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THE USE OF TECHNOLOGY AND INNOVATION TO INCREASE WATER SECURITY AND ENABLE ECONOMIC DEVELOPMENT IN THE WEST

HEARING

BEFORE THE

SUBCOMMITTEE ON
WATER AND POWER

OF THE

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ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

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CONTENTS

OPENING STATEMENTS

WITNESSES

ALPHABETICAL LISTING AND APPENDIX MATERIAL SUBMITTED

THE USE OF TECHNOLOGY AND INNOVATION TO INCREASE WATER SECURITY AND ENABLE ECONOMIC DEVELOPMENT IN THE WEST

WEDNESDAY, OCTOBER 30, 2019

U.S. SENATE,
SUBCOMMITTEE ON WATER AND POWER,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The Subcommittee met, pursuant to notice, at 10:00 a.m. in Room SD–366, Dirksen Senate Office Building, Hon. Martha McSally, presiding.

OPENING STATEMENT OF HON. MARTHA MCSALLY, U.S. SENATOR FROM ARIZONA

Senator MCSALLY [presiding]. The hearing of the Senate Energy and Natural Resources Subcommittee on Water and Power will come to order.

As with many sectors of our economy, technology and innovation are playing an increasingly important role in the management of our water resources. Meeting the water demands for our growing cities and businesses require us to develop new supplies and make every drop count. Technological advances are being deployed around the world to do both of these things and combined with traditional infrastructure, present a great opportunity to increase drought resilience and enable continued economic growth in the West.

As we think about the future of water innovation, it is important to remember that many of these innovative practices and systems are dependent on deployment of other advanced technologies such as broadband. So addressing the digital divide in America is not just about making sure our rural constituents have access to the latest Netflix shows, it is also about water security and economic security.

The advancements we are seeing address a broad spectrum of water management challenges and are being deployed in agricultural, municipal and industrial sectors. In our watersheds, modern forecasting, data and modeling are being used to better manage the reservoirs. On the farm, precision irrigation and other systems are reducing water and energy use. And municipal and industrial water users are deploying advanced membranes to get useable water from new sources like wastewater, salt water and oil and gas operations. We are also seeing creative partnerships, policy updates and financial structures that improve our water security.

Arizona has a long history of trailblazing innovative technology in institutions to improve water resource management. Whether developing the Palo Verde nuclear power plant to run entirely with reclaimed water, adopting forward thinking groundwater codes and resolving tribal water rights or one of the numerous other practices adopted across our state, embracing outside of the box solutions has always been an important factor for Arizona's water supply. But these efforts are only accelerating.

The state strategic plan for water sustainability that looks out to 100 years calls for everything from seawater desalination in partnership with Mexico to direct potable reuse, while other options like modernizing the Roosevelt Dam operations using more advanced data and science-driven forest management to improve watersheds are also being pursued.

In desert cities like Phoenix and Tucson and Las Vegas, of course, there is also a close link between adopting these cutting-edge water technologies and practices and the ability to attract businesses and manufacturing because it demonstrates a long-term commitment to a sustainable water supply and provides a certainty needed to make major investments.

To this point, without objection, I would like to submit a written statement from the Greater Phoenix Economic Council for the record.

No objection?

Senator CORTEZ MASTO. No objection.

Senator MCSALLY. No objection.

[Statement from the Greater Phoenix Economic Council follows:]

Greater Phoenix Economic Council

October 30, 2019

The Honorable Martha McSally, Chair
The Honorable Catherine Cortez Masto, Ranking Member
U.S. Senate Committee on Energy and Natural Resources
Subcommittee on Water and Power
304 Dirksen Senate Office Building
Washington, DC 20501

Dear Chairman McSally and Ranking Member Cortez Masto:

As the President and CEO of Greater Phoenix Economic Council (GPEC), I thank you for the opportunity to address the use of technology and innovation to increase water security and enable economic development in the West. GPEC actively works to attract and grow quality businesses and advocate for the competitiveness of Greater Phoenix. As the regional economic development organization, GPEC works with 22-member communities, Maricopa County, and more than 160 private investors to accomplish its mission, and serve as a strategic partner to companies across the world as they expand or relocate.

GPEC and its members recognize that a secure and reliable water supply is essential to our residents, companies and communities. The Colorado River is one of the most engineered watersheds in the world with three major tributaries and 10 regulating reservoirs. In the United States and Mexico, the river supplies more than 40 million people with renewable water in nine states, 22 Native American nations, and 22 national parks and wildlife refuges. Furthermore, the Colorado River irrigates approximately 5.5 million acres of agriculture land and produces 4,180 MWh of hydroelectric power. Companies such as Intel Corporation, which employs over 11,000 Arizonans, rely on supplies of recycled water to manufacture the technology that impacts businesses worldwide and improves our daily lives.

This year marks a turning point for water policy in Arizona and the Southwest as a whole. State and local officials developed new policies to safeguard access to, and conservation of regional water supplies. Here are a few of concrete steps that officials at all levels of government have already taken to secure our long-term regional water needs:

2 N. Central Ave. Suite 2500, Phoenix, Arizona 85004 602.256.7700 gpec.org

- After the passage of state and federal authorizing legislation, representatives of all seven Colorado River Basin States, the U.S. Department of the Interior and the Bureau of Reclamation signed the drought contingency plans for the Upper and Lower Colorado River basins. Together, the plans are designed to help stabilize the river system and reduce the risk of the system reservoirs falling to critically low levels. The plans represent a tremendous degree of collaboration and compromise among the seven states, as well as the system's water users.

- Through a $1 million grant from NASA's Earth Science Division, an interdisciplinary team of Arizona State University researchers will work with the Central Arizona Project (CAP) on a comprehensive evaluation of climate and land use changes and how these changes impact the Colorado River Basin. Data collection for the study will involve Earth-observing satellites as well as ground data from the United States Geological Survey (USGS), the National Oceanic and Atmospheric Administration (NOAA) and other scientific entities.

- In February 2019, the Central Arizona Groundwater Replenishment District (CAGRD), the Gila River Indian Community, and Gila River Water Storage, LLC forged a historic partnership that provides a renewable water supply to the CAGRD for the next 25 years. This pioneering acquisition provides a substantial water supply that developers and home builders rely on for development in Central Arizona.

GPEC appreciates the opportunity to offer our perspective on technology use and innovation for water security in the Southwest. Improved water security will contribute to increased productivity in economic sectors throughout Arizona. By working collaboratively with the private sector and all levels of government, we can balance the needs of our communities with our obligation to protect our limited water resources.

Sincerely,

Chris Camacho
President and CEO
Greater Phoenix Economic Council

Senator MCSALLY. As we look to build off the progress made in Arizona and across the West, it is also important to look around the world to find the best practices that will continue to help move us forward.

By necessity, Israel has been leading the way on many aspects of water innovation for several decades. So I appreciate Mr. Lang being here and look forward to hearing from him and our other witnesses about potential opportunities for technology transfer and international cooperation on this issue.

I want to thank the witnesses for being here. I look forward to hearing about both the state of innovation in the water sector and opportunities to further utilize advanced technologies to increase our water security.

With that, I will now turn to Ranking Member Senator Cortez Masto.

STATEMENT OF HON. CATHERINE CORTEZ MASTO, U.S. SENATOR FROM NEVADA

Senator CORTEZ MASTO. Thank you, Chairman McSally, for holding this hearing on an issue that, I think, we both can agree is so important to the Western states.

I would like to welcome our panel of expert witnesses. As the Chairwoman mentioned, we will hear from a range of viewpoints today on different water innovation and technology approaches. This is an increasingly important topic, because we must embrace forward-thinking solutions when addressing water security.

Growth in population and the economy, along with food, energy and environmental needs, pose challenges in the ability to meet water demand. Looking to the future, climate change is expected to further stress our water systems both here in the United States and around the world. Solutions to these growing water challenges lie, in part, in developing and adopting innovative water policies and technologies.

In my home State of Nevada, water providers recognize the competing uses of water and how this adversely affected water management. These stakeholders came together in the 1990s to create a regional water agency which is the Southern Nevada Water Authority. The creation of this water authority was considered innovative at the time and brought a new collaborative approach to water management in Southern Nevada, one that integrates people, economies and resources on a regional scale.

In Nevada, we have drastically reduced consumption by recycling water, and this is a critical component of the state's effort to use water supplies more efficiently. In Nevada, we recover roughly 75 percent of our wastewater. And in Southern Nevada, we currently reuse nearly all of our wastewater. Water recycling and reuse play an important role in addressing water security in the arid West.

Although water recycling and reuse is just one tool in our waste management toolbox, we must also look at many different approaches to water management.

I am especially pleased to have Mary Beth Sewald here today from the Las Vegas Metro Chamber of Commerce to highlight the diverse approaches Southern Nevada is deploying to address their water needs. The Las Vegas Metro Chamber of Commerce has been

instrumental in supporting a number of municipal policy innovations that have significantly changed Las Vegas' reliance on water. The Chamber continues to work tirelessly on partnerships that promote smart water use and ensure economic development in the region. Southern Nevada is a recognized leader in water conservation and, as Mary Beth will discuss, has many forward-thinking policies that holistically address water supply and demand.

We must also look at the complex relationship between energy and water. It takes a lot of water to produce energy, and it takes a lot of energy to produce clean water. That is why I am planning to introduce a bill that aims to decrease water and energy intensity by directing the Department of Energy to incorporate water use and manufacturing into all of its relevant research and development programs. This bill is a good example of how innovative solutions to improve energy and water efficiency are developed, and it is an important component in our discussions today about addressing water security with innovation and technology.

I would be remiss not to mention the Drought Contingency Plan (DCP) and how important water innovation and the discussions we are having here today are for managing our water resources within the Colorado River Basin. While we may have different water concerns and needs depending on our corner of the world, we can certainly take the lessons learned from these experts to think differently and more innovatively about our approaches to water management.

