



1800 Limerick Street  
Alexandria, VA 22314  
alexrenew.com

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January 5-6, 2024

## Board of Directors Retreat

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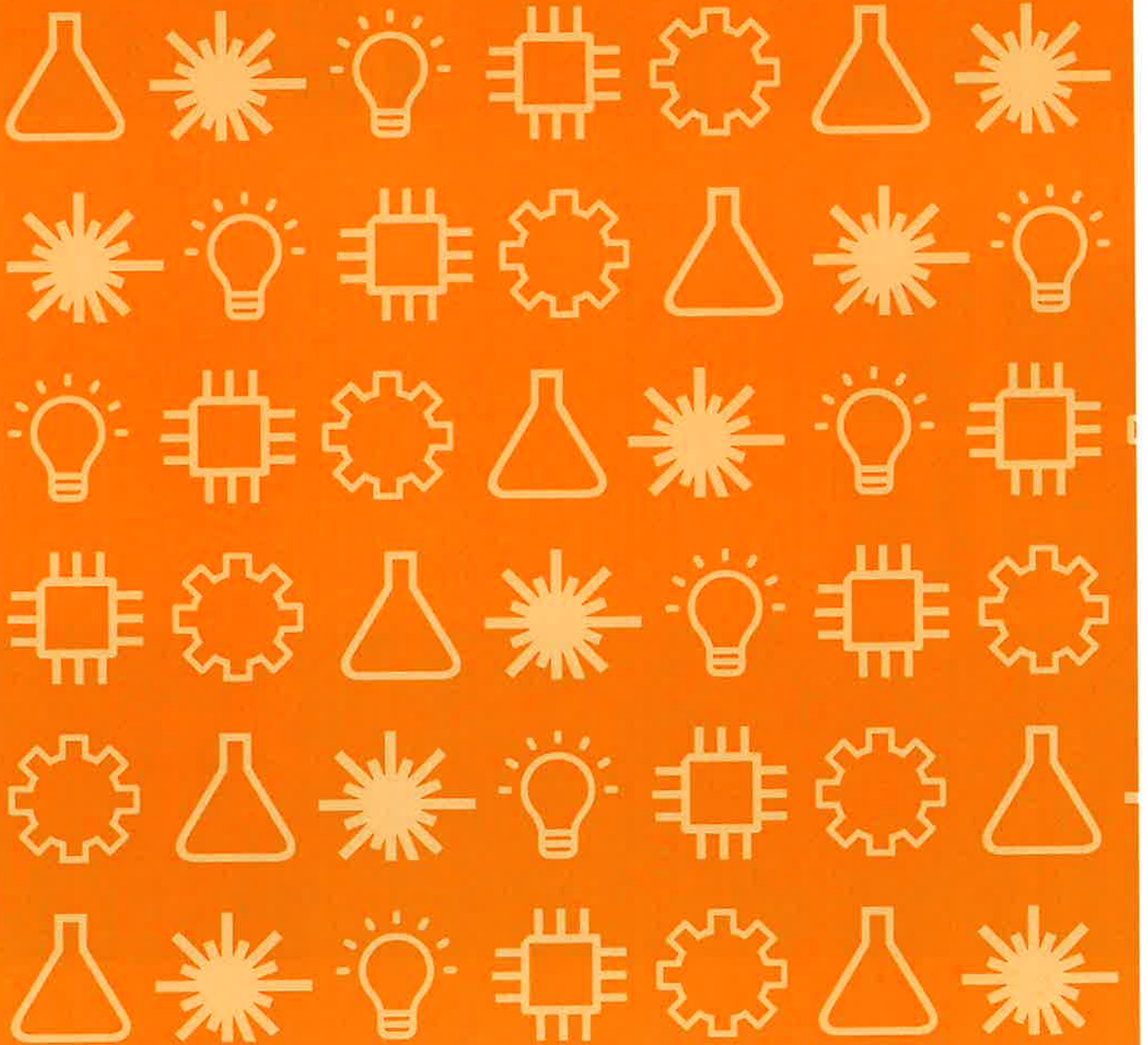
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# INNOVATION ELEVATED

## Offerings Guide



# About Innovation Elevated

## Building Momentum

Building Momentum has been training the Department of Defense with Innovation Boot Camp since 2014, bringing 21st century technology to active-duty service members all over the world. This same training has become the cornerstone of the bespoke offerings made to schools, community groups, and corporate clients through Innovation Elevated and Innovation Academy.

## Innovation Elevated

Innovation Elevated trains individuals, teams and organizations to think differently about the problems they are charged to solve. Whether it is on the battlefield or in the boardroom, our unique curriculum empowers participants to break outside of their everyday routine and approach one another, their work and challenges in new and exciting ways.



## Why Innovation Elevated Works

- Encourages teamwork through productive conflict
- Sparks all-encompassing organizational change
- Delivers high level, challenge-driven management training
- Fosters introspection and accountability across organizational levels
- Expedites training for a quicker path to success
- Increases staff engagement by providing tools for open communication
- Draws upon the concepts of design thinking
- Creates new team dynamics by using technology as a common obstacle

"We offer these courses to get your team started, but we really want to understand your problems, and develop training unique to your team and based on what's shared."

- Cheyanne Dwyer,  
Chief Strategy Officer

Interested in booking an Innovation Elevated session? Get in touch!

facilitate@buildmo.com  
www.buildmo.com



## Contents

Pages 4-10 | Half-Day Offerings\*  
Pages 11-12 | Full-Day Offerings

\*Multiple half-day offerings may be combined to create a full-day experience. Please contact our team to learn more about custom offerings.

## The Claw Game

Duration: 1.5 to 3 Hours  
 Group Size: 9 to 20  
 Off-site Available: Yes



Participants will:

- Strengthen and build team rapport
- Enhance strategic and creative problem solving
- Practice collaborative and iterative work
- Stoke or revitalize team spirit and excitement
- Encourage open discussion and processing

Remember that frustrating arcade claw game where you try to pick prizes up with a mechanical claw? Those prizes always seemed to slip out of your grasp at the last second! Well, in Innovation Elevated's "The Claw Game!", the prize is an improved team and winning is guaranteed!

Teams will design and develop a moving claw using craft supplies, and a variety of other materials. Participants will pick objects up off the floor from a mezzanine, or other second-story structure, while they race against the clock, and each other, to haul up the most prizes. Our certified facilitators assist teams during the challenge and provide useful conflict management and interpersonal dynamics strategies. Teamwork, creativity, communication, and time management are all essential in this mechanical design challenge.

After we get those high scores on our leader board and deliver some well-deserved awards, Build Mo will facilitate our Retrospective where participants can reflect on their actions and experiences.

Covered Themes



## Primary Activity

### Electric Vehicles

Duration: 2 to 4 Hours  
 Group Size: 9 to 80  
 Off-site Available: Yes



Participants will:

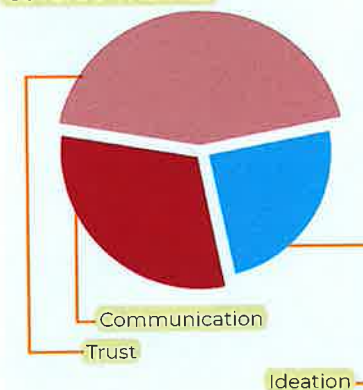
- Strengthen and build team rapport
- Enhance strategic and creative problem solving
- Practice collaborative and iterative work
- Redirect and revitalize team narratives
- Encourage open discussion and processing

Don't let your team short-circuit from a bad feedback loop! Get your vehicles floating, fleeing, or flying with this shockingly fun team building challenge! Your employees will be amped up as they get to experience soldering and intense teamwork in "Electric Vehicles".

Participants get the chance to learn skills like soldering and mechanical design as they balance budget and time to craft a battery-powered motorized vehicle. Teams may be constructing boats or cars. No matter the vehicle—they will all culminate in an exciting race! Our certified facilitators will aid teams during their design and construction phases as our instructors cover the technical skills.

Individuals will rely on teamwork to respond to real-time problems and changing demands. When tensions rise, we help your team power through problems to recharge their self-awareness and improve their function as a unit. After the race and some awards, Build Mo will facilitate our Retrospective where participants reflect on their actions and experiences.

Covered Themes



## Chalice Challenge

Duration: 2 to 4 Hours  
Group Size: 6 to 30  
Off-site Available: No



### Participants will:

- Cultivate and strengthen bonds to improve team dynamics
- Practice a systems model approach to problem solving
- Develop time management and communication skills
- Demonstrate individual and collaborative ingenuity
- Exercise efficient resource utilization and management

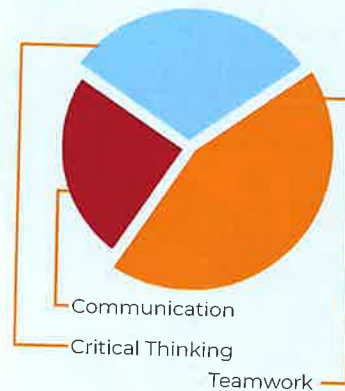
Are your employees struggling to work together effectively? Is communication falling flat? Well, have your teams test their mettle as they learn to weld metal while trying to win a medal in "Chalice Challenge"!

Participants will learn about welding as they are outfitted with all the necessary safety equipment. After a brief demonstration it is time to get into the hands-on-metal action! Our skilled instructors will guide participants through their first welds, coaching them and offering technical tips. Following the instruction period, participants will be able to weld their name and create a name plate to take home.

Then the challenge begins! Teams will work together to fabricate a chalice with their newly minted welding skills. The chalice that holds the **most water** wins! Our certified facilitators will assist teams as they design and build. Success depends on cleverness as much as it does metal working!

After testing and medals, Build Mo will facilitate a brief Retrospective where participants reflect on their experience.

### Covered Themes



## Eggstreme Defense

Duration: 3 to 4 Hours  
Group Size: 10 to 80  
Off-site Available: Yes



### Participants will:

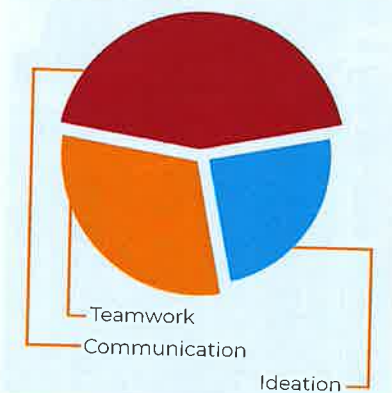
- Practice a systems model approach to problem solving
- Develop new communication strategies under pressure
- Demonstrate individual and collaborative ingenuity
- Improve iterative skills through frequent failure
- Exercise efficient resource utilization and management

Strong teamwork is *eggstremely* important for every situation; see if your team cracks under the pressure of "Eggstreme Defense"! Participants will experience the role of packaging engineers as they navigate communication and budgeting challenges to design a contraption that keeps their egg safe. But it would not be an Innovation Elevated *egg*sperience without a technology twist! Yep, this is not your old high school egg drop—you will also be building a launcher for your egg. Learn new skills as you take your eggs to the next level!

Our certified facilitators lead teams to create **devices** that will protect their eggs **from falls, landings, and projectile impact**. The teams will have a planning period where they discuss how to divide and conquer their engineering design challenges. They have a budget of 'Build Mo Bucks' to purchase materials, but they should be used wisely on the chance another challenge pops up!

After some dynamically destructive testing and a few awards, Build Mo will facilitate our Retrospective where participants reflect on their actions and experiences.

### Covered Themes



## Add-on Activity

### Learn to Weld Add-On

Duration: 0.5 to 2 Hours

Group Size: 10 to 30

Off-site Available: No



#### Participants will:

- Practice trying new skills in a safe environment
- Develop closer bonds from shared experiences
- Demonstrate individual ingenuity
- Exercise ability to feel comfortable in the unknown

Are the wrong type of sparks flying between your employees? Bring them closer together as they weld metal together in "Learn to Weld!" This mini-Innovation Elevated offering lets you dip your toes into our dynamic corporate team bonding experience.

Participants will learn about welding as they are outfitted with all the necessary safety equipment. After a brief demonstration it is time to get into the hands-on-metal action! Our certified facilitators will guide participants through their first welds, coaching them and offering technical tips. Following the instruction period, participants will be able to weld their name and create a nameplate to take home.

The event will wrap up with the group showing off their work. Want a little bit more of an experience? If your team size and time permits, you can weld a metal "buddy" figurine.

Want your metal pieces to be as unique as your team? Ask about our customization options!

#### Covered Themes



## The Sky is Not the Limit

Duration: 2 to 4 Hours

Group Size: 10 to 30

Off-site Available: Yes



#### Participants will:

- Address interpersonal conflicts in team dynamics
- Strengthen and build team rapport
- Practice trying new skills in a safe environment
- Redirect and revitalize team narratives
- Develop closer bonds from shared experiences

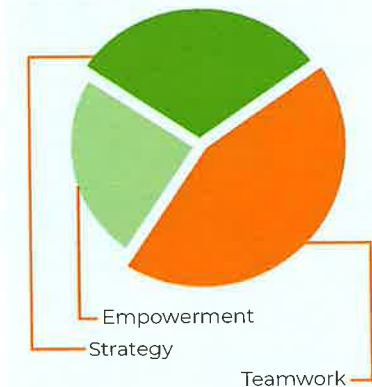
Look, up in the sky! It's a bird... no, it's a plane! No... it's an engaging and effective team building experience! "The Sky is Not the Limit" is the perfect Innovation Elevated offering for anyone who feels like their team has been hovering in one place.

You will not hear our certified facilitators droning on and on—participants will be jumping straight into the action with a customized selection of drone challenges and activities. All our drone options include a competitive aspect and require efficient strategy with more than a little trust!

Our certified facilitators will assist teams as they pilot their way through hoops—avoiding obstacles and speeding through complicated turns—while relying on information from other team members.

After the results are tallied up and winners announced, Build Mo will facilitate a brief Retrospective where participants reflect on their experience with their peers.

#### Covered Themes



## Iron Gondola

Duration: 4 to 5 Hours  
 Group Size: 20 to 50  
 Off-site Available: No



Participants will:

- Demonstrate individual and collaborative ingenuity
- Redirect and revitalize team narratives
- Develop new communication strategies under pressure
- Build team support and appreciation
- Identify and highlight areas of improvement

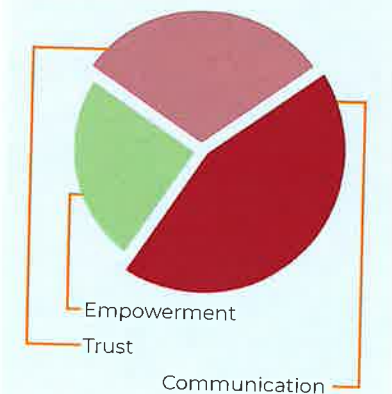
Want to prevent your team from crashing and burning? First, have them crash and burn! "Iron Gondola" not only promotes efficient communication and trust, but it also results in a more empowered team!

In this humanitarian aid inspired challenge, teams must work together using new skills to build metal carts and evacuate to safety. Participants will learn about welding as they are outfitted with all the necessary safety equipment. They will also learn how to use shop tools from our expert instructors. Then the challenge begins!

Teams will work together to design and fabricate a gondola from supplied metal, casters, and wood. Teams must transport everyone from one side of a parking lot to the safety of the other side. But be careful... if you crash, you must start over.

Will everyone fit? Will the gondola break? The team that addresses these questions and gets everyone across the parking lot first wins. Certified facilitators work with teams and provide post-activity skills and interpersonal dynamics strategies in our Retrospective.

Covered Themes



## Viking Skeeball

Duration: 6 to 8 Hours  
 Group Size: 24 to 90  
 Off-site Available: No



Participants will:

- Improve iterative skills through frequent failure
- Grow closer bonds from shared experiences
- Practice a systems model approach to problem solving
- Develop new communication strategies under pressure
- Demonstrate individual and collaborative ingenuity

Want to forge a team stronger than any other? Well get them ready to catapult into "Viking Skeeball"! Your team dynamics will be put to the test, enhanced, and honed with an exhilarating challenge of engineering and strategy. This is Skeeball like you've never seen it before... yep, we are talking about catapults!

Participants will learn about welding as they are outfitted with safety equipment. In addition to a welding demonstration, they will also learn how to use shop tools. Then the challenge begins!

Our certified facilitators will guide teams as they design and fabricate catapults from metal and wood. These Viking-esque devices will launch bean bags into buckets. The farther the launch, the more points awarded! Strategic design, inter-team communication, iterative testing, and time management are all needed to succeed.

After a Skeeball battle worthy of Valhalla and some awards, Build Mo will facilitate our Retrospective where participants reflect on their actions and experiences.

Covered Themes



## Slot Cars

**Duration: 6 to 8 Hours**

**Group Size: 18 to 30**

**Off-site Available: No**



### Participants will:

- Learn the importance of communication on all sides
- Exercise trying new skills in a safe environment
- Address interpersonal conflicts in team dynamics
- Encourage open discussion and processing

Is your team revving to go, but stalling or breaking down every time they start? We'll put your team into gear because Building Momentum is the pit crew for you. "Slot Cars" will not only get your team going, but also teaches the interpersonal tools you need so your team can do their own diagnostics and repairs, and drive circles around others.

Your team will be taken on a joyride as we teach them laser cutting, 2D drawing, and electronics to complete the challenge. Teams will learn to solder and attach DC motors to their custom-cut cars. Throughout the challenge, teams will gain experience with the engineering design loop as they work toward the finish line. It may seem challenging at times, but just remember communication is key.

After some exciting moments with your teams on track, our certified facilitators will help shine a light on the obstacles that popped along the way in Build Mo's Retrospective.

### Covered Themes



## Event Venue Pricing

Looking to spend more time with your team following your Innovation Elevated session? We would love to host you in our unique event space, The Garden, for your meeting, networking session, or Happy Hour! Meeting support services such as video conferencing capabilities and coordination for catering are available upon request.

Location Capacity	Friday-Saturday Peak/hr	Sunday-Thursday Regular/hr	M-F, 8 am-4 pm Corporate/hr
Large Event Space 150-200 people	\$450	\$400	\$300
Medium Event Space 75 people	\$250	\$200	\$200
Upstairs Event Space 30 people	\$200	\$150	\$150
Meeting Room 25 people	\$200	\$150	\$150
Upstairs Conference 12 people	\$85	\$70	N/A
Workshop (Full) 150 people	\$400	\$400	N/A
Workshop (Half) 75 people	\$250	\$250	N/A





# More From Building Momentum

## Innovation Academy | After-school programs, camps, clubs, field trips and one-day workshops

Innovation Academy camps and classes empower kids to safely and correctly use "grown-up" tools and to stretch their imagination. Kids will engage in hands-on building while improving problem solving and communication, and giving them lifelong skills that can be transferred to any area of their lives.

Class subjects include, welding, wood shop, 3D printing, laser cutting, CAD/CAM, coding, circuit making and so much more!



## Private Lessons | Hone your welding skills with an expert

Both beginners and experts may now schedule private welding classes. Learn at your pace with one-on-one help from our Education team!

