State Water Board will look to meet a requirement to adopt uniform water recycling criteria for DPR via raw water augmentation by the end of 2023.

Without proper regulations and government support of reuse, its full role in the water conversation remains untapped.

[9] https://watereuse.org/advocacy/state-policy-and-regulations/

3 projects making an impact

Despite its uneven implementation around the world, these three potable reuse programs already in practice are challenging other cities and regions to take a fresh look at how they're using water, explore how they can better protect the source of their sustained livelihood and adopt a more holistic approach to water management.

Recharging a disappearing water source

In southeastern Virginia, communities are using groundwater from the Potomac Aquifer, faster than it can naturally be replaced. Knowing their water is too valuable to waste, the Hampton Roads Sanitation District, a regional wastewater treatment agency that provides service to 18 counties and cities, began exploring a way to reuse their treated water, instead of just discharging it to the Chesapeake Bay. Their solution, an innovative indirect potable reuse project called SWIFT (Sustainable Water Initiative for Tomorrow), takes highly treated water that would otherwise be discharged into local rivers and puts it through additional rounds of advanced water treatment to produce drinking quality water.

The water is then injected into the Potomac Aquifer, ensuring a sustainable source of groundwater while addressing environmental challenges such as Chesapeake Bay restoration, sea level rise and saltwater intrusion. HRSD's state-of-the-art demonstration facility is already recharging dwindling Potomac Aquifer resources at a rate of one-million-gallons per day and the agency is working on the required regulatory steps for future full-scale facilities that will reach 100-million-gallons per day by 2030. These full-scale advanced treatment facilities are also expected to eliminate more than 90 percent of HRSD's discharge, reducing nutrients discharged to the Chesapeake Bay.[10]

HRSD **wins** for the **SWIFT** project

2018 U.S. Water Alliance
U.S. Water Prize

[10] http://swiftva.com/

Brewing change with public acceptance

The Colorado River serves 30 million people and irrigates 3.5 million acres of cropland in the U.S. and Mexico – but climate variation and higher temperatures have put its long-term viability at risk. Between 2000 and 2014, the river lost nearly one-third of its flow and that number is expected to increase in the next 40 years, by up to another 20 percent.[11]

Arid Arizona is one of the states depending on the river, currently receiving nearly 40 percent of its water from Colorado River flows. Even with dedicated water conservation practices, the future for Arizona was clear – they needed to find a more sustainable water resource. So, they turned to a renewable resource already available in every community: wastewater.

Recycled, treated wastewater had already been used for decades in Arizona to keep golf courses, parks and other landscaping green and with advances in treatment technology, state decision makers realized it would just be a small step to also use this purified recycled wastewater to create safe, quality drinking water. Arizona is now the first U.S. state to adopt a full regulatory approach for DPR and its unique approach to public acceptance is certainly one to toast. In 2017, the Arizona Community Foundation launched a water innovation challenge called AZ Pure Water Brew to better inform Arizonans about water issues, water reuse and technologies currently available to purify recycled wastewater into drinking water.

Using proven technology that involves a 5-step water purification process, the AZ Pure Water Challenge transformed recycled community wastewater into Pure Water, which brewers throughout the state used to produce beer. On average, it takes about five barrels of water to produce just one barrel of beer. And that is not even the most water-intensive part of the process – it's the agriculture behind brewing.[12]

By partnering with local breweries, the AZ Pure Water Challenge demonstrated the applicability of potable reuse, helping build public support while eliminating negative stigmas, all by creating a product from the water that the public already loves – craft beer. The challenge also spurred a follow-on effort to bring Colorado its first craft beers made from recycled water, further spreading the positive potable reuse message.

Growing the barley and hops needed to make just **one gallon of beer** takes an estimated **590 gallons of water!**

[11] https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1002/2016WR019638
[12] http://www.azpurewaterbrew.org/

Turning water scarcity into international successes

In the 1960s, the island nation of Singapore faced such water stress that they had to ration the precious resource just to meet minimum needs. Today, thanks to an integrated water management strategy nationwide, Singapore is one of just a few cities in the world to harvest its stormwater and practice large-scale water reuse as part of its diversified water supply approach.

PUB, Singapore's National Water Agency, has long been a leader in water reuse innovation. PUB developed NEWater, its own brand of ultra-clean, high-grade reclaimed wastewater. With the country's water demand expected to double by 2060, Singapore is looking to use NEWater to meet more than half of this future water demand. Key to meeting this goal is the Deep tunnel Sewerage System (DTSS), a super highway to collect all the used water for further reclamation into NEWater.

The first phase of DTSS covers the eastern half of Singapore while the second phase will take care of the western side of the island. A key component of the DTSS Phase 2 is the Tuas Water Reclamation Plant (WRP), a new facility under design in the west of Singapore. When completed, the plant will treat 800,000 cubic meters of used water per day for reuse to meet both industrial and drinking water needs.

A first in Singapore, the Tuas WRP will be integrated with the National Environment Agency's Integrated Waste Management Facility (IWMF), collectively known as the "Tuas Nexus." Tuas Nexus is a first-in-the-world green-field development, which integrates two complex facilities to reap synergies of the water-energy-waste nexus, resulting in improved efficiencies.

For example, food waste received at the IWMF will be co-digested with used water sludge at Tuas WRP to increase the yield of biogas, which in turn is used at IWMF to improve steam quality and give rise to higher overall plant thermal efficiency. As such, Tuas Nexus **will double energy recovered from used water** and export more electricity to the national grid, while allowing both facilities energy self-sufficiency.

