Testimony of
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"Water infrastructure: Growing new business on less water and building resilience in America's manufacturing sector, domestic and overseas"

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> *ASU is a comprehensive public research university, measured not by whom it excludes, but by whom it includes and how they succeed; advancing research and discovery of public value; and assuming fundamental responsibility for the economic, social, cultural and overall health of the communities it serves.*

Future H2O Mission:

> *To change the narrative about water from one of risk and scarcity to one about future opportunity through use-inspired research that underpins the achievability of better water futures.*

Water Infrastructure and Manufacturing

Manufacturing is a little more than a tenth of the US economic output[1] and products as diverse as automobiles, plastic, microchips, oil & gas, and beverages like soda and beer require water to produce. Hence, even without considering agricultural production, the US economy depends on water; however, water infrastructure is nearly failing. Grades for dams, levees, drinking and waste water treatment and inland water ways are all lower than C (D-D+) in the American Society of

[1] https://www.thebalance.com/u-s-manufacturing-what-it-is-statistics-and-outlook-3305575

Civil Engineers 2017 Infrastructure Report Card [2]. Broadly speaking, resilient manufacturing infrastructure requires water infrastructure that can buffer the extremes—providing adequate water during drought but protecting key facilities from floods. The following examples, provide a broad brush description of different types of critical infrastructure in the water sector and illustrate how extreme events—droughts and floods—are stressing our nation's infrastructure but could also pose an opportunity for resilience if managed with new tools, technologies and policies.

> *Example 1*: Flood protection—upgrading for larger extremes. At the end of California's 2011-2017 drought, atmospheric rivers dropped over a foot and a half of rain and up to twelve feet of snow in places in California, in one of the rainiest winters in a century. Reservoirs that had once been empty, filled to dangerous levels[3]. This caused the partial failure of the spillway of the Oroville Dam on the Feather River. US dams have a solid D grade in the ASCE infrastructure report card. Alternation between extreme drought and flooding will continue to expose their poor standing.
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> *Example 2*: Storage of flood water in aquifers. Climate scientists predict that the West will experience more extreme weather, including flooding. Aquifers offer potentially vast, empty storage vessels. California is now exploring the potential for storage of flood waters in aquifers beneath farmland in the Central Valley taking some of the pressure off downstream dams for flood protection and providing local storage for later use during dry season or drought conditions for irrigation. This is called Flood Managed Aquifer Recharge or Flood-MAR[4]. Arizona has stored almost 12 million acre feet of water in its aquifers in the last decade.
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> *Example 3:* Exchange. The storage reservoir for the Lower Colorado River compact states—Lake Mead—has not been full since the late 1990s. Though the recent Drought Contingency Plan has staved off emergency declarations and rationing, there is a growing interest in supply augmentation. One option is the proposed US/Mexico Joint Desalination Plant. This new treatment facility would be built in Mexico's Sea of Cortez and could provide Mexico with an additional 100-400 thousand acre feet, which would be used in Mexico but traded for Colorado River water otherwise delivered through the International Boundary and Waters Commission 1944 Treaty across the border. The water that could be exchanged through the Joint Desalination Plant is significant, but not a complete solution to imbalance between supply and demand on the Colorado River.
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> *Example 4*: Rebuilding natural infrastructure to enhance resilience to extremes. Natural infrastructure includes forests, wetlands, coastal marshes among other natural habitats. These natural features can store water, dampen flood peaks and remove nutrients from freshwater bodies. Most western cities now actively manage forest health as a means for safeguarding fresh water supplies. In brief, forest fires cause erosion and sediment loading to rivers from this erosion diminishes water quality and reduces the capacity of our reservoirs via sedimentation. Hence proactive management and even replanting of upstream forests reduces water treatment costs and safeguards long term supplies. There

[2] https://www.infrastructurereportcard.org/

[33] https://www.usatoday.com/story/weather/2017/01/12/northern-california-drought-ends/96487788/

[4] https://water.ca.gov/Programs/All-Programs/Flood-MAR

are exciting new examples of public-private sector collaboration on these restoration and natural infrastructure projects including, Intel and Arizona's Salt River Project. Many other companies engage in these partnerships through projects with the US Department of Agriculture.

The aforementioned examples, though diverse, illustrate that there exists a broad water infrastructure portfolio which provides a whole greater than the sum of the parts for either flood protection, storage or both. As we look to improve our infrastructure grade, I advocate that we strive to better couple flexible portfolios that provide flood protection and storage using both built and natural infrastructure.