These classes start at \$125 per person and can be for big or small groups. During class you can participate in either a welding challenge or you can build your own metal creation—the choice is yours! These classes typically range between 2–4 hours.

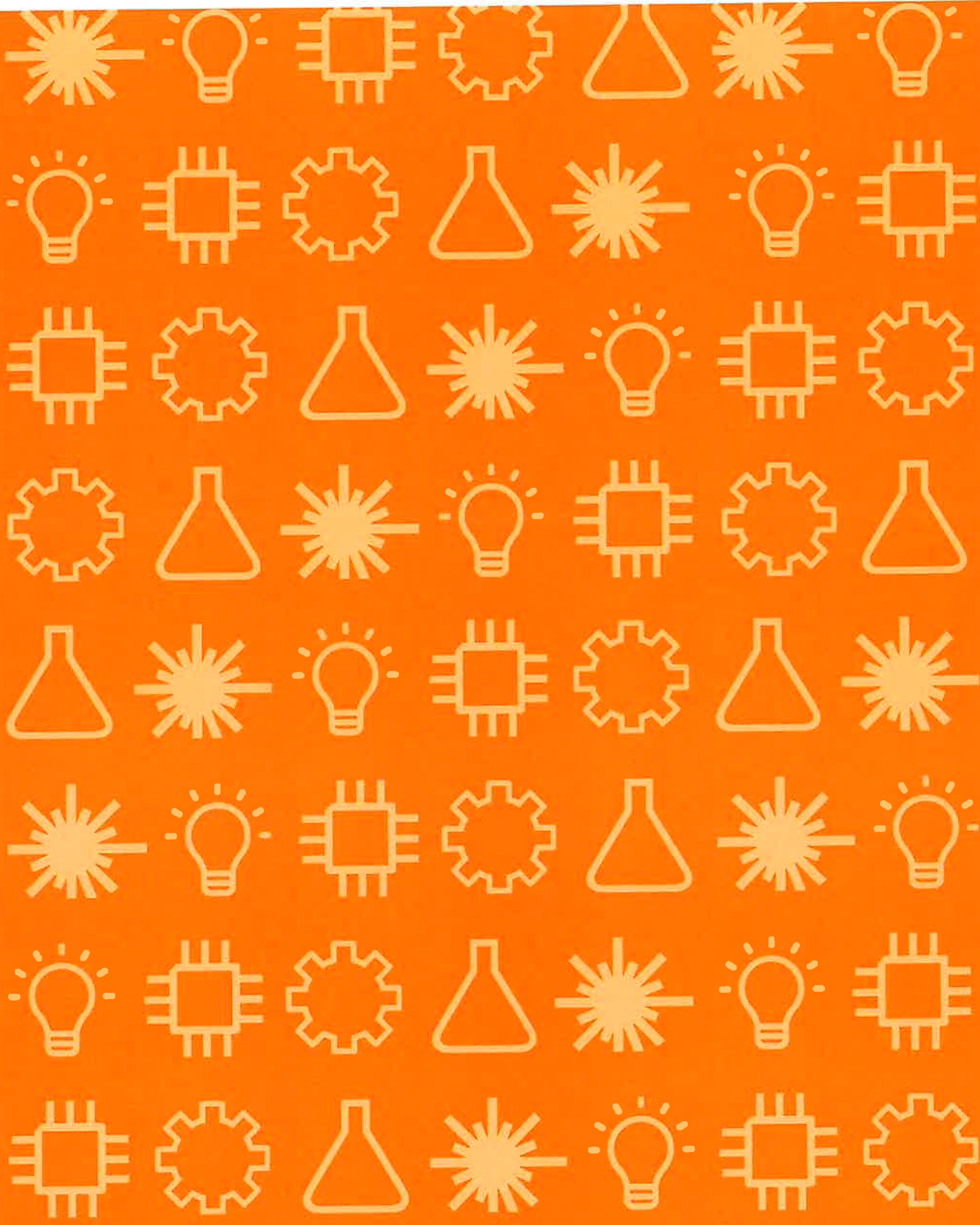


## Workshop Classes | The perfect outing; experiences that are perfect for partners and friends

Looking for a night out? Join us for Wine and Welding—our most popular night out—which has partners to learn MIG welding, create, and then wind down with a sampling of wines.

Want to learn a new skill or hone a hobby? Join us for Last Saturday! Class subjects include, welding, wood shop, 3D printing, laser cutting, and so much more!





**Get in Touch**

facilitate@buildmo.com  
www.buildmo.com

5380 Eisenhower Ave, C  
Alexandria, VA 22304



**Follow Us**



# 2040 Vision

**By 2040, we have effectively partnered with all watershed stakeholders to:**

- Enable local citizens the opportunity to **embrace the best use of water resources and establish a personal connection with local waterways.**
- **Sustainably manage water as a single resource** through the entire water cycle.
- **Create a healthy environment and improve our quality of life** through the exceptional reclamation of used water resources.
- **Maximize use of multiple financial options** to continue our fiscal stability.

## Strategic Outcomes

### 1. Operational Excellence

Continually enhance water resource and recovery procedures to provide exceptional quality products.

### 2. Public Engagement and Trust

Engage our community to help them to become informed consumers and supporters of clean water.

### 3. Watershed Stewardship

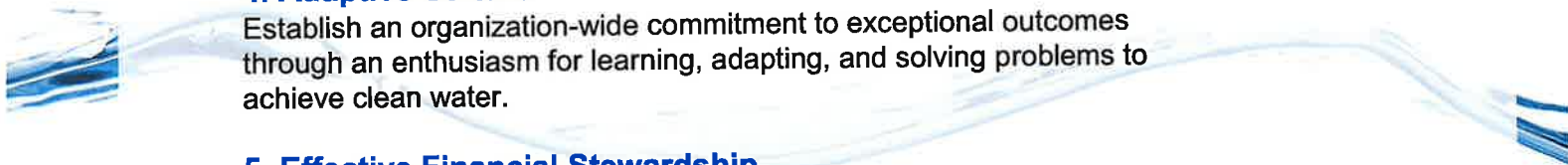
Facilitate collaboration to collectively manage and improve water resources.

### 4. Adaptive Culture

Establish an organization-wide commitment to exceptional outcomes through an enthusiasm for learning, adapting, and solving problems to achieve clean water.

### 5. Effective Financial Stewardship

Manage our financial resources to create an efficient and resilient organization that contributes to the health of the local economy.





**AlexRenew**

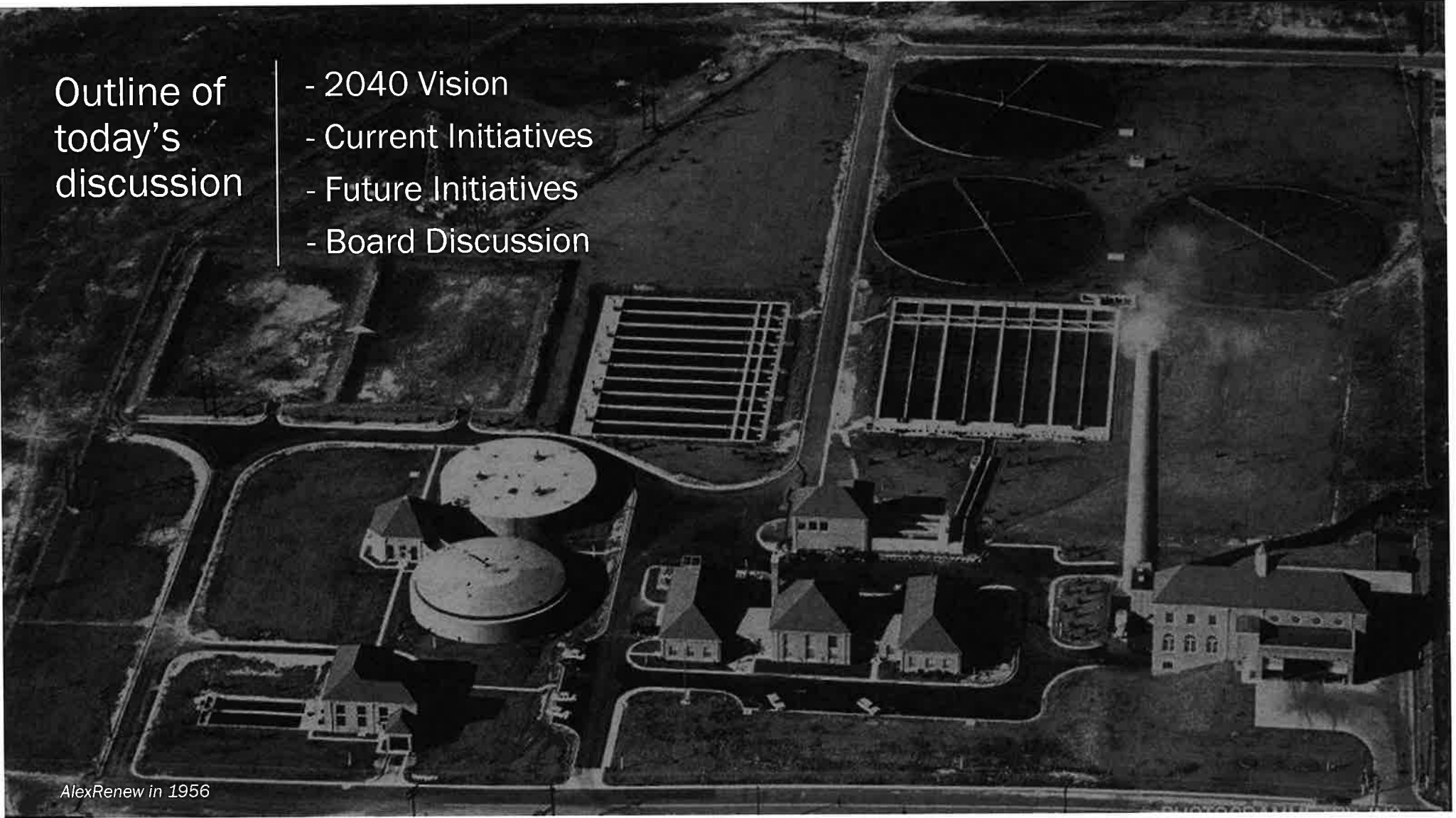
Board of Directors Retreat

**Visioning for AlexRenew's  
Changing Future**

January 6, 2024

Outline of  
today's  
discussion

- 2040 Vision
- Current Initiatives
- Future Initiatives
- Board Discussion



AlexRenew in 1956

## Using AlexRenew's 2040 Vision to shape today's discussion

- **Healthy Environment**

Create a healthy environment and improve our quality of life through the exceptional reclamation of used water resources.

- **Operate Sustainably**

Sustainably manage water as a single resource through the entire water cycle and maximize fiscal stability.

- **Establish Personal Connections**

Enable local citizens the opportunity to embrace the best use of water resources and establish a personal connection with local waterways.

## Current Initiatives | Healthy Environment

### ■ **Nutrients & Bacteria**

- Nutrient waste load allocations
- Hunting Creek Bacterial Total Maximum Daily Load

### ■ **Contaminants of Concern**

- Polychlorinated biphenyls, per- and polyfluoroalkyl substances, microplastics, endocrine disruptors
- Wastewater plant at or near limits of technology

### ■ **Climate Resiliency**

- Extreme weather
- Sea level rise
- Localized flooding

### ■ **Flow Trends**

- Densification/development
- City/County flow balance
- Higher wastewater concentrations

### ■ **RiverRenew**

- Additional wet weather flow

## Current Initiatives | Operate Sustainably

### ■ Workforce

- Diversity and inclusion
- Apprenticeship program
- Skilled trades to support 24/7 operation

### ■ Financial

- Limited debt capacity
- Managing rates
- Help those struggling to pay

### ■ Asset Management and Reinvestment

### ■ Sustainable Operations

- Reductions in natural gas, electricity, and potable water usage (GHG reductions)
- Stormwater management
- Envision/LEED

### ■ Smart Utility

- Computer and data advancements
- Data driven decisions

### ■ Cybersecurity



## Current Initiatives | Establish Personal Connections

### ■ Community

- Environmental justice
- Volunteer efforts
- Web/social media
- Newsletters
- Community enhancements
- Build on RiverRenew

### ■ Partnerships

- City of Alexandria
- MWCOG
- Carlyle Plaza connection to Limerick Field

### ■ Education

- Intern program
- Tours
- Lobby
- School outreach
- Installations at public sites

### ■ Stakeholders

- Riverkeeper, Chesapeake Bay Foundation
- Stakeholder Advisory Group, Council-Board Workgroup



## Future Initiatives

### Respond to Increased Wastewater Demands

- New contaminants of concern
- More complex and restrictive regulations
  - Driven by public perception and pressure
  - Are not supportive of local needs
- Regional development and growth
  - Manage stringent plant load allocations and permit requirements within limited footprint
- More stringent stormwater regulations that require advanced treatment



## Future Initiatives

### Respond to Increasingly Severe Climate Change Impacts



Rising sea levels  
inundates  
wastewater  
infrastructure



Extreme wet  
weather impacts  
the community,  
staff, plant, and  
permit compliance



Extreme heat  
impacts staff and  
plant (cooling,  
employee health)

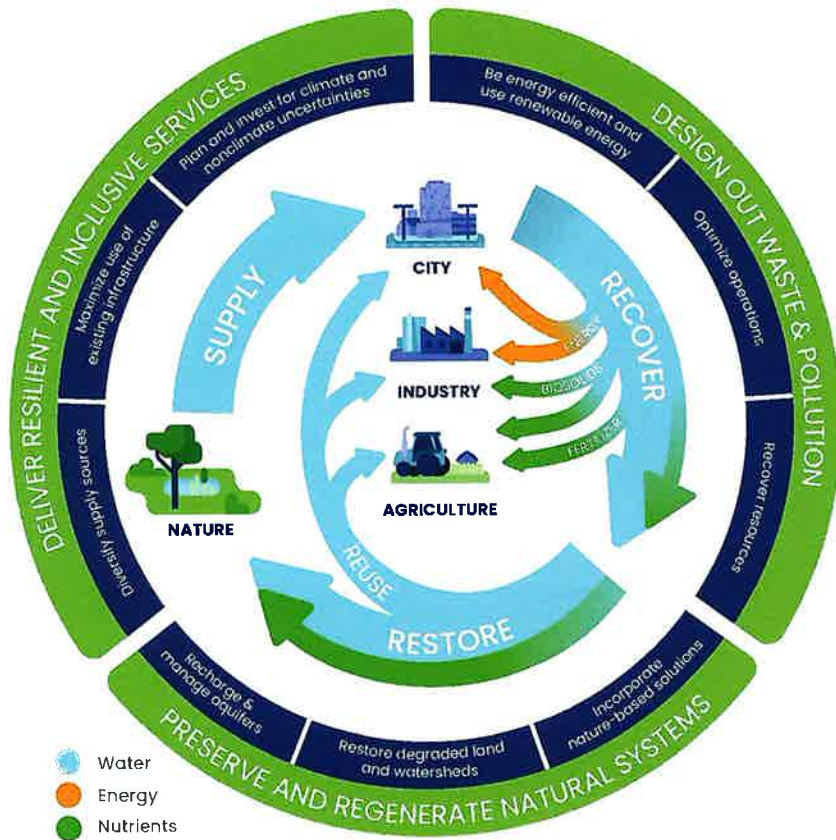


Energy neutrality  
reduces  
greenhouse gas  
emissions from  
treatment

# Future Initiatives

## Focus on a Circular Water Economy

Operate Sustainably

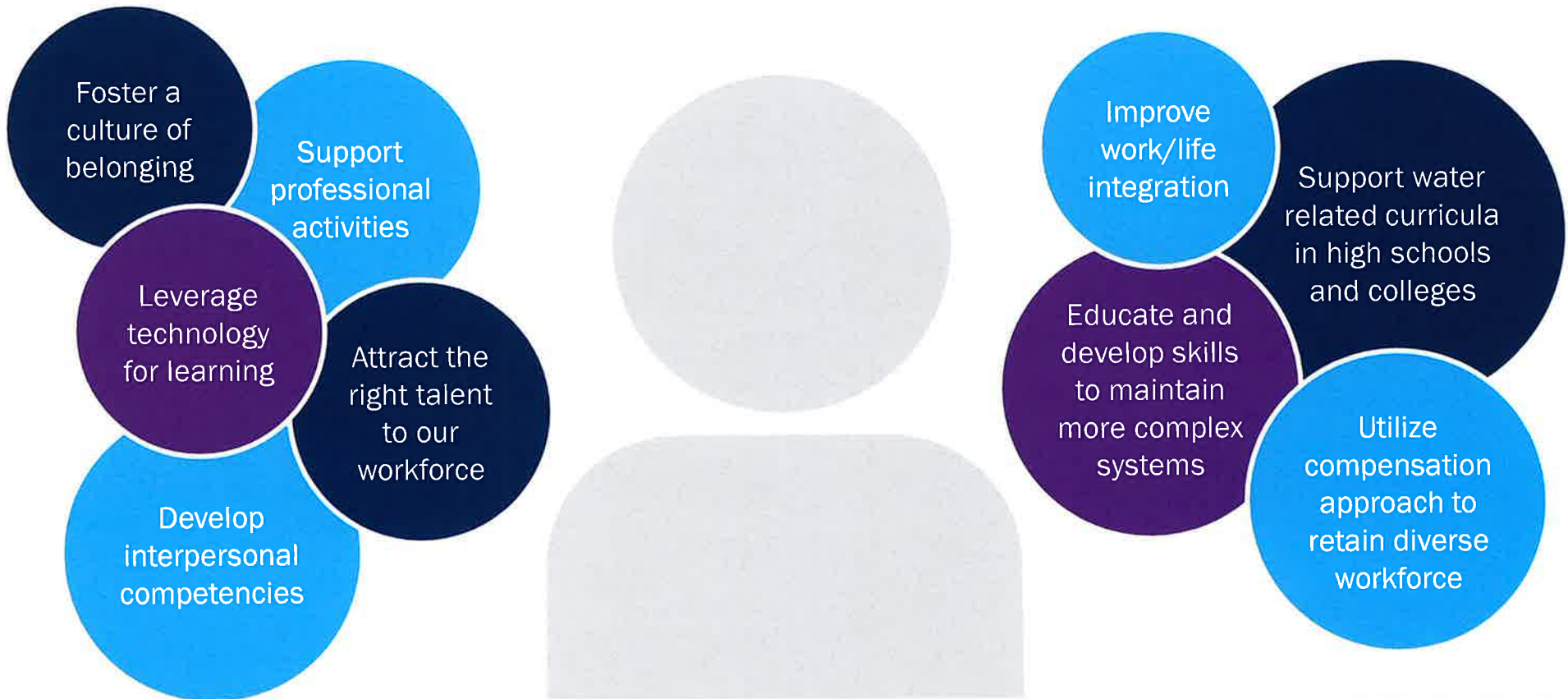


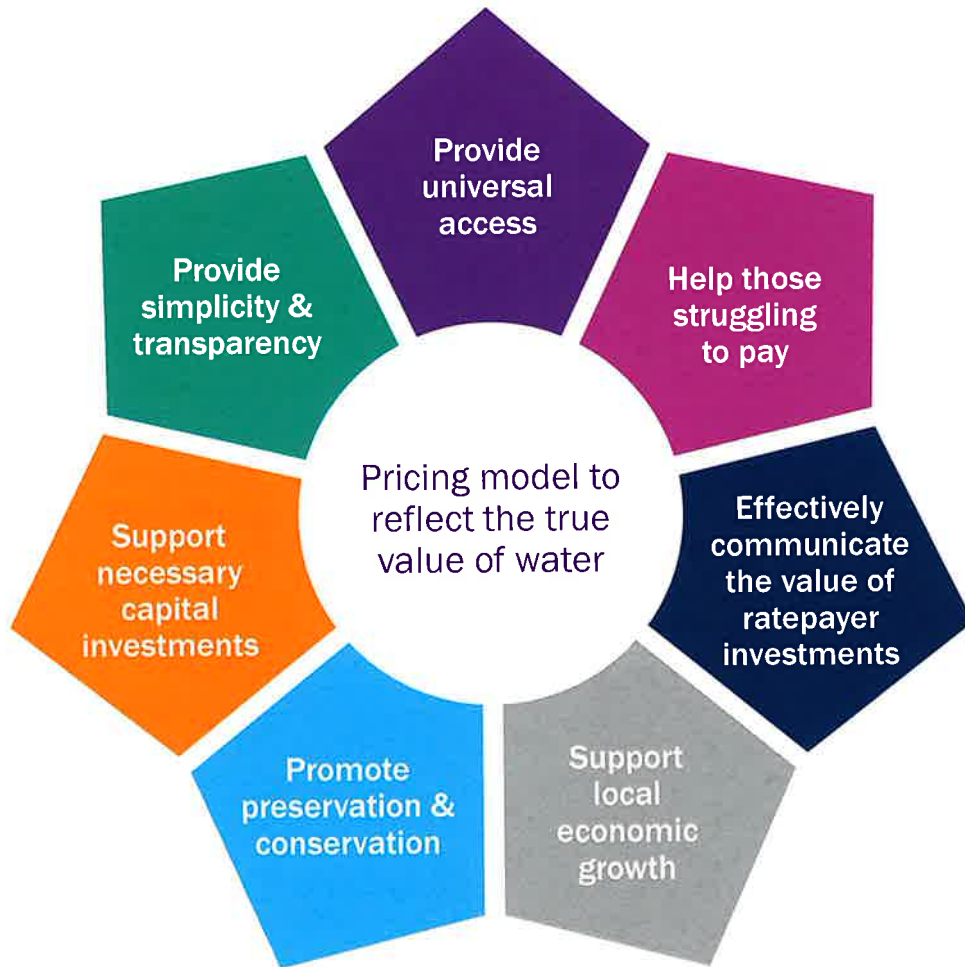
The five Rs of circular water management:

- **Reduce** water losses by boosting water efficiency
- **Reuse** water that needs minimal or no treatment for the same or different processes
- **Recycle** resources and wastewater
- **Restore** and return water to the source at the same or better quality
- **Recover** resources from wastewater and put them to use

## Future Initiatives

### Develop the Workforce of the Future



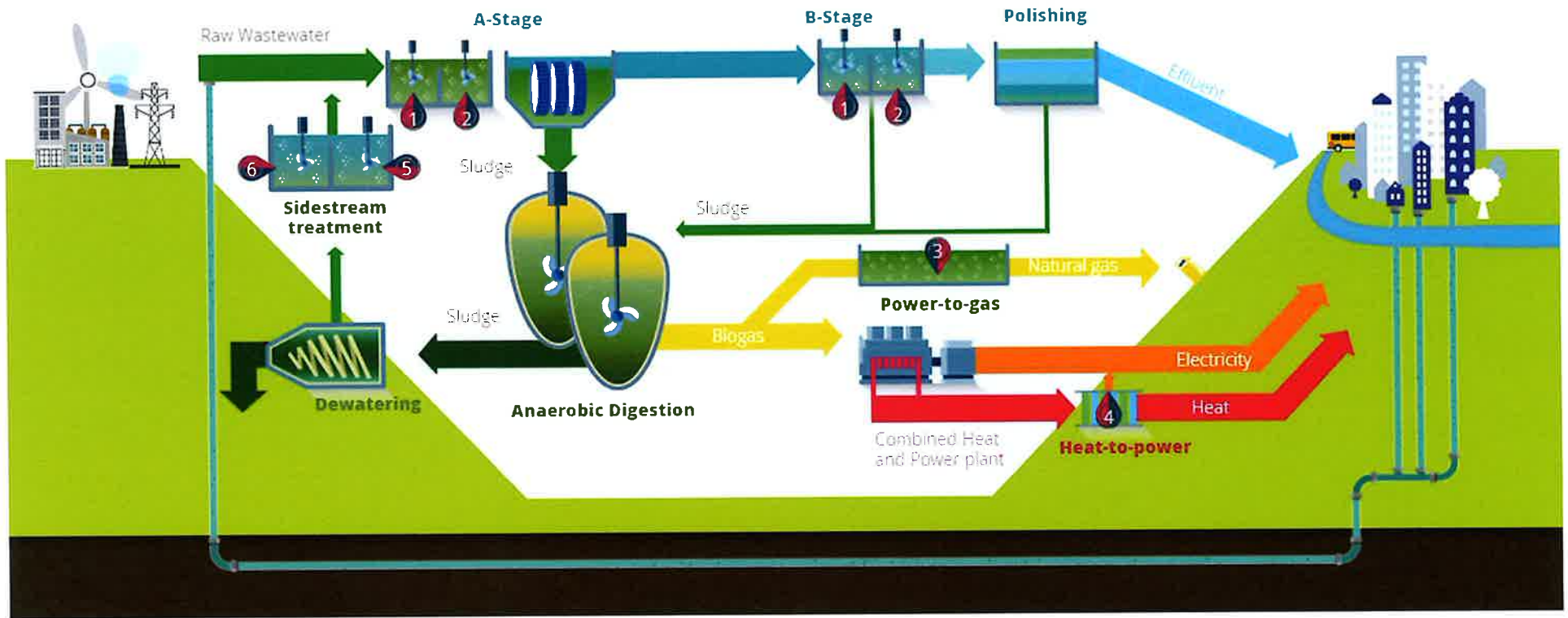


Future Initiatives  
Establish Pricing  
Model to Reflect the  
True Value of Water

# Future Initiatives

## Transition to Fully Renewable Energy & Carbon Neutrality

Operate Sustainably



## Future Initiatives

### Implement a One Water Governance Approach

- Integrate water resources management and decision making at a watershed level
- Form collaborative agreements and governance models to leverage people and funding resources
- Help provide equitable services to all communities

Watersheds are cradles of irreplaceable ecosystems – they do not recognize political boundaries



Source: Denver One Water Plan, denvergov.org



# Future Initiatives

## Advance Public Trust & Understanding

Personal Connections





## Personal Connections

### Future Initiatives

## Build Personal Connections to Water

- Enable stronger personal connections to water, including a shared sense of responsibility for water
- Develop a community mindset that water is personal versus water is local
- Share meaningful water stories

Source: <https://www.waveoneopenwater.com/washingtons-crossing>

# Discussion





# THINK TANKS SUMMARY and PATH FORWARD



# WATER

is the world's most vital resource.

It supports all life, sustains the natural environment, and undergirds national and local economies.

It grows food, transports goods, and keeps communities healthy and clean.

It is the common thread that stitches together cultures and civilizations and sews the natural tapestry around them.

## Water also faces an uncertain future.

In the next 30 years, the most salient environmental and social issues will involve water: who has it, who does not, whether it is safe, whether it is affordable and accessible, how it is managed, and by whom.

Water issues will impact economies, shift populations, and drive innovative technologies.

Water will be central to pivotal governance decisions, intractable social debates, and climate initiatives.

*But we are not powerless to create a bright water future. With bold thinking and collaboration, we can act to assure a successful and sustainable future.*

**It is out of this reality that  
Water 2050 was born.**

# Water 2050

## Water 2050 is a collaborative initiative to envision the future of water and chart a course for future success and sustainability.

Under the leadership of the American Water Works Association (AWWA), this effort brings together diverse voices to explore water's long-term challenges and opportunities.

### AWWA's Role

AWWA is uniquely positioned to host the Water 2050 conversation.

With 50,000 members from North America and over 90 countries, AWWA is the largest and oldest water association in the world. Members represent the full spectrum of the water community, including utility professionals, consultants and manufacturers, regulators, elected leaders, academics and many others involved in an essential sector with a worldwide market size of \$500 billion.

### Water 2050 Think Tank Process

*A central component of this journey was five intimate think tanks that examined water through the prism of the following five core drivers influencing the future of water. Each think tank was strategically held in a location that would immerse participants in the driver being explored.*

**Sustainability**, held at the Springs Preserve in Las Vegas, Nevada, September 21–23, 2022

**Technology**, held at the Computer History Museum in Mountain View, California, December 5–7, 2022

**Economics**, held at The Penn Club in New York City, January 23–25, 2023

**Governance**, held at the Xylem Reservoir Center for Water Solutions in Washington D.C., February 27–March 1, 2023

**Social/Demographics**, held at the Birmingham Civil Rights Institute in Birmingham, Alabama, April 26–28, 2023

At each gathering, a small, diverse group of influential thinkers, experts and emerging leaders from within and outside of the water profession engaged in thoughtful, intentional discourse.

Their charge was to explore together what our communities could look like in the year 2050 and examine how water could be managed, accessed and valued. Each collection of thought leaders was asked

to emerge with a set of recommended actions that guides the water community toward a sustainable and resilient future for the world's most vital resource.

In addition to the think tanks, AWWA gathered insights – and continues to do so – through a variety of other inputs. Among them:

- To highlight the voices of the next generation of water leaders, AWWA Young Professionals shared their perspectives on the future of water, which were compiled into a series of videos intended to paint a picture of the world of water in 2050.
- An online survey was conducted to capture AWWA members' perspectives on what water will be like in 2050, receiving 1,370 responses.
- Many of AWWA's 43 geographical Sections hosted their own Water 2050 explorations, each bringing perspectives from their unique regional viewpoints.
- Each of AWWA's six volunteer councils and many committees contributed insights for a time capsule project initiated at the AWWA Conference and Exposition (ACE23) in Toronto, and the AWWA Board of Directors participated in multiple interactive sessions.

### Recommended Actions

The vision for the future of water is bigger than any single organization or entity and will require bold action and collaboration to create significant and lasting change. Participants in the five think tanks put forth a combined 47 recommended actions for the water community – many of which carried common themes.

While each think tank focused on one driver, recommended actions emerging from each discussion often were connected to those from other discussions.

The themes and recommendations are a starting point from which more detailed actions will be developed through future events and discussions, scientific research, published works, policy development, partnerships and other contributions to the Water 2050 initiative.

# •••• Water 2050 Themes

## Theme 1: Create a One Water Ecosystem

The pathway to 2050 will require an intentional approach to system optimization, with actions prioritized by their impact on long-term water quality and availability, carbon emissions, and the resilience of our communities, environment and planet. The water community will develop and refine a circular economy in which streams of “waste” are valued as renewable resources. As one think tank participant noted, “There is no such thing as wastewater. There is only wasted water.”

Achieving a circular economy will require a One Water approach – emphasizing that all water is valuable, wherever it exists in the natural or human-engineered cycle – which integrates water, wastewater, reuse, stormwater and even energy utility services and increases overall operational and management efficiencies. Such a shift requires comprehensive planning that transcends siloed thinking, exploration of regional or national water plans, integration or

consolidation of utilities, and a new level of cross-sector collaboration. Viewing water management from the perspective of watersheds will encourage a shift toward fewer utilities – far fewer than the 50,000 water systems that exist in the United States alone today, for example. By encouraging water governance from a watershed rather than geo-political perspective, the water community is better positioned to sustain and make efficient use of resources, while encouraging new and innovative water management strategies. Centralization of operational and managerial functions can support decentralized and right-sized infrastructure.

Globally, governing bodies will introduce strategies to address cross-border resource and resilience concerns and advance a One Water mindset. The scope of water regulations will expand from “drinking” and “wastewater” quality to include a range of fit-for-purpose standards, allowing for treatment specifically to the needs of the end user.

### Recommended Actions within Create a One Water Ecosystem Theme

Think Tank	Recommended Actions
Sustainability	<ul style="list-style-type: none"> <li>• Achieve economies of scale of water systems through consolidation and operational efficiencies</li> <li>• Integrate management of drinking water, wastewater, reuse, and energy utilities</li> </ul>
Governance	<ul style="list-style-type: none"> <li>• Regionalize water utilities on the basis of watersheds</li> <li>• Integrate water-related utilities and partner with other utilities to contribute to a circular economy</li> <li>• Encourage national governance structures with a One Water focus and regulatory frameworks that include diverse stakeholders</li> <li>• Establish widely accepted fit-for-purpose standards</li> </ul>
Social/Demographics	<ul style="list-style-type: none"> <li>• Provide collaborative, sustainable water services across the entire water cycle utilizing cross-sector partnerships</li> </ul>

## Theme 2: Climate Resilience

In the next 30 years, the water sector must anticipate, mitigate, and respond to challenges introduced by a changing climate. Extreme weather events, high intensity/duration of rainfall events and flooding, extended droughts and wildfires, new snowpack runoff timetables, and sea level rise will impact how water is managed, treated, distributed, collected, reused and returned to the environment.

The future calls for a broader and more efficient supply portfolio that includes desalination, potable and non-potable reuse, stormwater capture, and consideration of innovative and decentralized infrastructure solutions. Advances in technology and better leveraging of energy sources (especially renewable sources) will help facilitate this transformation. For example, developments in predictive analytics and materials sciences will allow for a more holistic approach to asset

management throughout all aspects of the physical infrastructure, from the asset supply chain to condition assessment and renewal. Real-time monitoring, using robust sensors designed to last the life of the asset, and remote monitoring techniques will dramatically advance reliable data collection. The water community will employ forward-looking economic and business models designed around climate resiliency and adaptability as a central aspect of financial planning.

The sustainability of water resources demands a no-waste mentality. To overcome challenges exacerbated by climate change, water utilities will advance a circular water economy that transforms existing waste streams into valuable resources. The current and future challenges will require purposeful collaboration across sectors and governments at a watershed scale.

### Recommended Actions within the Climate Resilience Theme

Think Tank	Recommended Actions
Sustainability	<ul style="list-style-type: none"> <li>• Reduce the water community’s impact on climate change through adaptive management</li> <li>• Define and quantify a net zero water community</li> </ul>
Technology	<ul style="list-style-type: none"> <li>• Apply real-time monitoring, predictive analytics and material science to create eternal infrastructure and support resilient resources</li> </ul>
Economics	<ul style="list-style-type: none"> <li>• Integrate climate impact and resiliency into economic and financial modeling</li> </ul>
Governance	<ul style="list-style-type: none"> <li>• Enable a flexible governance framework that encourages proactive planning for extreme events and uncertainties</li> </ul>



# Water 2050 Themes

## Theme 3: Financial Sustainability

Cost-of-service-based pricing is critical to ensure that water services remain financially sustainable in 2050. While North American water utilities strive for rates that are cost-based, fair and equitable, they find that revenue from rates often does not fully cover critical infrastructure investments or increasing treatment costs. Even rates that do not recover the full cost of service can result in affordability concerns, particularly among underserved communities.

For water resources and systems to be financially sustainable, and at the same time be affordable beyond 2050, innovative financial approaches are needed. Utilities must be able to cover the cost of infrastructure solutions and operations in both centralized and decentralized models. While increased support from

government is critical, water resilience can also be a key target for economic, social and governance (ESG) investing in the decades ahead. The water community can help by actively promoting the social and environmental value of water resources and systems.

The development of cities and surrounding areas creates continued pressure on water systems to provide One Water management, fund infrastructure expansion, and provide water services to meet the demands of an ever-increasing population. The water community will be empowered to take a leading role in shaping community development, shifting decision-making away from purely political forces and aiming toward a growth model compatible with water resource sustainability.

### Recommended Actions within the Financial Sustainability Theme

Think Tank	Recommended Actions
Sustainability	<ul style="list-style-type: none"><li>• Rapidly identify financing and funding sources for resilient systems of the future</li><li>• Reframe the value of water to reflect the need to prepare for a sustainable future</li></ul>
Economics	<ul style="list-style-type: none"><li>• Establish a pricing model that covers all the costs of water</li><li>• Enable utilities to finance distributed water technologies and systems</li></ul>
Social/Demographics	<ul style="list-style-type: none"><li>• Align utility sustainability plans and economic growth plans</li></ul>



# Water 2050 Themes

## Theme 4: Equity, Affordability & Access

Water infrastructure and services – like many community investments – have not always been equitably distributed. Past land use and zoning practices created neighborhoods that suffered disproportional environmental impacts and lower quality services.

In the future, water affordability will be seen in the broader context of poverty, and therefore should be addressed through broad societal initiatives rather than only through the utility's rate-setting approach. The water community will need to engage many public, private and philanthropic partners, as well as government at all levels, to advance equitable water services.

By 2050, water will be understood as a merit good, with greater recognition of its numerous external benefits, including enhanced public health and sanitation, environmental protection and business continuity. In the same way they assist struggling individuals with

food, governments will need to play a role in supporting low-income households in order for full-cost pricing and affordability to coexist.

Beyond sources of funding and affordability programs, the application of new technologies for water management has the potential to address long-recognized inequities in water quality, services and resources. For example, real-time access to water quality data, made possible by in-home sensors, can provide critical information to both utilities and consumers. Artificial Intelligence (AI) and digital twins can help utilities visualize their systems in a new way and identify where services are not equitably distributed.

The water community will need to work continuously to ensure that innovators, utilities and governments make transformational technology quickly accessible to everyone, particularly those in smaller and disadvantaged communities.

### Recommended Actions within the Equity, Affordability & Access Theme

Think Tank	Recommended Actions
Sustainability	<ul style="list-style-type: none"> <li>Assure that equity and affordability are key considerations in water infrastructure and resource investments</li> </ul>
Technology	<ul style="list-style-type: none"> <li>Strive for the rapid adoption of technology that results in equitable and sustainable outcomes</li> </ul>
Economics	<ul style="list-style-type: none"> <li>Recognize water as a merit good</li> </ul>
Governance	<ul style="list-style-type: none"> <li>Set rates that reflect the full cost of service while advancing affordable access and recognition of the human need to water</li> </ul>
Social/Demographics	<ul style="list-style-type: none"> <li>Meet communities' water needs affordably, equitably, efficiently and transparently</li> </ul>

## Theme 5: Optimize Efficiency to Create a Circular Economy

The best way to achieve an efficient and sustainable water future is to create a circular economy in which each component produced through treatment processes – liquid, solid and energy – is leveraged as a new value stream. Eliminating waste throughout the water cycle reduces the water community’s water footprint, collective carbon emissions and, ultimately, its impact on climate change.