I look forward to hearing from our witnesses about the future of technological innovation and what else we can do as a society to ensure we have adequate water supplies for future generations.

Thank you.

Senator MCSALLY. Thank you.

And yes, the Drought Contingency Plan was where everyone came together. Seven states, all 14 Senators, and within six days we got it passed out of the Senate and the House which is why you probably didn't see it on the evening news because it was an important issue that was unifying here in Washington, DC.

Anyway, we are pleased to have five excellent witnesses with us today. First up is Dr. John Sabo, Director of Future H_2O at Arizona State University (ASU). ASU and the University of Arizona are doing a lot in this area, so it is great to have John talk about his work in Arizona and across the globe.

Next, we will hear from Mr. Amit Lang, who is the CEO of EMS Mekorot Projects, a subsidiary of Israel's national water company. Mr. Lang, we are very pleased to have you here today, all the way from Israel, to share your extensive, on-the-ground experience with this issue.

Ms. Margi Hoffmann, the Community Relations Director at the Farmers Conservation Alliance, will testify after that.

Then we will hear from Ms. Mary Beth Sewald, who is the CEO of Las Vegas Metro Chamber of Commerce.

And finally, we will hear from Mr. Stephen Harper, the Global Director of Environment, Energy and Sustainability Policy for Intel.

Dr. Sabo, thank you again for being here. You are recognized for five minutes.

STATEMENT OF DR. JOHN LOUIS SABO, DIRECTOR, FUTURE H2O, ARIZONA STATE UNIVERSITY

Dr. SABO. Senator McSally, Ranking Member Cortez Masto, thank you for having me. It's a pleasure to be here.

I'm going to talk today about manufacturing and infrastructure in the context of technology.

Water is a key component of economic growth and an essential ingredient of our nation's manufacturing machine. It accounts for 12 percent of U.S. economic output and only uses 6 percent of the nation's water and that's compared to, on the farm, 6 percent production for 37 percent of the water use.

Products as diverse as automobiles, plastics, microchips, and we're going to hear from Intel later, paper, oil and gas, beverages like soda and beer, all require water for production. Hence, without even considering food or agriculture, water is driving the U.S. economy and it depends on it. But water infrastructure is failing and that's one of the points that I want to spend a little bit more time on today.

So grades for dams, levees, drinking and wastewater treatment facilities and inland waterways are all lower than Cs. I'm a professor, so I know that's bad. They're all in the D to D+ range. Examples of infrastructure beyond the ones I mentioned, dams and levees are canals, aqueducts, which, you know, are important in the West and also natural infrastructure, including wetlands, coastal marshes, forests and most importantly aquifers, which are an unrecognized but very strong part of our natural infrastructure portfolio. Hence, the portfolio includes both built and natural components.

Broadly speaking, resilient manufacturing infrastructure requires water infrastructure that can buffer against the extremes, so that infrastructure needs to provide adequate water during a drought but also protect key other components of infrastructure and manufacturing from things like floods.

The dependence of water and manufacturing is multisector, and it's a consistent theme across the U.S. sunbelt. I want to broaden it from the West to the sunbelt because that's where 88 percent of the population growth will occur in the United States between now and 2030, and it's also where extremes are expected to intensify both in terms of droughts, which we've heard before, and hurricanes.

So secure water supplies will increasingly become a key predictor of business growth in the sunbelt, especially cities in the sunbelt. The key question that the cities in the sunbelt should be asking is how do we attract new business and grow business with less water? And this is a theme that Nevada is very familiar with and, in fact, I've talked to many people from Nevada about this theme and business development there.

At the ground level, businesses will need to engage directly with municipalities to develop the infrastructure necessary for securing their water and Intel has great experience in doing this in Phoenix, in particular. But, most importantly, sunbelt cities are an ideal location for new places of business development for developing the business around the technology of water use efficiency. And that business then would be important not just in manufacturing but in

other sectors like agriculture and in municipalities. Hence, water sustainability is the business opportunity itself and that should be the motivation, I think, in sunbelt cities and in engaging organizations like the Chambers.

Okay, so, theory of change. I would encourage the water community and this Committee to view the future of water as one with opportunity and potentially even abundance. Our goal should not be to achieve an A tomorrow, but rather to first get a passing grade and then continue on with perseverance toward that A mark later in the future.

Improving U.S. water infrastructure and safeguarding manufacturing both domestically and abroad requires investment in three areas: First, research; second, incentivizing the business of water technology across cities in the sunbelt; and third, in institutions, in particular in finance reform. So I'm going to talk a little bit about those three in my final minute.

The first is in research. I propose coordinated, cross-agency investment in use-inspired water research in three areas: The first is in resilient infrastructure, and this area would include research about how to coordinate natural and built infrastructure; second, in manufacturing and, in particular, the efficiency of the manufacturing process with respect to water; and the third, as the Ranking Member mentioned before, the link between water and energy is very relevant to the manufacturing processes. And I can answer questions about that later.

The second area is growing water-wise business. I propose that cities across the U.S. sunbelt—we know that, for example, automobile manufacturing has increased dramatically in the Southeast United States, so it's also important there—look to incentivize innovation ecosystems like those in Israel around water technology and leverage those to grow the business of water security. Growing the business of water security is what we need to be doing.

And then finally, finance, and I have four seconds left, there are reforms in finance that are important. I think looking to the water, the municipal water supply in Washington, DC, and the finance innovation that they've done here, both with green bonds and with 100-year bonds, is important. I also think we have existing programs like the revolving funds which could be expanded, both in terms of funding and scope, to help not just municipalities but agriculture and manufacturing achieve water security goals.

And I'll stop there.

Thank you.

[The prepared statement of Dr. Sabo follows:]

ASU Future H_2O

Arizona State University

Testimony of
John Louis Sabo, PhD
Director, Future H2O
Arizona State University

Before the
Subcommittee on Water & Power;
Energy and Natural Resources Committee
U.S. Senate

October 30, 2019

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

ASU Charter:

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.

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.

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.

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.

Senator MCSALLY. Great. Thanks, Dr. Sabo.
Mr. Lang.

STATEMENT OF AMIT LANG, CHIEF EXECUTIVE OFFICER, EMS MEKOROT PROJECTS LTD. ISRAEL

Mr. LANG. Good morning. I wish to thank Chair Senator McSally, Ranking Member Senator Cortez Masto and members of the Subcommittee for your kind invitation.

My name is Amit Lang, and I'm the CEO of EMS Mekorot Project which is a subsidiary of Mekorot, the Israeli national water company.

Since you have my written testimony I'd like to start with the bottom line. Water shortage, scarcity, secured and reliable supply can be overcome and is achievable. We in Israel did it and have been doing it for decades. By we, I mean, the State of Israel through Mekorot, it's national water company, which is responsible for approximately 70 percent of the total water supplied in Israel with less than 3 percent loss in the water of Mekorot.

In order to achieve those goals, even in very challenging climate zones and changes—most of Israel is in an arid and semi-arid climate—one must have a good infrastructure for transition of the water with very low weight of loss. This is a fundamental pillar that on top of it come the other layers of management systems, remote control and command systems, dealing with different sources of water and many more.

Alongside that, one must have supportive regulatory framework that it's main goal, from our experience, is making sure that the different areas for end users will cover all costs. That's what we do.

It all started when the young state decided upon the largest infrastructure project that has ever been held in Israel and Mekorot to be the national carrier which its main idea was to carry water from the North of Israel that was relatively rich with water, mainly the Sea of Galilee, to the dry South to enable population and agriculture. It was inaugurated successfully in 1964 and still is the basic foundation of the national network.

Later on, Mekorot was the pioneer in implementing and installing pumping equipment in the mountain aquifer. As early as 1960 and 1970s Mekorot drilled boreholes to the depths of up to 5,000 feet, depths usually associated with the search of oil. Those boreholes were installed with tons of pumping equipment and are still supplying water today.

When that wasn't enough and the population grew and more isolated rural communities arised, we in Mekorot were one of the pioneers in implementing reverse osmosis simulation. In 1975, Mekorot built the first RO desalination plant for brackish water for the City of Eilat. Eilat, the most southern city in Israel that was so isolated by the desert and as a result of that, without connection to the national water carrier, became the most visited city in Israel as a popular destination to visit the Red Sea.

Alongside desalination, Mekorot also developed the ability to reclaim effluents, which brought Israel to the first place globally in reclaiming an almost 90 percent wastewater for agriculture use and by that, lowering the demand for natural water.

The "Shafdan" facility, which is operated by Mekorot for many years, is an example of advanced technology. The facility generates a larger quantity of effluents than the drinking water supplied by a single mega desalination plant on the seashore. After the best practice treatment, the effluents are supplied for unrestricted agriculture use in the Western Negev which is an arid zone.

Nowadays, altogether, Mekorot is managing four different water sources together using the same system while managing demand in real time. To the best of our knowledge, there is no precedent to this. In order to do that, every point in our water supply system is controlled, monitored and managed. Data collected includes flow, pressure, temperature and many, many other parameters.

Integrity management and the use of advanced control systems are critical. This system monitoring control processes are involved in the production, secure delivery and supply of water and the optimal management of the operation and maintenance of facilities. In fact, there was not even a single moment in Israel's history where we were unable to meet demands or taps were dry.

Another issue is the energy usage management. The metering and monitoring systems enables Mekorot to constantly implement solutions that reduce the energy consumption. This has led to considerable savings in recent years.

The coming years we'll be focusing on digital transformation. The data revolution is bringing new capabilities which exceed the current ones. Better solutions in the fields of water management, water quality and safety, energy efficiency, predicted maintenance and more are available. Where there is data, a meaningful solution can be offered.