Dependency of US Manufacturing and Economic Output on Water

Water is a key component of economic growth and an essential ingredient of the nation's manufacturing machine. Manufacturing accounts for 12% of the US Economic Output but only 6% of the water withdrawals[5] (compared to 5.4% output for agriculture, food and related industries[6] fueled by over 37% of water withdrawals).

The dependence of water in manufacturing is multisector and a consistent theme across the US Sunbelt, where 88% of population growth in the US will occur between now and 2030[7], and this growth is fueled (or correlated with) expansion of major industries like tech, automotive and aerospace. The Sunbelt is also the region poised to experience most significantly intensified extremes in climate (i.e, droughts in California, Texas and Georgia in the last two decades and hurricanes along the Atlantic seaboard and Gulf Coast). Water-intensive industries include, microchip manufacturing, data centers, chemical manufacturing, oil & gas, automotive, aerospace, paper products and food & beverage. The clear connection between water and energy production[8] also impacts manufacturing—water efficient manufacturing technologies may also deliver energy savings. These energy savings are often a larger economic incentive for water-use efficiency because energy is a larger cost than water in manufacturing.

Manufacturing facilities are concentrated in cities and hence industry and municipalities share a need for clean and reliable water supplies. The availability of high quality manufacturing jobs improves quality of life and the livability of cities. Secure water supply will increasingly become a key predictor of new business growth in cities. In the Sunbelt a key question is: "How do we attract new business and grow high paying jobs while using less water?" At the ground level, businesses will likely need to engage directly with municipalities in developing and securing water; long range business plans will include sustainable water supply development and associated infrastructure. Moreover, the Sunbelt is an ideal location for developing water efficiency and security technology as a business itself. Here, water sustainability is the business and the

[5] https://pubs.er.usgs.gov/publication/fs20183035; Including the industrial and mining categories from the 2015 Water Use Dataset.

[6] https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/ag-and-food-sectors-and-the-economy/

[7] Sun Belt Growth Shapes Housing's Future, Professional Builder, 1 May 2005 Archived 24 June 2008 at the Wayback Machine

[8] https://www.energy.gov/sites/prod/files/2014/07/f17/Water%20Energy%20Nexus%20Full%20Report%20July%202014.pdf

opportunity itself, rather than the motivation for business development in other sectors[9]. Finally, applied research is needed to develop and commercialize water efficient and dry manufacturing technologies that enhance water value in the supply chain.

Many of our manufacturing companies operate overseas. Dow has an important facility in Shanghai, China in the mouth of the Yangtze River. Intel has a training facility in Viet Nam, a place where ASU is collaborating to grow a more highly trained tech workforce. Operations overseas require political stability, which in turn is inextricably linked to natural resource development and water security[10]. Sustainable development of natural resources requires data to develop transparency and trust and processes that promote data sharing and data openness. Hence there is a link between water data science and national security, and an opportunity for us to use such data science to facilitate better transboundary cooperation over water issues. The US State Department is actively engaged in promoting transparency and stability in transboundary watersheds across the world. This diplomacy is an essential part of soft power in regions like Lower Mekong, Indus and Nile River basins.

Theory of change

As a nation we should strive to invest in research, business and institutions that improve water infrastructure so that we safeguard existing manufacturing in the US, promote new water-wise business startups in growing sunbelt cities and improve national security and hence the business environment for manufacturing overseas.

Path forward

I would encourage the water community and this committee to view the future of water as one with ample opportunity to build resilience and even abundance. Our nation's water infrastructure is failing, and hence, has upside in that there is much room for improvement. Our goal should not be to immediately achieve top marks, but rather, to chart a patient path that first, achieves a passing grade and consistently targets improvement.

Improving US water infrastructure and safeguarding manufacturing requires investment in three areas: research, the business of water technology, and institutions.

Investment in research (innovation)—
I propose coordinated, cross-agency investment in use-inspired, water-related research:

- Resilient Infrastructure: Multi-agency, collaborative grant programs to stimulate innovation in design, planning and operations of natural and built infrastructure. What is the phase-in of small-scale distributed infrastructure in the portfolio of long-lived large-scale, centralized systems that are aging? How does natural infrastructure enhance a safe-to-fail rather than fail-safe approach to water infrastructure upgrade?
- Manufacturing: Multi-university, multi sector research hub focused on improving water resilience in manufacturing. How can we create high quality exports while using (and

[9] https://innovationisrael.org.il/en/program/israel-nevada-water-innovation-program
[10] https://www.smithsonianmag.com/innovation/is-a-lack-of-water-to-blame-for-the-conflict-in-syria-72513729/

exporting) less domestic water? How can we manufacture more water-wise manufacturing systems and processes?