Achieving a circular water economy requires long-term cross-sector partnerships, prioritizing circularity practices, leveraging technology, and implementing new water governance and regulatory frameworks. The water community will need to assess a diverse portfolio of resource management, infrastructure, and treatment options, including conservation, reuse, desalination, resource recovery, nature-based solutions, water loss control and others, evaluating them in light of both resource and emissions goals.

Real-time data monitoring, AI and machine-learning technologies will be more broadly and economically implemented to optimize and automate processes throughout the water lifecycle, democratizing technology and managing cyber risks. For example, variable water pricing may be driven by real-time changes in consumption or fit-for-purpose water quality requirements. The challenge in the coming decades will be to engineer robust and resilient automation and data networks while maximizing efficiency and safety through revolutionary new technology.

Creation of a circular water economy will require consideration of a new approach to water governance, with regulatory standards broadening beyond water quality to encompass effective utility management. Whether these standards are voluntary, incentivized, or integrated into new or existing regulatory frameworks, they will require flexibility in implementation and alignment with federal, state/provincial, and local oversight agencies.

### Recommended Actions in the Optimize Efficiency to Create a Circular Economy Theme

Think Tank	Recommended Actions
Sustainability	<ul style="list-style-type: none"> <li>Maximize efficiency through reuse, conservation, and expanding collaboration with other sectors</li> </ul>
Technology	<ul style="list-style-type: none"> <li>Employ digital solutions such as artificial intelligence (AI) and machine learning (ML) to optimize efficiency, operations, and water quality</li> <li>Establish a water community system and culture in which cyber risks are proactively and uniformly addressed</li> </ul>
Economics	<ul style="list-style-type: none"> <li>Optimize efficiency through a circular water economy</li> </ul>
Governance	<ul style="list-style-type: none"> <li>Promote the integration of utility performance standards that support better technical, managerial, and financial practices</li> </ul>

# Water 2050 Themes

## Theme 6: Advance Innovation

The future of water requires an innovative, collaborative water community culture that embraces and adopts new technologies and new ways of thinking across the full water cycle. Owing to its responsibility to protect public health and the environment, the water community is often perceived as risk-averse. However, technology itself can be leveraged to overcome barriers to innovation and satisfy protective regulatory oversight, thereby “de-risking” innovation. New technology and creative approaches may accelerate the movement toward a One Water paradigm, in which water is managed in a sustainable, inclusive, integrated way under a single regulatory system.

By 2050, technology providers and investors will be emboldened by a water community culture that encourages and incentivizes innovation. Governments will actively seek out and provide funding to water

systems and technology developers to facilitate collaboration, confront emerging challenges and pursue efficient One Water solutions in creative ways. Without investment, there can be no innovation.

Climate change, coupled with increasing domestic and international migration, is putting a strain on existing infrastructure, and the water community must find new approaches to respond to expanding and contracting populations in different locations. Over the next 30 years, the water community will better understand migration patterns and trends and employ predictive analytics to sustain water resources and infrastructure. In addition, innovative approaches to building a sustainable water workforce will be employed, as communities large and small seek sufficient human capital and a new mix of roles and skillsets to match the needs of evolving population trends and advancing technology.

### Recommended Actions within the Advance Innovation Theme

Think Tank	Recommended Actions
Technology	<ul style="list-style-type: none"><li>• Leverage technology to break down barriers to innovation, address regulatory compliance, and mitigate unintended consequences</li><li>• Incentivize investment in innovation and experimentation</li></ul>
Economics	<ul style="list-style-type: none"><li>• Adopt innovative financing models and technologies to support all water infrastructure</li></ul>
Governance	<ul style="list-style-type: none"><li>• Integrate research and data across agencies to drive a culture of change and innovation</li></ul>
Social/Demographics	<ul style="list-style-type: none"><li>• Prepare the water community to meet the needs of migrating populations</li></ul>



# Water 2050 Themes

## Theme 7: Community Engagement & Empowerment

As we move toward 2050, all people – from water professionals to decision-makers to the community at large – will develop a shared understanding of the value of water and their part in protecting this vital resource for future generations.

Water providers must act today to build relationships, seek out the opinions of diverse audiences, and engage in meaningful dialogue about the connection between water and everyday life. Serving as anchor institutions, water utilities of 2050 will value communications and community engagement in the same way they value water science and engineering, and employees will serve as ambassadors and champions of water in their own communities.

To succeed in a technology-driven future, the water profession must be perceived as, in the candid words of a young professional participant, “cool as hell.”

The next generation of water workers will usher in an era of digital solutions that reconfigure many utility roles and demand new expertise. As digital/AI natives, future water professionals will be technologically savvy, data-driven, and prepared to revolutionize the sector.

New technologies will also allow water providers to communicate with a new level of transparency, a positive step in strengthening public trust in water quality and services. Advances in sensors and other monitoring technologies will allow for a continuous stream of water quality data at each home. At a broader level, water systems will continuously monitor real-time water quality and system performance at the source, throughout the treatment, distribution, and collection systems, and as used water is returned to circular systems or discharged to the environment. More confident and informed consumers will be more willing to invest in essential water resources and services.

### Recommended Actions within the Community Engagement & Empowerment Theme

Think Tank	Recommended Actions
Technology	<ul style="list-style-type: none"> <li>• Cultivate a technology-savvy water workforce</li> <li>• Empower consumers with real-time information to make informed decisions</li> <li>• Strengthen public trust through steadfast data protection</li> <li>• Transform water management through expansion of in-home and fit-for-purpose treatment technologies</li> </ul>
Economics	<ul style="list-style-type: none"> <li>• Drive public behavior changes through targeted and sustained education</li> <li>• Invest in water workforce talent attraction and development</li> </ul>
Social/Demographics	<ul style="list-style-type: none"> <li>• Create a culture in which everyone has a personal connection to water and a sense of shared responsibility for it</li> <li>• Build public trust in water services providers so that they are recognized as anchor institutions in every community</li> <li>• Build a water sector workforce that reflects the diversity of the communities it serves and excels in both communications and technical competencies</li> </ul>

# Water 2050 Themes

## Theme 8: Collaboration & Partnerships

Between now and 2050, purposeful and focused collaboration among many partners is essential to overcome the complex challenges facing water. Protecting water sources, ensuring access, and building resilient infrastructure require cross-sector and cross-community collaboration. Led by water utilities, these partnerships will lead to innovative water management solutions and cultivate a shared understanding of our responsibility to care for water resources and systems.

A successful water future calls for many forms of strategic partnerships, from basic knowledge-sharing among utilities, to regional collaboration across

multiple stakeholders, to complete consolidation of physical and management infrastructure. Partnerships will be key in protecting water quality and quantity, enabling resilient water systems and addressing inequities in service and access.

Watershed-scale collaboration will be a hallmark of this new era, with partnerships forming among local, regional, and national governments and between urban and rural communities to solve resource challenges. The water sector will collaborate closely with agriculture, energy, and other sectors to strengthen resource sustainability and identify economic efficiencies.

### Recommended Actions within the Collaboration & Partnerships Theme

Think Tank	Recommended Actions
Sustainability	<ul style="list-style-type: none"><li>• Cultivate a new era of structured partnership with agriculture and other major water users</li><li>• Shift to watershed-based thinking</li></ul>
Economics	<ul style="list-style-type: none"><li>• Foster strategic partnerships based on shared economic interests</li></ul>
Governance	<ul style="list-style-type: none"><li>• Take a multilateral and cooperative approach to water governance</li></ul>
Social/Demographics	<ul style="list-style-type: none"><li>• Fully engage the broader community in water policy decision-making and service delivery</li><li>• Integrate decision-making practices for water resource management across urban and rural communities</li></ul>



## •••• The Path Forward

With the completion of the five think tanks, Water 2050 advances from a stage of deep exploration to phased implementation. The recommended actions, along with additional inputs from the wider water community, outside-the-water-sector voices, and AWWA's sections, Board, councils and members, will form the foundation of a Water 2050 Action Plan that will span three decades and inform water community strategies for the foreseeable future.

Ahead of an October 2023 AWWA Council Summit, the Water 2050 Leadership Team is refining the eight cross-cutting themes that emerged from the think tanks into Strategic Focus Areas. Composed of presidential officers and Water 2050 Advisory Board members, the leadership team will prioritize concepts, initiate research to fill data gaps, and lead the creation of Strategic Implementation Teams for each Strategic Focus Area. The Strategic Implementation Teams, which will include diverse subject matter experts from within and outside the water sector, will ultimately create Strategic Focus Area Action Plans.

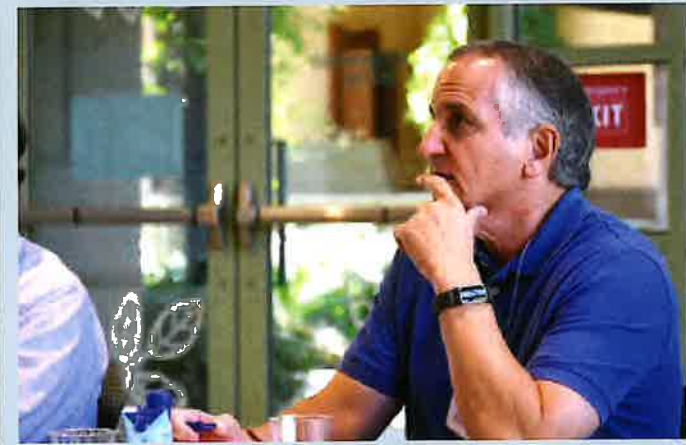
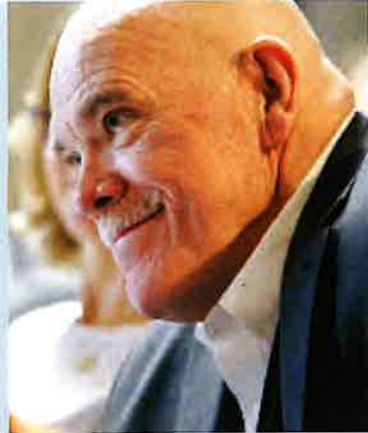
While Strategic Focus Area Action Plans will be unique, they will all review and pursue research as necessary, leverage water community events, publications and networks to explore concepts, and consider how ideas might inform water policy in the years ahead.

## The Year Ahead: Strategic Actions to Implement Water 2050

Over the next year, as Water 2050 transitions from idea to action, AWWA will take a three-pronged approach: validate, engage, and mobilize.

- **Validate:** The Water 2050 Leadership Team will initiate research to assess, validate, and prioritize recommended actions. It will:
  - » Conduct a gap analysis to determine additional actions for implementation
  - » Align Strategic Implementation Teams to pursue recommended actions
- **Engage:** A vital component of the Water 2050 journey is broad engagement. AWWA will assemble a cross-functional team dedicated to assuring engagement with partners within and outside the water sector. Composed of experts in engineering, utility finance, communications, government affairs, international relations and other fields, the team will focus on maintaining a One Water approach throughout the initiative. It will:
  - » Identify and prioritize key stakeholder groups within and beyond the water community
  - » Develop and implement a robust stakeholder engagement strategy
  - » Align and empower Water 2050 champions to lead engagement efforts
- **Mobilize:** Navigating toward a sustainable water future will require participation across all of AWWA, including its sections, councils, young professionals and staff. However, to be truly successful, it must proceed with a global mindset that inspires participation from all water sector organizations and from partners outside North America. Water 2050 ambassadors will present at conferences, publish articles, and bring a Water 2050 perspective to strategic planning processes. Leveraging AWWA's International Council and relationships with global associations, the Water 2050 initiative will remain focused on AWWA's vision of "a better world through better water." It will:
  - » Identify opportunities to mobilize sections, young professionals and international partners
  - » Continually share Water 2050 thought leadership in water sector and outside-the-sector publications
  - » Incorporate Water 2050 into the AWWA Strategic Plan and inform other organizations' strategic plans







# •••• The Path Forward

## From 2024-2050: Realizing the Vision

The purpose of the Water 2050 initiative is to envision the future of water and chart a course for future success and sustainability. Over the past year, AWWA and many colleagues and organizations collaborated to identify the long-term actions necessary to assure a strong water sector and a secure water world for generations ahead.

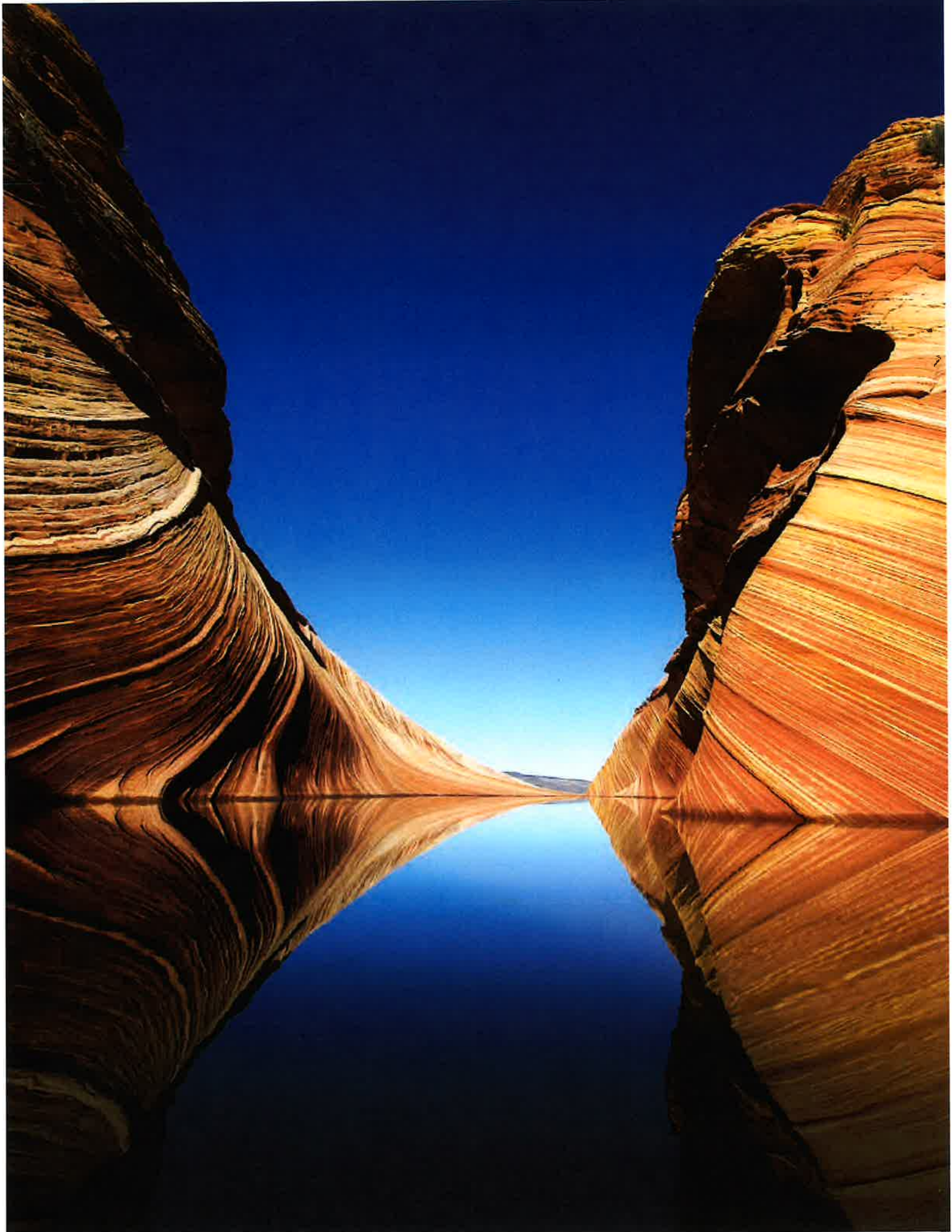
By June 2024, many implementation strategies associated with think tank recommendations and wider consultation will be ready for launch. Strategic Implementation Teams consisting of leaders from within and outside the water community will pursue the bold work necessary to realize the Water 2050 vision. Team members will be diverse in their backgrounds and experiences, including representation from academic, corporate, utility, consulting and nonprofit communities. In collaboration with many new partners and leveraging the network of AWWA sections and other water sector organizations, these

teams will implement action plans that accelerate the transformation of water.

By the close of 2024, a comprehensive roadmap that guides the initiative to the year 2050 will be completed. As with any authentic exploration, new data and innovative ideas will illuminate new pathways and suggest course corrections. Water 2050 should therefore be viewed as an iterative expedition. Strategic Implementation Teams will regularly share their work through events and publications and actively solicit feedback. Insights will be incorporated into action plans, and progress reports will be issued.

The timetables for implementing recommendations from the Water 2050 process will vary, and the success of some may depend on the outcomes of others. Still, the best way to move toward a new destination is to know where you are going and to move in that direction. With the completion of a year of exploration, Water 2050 is moving forward with purpose.





# •••• Get Involved!

A vital component of the Water 2050 process is broad engagement – tapping into the diverse perspectives of voices from within and outside of AWWA and the greater water community. A collaborative exploration is essential to challenge currently held beliefs, put forth bold solutions and cultivate the most resilient course for the future.

Water 2050 invites participation beyond the think tanks in many ways. The initiative was center-stage at the 2023 AWWA Annual Conference and Exposition in Toronto, where a large pavilion featured interactive artwork depicting how the future of water may look. AWWA young professionals, councils and committees contributed to a time capsule – to be opened at the annual conference in 2050 – and multiple sessions featured Water 2050 panel discussions. Over the past year, board members and councils have engaged in multiple deep-dive discussions, AWWA members-at-large and staff contributed their insights through

surveys, and many of AWWA's 43 sections hosted events to collect and share visions of the future from their unique geographical perspectives. The Water 2050 Strategic Implementation Teams will engage many organizations and spawn new partnerships.

But Water 2050 is far upstream from its final destination. To navigate toward a sustainable water future, Water 2050 needs your voice. If you, someone you know, or an organization you recommend want to be part of this journey, please contact the Water 2050 team at [Water2050@awwa.org](mailto:Water2050@awwa.org).

*For Water 2050 to reach its potential, it needs your voice.*

~ AWWA CEO David LaFrance



# Water 2050 Think Tank Participants

The Water 2050 Think Tanks brought together over 125 experts from within and beyond the water community.