Today, Singapore's water journey, turning water vulnerability into an opportunity to pilot new technologies and innovative solutions, serves as an international model for water management that extends across all facets of the water cycle to create a sustainable legacy for years to come.

Tuas Water Reclamation Plant, when complete, will be the **largest** membrane bioreactor facility **in the world!**

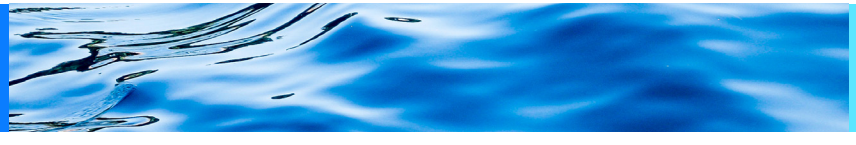
TUAS NEXUS

From yuck to yes: the path to widespread implementation

Water reuse is growing around the globe, with utilities investing in new opportunities, as well as industrial verticals such as power, data centers and food and beverage exploring how recycled water can help meet demands. But to meet these future water demands and goals, investment in and application of water recycling and reuse needs to increase significantly.

To truly untap reuse's potential to confront the global water crisis, the world needs to:

1. **Think differently about water.** Water reuse is consistent with the One Water approach, stewarded by the U.S. Water Alliance, that encourages a mindset that all water, no matter the type, is valuable. When we shift the mindset about water – whether it is from lakes and streams or storm and wastewater – we can harness nature's water cycle to unlock triple-bottom-line sustainability benefits and lay the groundwork for successful potable reuse programs as a natural solution.
2. **Build public awareness and eventually, acceptance of water reuse.** Industry experts acknowledge that public perception is the biggest barrier to utilities and cities reusing water endlessly. Using fun, interactive ways to introduce the public to the safety and benefits of water reuse, such as community education centers like the The NEWater Visitor Centre in Singapore or water-to-beer events like those in Arizona, are already helping promote the positive impacts water reuse can have. Additionally, even changing the way we talk about water reuse can help dissuade negative perceptions. For example, instead of saying "recycled wastewater," the AZ Pure Water Brew team uses "purified or advanced purified water" to describe their reuse water and emphasizes the key message that all water is recycled water.
3. **Form strong partnerships to maximize potential.** Exploring alternative delivery models or a strategic alliance may unlock other avenues to create new landmark projects for utilities and professional service companies alike. Alternative delivery models can help finance infrastructure upgrades or new systems, provide opportunities for leading experts to revamp applied technologies and even help optimize operations of facilities after they are built. In less-developed locations, non-profit organizations can facilitate wider application of water reuse in their efforts to help impoverished communities gain access to water. For example, implementing a self-sustaining reuse facility in these locations could help diminish future water shortages and eliminate harmful discharge into local waterways – a main cause of water, sanitation and hygiene-related diseases.
4. **Increase support and opportunity to apply reuse and develop new technologies.** With feasible, actionable guidelines and regulations for potable reuse in place, utilities and industry can streamline efforts to put water reuse into action in the places that need it most – ahead of the devastating effects that a non-secure water supply can cause. Additionally, with support from the top down, there would be more freedom for the science and engineering community to push modern treatment and sanitation even further with technology advancements – making solutions more sustainable, safer and even more affordable.



Meet Jacobs

As water issues intensify, so does awareness of the effects of water management decisions. Decisions at one point in the water cycle affect all the others—from water supplies to treatment, conveyance, wastewater treatment, reuse and return to the natural environment. Our global community cannot afford to use water once and dispose of it, especially as fresh water supplies grow scarcer and populations surge – and that is where Jacobs comes in.

For more than 50 years, Jacobs has led the industry in potable reuse. In fact, the company won the Stockholm Industry Water Award for pioneering potable reuse and public acceptance in 2015. The landmark work Jacobs led with Denver Water and Singapore PUB in the 1980s and 1990s paved the way for the direct potable reuse operations being planned and executed today. Currently, Jacobs partners with utilities and agencies around the globe at the forefront of water reuse technology advancement, bringing different thinking to help solving the world's most complex water challenges.

Specializing in projects across the entire water cycle – not only reuse – Jacobs provides solutions focused on ensuring access to safe, reliable water supplies; addressing the world's water-energy nexus and pushing modern sanitation forward to give more people access to clean water and a healthier environment; balancing people, planet and profit to secure reliable, operation-critical water supplies; moving and protecting the world's water with conveyance and storage systems; and enhancing operations to protect assets, improve efficiency within their organizations, make wise decisions and more fully leverage existing information systems.

'Water' Our Sources?

Glad you asked. Sources cited and referenced include:

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Explore Jacobs' capabilities and more Jacobs-supported efforts like those highlighted in this white paper, so together, **we can help deliver the promise of a more connected, sustainable world**.

ENR Rankings

#1 Top 500 Design Firms

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About Jacobs

At Jacobs, we're challenging today to reinvent tomorrow by solving the world's most critical problems for thriving cities, resilient environments, mission-critical outcomes, operational advancement, scientific discovery and cutting-edge manufacturing, turning abstract ideas into realities that transform the world for good. With approximately $14 billion in revenue and a talent force of more than 55,000, Jacobs provides a full spectrum of professional services including consulting, technical, scientific and project delivery for the government and private sector visit www.jacobs.com, and connect with Jacobs on Facebook, Instagram, LinkedIn and Twitter.

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