We have realized that our database, stored in the company's computers and servers or in the cloud, for all intents and purposes, is a "gold mine."

I want to conclude by saying that the Israeli government recently decided to allow Mekorot to share their extensive knowledge accumulated by their company for the purpose of exporting digital knowledge services.

We will be happy to work with any American company organization in the public or private sector to help implement a reliable and secure water supply, anytime, anywhere.

Thank you.

[The prepared statement of Mr. Lang follows:]

Written Testimony of Amit Lang,
Chief Executive Officer, EMS Mekorot Projects Ltd. Israel
Before the U.S. Senate Committee on Energy and Natural Resources,
Subcommittee on Water and Power

Hearing on The Use of Technology and Innovation to Increase Water Security
and Enable Economic Development in the West
United States Senate
October 30, 2019

Chairman Murkowski, Ranking Member Manchin and the members of the Subcommittee.
I wish to thank for the opportunity to share the vast knowledge of Israel and Mekorot in the field of water supply.
I am honored to present the written testimony about Mekorot's activities and contribution to water infrastructure, water treatment, secured supply and management, which are continuously evolving alongside the most advanced technologies over the years.
Mekorot is a fully owned government company and defined by law as the Israeli national water company. The Mekorot Group engages in various fields such as: Water supply, Water resource management, Water quality, Water security, Desalination, Hydrology and drilling, Effluent reclamation, Wastewater treatment, Rain enhancement, R&D and more. Mekorot supplies approximately 70% of the total water consumption in Israel.
Mekorot was founded in 1937, before the establishment of the State. Since then, Mekorot made a profound national contribution to realizing the Zionist vision and transforming it into a sustainable reality. The infrastructure and huge water plants, founded by the company, have essentially facilitated life in Israel and provided solutions, at all times, to all sectors – households, agriculture and industrial plants.

Introduction

Israel has 3 different climate zone types: Mediterranean in the north, Arid in the south and Semi-Arid in central Israel. From the early days of the State, Israel suffered from lack of water. The constant population growth alongside the reduction of natural water resources led the country to initiate research and implement astonishing solutions.
The water supply system in Israel was created during the early years, based on several different sources and combinations covering the entire country. At present, pursuant to the climate change

and global warming, Mekorot uniquely provides water from no less than four water sources: surface water (Sea of Galilee), groundwater (mostly from the Mountain and Coastal Aquifers), desalinated water, and reclaimed water. The ability to use the same system for all four sources together, while managing demand in real time, makes Mekorot a reliable company for continuous and secure supply of water. There is no precedent for this in the entire world.

Surface Water:

In early days, our country realized that given our challenging geo political environment, Water is the most essential resource to evolve demographically and agriculturally. Therefore, Israel set up in primary stages of its independence, a national transmission network.

The establishment of the National Water Carrier, inaugurated in 1964, which is still considered to be the largest infrastructure project in Israel, was the result of groundbreaking thinking in which water is transferred from a relatively rich water source at the north of the country, from the Sea of Galilee to areas at the south of the country on the edge of the desert.

The National Carrier Project enabled the State of Israel's development and the establishment of many new communities, including agricultural communities in distant and isolated areas even next to border zones close to unfriendly neighbors.

Mekorot has always considered the development of the State, the blooming of the desert and painting Israel green to be a national imperative. In the spirit of this vision, the company has succeeded in developing knowledge and unique capabilities based on careful and accurate planning processes.

For the past twenty years, the major part of the underground piping infrastructure of the national water system has been protected by a cathodic protection system. Mekorot has advanced wireless control systems which provide up-to-date information about the status of the infrastructure, the cathodic protection level and even automatic regulation of the corrosivity level.

Cloud Seeding:

In addition to efforts and investments in water management and distribution, the rain enhancement operation, commenced in 1961, increases the water resources. Studies conducted during the 1960s and 70s showed that precipitation in Northern Israel was enhanced by 13% due to the rain enhancement operation. This provides some flexibility to the water management system, especially during drought years. At the present time, the cloud seeding efficiency is being re-evaluated in a multiyear study in cooperation with the academy. Although the official evaluation is incomplete, recent studies show that cloud seeding does indeed have a physical effect on rain clouds, which

can cause an increase in precipitation. We continue to examine ways and means to improve the seeding operation, aiming to reduce costs and increase its efficiency.

Ground Water:

Later on, Mekorot was a pioneer in implementing and installing pumping equipment in the Mountain Aquifer (which is much deeper and bigger than the Coastal Aquifer). As early as the 1960s and 1970s, Mekorot drilled boreholes to depths of up to 1,500 meters, depths usually associated with the search for oil. The company installed many tons of pumping equipment at depths of up to 500 meters and more, providing reliable water sources and additional water sources for mountain communities.

Desalination Plants

However, this was not sufficient, we were asked to provide additional water sources. The first of such sources was the use of desalination plants. Mekorot was one of the pioneers in implementing reverse osmosis technology for water desalination. In 1975 Mekorot built the first RO desalination plant for brackish water for the city of Eilat. Eilat, the most southern city in Israel that was so isolated by the desert and consequently without connection to the national water carrier, became the most visited city in Israel as a popular destination to visit the Red Sea.

From 1997 the desalination plant in Eilat, includes a sea water desalination facility and brackish water desalination plants from drillings nearby. The integrative advantage created in Israel significantly increased the recovery rate to 90% compared to the accepted world standard and is reducing the amount of specific energy required per cubic meter.

In Addition to the desalination plants in Eilat (which produce a total of 61,400 m^3 per day), Mekorot currently oprates several dozen (31) brackish desalination plants (which pruduce up to 13,000 m^3 per day). Mekorot is also committed to absorbing huge amounts of water from the five coastal desalination plants throughout the year, while also preserving the production capacity from the aquifers and managing surpluses in the system.

Reclaiming effluents and agriculture

Alongside desalination, Mekorot also developed the ability to reclaim effluents, which brought Israel to first place globally in reclaiming wastewater for agricultural use by reaching an almost 90% reclamation rate.

The "Shafdan" facility, which is operated by Mekorot for many years, is an example of advanced technology which aims at constant improvement. The facility generates a larger quantity of effluents than the drinking water supplied by a single mega desalination plant on the sea shore.

The effluents are treated and undergo a unique process, which includes infiltration into the aquifer, the SAT (Soil Aquifer Treatment), via a number infiltration ponds. This is intended to complete the effluent treatment and to achieve a higher and better quality than the tertiary quality.

After remaining in the aquifer for several months, the effluents are pumped out and, via a series of pipelines, reservoirs, and pumping stations, are supplied for unrestricted agricultural use in the Western Negev (arid zone).
This remarkable facility is now at a crossroad. On the one hand, the entry of innovative technology for primary and secondary treatment of waste water and, on the other hand, an increase in the quantity of waste water resulting from population growth and the connection of additional consumers in the center of the country.
This is a serious challenge. The existing infiltration ponds are reaching their limits and cannot be expanded, since they occupy prime real estate in the center of the country. Furthermore, the housing shortage requires a new way of addressing the challenge and working to relocate some of the infiltration ponds, to enable construction of thousands of housing units as part of the solution for the housing shortage.

Mekorot is preparing for this challenge. Over the past few years, many research projects and trials were conducted at the Shafdan R&D facility in collaboration with partners from Israel and abroad. Different technologies of effluents treatment for reclaiming them to drinking water quality were examined. The company gained knowledge and experience that will come to the front in the construction of a semi-industrial pilot which will examine advanced technologies, such as UF (Ultra Filtration) combined with RO (Reverse Osmosis), for improving effluents and bringing them to the highest quality, suitable for all usage needs. This pilot will serve as the basis for planning a large and advanced industrial facility which will produce around 50 million cubic meters per year and will serve as an alternative to the reservoirs which reached their full potential and will enable the release of land and housing solution for young couples in the central region of the country.

Of course, alongside the industrial facility, we must also increase the transmission and storage system to the existing supply system at the Western Negev.

Along side the investment in effluent, the State developed modern and advanced irrigation capabilities, concurrently conducting advanced research for the development of special fruit and vegetable varieties, resulting in increased production from the fields whilst also reducing water usage. The close cooperation between water management and agriculture created a technological advantage that enables export of Israeli knowledge to the wider world, increased exports, and creation of new jobs.

Furthermore, in the Harava, an arid zone, located south of the Dead Sea to Eilat (Red Sea), which has a saline aquifer, there are many fields of palm trees growing dates which are irrigated by brine from the local desalination facilities, (the brine is a byproduct of the desalination plant and it's usage is a greate economic environmental utility). Additionally, a huge algae growing plant for food additives loctated in the Harava, is irrigated by drilling saline water combined with brine from the local desalination plant. Other crops in that zone are irrigated by effluents. This great achievement is an example of how Israel develops an agricultural region in arid climate conditions. Moreover, Israel effectively decreased the demand for potable water and still provides an answer to continued growth of agricultural settlements in distant and isolated areas.

Management

Management of various water sources and the distribution of water supply in accordance with the differing and varying demands throughout the country required to implement large-scale monitoring and metering systems throughout the country, which generate millions of data items every day from a variety of devices, all connected to command and control systems. As a result, every point in the Israeli water supply system is controlled, monitored, and managed. Data collected includes flow, pressure, temperature, turbidity, conductivity, chlorine concentration and many other parameters. This operational data makes it possible to control operation of the water system using threshold values. The supply of different water mixes, often in a short period of time, creates "noise" of water quality in the measuring instruments. The effect of this "noise" must be reduced to distinguish between changes in water mixes and pollution in the system. Here, also, integrative management and the use of advanced control systems are critical: Operational deviations are transferred from the sensors array, through local control systems to human-machine interfaces (HMI), or via computer systems used to supervise, control and collect data - SCADA systems. These systems monitor and control processes involved in the production, secured delivery and supply of water, and the optimal management of the operation and maintenance of facilities. Another issue is the energy usage management. Mekorot is the largest consumer of electricity in Israel. The company spends hundreds of millions of Dollars annually for the energy needed to provide a reliable water supply. The metering and monitoring systems enable Mekorot to constantly implement solutions that reduce energy consumption. This has led to considerable savings in recent years.