**Cristina Ahmadpour**

President and Managing Director (Americas)  
Isle Utilities  
Think Tank(s): Technology

**Susan Ancel**

Director, One Water Planning  
EPCOR Water Services, Inc.  
Think Tank(s): Social/Demographics

**Janice Beecher, Ph.D.**

Director, Institute of Public Utilities  
Michigan State University  
Think Tank(s): Economics

**Kevin Bergschneider**

Vice President and Water Program Leader  
HDR, Inc.  
Think Tank(s): Economics

**Caitlin Berretta**

Director, Government Affairs and Sustainability  
Evoqua Water Technologies  
Think Tank(s): Governance

**Chelsea Boozer**

Government Affairs Manager  
Central Arkansas Water  
Think Tank(s): Governance

**Alain Borghijs, Ph.D.**

Deputy Representative, North American Representative  
Office  
Asian Development Bank  
Think Tank(s): Governance

**Christine Boyle, Ph.D.**

Vice President of Business Incubation  
Xylem Inc.  
Think Tank(s): Technology

**Adam Carpenter, Ph.D.**

Manager of Energy and Environmental Policy  
AWWA  
Think Tank(s): Sustainability; Economics; Governance;  
Social/Demographics

**Ed Carr, Ph.D.**

Professor and Director, International Development,  
Community and Environment Department  
Clark University  
Think Tank(s): Sustainability

**Chuck Chaitovitz**

Vice President, Environmental Affairs and Sustainability  
U.S. Chamber of Commerce  
Think Tank(s): Economics

**Clifford Chan**

General Manager  
East Bay Municipal Utility District  
Think Tank(s): Technology

**Pooja Chari**

Project Engineer  
Woodard & Curran  
Think Tank(s): Social/Demographics

**Colin Chung**

Founder and President  
Kayuga Solution  
Think Tank(s): Technology

**Heather Collins**

Water Treatment Director  
Metropolitan Water District of Southern California  
Think Tank(s): Sustainability

**Kelley Dearing-Smith**

Vice President of Communications and Marketing  
Louisville Water Company  
Think Tank(s): Social/Demographics

**Tom Dobbins**

Chief Executive Officer  
Association of Metropolitan Water Agencies (AMWA)  
Think Tank(s): Social/Demographics

**Jon Eaton**

Superintendent of Utilities  
City of Eagan  
Think Tank(s): Economics

**Zonetta English**

Strategic Initiatives and Project Delivery Director  
Louisville MSD (Louisville/Jefferson County  
Metropolitan Sewer District)  
Think Tank(s): Technology

**Marcus Firman**

Director  
AWWA Ontario Section  
Think Tank(s): Governance

**Iris Fisher**

Chief Financial Officer  
The Water Works Board of the City of Birmingham,  
Alabama  
Think Tank(s): Social/Demographics

**Peter Fiske, Ph.D.**

Executive Director  
National Alliance for Water Innovation and Water-  
Energy Resilience Research Institute at Lawrence  
Berkeley National Laboratory  
Think Tank(s): Sustainability

# •••• Participants

**Paul Fleming**

President  
Water Value LLC  
Think Tank(s): Sustainability

**Dave Fox**

Vice President  
Raftelis  
Think Tank(s): Economics

**Maury Gaston**

Manager of Marketing Services  
American Cast Iron Pipe Company (AMERICAN)  
Think Tank(s): Governance

**Judith Germano**

Founder and Lead Counsel  
GermanoLaw LLC  
Think Tank(s): Technology

**David Goldwater**

Vice President  
Stantec  
Think Tank(s): Governance

**Adam Roy Gordon**

Interim Executive Director  
United National Global Compact Network USA  
Think Tank(s): Governance

**Ben Grumbles**

Executive Director  
Environmental Council of the States (ECOS)  
Think Tank(s): Governance

**Sally Gutierrez**

Senior Advisor to the Director of the Center for  
Environmental Solutions and Emergency Response  
U.S. Environmental Protection Agency, Office of  
Research and Development  
Think Tank(s): Technology

**Jim Holway**

Director  
Babbitt Center for Land and Water Policy  
Think Tank(s): Social/Demographics

**Brianna Huber**

Director of Water Filtration  
City of East Moline  
Think Tank(s): Social/Demographics

**Stephanie Hubli**

Project Engineer  
Woodard & Curran  
Think Tank(s): Governance

**Jihyon Im**

Environmental Engineer  
CDM Smith Inc.  
Think Tank(s): Technology

**Stacey Isaac Berahzer**

Founder and CEO  
IB Environmental  
Think Tank(s): Economics

**Thomas Iseman**

Director of Water Scarcity and Markets, Global  
Freshwater Program  
The Nature Conservancy  
Think Tank(s): Sustainability

**Joe Jacangelo, Ph.D.**

Vice President, Director of Research  
Stantec  
Think Tank(s): Sustainability; Technology; Economics;  
Governance; Social/Demographics

**Chris Jarrett**

Director, Sales  
American Cast Iron Pipe Company (AMERICAN)  
Think Tank(s): Social/Demographics

**David L. Johnson**

Deputy General Manager, Operations  
Las Vegas Valley Water District Southern Nevada Water  
Authority  
Think Tank(s): Sustainability

**Michael Johnson**

General Manager  
The Water Works Board of the City of Birmingham,  
Alabama  
Think Tank(s): Social/Demographics

**Robert Johnston, Ph.D.**

Professor of Economics and Director and Research  
Professor, The George Perkins  
Marsh Institute Clark University  
Think Tank(s): Economics

**Amanda Jones**

Project Manager  
Tucson Water  
Think Tank(s): Social/Demographics

**Anthony Kane**

President & CEO  
Institute for Sustainable Infrastructure  
Think Tank(s): Sustainability

**Gigi Karmous-Edwards**

CEO  
Karmous-Edwards Consulting LLC  
Think Tank(s): Technology

**Patrick Keaney**

Worldwide Head of Business Development for Water  
Amazon Web Services  
Think Tank(s): Technology

# Participants

**Patrick Kerr**

Chair Of The Board Of Directors, CEO and President  
Baton Rouge Water Company  
Think Tank(s): Economics; Social/Demographics

**Cynthia Koehler**

Co-Founder and Executive Director  
WaterNow Alliance  
Think Tank(s): Economics

**Keith Kohut**

Process Engineer  
Associated Engineering Ltd  
Think Tank(s): Governance

**Nilaksh Kothari**

CEO  
Preferred Consulting  
Think Tank(s): Social/Demographics

**Adam Krantz**

CEO  
National Association of Clean Water Agencies  
(NACWA)  
Think Tank(s): Governance

**Thomas Kuczynski**

Vice President of Information Technology  
District of Columbia Water and Sewer Authority (DC  
Water)  
Think Tank(s): Technology

**Rose Kyprianou**

Supervisor, Capacity Development Branch of the  
Capacity and Compliance Assistance Division  
Environmental Protection Agency (EPA) Office of  
Ground Water and Drinking Water (OGWDW)  
Think Tank(s): Economics

**David LaFrance**

CEO  
AWWA  
Think Tank(s): Sustainability; Technology; Economics;  
Governance; Social/Demographics

**Rochelle Larson**

Principal Engineer – Planning & Engineering Division  
Albuquerque Bernalillo County Water Utility Authority  
Think Tank(s): Social/Demographics

**Angela Licata-Misiak**

Deputy Commissioner for Sustainability  
New York City Department of Environmental Protection  
Think Tank(s): Sustainability

**John Logan**

Senior Principal Engineer  
Hazen and Sawyer  
Think Tank(s): Economics

**Mahesh Lunani**

Founder and CEO  
AQUASIGHT  
Think Tank(s): Technology

**Ken Lykens**

General Manager  
Meridian Metropolitan District  
Think Tank(s): Governance

**Cissy Ma, Ph.D.**

Environmental Engineer  
U.S. Environmental Protection Agency  
Think Tank(s): Sustainability

**Paula MacIlwaine**

Deputy CEO  
AWWA  
Think Tank(s): Sustainability; Economics; Governance;  
Social/Demographics

**Josh Mahan**

Director, Government and Industry Relations  
Xylem Inc.  
Think Tank(s): Governance

**Barb Martin**

Director of Engineering and Technical Services  
AWWA  
Think Tank(s): Sustainability; Technology; Economics;  
Governance; Social/Demographics

**Paul Matthews**

Chief Financial Officer  
Tualatin Valley Water District  
Think Tank(s): Economics

**Sue McCormick**

CEO  
4Leaders, LLC  
Think Tank(s): Sustainability

**Trina McGuire-Collier**

Principal Strategic Communications Advisor  
HDR, Inc.  
Think Tank(s): Social/Demographics

**Brenley McKenna**

Chief of Subscriber Services  
The Water Research Foundation  
Think Tank(s): Governance

**Margaret Medellin**

Deputy Manager – Department of Transportation and  
Infrastructure  
City and County of Denver  
Think Tank(s): Social/Demographics

# Participants

## **G. Tracy Mehan III**

Executive Director, Government Affairs  
AWWA  
Think Tank(s): Governance

## **William F. Moody**

Director, Bureau of Public Water Supply  
Mississippi State Department of Health  
Think Tank(s): Governance

## **Randy Moore**

Director of Sales, Agency Development and Industry  
Affairs  
Tnemec Company, Inc.  
Think Tank(s): Technology

## **Olga Morales-Pate**

Chief Executive Officer  
Rural Community Assistance Partnership Incorporated  
(RCAP)  
Think Tank(s): Social/Demographics

## **Kevin Morley, Ph.D.**

Manager, Federal Relations  
AWWA  
Think Tank(s): Technology

## **Jason Mumm**

Principal  
FCS GROUP  
Think Tank(s): Economics

## **Shannon Murphy**

VP GM  
Aquamor  
Think Tank(s): Governance

## **Daniel Nix**

Utility Operations Manager  
City of Wichita Falls  
Think Tank(s): Sustainability

## **Martha Nunez**

Project Manager, Asset Management Products  
Autodesk, Inc.  
Think Tank(s): Technology

## **Kate Nutting**

General Manager, Southwest District  
Golden State Water Co  
Think Tank(s): Governance

## **Andy O'Reilly, Ph.D.**

Research Hydrologist  
U.S. Department of Agriculture  
Think Tank(s): Technology

## **Cheryl Porter**

Chief Operating Officer  
Great Lakes Water Authority  
Think Tank(s): Social/Demographics

## **Lucero Radonic**

Associate Professor  
Northern Arizona University, Anthropology Department  
Think Tank(s): Social/Demographics

## **Jon Radtke**

Water Sustainability Program Director  
Coca-Cola North America  
Think Tank(s): Sustainability

## **Vishnu Rajasekharan, Ph.D.**

Senior Manager, Innovation & Research  
Hach Company  
Think Tank(s): Technology

## **Andy Richardson**

Board Chairman Emeritus  
Greeley and Hansen  
Think Tank(s): Technology; Governance

## **Guillermo Rivera**

Environmental Engineer  
Miami-Dade County Division of Environmental  
Resources Management  
Think Tank(s): Sustainability

## **Matt Roberts**

President  
Roberts Filter Group  
Think Tank(s): Economics

## **Pete Rogerson, Ph.D.**

Professor of Geography and Biostatistics  
University of Buffalo  
Think Tank(s): Social/Demographics

## **Jennifer Sara**

Global Director, Climate Change Group  
World Bank Group  
Think Tank(s): Social/Demographics

## **Sagar Shah, Ph.D.**

Manager, Research and Strategic Initiatives  
American Planning Association  
Think Tank(s): Sustainability

## **Chi Ho Sham, Ph.D.**

Independent Consultant  
Think Tank(s): Sustainability; Technology; Economics;  
Governance; Social/Demographics

# Participants

## **Clayton Simons**

Senior Sales Representative  
American Cast Iron Pipe Company (AMERICAN)  
Think Tank(s): Economics

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Senior Director of Strategic Marketing  
Badger Meter  
Think Tank(s): Technology

## **Christine Spitzley**

Principal  
OHM Advisors  
Think Tank(s): Economics

## **Michelle Stockness**

Vice President  
Barr Engineering Co.  
Think Tank(s): Social/Demographics

## **Manuel Teodoro, Ph.D.**

Associate Professor of Public Affairs  
University of Wisconsin-Madison, The Robert M. La  
Follette School of Public Affairs  
Think Tank(s): Economics

## **Claudio H. Ternieden**

Senior Director, Government Affairs and Strategic  
Partnerships  
Water Environment Federation (WEF)  
Think Tank(s): Governance

## **Negin Tousi**

Project Manager  
David Nairne and Associates  
Think Tank(s): Sustainability

## **Pauli Undesser**

Executive Director  
Water Quality Association (WQA) and Water Quality  
Research Foundation (WQRF)  
Think Tank(s): Technology

## **Brian Van Nortwick**

Senior Construction Engineer  
American Water  
Think Tank(s): Economics

## **Carol Walczyk**

Vice President of Process Efficiency Analytics  
Veolia North America  
Think Tank(s): Technology

## **Cindy Wallis-Lage**

Executive Director of Sustainability & Resilience  
Black & Veatch  
Think Tank(s): Sustainability

## **Robin Webb, Ph.D.**

Director  
National Oceanic and Atmospheric Administration  
(NOAA) Physical Sciences Laboratory  
Think Tank(s): Sustainability

## **Shannon Wedding**

Director of Business Development & Product  
Management  
McWane, Inc.  
Think Tank(s): Technology

## **Michael Wertz**

Vice President-Senior Analyst, Public Finance Group  
Moody's Investors Service  
Think Tank(s): Economics

## **Casey Wichman, Ph.D.**

Assistant Professor  
Georgia Institute of Technology, School of Economics  
Think Tank(s): Economics

## **Renée Willette**

Vice President, Programs and Strategy  
U.S. Water Alliance  
Think Tank(s): Sustainability

## **Roger R. Wolf**

Co-Director  
Iowa Soybean Association – Research Center for  
Farming Innovation  
Think Tank(s): Sustainability

## **John Young**

Sole Member  
John S. Young JR, LLC  
Think Tank(s): Governance



## Advisory Board

### **Sue McCormick**

Former CEO of Great Lakes Water Authority

Ms. McCormick is CEO of 4Leaders, LLC, supporting leaders in developing high-performance teams, engagement and public partnerships. She has over 40 years of water utility leadership, including as CEO during the standup of one of the nation's largest public water authorities with more than 120 communities, the Great Lakes Water Authority. She achieved a 96% member-satisfaction rating within the first years, earning many awards and recognitions and championed engagement strategies and innovations in the Detroit area and in Ann Arbor and public partnerships in the Lansing area.

### **Andrew Richardson**

Former Chairman and CEO of Greeley and Hansen

In his more than four decades with the firm, Mr. Richardson worked on almost every aspect of engineering projects, including feasibility studies, designs, construction, and start-up commissioning for many major water, water reuse and wastewater treatment programs across the country. He has authored over 70 technical papers and made numerous presentations at national and international water and wastewater conferences. He is a past president of AWWA and was inducted into the AWWA Water Industry Hall of Fame.

### **Jennifer Sara**

Global Director, Climate Change Group, World Bank Group

Ms. Sara is responsible for overseeing the key strategic priorities and implementation of the World Bank Group's Climate Change Action Plan and leading five Practice groups on: Climate Operationalization and Impact, Climate Economics and Finance, Climate Funds Management, Climate Investment Funds Secretariat, and Strategy, Knowledge and Outreach. Prior to taking on this position, Ms. Sara served for eight years as Director and Global Director for the Water Global Practice, overseeing the Bank's \$30B water portfolio, analytics, trust fund management and knowledge agenda.

## Staff/Consultant Support

### **Greg Kail**

Director of Communications, AWWA

### **Angie Miller**

Executive Assistant, AWWA

### **Peggy Hofstra**

Senior Manager of Communications, AWWA

### **Cindy McCombe**

Director of Marketing, AWWA

### **Stephanie Passarelli**

Benchmarking Program Manager, AWWA

### **Megan McDowell**

Senior Communications Specialist, AWWA

### **Derek Fisch**

Creative Services Manager, AWWA

### **Kavita Sienknecht**

Principal and Co-Founder, UPlift Collaborative

### **Kristin Centanni**

Principal and Co-Founder, UPlift Collaborative

### **Ken Lund**

Subject Matter Expert, UPlift Collaborative

### **Roxane White**

Founder and CEO, Strategy with Rox

### **Yvonne Miranda**

Project Coordinator, Strategy with Rox

### **Sabrina White**

Strategic Project Manager, Strategy with Rox

## Photography

### **Fernando Felix**

Video Producer, AWWA

### **Chris Barber**

Senior Graphic Designer, AWWA

### **Kingmond Young Photography and Video**

*"Resilient" is the most common word AWWA members believe will best describe the water community in 2050.*

AWWA Water 2050 Member Survey

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THINK TANKS SUMMARY  
and PATH FORWARD

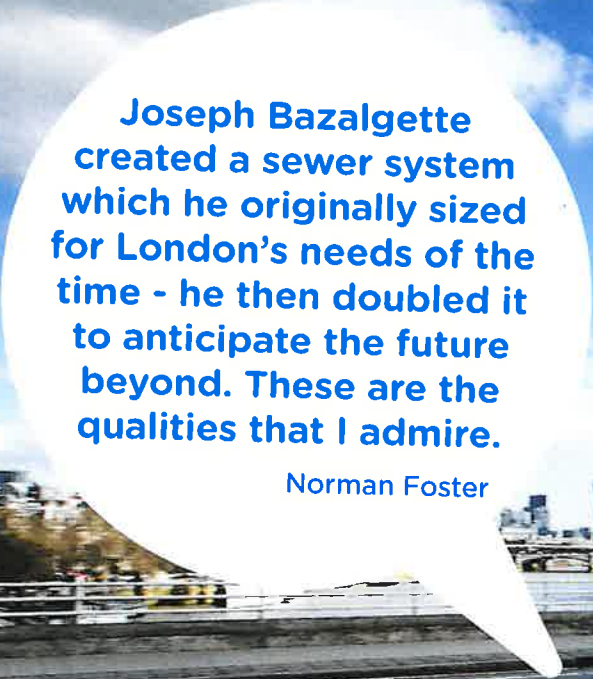
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# London's wastewater future.

London 2100: The case for change.





Joseph Bazalgette  
created a sewer system  
which he originally sized  
for London's needs of the  
time - he then doubled it  
to anticipate the future  
beyond. These are the  
qualities that I admire.

Norman Foster

# London 2100: The case for change

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# What do London's wastewater services look like?