- The link to energy: Regional modeling testbeds that allow us to improve our co-management of energy systems. How do we better deliver power to desalination given the existing energy generation portfolio and grid? What fraction of our fleet of energy production facilities must transition to dry cooling in order for NERC region to be buffered to increasing drought?

Growing water-wise business—

I propose that cities in the US Sunbelt—especially in the West—look to incentivize innovation ecosystems around water technology and leverage this to grow the business of water security. Here we can look to other countries for lessons, advice and continued partnership, like Israel, which have been successful at growing this business model. Las Vegas has been an early adopter of this idea[11]. The next steps are replicating early successes in other similar western cities and connecting local successes to create a regional innovation ecosystem around water technology. Key actors in these ecosystems include small start-ups, incumbent manufacturing companies (i.e., Intel in Phoenix), universities, venture firms, and business organizations like the US and state Chambers of Commerce. Innovation focus should be on i) creating water efficiency in existing manufacturing processes, systems with co-investment from the private sector, and ii) inventing and manufacturing new technologies that save water in and outside of manufacturing, for example in the home or on the farm. The following are examples of technology needs:

- Energy efficient and cost-effective filtration for reuse and desalination. The US Department of Energy just awarded a 5-year, 100 M desalination hub to a team led by the Lawrence Berkeley National Laboratory. This new hub exemplifies the types of investment that are needed, but desalination and water treatment is a research area of need that easily goes beyond a single hub.
- Water IT for creating smarter management of water resources. There is a big need for cyber systems, including sensors and software, which leverage big data to optimize urban water distribution, irrigation, predict the next water-main break and thereby reduce water inefficiency. In some cases, we just need better measurement of water use. For example, groundwater pumping and use is unevenly reported and hard to quantify from unevenly distributed wells. In the future we will measure water use and abundance using satellite, UAV or drone technologies at very fine special and temporal scales. This is an immediately business opportunity in the US and for overseas markets.
- Agriculture, oil & gas production and water security. Across the US Sunbelt, oil & gas drilling facilities are located next door to large scale agriculture. Both processes need water; both have treatment needs—in return flows from fertilized fields and of produced waters from oil and gas production. There is an immediate need to couple these two systems to make water for irrigation as well as energy from waste water treatment. This coupling requires technology trains, not single technologies. Such technology trains provide interesting opportunities for venture capital and could provide the breadth necessary to spawn innovation ecosystems in neighboring growing cities that are more known for agriculture (i.e., Bakersfield, CA or Lubbock, TX).

[11] https://innovationisrael.org.il/en/program/israel-nevada-water-innovation-program

Innovation in institutions & finance—

- Policy flexibility: US-Mexico Binational Water Treaty Organization provides platform for adding capacity via desalination across the border, IBWC Treaty "minutes" allow for the flexibility to advance adaptive capacity. Continued innovation across state and international boundaries in the sharing of infrastructure will increase long term resilience in supply.
- Reframing risk in public assets: In 2014, D.C. Water issued the first ever municipal century bonds to finance the construction of a tunnel to transport combined storm water and sewage to the Blue Plains Advanced Wastewater Treatment Plant. This century bond and the 30-year bond issued to finance Blue Plains (natural infrastructure) are impact or green bonds.
- Aligning existing tools with new purpose: The revolving funds programs associated with the clean water and drinking water acts have provided finance for water treatment and water quality management for 25 years. How can we scale and broaden the scope of revolving fund projects to include water efficiency (and quality) on the farm?

Conclusion

Manufacturing in the US is dependent on water, but water infrastructure needs to be upgraded to be more resilient to extreme events—droughts and floods. How do we get US water infrastructure from its current D- grade to an A? This will not happen overnight. The goal should be to get a C in the next decade, and to achieve this goal, diligence is more important than cleverness. We need to chart a path toward a future of water resilience, taking advantage of opportunities to invest in research, the business ecosystems of water security and the next, great policy reform. We also need to be willing to take risks and experiment with new technologies and new configurations of infrastructure—within bounds of human safety. Generally, the suburbs in growing US Sunbelt cities provide great promise for testing novel distributed water treatment technologies and enhancing local reuse. Retrofitting existing infrastructure in the core of older US cities remains a challenge, but technology innovation in leak detection can greatly enhance both the efficacy and resources available for rapidly upgrading old distribution systems. In the West there is a lot of storage capacity underground—recharging aquifers is an opportunity for improving long run resilience to drought. Recharge and recovery is likely also a less costly and a more politically palatable alternative to building new surface water reservoirs, but underground storage needs to be planned and executed systematically to rival surface water storage systems. Systematic execution of recharge and storage requires new infrastructure for both recharge (if active) and recovery. Recharge is also an opportunity to rebuild natural infrastructure, especially where passive recharge is used.