Epilogue

The advantage of integrate different sources of water, is the driving force behind our ability, despite long and difficult years of drought, to supply water to all of Israel. In fact, there was not even a single moment in Israel where we were unable to meet demands or taps were dry.

The integrative and holistic management has another positive result, the low system Non-Revenue Water Percentage, is the lowest in the world - less than 3%.

In addition to the aforesaid, Israel has encouraged residents to save every drop of water through media advertisements, especially during drought years, which together with the regulation enacted in Israel for differential water prices, prompted the end consumers to save water.

In the coming years, we will focus on the digital transformation. Since the beginning of the present decade, entrepreneurs, and leading companies in the computerization and software field have identified the need and begun to offer solutions that utilize the accumulated information in water utilities servers.

Better solutions in fields such as water management, water quality and safety, energy efficiency, holistic management of water and wastewater production facilities, predicted maintenance and more, are available. Where there is data, a meaningful solution can be offered.

We have realized that our database, stored in the company's computers and servers or in the cloud, for all intents and purposes, is a "gold mine".

The great advantage of Mekorot is our in-depth knowledge of the world of water, our ability to integrate solutions while creating synergetic values and an immediate return of investment due to the fact that the equipment is installed on the basis of innovative models, that use artificial intelligence to identify trends and anomalies in the water system. The integration of core solutions with computing capabilities provides great value. There is no doubat that the world of water resource management is an inseparable part of the Fourth Industrial Revolution.

Of course, we must not ignore the cyber field. As the data world becomes more important and data flows through communications systems to local or cloud servers, water systems are, as critical infrastructure, even more vulnerable and at risk. Hence, the importance of assimilating advanced cyber protection systems for information systems and operating systems as one cohesive unit.

The Israeli Government recently decided to allow Mekorot to share the extensive knowledge accumulated by the company for the purpose of exporting digital knowledge services. In addition, Mekorot is preparing to carry out a challenging five-year plan to implement a new AMI system, an advanced SCADA system, the first national operational system of its kind in the world and, finally, an advanced, supportive cyber array at an investment of millions of Dollars. This ongoing change will bring new operational management capabilities and the management of Israeli water resources to new heights.

I thank the Committee again for inviting me to testify and would be happy to share Israel's experience and knowledge in the field of water and answer any questions you may have.

Senator MCSALLY. Great. Thank you.
Next is Ms. Hoffmann.

STATEMENT OF MARGI HOFFMANN, COMMUNITY RELATIONS DIRECTOR, FARMERS CONSERVATION ALLIANCE, AND ON BEHALF OF THE FAMILY FARM ALLIANCE

Ms. HOFFMANN. Chair McSally, Ranking Member Cortez Masto, my name is Margi Hoffmann. I'm the Community Relations Director at the Farmers Conservation Alliance, and I just want to say thank you for being here today and for inviting us to speak. The Farmers Conservation Alliance—I'm also here on behalf of the Family Farm Alliance, and our two organizations have been working for decades to modernize irrigation systems in the Western United States.

Most of the water in the Western United States moves through irrigation districts that were constructed over 100 years ago. And while we have a lot of technologies that exist today, those technologies are sitting on the sidelines because a lot, because the technologies are sitting on the sidelines as we struggle with ways that we can come up with to modernize the systems and actually deploy those technologies for the benefit of the community.

Modernizing these systems is one of the single, biggest wins that we can do for energy security, for water security, for food production and agricultural community resilience and, also, conservation.

For example, Farmers Conservation Alliance is currently working with the Bureau of Reclamation just outside of Reno, Nevada, to install downstream fish passage at Derby Dam. And this will be the final piece in the puzzle to connect habitat for the Lahontan Cutthroat Trout which was once believed to be an extinct species.

We can modernize these districts. We are modernizing these districts but, in the decade plus that we have been working across our organizations to do so, I would say there's four key takeaways that I want to focus on today.

One is holistic planning and data. Oftentimes you have one side saying one thing and another side saying another thing, and there's no data to support either argument, either what the irrigation districts are capable of or what we can do in terms of meeting environmental needs. And so, what we do is go in and work with irrigation districts to look at the entire system and understand not only how that system can serve agriculture but also how that system can serve the community.

We looked at Hood River Farmers Irrigation District and had they started with a holistic plan, they would have saved their patrons over $12 million as they've been redesigning their system. So creating efficiencies, looking at capital stacking, looking at technology deployment, has to start from the whole district or the whole basin and work from that place.

Number two is calculating impacts. While we modernize these irrigation districts, we are reducing operations and maintenance costs, we are increasing agricultural resilience, but you can also install in-conduit hydropower generation, wi-fi capabilities, bury transmission lines and serve not just the irrigation and agriculture community but also provide broader benefits to the community writ large.

Understanding what those benefits are and the impact of those benefits helps leverage additional capital in addition to traditional funding sources, and it helps create strategic partnerships and alliances as opposed to continuing to fight over water in the West.

Number three is earned revenue. The Federal Government invests significant capital in irrigation modernization. The State of Oregon, for example, has a $15 billion bi-annual budget. So we can't keep pace with the matching that's required. So if you have an irrigation district that can make money by hosting a pollinator corridor or providing local, renewable generation capabilities or can install fiber-optic cable that can also serve rural broadband, those are earned revenue strategies that they now have a contract to make money over a 20-year time horizon that they can use to bank a loan to modernize their system. And so, supporting not just irrigation but also other policies that help enable those earned revenue strategies and make those real is critically important to agricultural resilience.

And number four is the co-location of infrastructure. If you bury a mile of pipe you convert a mile of open canal to pipe and then you do a mile of broadband and then you do a mile of buried transmission lines to reduce wildfire, that costs over $3 million. If you co-locate all that infrastructure, the costs of installation is $200,000. The irrigation districts have the rights-of-way already. We have an extensive network throughout the West. And then the irrigation districts can use that capital to reinvest in conservation that increases their community resilience and rural resilience as a whole.

I would say irrigation modernization, in general, would not happen without the support of this Committee. I commend you for what you have already done and look forward to working with you in the future.

I'll point to my written testimony where we have a litany of things that we would like to work on with Congress, but I'll point out three things that I want as takeaways.

Number one, if we're looking at infrastructure practices, we can't just talk about potholes. We have to talk about natural and irrigation and hard infrastructure for water. That has to be part of the conversation.

Number two, continued support of Farm bill programs like regional conservation partnership, the watershed planning and flood prevention, those are what is increasing the pace and scale right now.

And number three is directing the United States Department of Energy to specifically address the water-energy nexus. I love that you brought that up. Thank you.

Focusing on things like co-location, things like mixing of solar battery energy technologies that can also serve to power communities in the case that their power is shut off, as we're seeing right now across the Western United States due to wildfire.

So, I'm over. Thank you very much. I appreciate it.

[The prepared statement of Ms. Hoffmann follows:]

Testimony of Margi Hoffmann
On behalf of
Farmers Conservation Alliance
and
The Family Farm Alliance

Before the
U.S. Senate Energy and Natural Resources Committee
Subcommittee on Water and Power

Hearing to Examine the Use of Technology and Innovation to Increase Water Security and Enable Economic Development in the West

Washington, D.C.
October 30, 2019

Chairman McSally, Ranking Member Cortez Masto, and Members of the Subcommittee:

My name is Margi Hoffmann, and on behalf of the Farmers Conservation Alliance (FCA) and the Family Farm Alliance (Alliance), I thank you for this opportunity to present this testimony on a matter of critical importance to both memberships: the use of technology and innovation to increase water security and enable economic development in the West.

FCA is a non-profit organization that partners with irrigation districts, farmers, ranchers, and other agricultural water delivery providers to help them modernize their systems for the benefit of agricultural resilience, domestic energy security, and the environment. In short, FCA works to keep the water flowing for food, farms, and fish. Much of the water withdrawals in the Western United States are for irrigated agriculture, moving through infrastructure that was often constructed over 100 years ago. FCA recognizes that modernizing these systems is the single greatest opportunity in rural economic resilience and the environment.

FCA is currently working to modernize districts in four Western states and will scale the Irrigation Modernization Program across the Western U.S. We work in close partnership with irrigation districts, farmers, and ranchers. FCA works with federal agencies, such as the Bureau of Reclamation (Reclamation), Natural Resources Conservation Service (NRCS), U.S. Department of Agriculture (USDA) Rural Development, and U.S. Department of Energy (DOE), to name a few. We also work closely with state and local elected officials, community leaders, and environmental non-profit organizations. FCA's proven methodology shows that irrigation modernization brings communities together to solve water resource issues collaboratively and negates the need for costly litigation.

The Family Farm Alliance is a grassroots organization of family farmers, ranchers, irrigation districts, and allied industries in 16 Western states. The Alliance is focused on one mission: To ensure the availability of reliable, affordable irrigation water supplies to Western farmers and ranchers. We are also committed to the fundamental proposition that Western irrigated agriculture must be preserved and

protected for a host of economic, sociological, environmental, and national security reasons – many of which are often overlooked in the context of other national policy decisions.

This testimony will illustrate the problems Western farmers and ranchers face in terms of water supply reliability, and outline what Western producers and organizations like mine are doing to address these challenges. We believe the examples presented in this testimony show that the best solutions are locally driven and collaborative. They often are highly innovative and employ a range of new technologies that best address unique local challenges. In many cases, multiple benefits are achieved, including a more secure water supply, ecosystem improvements, and economic stability.