8 wastewater treatment works within the M25 serve 99% of the GLA population

153<sub>gWh</sub> renewable energy in total from wastewater assets

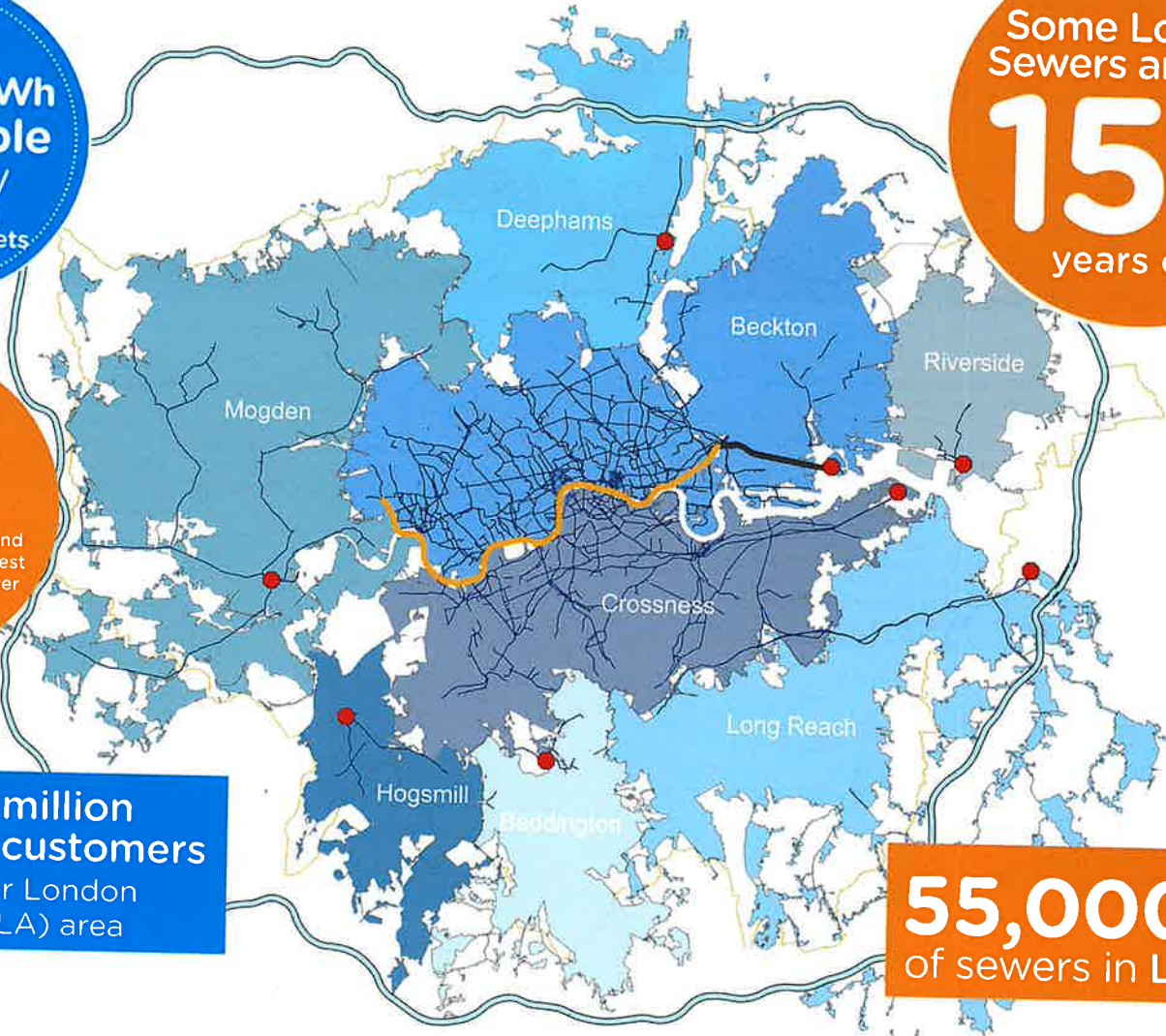
Some London Sewers are over 150 years old

On average per day We are one of the best value providers

Thames Tideway Tunnel  
15 miles long, 7m wide and upto 65m deep the biggest infrastructure project ever undertaken by the UK water industry

8.75 million customers in the Greater London Authority (GLA) area

55,000km of sewers in London



- M25
- Wastewater Infrastructure
  - Thames Tideway Tunnel
  - Lee Tunnel
  - Major sewers greater than 1m diameter
  - Wastewater Treatment Works

# What can we learn from the past?

## At the beginning of the 1850s London had no effective sewer system.

After 'The Great Stink' in 1858, legislation enabled construction of a sewer system which collected wastewater from central London and took it to Beckton.

Growing population after World War I resulted in hundreds of small local wastewater treatment works and increasing pollution of the river, which deteriorated further after World War II. In the 1950s the River Thames was so polluted it could not support aquatic life, but due to process improvements from the 1960s to current times, there has been a significant turnaround. In 2010, the River Thames won the Theiss International Riverprize which celebrates outstanding achievement in river management and restorations.

Much of London's sewer network, however, is "combined" - which means it handles both sewage and large amounts of surface water. The Thames Tideway Tunnel scheme is being constructed to intercept overflows of untreated sewage and clean up the River Thames.

History shows us that when wastewater strategy has changed it has made London a better place to live. Change has often happened in response to crisis: London 2100 is an opportunity to change our wastewater strategy before we reach crisis point.



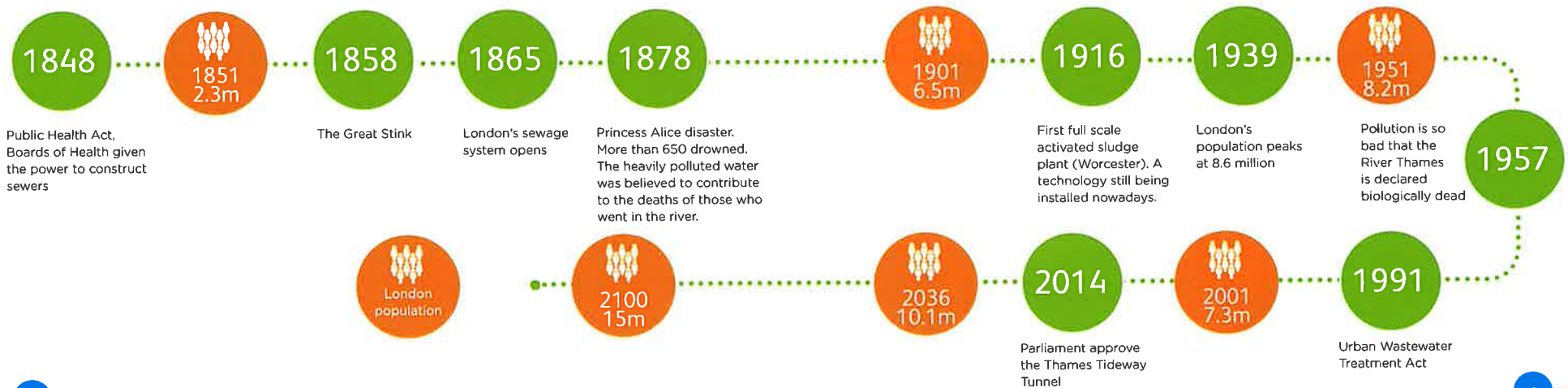
**How does the wastewater sector compare?**

If we look at sectors such as communications, medicine, transport, or computing, the pace of technological change over the last 80 years has been phenomenal.

Communication technology has changed from black phones and manual switchboards, to fibre optics and smart phones, some with more computing power than a 1980s supercomputer. The capabilities of computing technology is currently doubling in less than 5 years, and the rate of change is increasing almost exponentially.

In the wastewater sector, although some significant developments and improvements have been made, we are essentially using a 100-year-old technology to treat sewage.

So let's now fast forward to 2100 and imagine what the world could look like.





# What could the future look like?

We can't predict exactly what London will be like in 2100 but here are 10 things being discussed today which could become everyday reality during the 21st century.

We need to consider how these, and other changes, could impact individuals' lifestyles and London's wastewater services.

**1** Society will be using new materials and applying nanotechnology. Materials such as graphene, titanium foam and artificial spider silk could revolutionise our world, with applications in bio-medical science, computing and consumer devices. Desalination and direct reuse of wastewater could be commonplace because of nanotechnology.

**2** Our diet will be different. People may be eating much less meat and the meat that we do eat could be grown from stem cells in a lab, reducing the amount of land and water required to produce it.

**3** People will be healthier and could live longer. New materials, genetic engineering and personalised medicine could mean we live longer. According to the Office National Statistics, approximately 35% of people in the UK are expected to live to 100 by 2112.

**4** 3D printing will be commonplace. 3D printers could be in our homes and businesses, revolutionising the way we manufacture, obtain and consume products and services.

**5** We will live in an augmented world. Everyday objects will be connected through the Internet of Things and devices such as intelligent contact lenses could be implanted in our bodies, meaning that we live in a permanently augmented world.



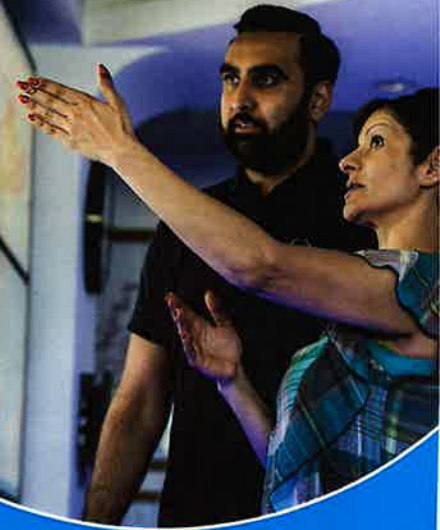
**6** Specialist micro-organisms will be generated to treat waste. So-called 'smart bugs' could be genetically engineered to provide super-efficient, highly focused treatment of our waste products and to optimise the extraction of energy and recovery of resources.

**7** Autonomous technology will transform the city. Passengers could travel and goods will be moved by vehicles run by computers. Utility networks will be integrated and could be operated and maintained by predictive Artificial Intelligence technology.

**8** Robots will take over the service industry. Robots are likely to replace workers in sectors which involve routine and repetitive tasks, including hospitality, retail, entertainment, utilities operation and maintenance and even health and medical care.

**9** Londoners will live in vertical communities and the city will be greener. People could live, work and play high above ground level and new buildings in London could provide the substrate for vertical forests.

**10** London will be a champion of the circular economy. Our use of energy and resources will be extremely efficient. London could be a carbon neutral city and even a net exporter of energy.



# Challenges and opportunities

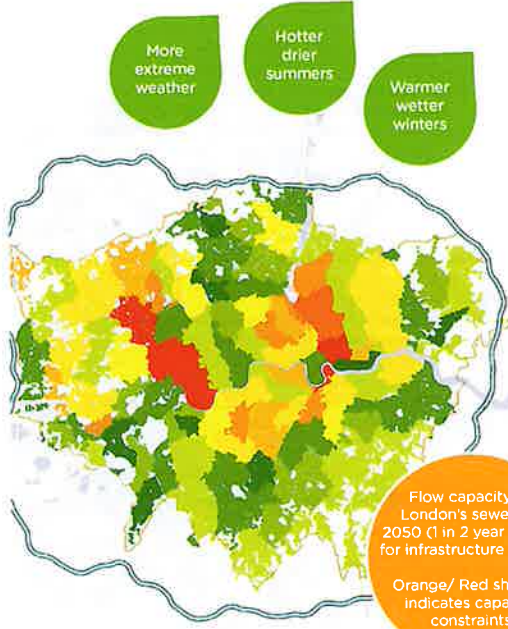


Now that we have reviewed the past and taken a glimpse of the future, we turn our attention to the specific challenges and opportunities that London's wastewater services face.

## Climate change

Over the next 25 years, we are likely to see wetter, warmer winters and hotter drier summers in London. By 2100, the picture becomes highly uncertain, forecasts show up to an 8% rise on summer mean temperature and more than a 50% rise in winter rainfall compared to today. The potential for disruptive events also increases as 'tipping points' are passed.

We know that climate change could put London's wastewater systems at more frequent and more severe risk of flooding. There could also be an impact on the performance and condition of London's wastewater assets because of changes in sewer flows, water quality, ground conditions, the sensitivity of receiving water courses and the demand for sludge recycling. Increases in temperature could affect the efficiency of treatment works.



## Social change and customer expectations

London's wastewater strategy must reflect what customers want now and in the future. Society's response to transformational change depends on values: some people favour sustainable solutions whilst others see infrastructure as a question of economics.

Customers could become more active in wastewater services, transitioning from "consumers" to "prosumers" (producing outputs from their own wastewater) with increasing control. Customer preferences could create demand for new services such as home bio-energy appliances and nanotechnology for local wastewater treatment. Despite these changing preferences; maintaining reliable service, preventing households from flooding and receiving value for money are likely to remain key priorities.



## Demographic change

History has seen London's population fall as well as rise. The London Plan envisages London's population growing from 8.75 million to 10.1 million in 2036 and one estimate puts the city's population at 15 million by 2100. Such change is being driven by migration but also natural change (births and deaths).

The challenge for wastewater planners is not simply the increase in flows that this population growth represents, but the distribution of growth relative to the remaining capacity at existing treatment works.

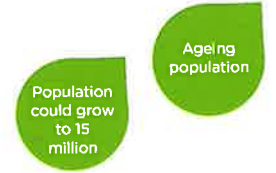


Note: numbers shown are "population equivalents" making allowance for trade flows.

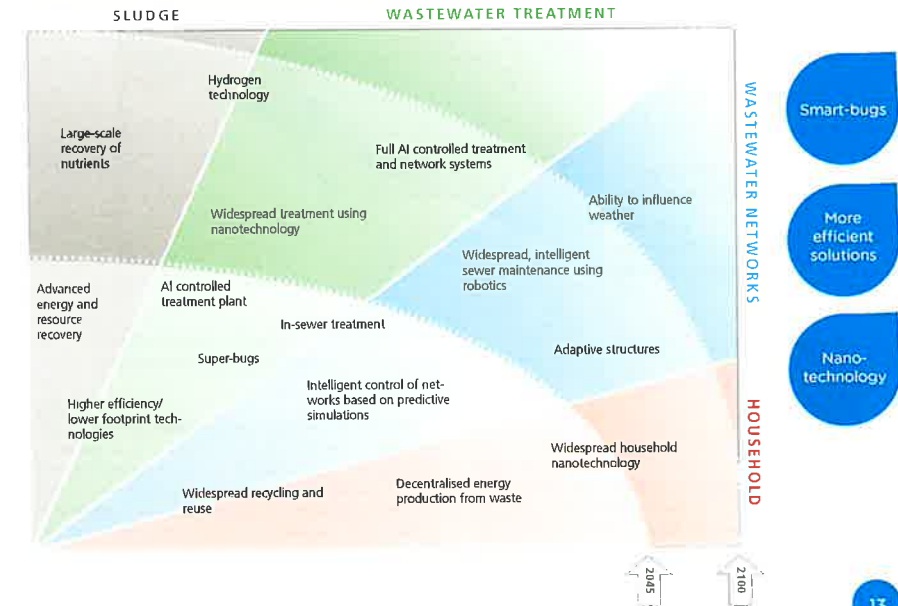
## Technological change

A range of new technologies are on the horizon which could revolutionise wastewater services. These include: nanotechnology, graphene and smart-bugs. The challenge for London 2100 is to move towards technologies that can tackle London's specific challenges within the time period available.

We have an opportunity to choose more efficient technologies that maximise wastewater services whilst minimising resource use (including land), and exploiting options for energy generation and resource recovery.



## Wastewater technology on the horizon



# Challenges and opportunities cont.

## Ageing network and sustainable drainage

Many of London's sewers are over 100 years old and are increasingly at risk of blockages, collapse and groundwater infiltration. As most of London's sewers carry surface water as well as foul drainage, development and urban creep (which increase the impermeable area) are putting an additional burden on the system, exacerbated by increasing rainfall intensity due to climate change. Floods with a likelihood of occurring once every 30 years today, could occur as frequently as once every 10 years by 2100.

The Thames Tideway Tunnel is a major investment to intercept overflows and improve river water quality. New infrastructure is not the only solution and opportunities to capture stormwater before it enters the sewage system will be key, using sustainable drainage systems (SuDS). SuDS measures to offset over 30% of impermeable areas could be required in future. This could be achieved at a local level (e.g. on-street rain-gardens) and household level (stormwater and grey water recycling). However, to be effective, SuDS approaches require strong and sustained stakeholder collaboration.

Increase flood risk

Local and household sustainable drainage

Old sewers are deteriorating

## Workforce

The UK is facing a significant skills shortage in science technology, engineering and mathematics (STEM) subjects. In addition, the workforce is aging.

The effects of these challenges could be particularly acute in the wastewater sector which relies on scientific and technical skills and experience.

Technology could offer a partial solution to some workforce challenges: increasing automation and advances in digital technologies, robotics, Virtual Reality (VR) and Augmented Reality (AR) and materials science could change labour requirements, leading to an increase in demand for skills such as software development and coding.

Technology may also reduce the size of the workforce, replacing many professional roles in the future. We may still need more skilled maintenance and high level decision making but mid-level support services could become squeezed.

Ageing workforce

Technology could help



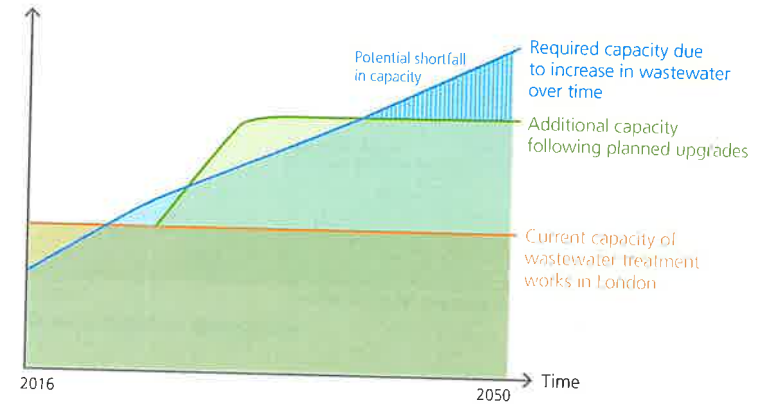
## Pressure on wastewater treatment

Most of London's wastewater treatment works were constructed in the early 1900s although additional capacity has since been retrofitted to extend their life span. Despite these efforts, between 65% and 85% of civil assets at all but two of London's major treatment works will have exceeded their engineering lives by 2045.

Some critical processes are fast reaching their capacity; by 2040, London's wastewater treatment works will have insufficient capacity to handle the flow from the population.

Works at capacity

Amount of wastewater that can be treated (capacity)



## Environmental Legislation

In recent decades, increasingly stringent environmental requirements for wastewater and effluent have been introduced and the Water Framework Directive (WFD) requires water-bodies to meet "good status" by 2027. One of the biggest challenges the industry currently faces is maintaining compliance with tightening phosphorous standards and future legislation dealing with micro-pollutants could have a significant impact on wastewater treatment requirements.

Much of our environmental legislation is based on European Directives so that the ongoing uncertainty relating to Brexit make it difficult to be confident what the future may hold. Current European environmental legislation appears only likely to get tougher and to date UK government have committed to no diminution on current standards when we are governed solely by domestic law. However, the final conditions of Brexit

Catchment management

may look rather different. For the moment the focus is on catchment management and innovative solutions as the mechanisms to meet increasingly stringent standards. Irrespective of the need for compliance with regulations, without developing the additional capacity to meet these standards we would run the risk of causing environmental damage.

Micro - Pollutants

Tightening standards

## Challenges and opportunities cont.

No space to expand

### Pressure on land

London's treatment works were originally built away from communities but are now surrounded as the city has grown, with little land left to expand (see below images for how Beckton has developed since 1945). Growth, together with the establishment of the green belt, has meant that land values have increased rapidly. For example, the average house price around Beckton – formerly an industrial wasteland – has increased by 500% over the past 20 years.

The lack of land, coupled with increasing population (and therefore wastewater flows), presents a significant challenge as land at existing treatment works is severely constrained. In addition, the close proximity of housing presents challenges in terms of odour nuisance.

Odour



Beckton 1945



Beckton 1999



Beckton 2017

### Competition and market reform

The Government is promoting new markets to encourage cost-efficiency and innovation in a sector that has been dominated by monopolies and regulation. Reform of the sludge market, to make it more competitive, is already underway.

Fast forward 20-25 years and there could be radical reform with expansion to treatment competition alongside water abstraction and resources trading. It is possible we will see total de-regulation, multi-sector utilities, a national water network and vibrant markets in bio-resources. There may be more community-based, decentralised activities, where consumers take more control of their wastewater.

More competitive services

Multi-utilities

Decentralised systems

## Scenario planning for the future

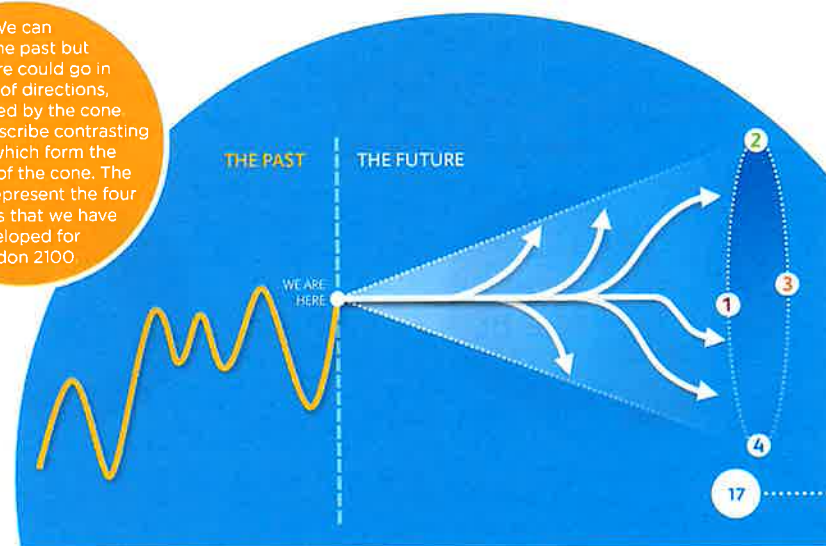
The future of wastewater services could develop in many directions. Whilst we cannot predict exactly how the future will develop, scenario planning provides a disciplined method for forecasting how social, economic, political, technological and environmental drivers could interact.

Using scenarios, we can uncover evidence in the here and now that enables us to set a direction and develop options that integrate new technologies and create resilience, whatever future may emerge. In other words, we can use scenario planning to help deliver wastewater services that are future-proofed against whatever shocks may lie ahead.

There are similarities between how other organisations have developed their scenarios and the approach we outline on the next page. Many scenarios are constructed around dimensions of social-economic change. For example, National Grid's Future Energy Scenarios are based around the level of prosperity and society's level of green ambition (similar to societal attitude in our scenarios). Sydney Water's Future of Urban Water scenarios explore change in the degree of centralisation of systems and the level of integration of utilities.

Other utilities around the world are using a similar approach to inform their investment plans. For example, scenario planning has been used to inform the planning of urban water systems in Sydney and energy infrastructure investment strategy in the UK.

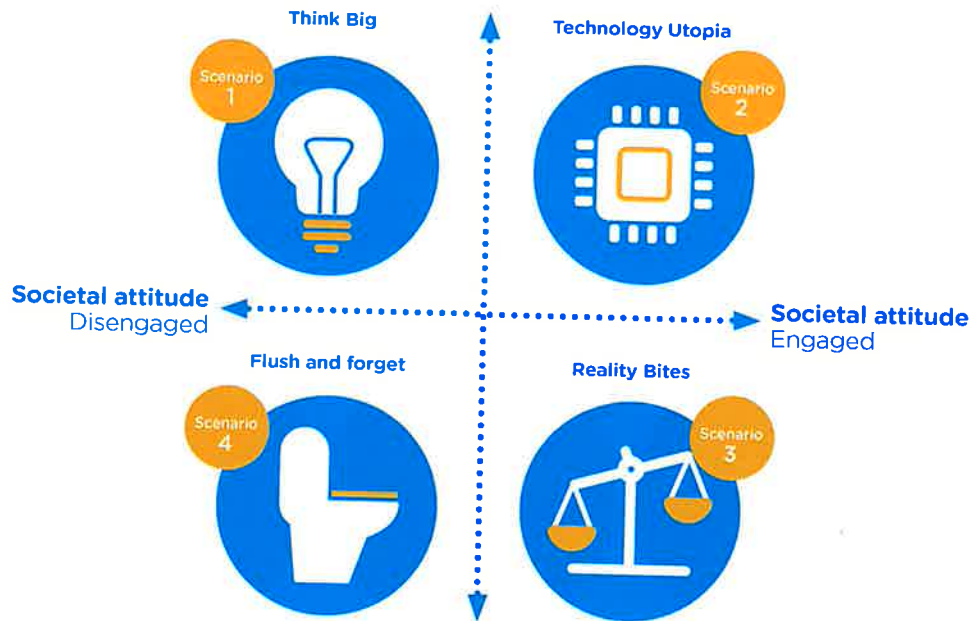
We can plot the past but the future could go in a range of directions, represented by the cone. Scenarios describe contrasting futures which form the boundary of the cone. The numbers represent the four scenarios that we have developed for London 2100.



# Scenario planning for the future cont.

To explore what wastewater services could look like in 2100, we have created four scenarios or future worlds, using a foresight engineering framework. Here four future worlds are formulated, guided by axes representing two key drivers. This exercise is designed to be thought provoking, broadening the mind on a range of future possibilities.

## Landscape for innovation Buoyant economy and rapid pace of change



## Landscape for innovation Stagnant market and slow pace of change

### Key drivers:

- **Societal attitude** – this axis describes how engaged society is in wastewater services, wider sustainability and environmental issues: from a highly engaged, green society to a totally disengaged society that cares little for the environment.
- **Landscape for innovation** – this axis describes the precursors required for innovation and technological change, from a buoyant economy and rapid advances in technology to a stagnant economy where there is little change.



### Think big

Advances in technology enable centralised wastewater treatment to continue

Advances in low-footprint technology as well as available finance mean that wastewater is treated at hyper-efficient, centralised treatment works. Greater flows can be treated in a smaller space, with the products used for large-scale energy generation. Customers are not very interested in wastewater and expect utilities and local authorities to adapt to climate change, resulting in development of large scale SuDS to reduce flood risk in London. Utilities are regulated by a central body, focusing on environmental quality. Customers are predominantly materialist consumers with the environment low on their list of priorities.



### Technology utopia

People care deeply about the environment and water, waste and energy services are integrated at a local scale

Technology leaps have resulted in significant changes in provision of wastewater services. Resources and carbon are managed prudently and a circular economy is well established. All 'waste' has value and technology enables significant energy generation and resource recovery from sludge. Wastewater treatment happens mainly at a community scale and the products are traded in vibrant markets. Regulation – minimal as inefficiency and environmental damage are socially unacceptable. London is a vibrant megacity and an attractive place to live. Customers care about the future and trust technology to solve future challenges.



### Flush and forget

Utilities are squeezed between rising customer expectations and slow technological change

London's population declines as the cost of living is high and remote working is normal. Lower flows mean that centralised wastewater treatment remains possible. Slow technological change means that there has been no wholesale overhaul of wastewater assets although their running is optimised relative to age. Service failures occur and customer relations are generally poor. Regulation is the main driver of change, focusing on reliability and keeping bills low. Utility affordability is a key point of issue. Customers are struggling with managing fertility and give little thought to the future.



### Reality bites

People have a choice of utility providers at a range of scales

Competition in the utility sector is well developed and customers can choose bundles of water, wastewater and energy services from a range of providers, including community scale services. Technology has been slow to develop and wastewater treatment processes have changed little but greater localisation in response to the pressure for land means that there are more, smaller treatment facilities across London. Customers are heavily involved in regulation and are empowered to reward success and penalise failure.

# What can we learn from other cities?

London is not alone in facing challenges due to population growth and climate change. Here we look at three other cities to see what we can learn from their approach.

## Rotterdam

The threat of flooding from sea level rise and extreme rainfall has led the city to pioneer approaches to urban water management.

Massive underground storage facilities are there to relieve pressure on the city's sewers during heavy rainfall. An underground car park near the Museumplein is the largest water storage facility in the Netherlands, with capacity for 10,000 m<sup>3</sup> of water. Rotterdam's water plazas are public spaces set lower than ground level which fill with water during heavy rainfall and then drain slowly back into the sewer system once the storm is over. During dry weather, the water plazas operate like any public squares with landscaping, seating and space for public events.

## Singapore

Singapore provides an excellent example of an integrated approach to water and wastewater management. The city has a significant water scarcity and has historically imported water from Malaysia. This, coupled with an expected doubling of water demand by 2060, has driven Singapore's Water Agency to take a different approach. As well as optimising surface water resources, the city re-claims water from wastewater treatment, purified using advanced membrane technologies and ultra-violet disinfection. A 48-km-long used water superhighway conveys used water to five water reclamation plants. Presently Singapore's NEWater plants meet up to 40% of the nation's water needs. By 2060, NEWater is expected to meet up to 55% of Singapore's water demand.

## Sydney

Sydney Water is addressing risks to water supply from climate change and population growth by diversifying supply, including recycling treated wastewater and storm-water harvesting.

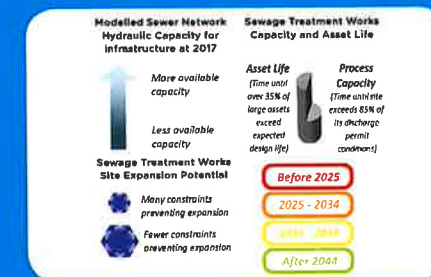
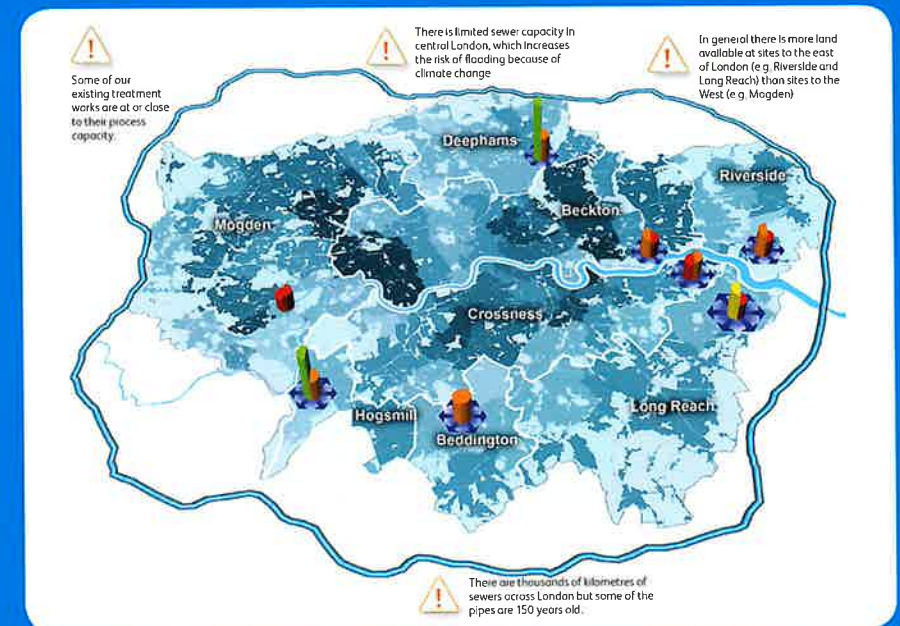
Wastewater is extracted from the sewer network and treated to produce recycled water, a process known as "sewer mining". Wastewater is treated locally at small treatment plants and the recycled water is used for toilet flushing, some industrial operations and to irrigate sports fields and golf courses.

There are around 70 stormwater harvesting projects across the Sydney region. Storm water is collected and used to water parks and gardens and flush public toilets. Together, these projects collect over 1.3 billion litres of water each year. This is about the same as 520 Olympic swimming pools.



# The case for change

In the past, when faced with increasing flows or treatment requirements, we have extended or upgraded our existing wastewater treatment works and associated infrastructure. The scale of long-term challenges faced means we have to take a different path. The map below sets out some of these factors in a geographical context.



The map shows that there are a number of existing sites with limited spare capacity and little room for expansion: most notably Mogden in the west of London and Beckton in the east. Process intensification such as the recent upgrades at our Deephams works can provide medium-term solutions, but these will not address long-term challenges. This, coupled with an increase in flood risk in central London, demonstrates why we need to think differently about wastewater services in London.

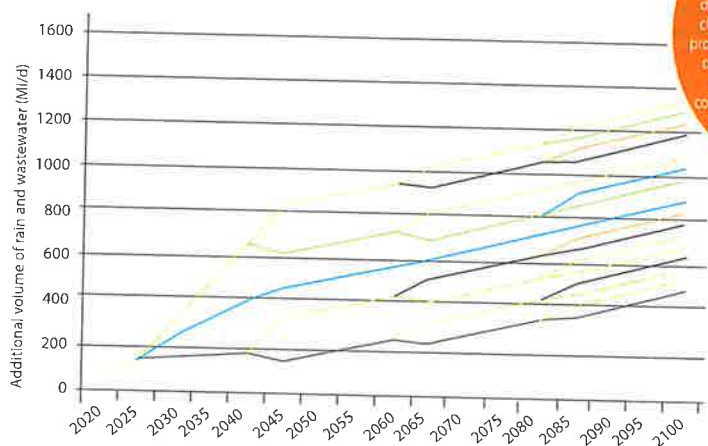
# Our approach

The challenge for London 2100 is clear: how do we plan effective, efficient and resilient wastewater services in London in the face of a highly uncertain future?

One approach that lends itself to problems that are complex, long term and uncertain is adaptive pathways.

Adaptive pathways means a framework that enable routes or pathways to be established based on socio-economic and environmental data that map an array of interventions to a changing world. The pathways are dynamic, changing with feedback from appropriate monitoring data.

This approach is widely adopted in flood risk management to take account of uncertainty over climate change, classically represented by the Thames Estuary 2100 plan (TE2100). TE2100 uses sea level data



to determine when and what type of intervention is necessary to manage tidal flood risk until the end of the century and beyond.

Our first steps towards developing an adaptive framework for London 2100 are to look at future worlds, forecast data and draw up long lists of potential interventions. This work is currently underway.

The diagram on the opposite page provides an illustration of different interventions we could take. The arrows depict starting points for developing solutions to the wastewater challenges in London - some traditional practices, some more unconventional. The adjacent text describes the challenges associated with these pathways. A combination of these approaches will be used in defining the optimum way forward.



### Innovative process technologies

Innovative technologies are emerging which could allow us to treat greater flows in a smaller area at our treatment works. Waiting for an "innovation leap", however, could be risky and requires the rate of technology change to keep up with the demands from population increase and other factors.

### Business as Usual

Expanding existing wastewater works using conventional technology requires a significant amount of land to be available adjacent to the site. For example, if we expanded Mogden to accommodate the anticipated population in 2100, the site may need to be as much as 50% bigger.

### Localisation

Breakthroughs in nanotechnology could allow more and more wastewater treatment to be undertaken at a local household level (as well as energy generation and resource recovery). If these breakthroughs happened at a sufficient pace, this could help offset the increasing demands at our wastewater treatment works.

### Big infrastructure

Big infrastructure (new treatment works or super-sewers) could be part of the answer if we can mitigate cost, land, and carbon impact whilst ensuring adaptability to technology changes.

### Catchment management

Catchment management approaches sustainable resource management from a catchment perspective ultimately leading to a "smarter catchment". For wastewater services, this could mean restoring natural flood storage by installing sustainable drainage systems or delivering projects on a local scale with local communities. In all cases, a high degree of stakeholder collaboration is required.

London 2100 is an opportunity to change the way we think about wastewater services. We have to do this now because:

- There is very little land left to expand existing treatment works or build new ones.
- More conventional approaches will require substantial additional land to meet the challenges faced.
- Exciting new technologies are on the horizon which could replace traditional approaches.
- London's natural environment is precious and we must nurture it.
- We need to keep up with our customers' changing expectations and behaviours.
- Our services must remain resilient and affordable.

# Our team

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We're serious about changing our approach and taking a longer term planning horizon. That's why we have set up a dedicated team to lead our work on London 2100.

The dedicated team is made up of experts in various specialist fields, including: wastewater networks, wastewater treatment, climate change, sustainability, resilience, land availability, population forecasts, technology advances, customer attitudes, legislation, catchment management, market reform and evidence based forecasting.



# Join us in shaping London's wastewater service

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## Next Steps

Our work on understanding the future of London's wastewater service is ongoing. We are starting to shape an adaptive pathway framework by developing a range of solutions. This will be aligned to industry guidance, including:

- Water UK's 21st Century Drainage Programme
- OFWAT and EA's Drainage Strategy Framework

## Get Involved

Engaging with and collaborating with our external stakeholders is imperative to the success of the London 2100 project. We want to draw on your expertise and knowledge of London and invite you to work with us to meet the future need of wastewater services across our capital.

## Contact us

We really want you to be involved. Please comment on what you have read here by e-mailing us at:

 [london2100@thameswater.co.uk](mailto:london2100@thameswater.co.uk)



Notes

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Notes

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In collaboration with the Swiss Agency  
for Development and Cooperation



THE IMAGINE IF WATER SERIES

## **Circular Cities:**

A circular water economy  
for cleaner, greener, healthier,  
more prosperous cities

BRIEFING PAPER

JULY 2021



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# The **Imagine If** Water Series

This is the first in a series of papers that highlight new ways of thinking about global water resources. This **Imagine If Water Series** aims to inspire, provoke and invite new ideas. The world's water resources are a system already pushed to the edge. At the same time, water is connected to a diverse set of burning economic, social and environmental issues. In today's context, where the world strives to restart its engines while addressing multiple economic and social priorities, it is necessary to see water as a catalyst and as a key to unlocking multiple wins spanning these pressing issues to achieve a more equitable and sustainable global economy.

# Imagine if...

**Imagine if** cities of the future could enhance humanity's quality of life, becoming **healthier** places to live, more resilient to climate-related **shocks**, more sustainable, supporting vibrant hubs of economic activity, innovation and job opportunities.

**Imagine if** cities were recognized as **global** climate champions in the "race to net-zero" **carbon** economy. Circular cities, where the use and reuse of **water and** wastewater resources are optimized, can **unlock** the true value and potential of urban areas and propel the world towards achieving this vision.



# The challenges that cities face

Urban areas around the globe are becoming less liveable due to water stress, exacerbated by climate change. This needs to change right now.

Over the next three decades, the world's population living in urban areas is projected to swell to nearly 7 billion people, which will be more than two thirds of all humanity.<sup>1</sup> Yet in this time cities will be less liveable due to climate change, unstable weather patterns and extreme meteorological events.

Cities face a real challenge with increasing water stress, as some are already running out of water. In 2018, Cape Town was poised to become the first major global city to hit "Day Zero", the day when the taps would be turned off due to drought, high demand and inadequate supply. The metropolis came close. It isn't alone – Istanbul, Mexico City and Chennai have all faced water crises recently.