Personal Background

I have been the Director of Strategic Operations for the Farmers Conservation Alliance for four years. During that time, I have worked with FCA, irrigators, farmers, ranchers, federal, state and local agencies, and environmental non-profits to develop, pilot, demonstrate, and scale the Irrigation Modernization Program across the Western states. Prior to joining FCA, I served as a natural resources policy advisor to two Oregon Governors, and I have worked on collaborative approaches to solving natural resource issues in the Western United States for over 10 years. My particular focus has been on the timber, agricultural, and domestic energy development sectors.

FCA and Alliance Collaborative Philosophy

FCA's Irrigation Modernization Program focuses on helping irrigation districts and the farmers they serve revolutionize their infrastructure. Past initiatives have focused on specific goals, such as water conservation, hydropower production, system efficiencies, or broader conservation benefits. Unfortunately, there has been little progress in creating a methodology that attracts large-scale investment in comprehensive, unifying solutions. FCA's innovative program reduces the cost and time required for project planning and implementation, addresses key regulatory and institutional barriers, leverages funding from multiple resources. It further demonstrates how modern agricultural water management can mitigate the impacts of long-term drought and other serious environmental and agricultural challenges.

Perhaps most importantly, FCA's program moves beyond typical engineering and/or data collection. We also focus on developing strategic partnerships with irrigators, and agency and community stakeholders. Through these partnerships, we identify the values and goals the partners collectively want to achieve in the future, quantify the benefits of modernization, and develop strategies for funding and implementation. FCA has proven that focusing on the broader social context of communities and better understanding their needs helps accelerate the pace and scale of irrigation modernization, never losing sight of all of the benefits modern systems provide more broadly.

The Alliance has a long tradition of developing practical solutions to the challenges facing Western agricultural irrigators. The organization conveys these solutions to Congress, the executive branch, and other water policy makers through a variety of forums. Through the years, the Alliance has also published several reports that have provided guidance to policy makers on issues important to irrigated agriculture.

For family farmers and ranchers, finding solutions to constantly emerging challenges is just business as usual. Nature, the markets and the government are always finding new problems to throw at farmers, and farmers who are not determined, resourceful and innovative do not succeed – at least not for long. Family farmers and ranchers have a proven track record of finding solutions to constantly emerging challenges. The ongoing, initial response of irrigators and water agencies to current water supply challenges may provide some insight into the possible measures that might be taken to cope with long term water supply reductions resulting from climate change and competing uses.

FCA and the Alliance have a track record of working with diverse partners to achieve solutions with mutually beneficial outcomes. For example, both organizations are members of the Western Agriculture and Conservation Coalition (WACC), a diverse group of organizations that first came together a decade ago around the Farm Bill conservation title with the goal of supporting the common interests of agriculture and conservation. Other founding steering committee members included Trout Unlimited, The Nature Conservancy, California Farm Bureau, Environmental Defense Fund, Public Lands Council, Arizona Cattle Growers Association, Wyoming Stock Growers Association, and the Irrigation Association. The threats to a viable and sustainable rural West are numerous, complex, and variegated. A broad and authoritative voice like that of the WACC is needed to effectively address these threats with collaborative solutions.

Why Irrigation Modernization Matters

Aging agricultural infrastructure, expanding population, persistent droughts, and declining fish populations are stressing scarce water resources. Farmers in the Western United States rely on irrigation to grow food. But the dams and canals that capture and convey this water from rivers to farms are aging and sometimes inefficient. In many scenarios, farmers and rivers do not get the water they need. By replacing outdated infrastructure with modern technologies, farmers can do much more with less. Irrigation modernization addresses fundamental problems in aging infrastructure, unifies solutions for rural farming communities, and enhances the enviornment. Irrigation modernization positions rural communities for long-term resilience, enhancing our domestic food supply and a healthy environment for generations to come.

Economic and Food Production Benefits from Western Irrigated Agriculture

Western agriculture is a significant contributor to the economy. The Alliance in 2015 published "The Economic Importance of Western Irrigated Agriculture" (prepared by the Pacific Northwest Project), a white paper specifically drafted to be read by policy makers seeking to better understand the direct economic impact of Western irrigated agriculture. The report also serves to acknowledge the growing chorus of voices bringing attention to food security and irrigated agriculture as a national economic issue. The full magnitude of irrigated agriculture's contribution to the economy is rarely, if ever, quantified in terms of total household income for the Western U.S. region. For the 17 Western states studied in the report, the total household income impacts from irrigated agriculture, associated service industries, and food processing sectors is $172 billion. There are also direct and indirect linkages to the economy derived from a low-cost food supply. For example, inexpensive food makes available large blocks of disposable

income to the consumer spending economy, which is one reason why U.S. citizens currently spend less of their disposable income on food than anyone in the world.

Western irrigated agriculture is a major source for our availability of high-quality food. The farmers and ranchers who bring us this food are part of the irrigated agriculture industry that is a huge economic driver in many Western states, particularly in rural communities. Given the magnitude of the food security issue to economic wellbeing, protecting and encouraging irrigated agriculture should be a high priority.

Innovative Solutions

Irrigators and their local water agencies are responding to the challenges of reduced water supply reliability with determination, resourcefulness and innovation. They also are bringing those attributes to bear in planning for a future where "drought" may be a long-term or even permanent condition. Throughout the West, farmers, ranchers and irrigation agencies have undertaken creative measures to efficiently manage increasingly scarce water resources in providing water supply to irrigated agriculture. Some of these actions were intended to address the immediate crisis of recent western droughts; others have been implemented as part of the broad portfolio of actions that successful farmers are employing to stay profitable in today's fierce economic and regulatory climate. We have found that, when federal agencies are willing to work collaboratively with farmers and ranchers, the result is better management of water for both economic purposes and environmental uses.

The water shortage problems we all face vary by region, topography, climate, soil conditions, hydrology, and crop. These problems have some elements in common, including inadequate or deteriorating water storage infrastructure, inflexible or outdated operational requirements, and regulatory conditions on operations. Often times, government agencies are not nimble enough, or not motivated to seek out and embrace better ways of doing things to ensure the most benefit for the broadest suite of public interests. Solutions also vary by state or by region, but they, too, are characterized by certain common elements, including creativity, flexibility and balance.

Below are some examples of successful Western solutions and potential solutions where technology and innovation improve water security and bolster economic development.

Collaboration, conservation, energy and water reliability, and regulatory assurances: Farmers Conservation Alliance (CALIFORNIA, MONTANA, NEVADA, OREGON)

Derby Dam Downstream Fish Passage (NEVADA)

FCA, in partnership with Reclamation, has broken ground on the Derby Dam fish screen. When construction is completed (scheduled for fall 2020), this innovative technology will restore watershed connectivity and support fish movement along the Truckee River. The finished project will promote both the recovery of the federally threatened Lahontan Cutthroat Trout (LCT), as well as fishing and recreation opportunities in Nevada. Derby Dam, completed in 1905, was one of the first U.S. Reclamation Service projects, organized under the Reclamation Act of 1902. After the completion of Derby Dam, the LCT lost access to their spawning habitat, which eventually led to their extirpation in the Truckee Basin. This project combines the biological expertise of the U.S. Fish and Wildlife Service

(USFWS), the engineering and construction expertise of Reclamation, and FCA's innovative Farmers Screen to fully restore LCT's access to their full reach of habitat, from Pyramid Lake up the Truckee River.

Basin-Wide Irrigation Modernization (OREGON)

FCA, in partnership with the Deschutes Basin Board of Control, NRCS, Energy Trust of Oregon, Oregon Department of Environmental Quality and local environmental organizations have worked to develop comprehensive modernization strategies for seven districts in the Deschutes Basin. Collectively, the impact of modernizing these districts will save 555 cubic feet per second and improve 514 miles of stream over 100,000 acres of agricultural land. This translates into $900 million in economic development, improved water quality and increased habitat protection for threatened and endangered species. Working together, the partners over the past three years have been able to leverage nearly $150 million from the federal and state governments, demonstrating the "art of the possible" for the community. This project has helped to alleviate the tension between agricultural and environmental interests, and has galvanized a partnership in modernizing infrastructure to achieve a mutual benefit.

In-Conduit Hydroelectric Generation: Irrigation Modernization Acceleration Tool (OREGON)

In partnership with DOE, FCA worked to develop a case study that assesses the impact of installing in-conduit hydroelectric generation facilities in irrigation district systems. In-conduit hydropower generates electricity using pressurized water flowing through a closed-pipe system to spin a turbine. Irrigation districts can sell the power generated to local utilities, providing the district with an additional revenue stream that they can use to accelerate investment in modernization projects.

Central Oregon Irrigation District (COID) is one of the largest irrigation districts in Oregon, serving urban, suburban and rural communities. The district provides water to about 45,000 acres using over 700 miles of mostly open irrigation canals that, in some cases, lose up to 50% of the water diverted to seepage and evaporation. The single largest opportunity for water savings is to convert open canals to closed, pressurized pipe. The biggest challenge is figuring out how to pay for the cost of conversion.

In COID's Pilot Butte canal, the district has the potential to generate approximately 10 megawatts of hydroelectric energy. Installing these energy generation facilities would save each farmer in their district approximately $400 and provide the district over $9 million in value, every year. The projects would also help the district to return 167 cubic feet per second of water to the Deschutes River, and support 330 local jobs and over $15 million in regional economic activity. Installing in-conduit hydroelectric generation facilities increase rural energy security and provide irrigation districts with a value-added revenue stream to accelerate their investment in irrigation modernization.