One in four cities – representing over \$4 trillion in economic activity – are already water stressed.<sup>2</sup> This is also true of 70% of the world's megacities.<sup>3</sup> If the world continues with business as usual,<sup>4</sup> 45 cities, each with over 3 million residents, will face extremely high-water stress by 2030; and by 2050, the number of urban dwellers facing acute water shortages could climb to over 1 billion.<sup>5</sup>

Water problems are not limited to droughts; the number of extreme rainfall events is also growing due to more energy in the atmosphere. These produce intense precipitation, resulting in increased urban flooding.<sup>6</sup> Extensive cityscapes consisting of concrete, tarmac and buildings create higher flood flows within metropolitan areas.<sup>7</sup> In 2020, Jakarta saw the highest daily rainfall since records began in 1866: floods killed 19 people and 62,000 people were evacuated.<sup>8</sup>

At the same time, cities are becoming hotter. Nine of the planet's 10 warmest years have taken place since 2005, with the five warmest all occurring since 2015.<sup>9</sup> By 2050, more than 970 cities will experience average summer temperature highs of 35°C. Right now, only 354 cities are this hot.<sup>10</sup> By 2050, heat waves will affect more than 1.6 billion people in urban centres.<sup>11</sup> Towards the end of the century, cities could warm by as much as 4.4°C on average.<sup>12</sup> Builders predominantly construct cities using concrete, which traps this warmth and creates an urban heat island effect, increasing temperatures.

Climate change is exacerbating these impacts, making them more frequent and intense. Adding to this, rapid urbanization is escalating demand for and pressure on city resources. Every month, 5 million people migrate to urban centres around the globe, much of this in the developing world.<sup>13</sup> This means increasing demand for water and energy, as well as more human waste and water pollution. This puts increasing strain on wastewater treatment plants and utilities, and the riverine systems into which water is often discharged.

Water pollution is making waterways sick and deteriorating the environment, potentially having adverse effects on human health. Over 80% of the world's wastewater is still released into the environment without treatment:<sup>14</sup> roughly 30% in high-income countries; 62% in upper middle-income countries; 72% in lower middle-income nations; and a staggering 92% in low-income countries.<sup>15</sup>

This level of pressure on urban ecosystems is not sustainable.

Over 80%

of the world's wastewater is still released into the environment without treatment

92%

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If the world continues with business as usual,

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One in four cities – representing over

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70%

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2

# The design of cities is the issue

When it comes to urban areas, water is used in a linear way. It is captured, used and disposed of – a system that must change rapidly in a climate-conscious world.

In the 21st century, the design, development and building of cities is not fit for purpose. Grey infrastructure is predominantly used to capture rainfall and runoff to channel water from upstream dams, distant watersheds or groundwater extraction and pipe it into cities. It is then shifted out using drainage systems and channelled waterways built using concrete and human engineering.

Therefore, most city water follows a linear path: cities capture it, use it and then dispose of it, treated or untreated, into waterways that eventually flow into the ocean. This approach to water infrastructure in urban areas is not sustainable in the long-term because it does not value water as a finite resource that is unpredictable in its supply. Without changes in design, cities will become less liveable in the second half of this century.

By 2050, the world will add 1 million square kilometres of urban space,<sup>16</sup> stretching across tens

of thousands of cities globally – a surface area larger than Egypt. The current urban development model means this expansion is likely to be concrete and grey infrastructure.

This business-as-usual approach has other consequences. Reducing heat in ever expanding concrete jungles is a challenge. Cooling as an industry consumes up to 30% of global electricity and generates 8% of greenhouse gas emissions worldwide. By 2030, the number of air conditioners will increase by two-thirds from the 2 billion units currently installed.<sup>17</sup> Electricity demand for cooling in buildings could also rise by as much as 50% globally.<sup>18</sup> The strain on cities will be palpable.

Hotter cities also impact economic activity. The costs of lower labour productivity worldwide due to rising temperatures is expected to hit humanity hard, with an accumulated financial loss due to heat stress amounting to \$2.4 trillion by 2030.<sup>19</sup>



# The circular water economy within cities

Closing the loop on water use will insulate cities from future climate-related shocks.

In a post-COVID-19 world, it is necessary to redesign cities: building back better and greener should be the new imperative. The world's 50 largest economies have pledged \$14.6 trillion to long-term recovery measures, with \$341 billion earmarked for green initiatives.<sup>20</sup> At the same time, green finance is reaching new heights, with traded green bonds now valued at over \$2.3 trillion.<sup>21</sup>

Rethinking water infrastructure must be at the forefront of this agenda. It plays an incredibly vital role in creating a more sustainable cityscape. The quality and amount of water an urban area uses, reuses and exchanges with the wider watershed is intrinsically linked to the health of the local environment.

Circular cities with water at the core – where they manage water in cycles and maintain it at its highest possible intrinsic value within the urban environment – should be a fundamental aim. This puts less stress on natural ecosystems. It also insulates cities from external environmental stresses. Cities need to adapt and become resilient to the impacts of climate change already manifesting themselves today and projected to become worse – namely heatwaves, flooding, unpredictable rainfall and imminent Day Zeros.

The main goal needs to be closing the loop on water use. Cities must look to reuse *all* materials in water and water itself, minimizing waste from drinking, sanitation, irrigation, heating and cooling. In a circular city there is no such thing as wastewater. Each metropolis would tap this resource fully, as a rich source of energy and nutrients – including carbon, nitrogen, phosphorus, heat, organic waste and biosolids – as many are crucial to urban living.

Managing water efficiently in cycles within an urban area will insulate a city from climate change, decoupling a city's economic growth from water use, allowing cities to grow significantly without consuming more water. By the middle of this century, the circular economy has the potential to reduce water consumption from primary resources by 53%.<sup>22</sup>

Cities would also benefit from using water to enhance natural capital throughout urban spaces. Ponds, bioswales, creeks and lakes, which also boost biodiversity, are more desirable places to live and work next to, enhancing the quality of life and mental well-being of city dwellers.

Investments in better water management can drive operational savings. They are value-creating investments with short payback periods; they also have environmental benefits. This money could be used to reinvest in new water infrastructure that is more geared towards the circular economy.

For instance, research on the opportunities associated with efficient wastewater management found that by deploying readily available technologies, \$40 billion in savings could be made across the US, Europe and China, and that nearly 50% of electricity-related emissions from the global wastewater sector could also be abated.<sup>23</sup>

Cities with ambitions to become more circular could additionally unlock significant amounts of green and climate finance to build new water infrastructure that is not an environmental, social and governance (ESG) risk, but an asset. This will also future-proof urban growth in a more sustainable world.

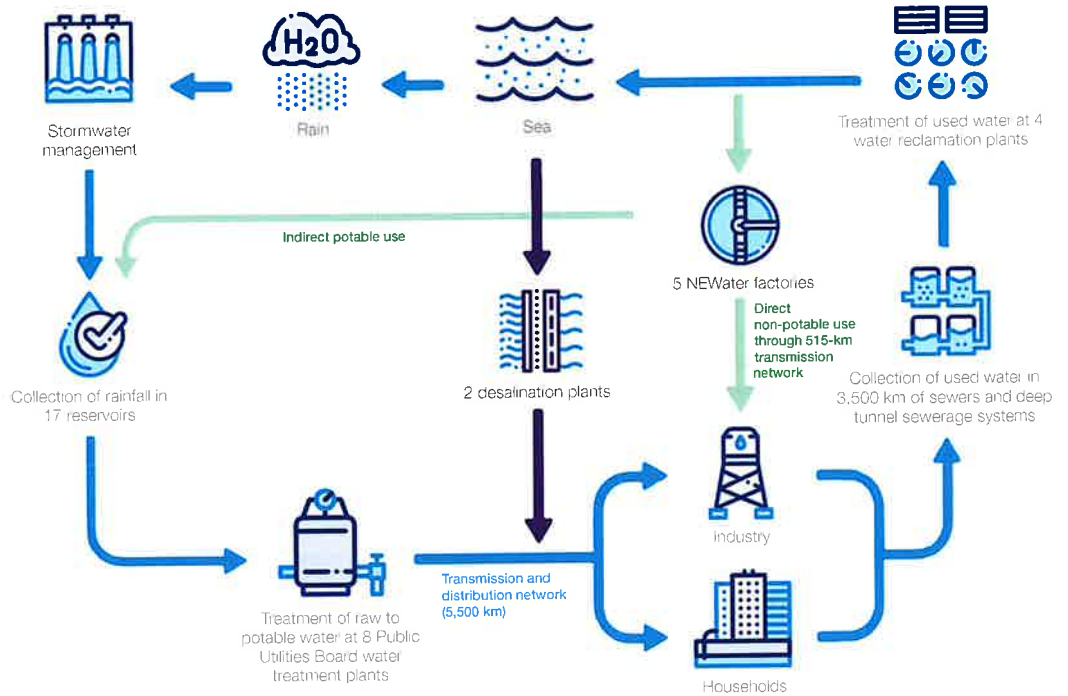
Such water investments would also create jobs in a circular economy. The recycling industry employs more than 1.5 million people worldwide.<sup>24</sup> New jobs will be in blue-green industries and reworking city water ecosystems. New job titles that will emerge include "green rooftop water manager", "city wetland executive", "urban cooling supervisor", and "circular water director".

Cities cannot achieve full-blown circularity overnight. It involves replumbing entire neighbourhoods and cities, even watersheds. But some urban areas are starting to make progress through their circular water initiatives. It will be vital to increasingly bring these together in one place: much greater value is generated when one district's waste is another's resource and vice versa.

**BOX 1 Learning from Singapore and its circular water economy**

Singapore, a city-state with no natural aquifers, is at the forefront of the circular water economy. Reclaimed water satisfies 40% of current water demand.<sup>25</sup> Called NEWater, it is projected to expand to 55% by 2060. Public acceptance of drinking recycled water is a challenge that the country has overcome through widespread education. It has even produced a beer from

recycled water.<sup>26</sup> Water reuse is one of the most important pillars for Singapore to provide safe and reliable water sources in the future.<sup>27</sup> The city collects stormwater in reservoirs within city boundaries; it is also rolling out 300,000 smart water meters by 2023.<sup>28</sup> Singapore has become a global hydro-hub, pioneering new water technologies and jobs.<sup>29</sup>



Adapted from: *Public Utilities Board, Singapore*

**BOX 2 The 50L Home Coalition**

As more cities face the risk and uncertainty of severe water shortages and potential Day Zero scenarios, a group of private sector leaders has come together with the 2030 Water Resources Group, World Business Council for Sustainable Development and World Economic Forum to form the 50L Home Coalition – an initiative that aims to reinvent the

future of water by reimagining city infrastructure and changing the narrative on domestic water consumption. As part of its efforts, The 50L Home Coalition is generating new ideas and opportunities to accelerate innovations in homes and across urban infrastructure and ecosystems to enhance water circularity and water reuse.

# A portfolio of circular water solutions

Many innovations already exist around the world. Cities must deploy these at scale and interconnect them to achieve a circular water economy.

## Water capture and storage

### Sponge cities will act as a water buffer

Shanghai's mission to improve the city's resilience to climate change prompted the Chinese megacity to rewrite its urban-drainage strategy, putting nature-based solutions first. It has deployed sponge city districts, which store vast amounts of stormwater until needed. This type of blue-green infrastructure was tens of billions of US dollars cheaper than the grey solutions initially proposed.<sup>30</sup>

with its green roofs, buffer ponds and stormwater cisterns, reduces summer temperatures by 2°C.<sup>31</sup> The evapotranspiration of planted trees in Mexico City can reduce urban air temperatures by 1°C.<sup>32</sup>

### City water sources will save energy on cooling

Toronto and Paris have deployed free cooling from urban water sources to cool buildings. Climespace takes 50% of its cooling needs from the River Seine, meaning 35% less electricity, 50% less CO<sub>2</sub> emissions and 65% less water consumption than traditional air conditioning.<sup>33</sup>

### Cities must use captured rainwater for cooling

Blue-green infrastructure can offset urban heat islands. For instance, Potsdamer Platz in Berlin,

## Wastewater

### Wastewater use is key to circular city movement

Wastewater is the largest untapped city waste category – as big as all solid waste types combined.<sup>34</sup> It has up to 14 times more embedded chemical and thermal energy within it compared to tap water.<sup>35</sup> For a city of 4 million people, the value of the carbon, ammonia and phosphorus recovered from wastewater could be worth \$300 million a year.<sup>36</sup> However, the adoption of circular water infrastructure requires up-front investments and legislation.

### Use circular sanitation centres

The Suvridha programme in India deploys urban sanitation community centres in low-income neighbourhoods. The programme designs them with a circular economy approach to water using rainwater and recycled water from showers, handwashing and laundry facilities for flushing toilets. This saves 21 million litres of water across four centres, serving 12,000 people in Mumbai.<sup>37</sup>

### Reward dry factories that are less water-intensive

The circular water economy is progressing well at city factories. There is a strong trend towards dry factories, where they recycle and reuse a significant portion of the water used for industrial purposes in a closed loop, reducing external demand for water.

### Invest in industrial symbiosis

Grouped industrial factories can exchange wastewater and resource streams in a symbiotic manner. Wastewater from one can be treated and reused as a resource and input for another. Kalundborg, Denmark, has popularized this system, sharing water, energy and resources between 14 different factory units.<sup>38</sup> It has a cost-benefit ratio of between 32:1 and 53:1,<sup>39</sup> saving millions of euros, as well as 635,000 tonnes of CO<sub>2</sub>-equivalent emissions and 2.9 million m<sup>3</sup> of water a year.<sup>40</sup>

### BOX 3 | Pinpointing circular water solutions



New office blocks with rain capture and stormwater cisterns can minimize piped-in water use and be self-sufficient in water.



Rainwater stored via permeable concrete in storm swales and via rooftops can be used to water community gardens or for sanitation in apartment blocks.



Warm wastewater from industry or data centres can be a resource for district heating and energy savings.



Wastewater treatment plants can be reengineered to operate as net energy producers. Biogas from wastewater can also be harnessed to generate electricity.



If all resources are extracted from a city's wastewater, urban areas can be a net generator of fertiliser and organic matter to be used for profit on peri-urban farms.



Creating a platform for buying, selling or sharing wastewater would provide opportunities to reuse and monetize water, its energy and bioresources across sectors.



5

# Getting started

It is vital to support a concerted global push for circular water city initiatives. This creates demand and provides impetus for innovation and investment.

## Support a leader group of cities committed to a percentage of circular water infrastructure by 2030

It has already started: over the next three decades, China has said that 80% of urban areas should absorb and reuse at least 70% of rainwater; 30 pilot metropolises are involved as part of its Sponge City project.<sup>41</sup> The 17 countries that are home to a quarter of the world's population and face extreme water stress should be a priority.<sup>42</sup>

## Form a network of "100 Circular Cities" modelled after the 100 Resilient Cities or C40 Network

Candidate cities would be those that are already circular economy hotspots, including Amsterdam, Rotterdam, Malmö and Brussels. Combining these with potentially at-risk cities that may be close to Day Zero scenarios in terms of water scarcity, including London, Tokyo, Mexico City and Istanbul, would form an inspiring peer-to-peer learning and best-practice adoption network.<sup>43</sup>

## Set up "blue" circular economic zones, with tax breaks and lower tariffs like free trade zones

Industrial parks and new integrated city districts are a good place for circular economics with water at the core to start, since new clusters of businesses and housing would use each other's resources and waste streams, realizing savings and monitoring systems. These zones would encourage experimentation in the best circular economic models for water and attract green finance.

## Escalate consumer education and awareness globally on water and circularity

Education on how important toilet-to-tap water is for city dwellers will be crucial if circular city initiatives are to evolve. Trust, information and social norms are important when it comes to using recycled drinking water. Food and beverage companies continue to avoid using reclaimed treated water as a product ingredient because of consumer attitudes. This has to change.

## Fund circular city water outcomes

Blue bonds are already looking at outcomes for the ocean and circular economy investment funds. Blue-green bonds and other financial incentives must look at aligning environmental, social and governance (ESG) and water goals, and real estate investors must encourage cities to adopt circular approaches. Many environmental and social wins can also be water wins. Pension funds and institutional investors would look more favourably on new city and water infrastructure if they were circular.

### BOX 4 | Priority areas for action and impact



Commit cities now to further action on circular water initiatives



Show that a new economic model works at scale for circular water initiatives for cities



Invest in pilot projects and new neighbourhoods that use circular water principles

6

# A circular water approach for cities: An evolution in thinking

Water is the ultimate circular resource because it can be processed relatively cheaply, unlike clothes, electronics or plastic. Water can also be used productively again and again, thereby creating further value. With the high concentration of people in cities, significant energy potential and bioresources are embedded in the water used. This is a hugely underused and undervalued resource.

With further urbanization expected in the 21st century, this will continue. Worldwide, cities have massive water footprints. Cities occupy less than 3% of the land on Earth, yet the catchment areas that provide them with water cover roughly 41%.<sup>44</sup> This is not sustainable. The way humans use water must change right now.

A circular water approach represents an incredible opportunity to reduce cities' water footprints and unlock a virtuous cycle of resiliency, economic growth, and sustainability, while achieving gains in health, climate and nature. Urban areas will become more resilient – particularly to climate change – more sustainable, and healthier environments for their inhabitants. They will also be kinder to the watersheds and the natural environments they reside in. Above all, it will ensure water security for the future of cities.

Doing nothing is not an option. Now is the best time to rethink and redesign the role of water in urban areas for cities to thrive.



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World Economic Forum  
91-93 route de la Capite  
CH-1223 Cologny/Geneva  
Switzerland

Tel.: +41 (0) 22 869 1212  
Fax: +41 (0) 22 786 2744  
contact@weforum.org  
www.weforum.org



# Life Free of Water Challenges

## WEF Strategic Plan

### Our Mission

Inspiring the water community in pursuit of human and environmental well-being

### Our Vision

Life free of water challenges



### Our Three-Year Outcome Statement

Amplify the stories of water to grow, strengthen, and diversify the water community

### Our Strategic Goals

#### Goal 1

Attract and develop a diverse and passionate water workforce

##### Goal 1 Strategies

1. Raise public awareness about the importance of water and the water workforce
2. Reduce barriers to workforce entry and retention
3. Provide extraordinary opportunities for connection, growth, and education
4. Cultivate strategic partnerships

#### Goal 2

Cultivate a purpose-driven community to sustainably solve water challenges for all

##### Goal 2 Strategies

1. Drive connection and collaboration for the development of innovative solutions
2. Deliver best-in-class member experience
3. Creatively develop and deliver content and programming

#### Goal 3

Lead the transformation to the Circular Water Economy

##### Goal 3 Strategies

1. Convene stakeholders to craft WEF's Circular Water Economy framework and best practices
2. Proliferate WEF's Circular Water Economy framework and best practices
3. Champion adoption of Circular Water Economy
4. Eliminate barriers to Circular Water Economy adoption

### Our Core Values



Lead boldly with purpose and agility



Focus on our customers through empathy and service



Collaborate for collective impact



Integrate Diversity, Equity, and Inclusion in all we do