Economic and Environmental Value of Infrastructure Co-Location

Irrigation districts across the West will install hundreds of miles of modernization projects in the coming years. However, community resilience extends beyond water infrastructure, including the need for energy security and access to affordable internet, cable and telephone services. A significant barrier to improving telecommunications and energy infrastructure in rural areas is the great expense associated with siting, right of way acquisition, engineering, permitting, and construction. Irrigation modernization projects already cover most of these costs, improving the feasibility of installing fiber optic and electric

transmission/distribution lines, with several benefits. Building out these three infrastructure components individually would cost over $3 million per mile. However, co-locating the infrastructure projects in an irrigation district right-of- way concurrent with district modernization would save well over $2 million per mile. In addition, this fiber optic network enables farmers and ranchers to utilize the best available technology to maximize smart infrastructure and increase production, Irrigation districts would further be able to earn revenue from the lease of their right-of-way to an internet service provider or electric utility, accelerating their investment in modernization projects.

Improved snow measurement and runoff forecasts: Friant Water Users (CALIFORNIA)

As in much of the West, many of California's farms and cities rely on water that is stored for much of the year as snowpack. But patterns of snow accumulation and melt are changing; temperatures are higher in the "shoulder season," more precipitation is falling as rain instead of snow, and our snowpacks are diminishing. Throughout the Western U.S., water users are working adapt to these changing conditions while maintaining secure, reliable supplies of water. While adapting to the loss of snowpack may ultimately require new storage, building new storage requires time and has become difficult to permit and fund. Thus, operational improvements at existing water storage facilities have become even more important. In response to these pressures, over the past several years, a group of irrigation districts and other water agencies in California have been investing in a pilot application of a new technology that has dramatically improved both the measurement of snowpack in the Sierra Nevadas and runoff forecasts.

This new technology, called the Airborne Snow Observatory (ASO), emerged in the past seven years from NASA's Jet Propulsion Laboratory. It uses plane-mounted cameras and laser technology to measure snow depth and reflectivity on multiple points in every square meter of a watershed multiple times during months of snow accumulation and melt. The measurements and aerial imagery that are collected can be used to estimate the amount of water supply stored in the snowpack and assess flood risk and other on-the-ground conditions, such as forest health. They are also used to generate predictions of runoff into rivers, streams, lakes, and reservoirs that have shown to be 96%-98% accurate. This improves on conventional methods that have been shown to have up to 60% accuracy.

The program has already demonstrated improved understanding of peak runoff events, giving flood managers a two-week advance warning to make management decisions. Such advance warning also helps anticipate operations that could enhance groundwater replenishment projects. This is critically important in California and other highly productive agricultural regions with stressed groundwater basins.

Since 2013, water districts in California, including those in one of our member districts, the Friant Division of the Central Valley Project, have worked together with NASA, the California Department of Water Resources, Reclamation, and the USDA's Agricultural Research Service (USDA-ARS) and NRCS National Weather and Climate Center to operate the ASO program. The ASO operators conduct the flights and collects measurements; the USDA-ARS produces runoff forecasts; and local, state, and federal agencies use the information to manage water for multiple uses, including irrigation, flood protection, and groundwater recharge.

The ASO program began with the 460 square-mile upper Tuolumne River basin and by 2019 USDA-ARS had produced runoff forecasts for almost all the southern Sierra Nevada (nearly 21,000 square miles) that represents approximately one-third of California's agricultural water supply. In 2018, Turlock Irrigation District used ASO-derived information to save more than 150,000 acre-feet of water at Don Pedro Reservoir that would otherwise have been released to make flood space available. In other words, ASO can allow for increased water supply storage in existing reservoirs without needing new permits or construction. The Friant Water Authority estimates that, once fully implemented, the ASO program could improve deliveries by as much as 100,000 acre-feet in a given year through more effectively managed runoff. Additionally, Reclamation has used ASO-informed runoff forecasts to help refine Central Valley Project water supply estimates and improve operations for the restoration of salmon below Friant Dam.

This technology has broad relevance for flood, water supply, and environmental operations across the Sierra Nevada and Cascade Mountains; the front range of the Rocky Mountains of Colorado, Wyoming and New Mexico; the Colorado River tributaries in Utah and Arizona, and the Pacific Northwest, just to name a few. Unfortunately, despite its broad value, the program faces an uncertain future, as state, federal, and local funding is drying up.

Using best available science and the practical know-how of farm and refuge managers to reactive natural floodplain processes: Northern California Water Association (CALIFORNIA)

The Northern California Water Association (NCWA) represents water districts, water companies, small towns, rural communities and landowners that beneficially use both surface and groundwater resources in the Sacramento Valley. NCWA is part of a diverse coalition of conservation organizations, farmers, local governments, water suppliers and academic institutions who have come together to advance a new model for water management, fish and wildlife habitat restoration, and land use that seeks to reactivate historic floodplains in the Central Valley. This innovative, sweeping program is intended to upgrade California's aging water and flood infrastructure while simultaneously enhancing the function of river ecosystems for the benefit of fish and wildlife populations. Many successful projects have shown that integrating a working 21st Century scientific knowledge of how rivers work into the management of farms, flood protection and water infrastructure creates a system that functions far better for fish, birds, wildlife, farms, and cities.

California's Sacramento Valley is a rich mosaic of human settlement, farms, managed wetlands, and meandering rivers that support people, fisheries, and wildlife. Farms, rural communities and cities thrive next to wildlife refuges and rivers, and together they support millions of birds and other wildlife that have lived there for millennia. Nearly all of the Sacramento Valley floor is part of the historic floodplain—the naturally flood-prone areas surrounding the river. Before levees and dams were built to protect people from catastrophic floods, this floodplain supported robust fish and wildlife populations.

The Sacramento Valley is fertile ground for developing a new path forward for holistic water management. This approach incorporates best available science and the practical know-how of farm and refuge managers to innovatively reactivate the floodplain. Farmland (primarily ricelands), wildlife

refuges, and the river bypasses designed for flood protection can be managed to work together for dynamic conservation and to mimic the historic floodplain in the Sacramento Valley. Importantly, these features continue to provide flood protection for Sacramento and other parts of the Valley. Spreading out and slowing down water across this landscape mimics natural flows and provides multiple benefits year-round. This allows farmers to cultivate rice and other crops for humans during the spring and summer, habitat for wild birds, reptiles, and other fauna in the fall, and food and rearing habitat for migratory birds and native fish species in the winter.

This program embraces the best available science and the work of leading scientists from the University of California and throughout the world. Their work demonstrates the value and importance of reactivating floodplains as the key element to improve conditions for fish and wildlife within a managed water system like the Sacramento Valley. This effort engages many forward-thinking landowners in the Sacramento Valley who are implementing environmental farming practices and wetlands management techniques that reactivate the traditional floodplain for multiple benefits. This includes juvenile fish growing and rearing in fields in the bypasses; producing food on farm fields to be released to the river for salmon; the Delta Smelt food program for the north Delta; and reconnecting oxbows to the river channel.

This management regime also supports the return of birds and other species along the Pacific Flyway. It builds on the documented environmental success in the Sacramento Valley, where collaborative partnerships between scientists, conversation groups, agencies, and landowners have resulted in farms, refuges and managed wetlands providing essential habitat for waterfowl and shorebirds. This program recharges precious groundwater, consistent with state policy. And, it provides nourishment, spawning and safe rearing and migration for juvenile salmon, as learned from the reconnection of Butte Creek with the floodplain in Butte Sink and Sutter Bypass.

This innovative strategy implements and improves dynamic conservation strategies designed to create, retain and enhance habitat in temporary and adaptable ways. This will reinforce the value of floodplains and help species thrive in a changing world. Developing and deploying dynamic conservation strategies is especially important for migratory species–both birds and salmon - and will also become increasingly important for biodiversity conservation.

Science and experience are showing that flood protection river bypasses, farmland and wildlife refuges that occupy historic Central Valley floodplains can be managed to mimic the historic natural processes and patterns which create and sustain fish and wildlife habitat.

Using canals to augment tributary flows and reconnect lost fish spawning habitat:
Kittitas Reclamation District (WASHINGTON)

As part of Washington State's Yakima Basin Integrated Plan, a watershed-wide integrated collaborative approach to managing water resources for multiple benefits, the Tributary Supplementation Program (TSP) is now in its fourth year since its inception. The TSP uses the Kittitas Reclamation District (KRD) canal to augment flows to six upper Kittitas County tributaries that are intersected by the main and south branch KRD canals. Sections of these tributaries to the Yakima River historically have dried up during

summer and fall due in part to human-caused changes in flow regimes, such as irrigation diversions, resulting in loss of literally miles of spawning habitat for native fish species, including some protected as threatened or endangered species under the Endangered Species Act (ESA). Dry sections of these tributaries are supplemented with river water delivered through KRD irrigation canals, reconnecting the lost spawning habitat to the river.

Under the Integrated Plan, several entities are working together to address flows, habitat restoration, fish passage and Coho Salmon supplementation. These include Washington State Departments of Ecology and Fish & Wildlife; Reclamation, U.S. Fish & Wildlife Service and National Marine Fisheries Service; Trout Unlimited and Kittitas Conservation District; Yakima Tributary Habitat Enhancement Program; Yakama Nation and Kittitas Reclamation District.

Water conservation is a key component of this program. The ability to supplement flow to these creeks depends on increasing canal capacity to deliver irrigation and tributary water. KRD has lined about four miles of canals, resulting in conserved water and canal efficiencies that allow for the TSP to occur without impacting irrigation deliveries. Water quality and fish monitoring remain important components of the TSP, with an emphasis on flow, water temperature, dissolved oxygen (DO) and pH; and relative fish abundance by species. Installation of PIT tag detection arrays this past spring was a key addition to the monitoring program, allowing for the tracking and monitoring of tagged fish in the rejuvenated tributary habitat. As a result, recent spawning surveys have detected Chinook redds (nests) in the newly reopened tributary spawning beds.

Integrating agriculture, science, technology and ecology: The Intermountain West Joint Venture (Western United States)

The Family Farm Alliance works closely with the Intermountain West Joint Venture (IWJV), a leader in utilizing science and technology advancements to link agriculture, hydrology, and wildlife habitat conservation. The IWJV's Water 4 Initiative is focused on the importance of maintaining agricultural land for habitat conservation and landscape resiliency within western states. The rapid fragmentation of agricultural wildlife habitat, as well as crop conversions and changing irrigation practices, have implications that reverberate beyond agriculture and begin to impact local water availability for people and wildlife. Integrating agriculture, science, technology, and ecology can lead to improved understanding of key linkages related to the importance of agricultural irrigation and the need to invest in modernizing irrigation infrastructure. Such investments also have collateral benefits for landscape resiliency including groundwater recharge, habitat enhancement, and conservation of fish and wildlife.

There is a unique opportunity to address long term food security through investments in agricultural infrastructure that in turn have benefits for wildlife conservation. Below are three specific examples of IWJV scientific research projects currently underway to better understand the role of agriculture, conservation, and the importance of maintaining/modernizing irrigation infrastructure.

Quantifying the exact farm acreage needed to sustain bird populations

Spatial analysis combined with detailed water bird population information has allowed IWJV to begin to quantify the exact number of agricultural acres that need to be enhanced/protected in the Klamath

Basin in California and Oregon (among other locations) to provide habitat to sustain water bird and waterfowl populations. This has critical implications for the broader agricultural community in the Pacific Flyway. If habitat is not maintained in the Klamath Basin, migrating birds will likely move south, to California's Central Valley, earlier in the season. This earlier migration means birds may arrive before rice is harvested, resulting in potentially devastating impacts to rice production. This is just one example showing the importance of understanding landscape systems as a whole and the ripple effects that can occur through habitat loss.

In the West, bird habitat has been lost due to aging irrigation infrastructure, changes to traditional irrigation practices, diminishing volumes of water due to reduced snowpack, and fragmented agricultural land. IWJV is focused on better understanding these linkages. In this way, tools can be provided for strategic decision-making related to investments that benefit agriculture. These include modernizing aging infrastructure to provide water during critical periods for agricultural production while also providing vital habitat for fish and wildlife.

Long-term analysis of wetlands, agriculture, and water

The IWJV is integrating new research on water dynamics with land use practices. This integration will be used to identify historical patterns of overlapping agricultural production and wildlife habitat availability. With these patterns identified, decisions can be made as to where modernization of existing infrastructure will have the greatest long-term likelihood of meeting the water needs required to sustain agriculture. This data can be used to inform decision makers on where to make vital investments into aging agricultural infrastructure. These improvements are critically important for agriculture and the environment, since they can help provide water to wet meadows that support fish and wildlife.

Carbon Sequestration

Carbon storage in terrestrial ecosystems is seen by some as an increasingly important means to offset greenhouse gas emissions. In arid and semi-arid sagebrush rangelands of the West, green carbon (i.e. plant carbon) stores are concentrated in mesic[1] and wetland systems that contain ten times the abundance found in surrounding uplands. Water within these sagebrush landscapes plays an important ecological role that supports this carbon storage capacity and influences distribution of wildlife, like sage grouse and water birds. Water in these landscapes also supports and sustains human settlement and rural economies.

IWJV is proposing new science to identify carbon storage benefits associated with IWJV's habitat conservation initiatives. This could allow for "win-win" outcomes for migratory birds and greenhouse gas emission offsets. Work would leverage existing IWJV sage grouse mesic and wetland hydrologic models for the West, in addition to above/below ground carbon storage models developed by partners. Final products would be used to quantify past and future carbon sequestration linked to land protection and restoration outcomes. Demonstrating mutual wildlife and carbon storage benefits has the potential to greatly expand interest in conservation investments. This, in turn, could positively impact migratory bird populations in the long-term.

[1] In ecology, a *mesic* habitat is a type of habitat with a moderate or well-balanced supply of moisture.

Challenges

The true value of intact systems and agricultural lands that support those systems has not been fully recognized. This is a significant detriment to agriculture and conservation. The land fragmentation issue has impacts for water infrastructure and food security. Addressing this problem means protecting land before the fragmentation has started. Unfortunately, this is easier said than done. Right now, federal appraisal services (through Appraisal and Valuation Services Office, NRCS, etc.) require too much time. These delays are compounded when appraisals are so low they fail to incentivize landowners to move forward with conservation easements. That is because the value of the land associated with a prospective easement often does not increase until the development pressure is already there (and the system is unraveling).

This valuation challenge is a constant struggle. Federal agencies have a process that can support efforts to pay higher than fair market value of an appraisal. However, the internal approval processes vary, and there does not seem to be much desire to pursue these options within agencies. Federal funds and resources spent to pursue promising easements on important lands end up being wasted on inefficient and ineffective appraisal processes. As a result, these lands never end up getting protected. Congress could play a role in protecting land by helping to streamline and incentivize these conservation investments.

IWJV continues to build the critical linkages needed to demonstrate opportunities for "win-wins" between the agricultural and conservation communities. The above examples of cutting-edge science being utilized and developed by IWJV can help correlate the value of agricultural lands and practices to conservation outcomes. These outcomes, in turn, can be used to identify and inform the importance of investing in irrigation infrastructure. The end result is multiple benefits for people, wildlife, and local economies.

Improved conservation and drought resilience: National Young Farmers Coalition (Colorado River Basin)

In Wyoming, ranchers Pat and Sharon O'Toole have always managed their land with conservation in mind. Increasingly, new technology plays a role in those efforts. A trailer with mounted solar panels allows the O'Tooles the flexibility to move their alternative energy source across their grazing lands to power up wells and pump stockwater for their roaming herds of cattle and sheep. Supplemental water for fisheries is provided by High Savery Reservoir.

The O'Tooles and other irrigators have also worked with conservation and government agency partners to modify every diversion structure on the Wyoming side of the Little Snake River watershed to allow for fish passage. Several low-head diversion structures employ natural channel design concepts to allow for three warm water sensitive fish species to successfully navigate the diversion structures. Fifteen irrigation diversion structures have been modified at a cost of over $8 million dollars. A decade ago, the aquatic habitat was highly fragmented and access by native fish may have been restricted to only a few miles of river. Today, the irrigation diversion structures have opened up the entire watershed, so that fish can now literally move from the lower basin to the Continental Divide, over a 100 stream miles away.

The Family Farm Alliance report, "*Innovations in Agricultural Stewardship: Stories of Conservation & Drought Resilience in the Arid West*,"[2] focuses on this and four other case studies that profile producers across the Colorado River Basin and beyond who – with curiosity, creativity and seasons of trial and error – are conserving resources while enhancing productivity. The Alliance teamed up with the National Young Farmers Coalition on this report with the aim of elevating the voices of farmers and ranchers who are employing smart solutions to build drought resilience, steward water and grow good food.

Some of the farmers highlighted in the Alliance report are integrating efficient irrigation technology with soil health to increase both productivity and water savings. Others are navigating conservation within constraints outside of their control, such as the operations of the ditches which deliver water to farms. To paint a fuller picture of the complexities and nuances of agricultural water conservation in the West, the Alliance worked with the engineering firm Applegate Group to create a water balance for three of the case studies. These water balances utilize a technical, objective approach to assess the producers' water rights, current conservation efforts, and barriers or opportunities for future conservation. They underscore the reality that conservation practices are different on every operation and unique from farm to farm.

As the pressures of climate variability and drought increase, farmers and ranchers are at the forefront of our national adaptation strategy. Producers are coming together to help one another, but they also need support from consumers, policy makers, scientists, and service providers. The Alliance hopes that these case studies will provide policy makers and other stakeholders with a more nuanced understanding of the diversity and complexity of western agricultural water conservation and an appreciation of what continuing to take agricultural lands out of production might mean.

Technology that improves water delivery and on-farm water conservation: Imperial Irrigation District (CALIFORNIA)

The Imperial Irrigation District (IID) Water Department has been serving the Imperial Valley's water needs for over 110 years. The district provides raw Colorado River water for irrigation and also for non-potable residential and industrial uses to the Imperial Valley. To facilitate its delivery, IID operates more than 230 miles of main canals, 1,438 miles of canals and laterals (of which 1,456 miles are concrete lined or pipelined) and 1,406 miles of drainage ditches in the Imperial Valley. Nearly a third of Imperial Valley's 442,600 acres are dedicated to alfalfa. Another nine crops – including three types of grasses, lettuce, wheat, sugar beets, carrots, broccoli and onions – account for over 50 percent of irrigated acreage within the district. A virtual cornucopia of produce, grains, herbs and nursery stock make up the remaining acreage, as nearly 80 different types of crops are grown by Imperial Valley's farmers.

IID Diversion and Water Delivery Features

IID is entitled to 3.1 million acre-feet each year from the Colorado River. Imperial Dam located north of Yuma, Arizona, serves as a diversion structure for water deliveries throughout southeastern California, Arizona and Mexico. The operations of IID's River Division Office at Imperial Dam, as well as system wide water distribution, all fall under the direction of Reclamation. Water diverted at Imperial Dam for use in the Imperial Valley first passes through one of three desilting basins, used to remove silt and

[2] https://www.youngfarmers.org/wp-content/uploads/2015/05/NYFC-template-FINAL_lowNew.pdf

clarify the water. Each desilting basin is 540 feet wide by 770 feet long and is equipped with 72 scrapers designed to remove 70,000 tons of silt per day. The silt is returned to the river by means of six sludge return pipes that deposit the silt into the California Sluiceway. From the desilting basins, water is then delivered to the Imperial Valley through the All-American Canal.

Three main canals, East Highline, Central Main and Westside Main, receive water from the 80-mile long All-American Canal and distribute water to smaller lateral canals throughout the Imperial Valley. Farmers receive water in private ditches from the lateral canals to irrigate nearly 500,000 acres of farmland within IID's water service boundaries. Another important component of IID's distribution system are the seven regulating reservoirs and four interceptor reservoirs that have a total storage capacity of more than 4,300 acre-feet of water.

IID serves water through approximately 5,600 delivery gates for irrigation purposes. IID also maintains over 1,450 miles of drainage ditches used to collect surface runoff and subsurface drainage from over 32,000 miles of tile drains underlying nearly 500,000 acres of farmland. Most of these drainage ditches ultimately discharge water into either the Alamo River or New River.

Quantification Settlement Agreement for the Colorado River

The 2003 Quantification Settlement Agreement (QSA) for the Colorado River authorized the nation's largest agricultural-to-urban water transfers, which were necessary for California to reduce its Colorado River diversions to within the state's 4.4 million acre-feet entitlement. IID is implementing efficiency-based water conservation programs that improve its water delivery system and provides funding for on-farm conservation measures to create approximately a half million acre-feet a year of conservation. Under the QSA and related Agreements, IID agreed to transfer this conserved water, over 15% of its annual share of Colorado River water, for 45 years to the San Diego County Water Authority, the Coachella Valley Water District and Metropolitan Water District of Southern California.

IID's Systems Conservation Program

New technology plays an important role in IID's systems conservation program. Electronic monitoring and automation of gates and spillways helps to reduce system spills and provide for more accurate deliveries in real-time. The use of laptops and a private broadband network allows ditch riders (zanjeros) mobile access to current readings and gate controls. A centralized command center was developed early in the process to capture and relay data, allowing IID to meet monitoring and reporting requirements. Computerized water order scheduling and billing system through TruePoint allows for centralized data management. IID recently embarked on a program to update its Water Information System (WIS). The new system – called WISKEY – will compile disparate systems of billing, monitoring, and controls.

To date, the IID has committed significant resources to system improvements ($50 million in system capital and millions annually in O&M) over the past 15 years since the implementation of the QSA. Also through an on-farm partnership, the district and farmers are conserving water and securing that water is put to beneficial use in each field. This promotes the use of sprinklers, drip, pump-backs, land leveling, and other methods. The on-farm program encourages significant economic development in the region, with $50 million scheduled for 2019 and $36 million budgeted for 2020. Being that the IID system is a

terminal system, any savings to enable more accurate deliveries and reduce spills allow a larger quantity of water to be available to its users and to meet conservation obligations. These programs enable water security for the region and economic development in a farming sector that is struggling with rising labor costs and foreign competition.

Results

IID generates conserved water to meet the needs of the QSA water transfers by making water efficiency improvements in its delivery system. Conservation targets started at 4,000 acre-feet in 2008 with the goal of capturing and reusing operational discharge. With the completion of the first system conservation project (the Main Canal Seepage Interception project and other system projects), the district conserved nearly 45,000 acre-feet in 2015 through system conservation. IID system conservation measures generated nearly 50,000 acre-feet in 2016, with the goal of reaching 103,000 acre-feet annually in 2026. Collectively, with all its conservation efforts, IID will ultimately conserve about 15 percent of its consumptive use entitlement each year – over 487,000 acre-feet when all conservation measures are at full implementation. IID's system conservation efforts clearly demonstrate that modern technology can be employed to improve the reliability and flexibility of water deliveries and facilitate future on-farm conservation efforts.

Tracking and capturing monsoon runoff for irrigation and groundwater recharge (Elephant Butte Irrigation District - NEW MEXICO)

With less snowpack runoff and a more intense monsoon season, the Elephant Butte Irrigation District (New Mexico's largest irrigation district) has been instrumental in developing a storm weather tracking system that gives water managers time to react to monsoon events that can bring torrential rain events into the Rio Grande Valley. The new system can detect the storm event 20 miles away from the valley, calculate the rain event and determine the storm track before it hits the valley floor. The District then captures it in the Rio Grande River, diverts it into their canal system to irrigate farmland and into a system of drains that allow the storm water to recharge the underground aquifer.

Elephant Butte Irrigation District (EBID) is the New Mexico portion of the Rio Grande Project (RGP) in southern New Mexico and far west Texas, providing for international treaty delivery by the United States to Mexico. This region of the Chihuahuan Desert has great potential for agricultural production dating back to pre-Columbian times, but this productivity has been tempered by periodic severe and sustained droughts. The EBID delivers water to 90,640 acres through an extensive network of miles of canal system. Drought has become one of the greatest water issues facing the West; the District and its members have countered with innovative, creative and conservative practices to deal with this crisis.

The profound drought that the RGP has experienced for much of this century has led to dramatically reduced spring snowmelt runoff from southern Colorado and northern New Mexico. Historically, snowmelt runoff has been the controlled and regulated source of supply for the RGP. For most of the last two decades, snowmelt runoff has been far below the historical average. Local monsoonal rainfall and resulting intense and violent runoff was more of a hazard than a viable water source. Very basic flood control infrastructure in the form of earthen dams and conveyance channels to the Rio Grande, EBID drains and canals was developed from the 1950s to the 1970s with the objective of evacuating

storm water from the watersheds and irrigation system as quickly as possible to avoid structural or property damage from the intense flood waters of the monsoon.

EBID responded to the drought that began in the early 2000s by viewing storm water not as a threat but as a valuable resource. They began placing sensors equipped with telemetry on most of the main arroyo systems in the district to collect rainfall runoff data. One of the challenges of storm water management within the district is that there are at least 20 major watersheds and hundreds of small watersheds within the whole system. However, the U.S. Bureau of Land Management (BLM) owns most of the land where the sensors need to be placed. While EBID has achieved some access and cooperation with the BLM, much more collaboration is needed.

Drought and the prospect of an increasingly arid climate have motivated EBID to rethink the management of storm water. They began to look at storm water flows as a viable source of water. In the absence of resources to build large new flood control infrastructure, EBID has relied on state-of-the-art information infrastructure with strategic improvements to existing facilities that are deficient and degraded to more effectively capture and beneficially use the previously unusable and hazardous monsoonal flows coming into the District below the major Project storage facilities at Elephant Butte and Caballo reservoirs.

Stormwater capture in the district involves high intensity, generally monsoonal events downstream of Caballo Dam. The historical strategy was to evacuate water downstream as quickly as possible. Now the goal is to capture water in flood control dams, agricultural canals and drains. The direct use of storm water allows EBID to better meet downstream demand as well as provide opportunities for infiltration into the aquifer. In 2013-14, several thousand acre-feet were captured in canals, drains and in the bed of the Rio Grande after reservoir releases had ceased for the year. Additional benefits include improved downstream flood protection, enhanced riparian habitat and improved water quality.

Preparation is the key to managing storm water, and EBID's staff track storm formation from satellite imagery while it is still days away, off the Pacific coast, in the Gulf of Mexico, or streaming off the tops of the Sierra Madres in Mexico. As storm systems approach and their structure becomes clearer, Doppler Radar from the National Weather Service's National Mosaic and the EPZ radar station in Sunland Park, New Mexico provide information on the tack of specific weather cells that may produce runoff within a timeframe of several hours. As storms hit the area, it is critical to know how intense a precipitation event will be so that the appropriate action can be taken. Decisions on where to capture storm water and where to avoid it must be based on reliable information. While Doppler radar gives a general idea of storm intensity, actual rainfall hitting the ground is the key process, indicating runoff events with lead times of two hours to several minutes. Using telemetry data gathered remotely out in the field, EBID quickly analyzes where a storm is likely to hit, where it actually does, and then how much storm water is generated and fed into the system. With enough rain gauges in place, the data generated can greatly increase public safety in the event of a major storm event.

EBID is developing a network of rainfall gauges in the upper reaches of the key watersheds that drain into the Rio Grande, often through EBID facilities. These gauges continuously report data through a radio telemetry system that includes alarms sent to key personnel cellphones when precipitation events

occur. The district is working to get a rain gauge in each one of the contributing watersheds. The continued expansion of the data coverage area will provide a more complete picture, resulting in better water resource management. Further collaboration and support from the BLM is critical.

The knowledge of where precipitation is falling and at what intensity allows EBID personnel to fine-tune their response and capture the runoff where it is feasible and safe. The district has developed a compact rainfall gauge with radio telemetry that can be backpacked into critical watersheds in wilderness areas and national monuments where motorized vehicles are prohibited.

As rainfall runoff collects and concentrates in arroyos, both the opportunity and danger of capturing storm water become clear. EBID refines its response as instrumented gauges in major arroyos report flow rates in real time through the district's radio telemetry system. Very large events may require avoidance at the local level, but may be captured once they flow down the river and peak flow rates are attenuated. Smaller events can be captured directly and managed within EBID's conveyance and drainage system. EBID has modified drains, originally designed for the low flows associated with water table control to allow impoundment and regulation of significant arroyo flows. As arroyo flows reach the Rio Grande, focus switches to EBID's river gauging stations. EBID maintains six river gauges that are used by the district and other local agencies to monitor the status of reservoir releases as well as floodwater in the main stem of the river.

Diversions are done primarily at Leasburg and Mesilla Dams. Timing of the diversions is critical because the leading edge of a storm surge can have very high debris content. It is key to let the first surge of debris pass by before capturing for farm use or aquifer recharge. Captured storm water could potentially be several hundred acre-feet or more per event.

While EBID's primary goal in storm water capture is to either use the water directly for irrigation or infiltrate it as aquifer recharge, the district's efforts have many benefits. First, the storm water capture helps ensure the safety of persons and property downstream. Second, storm water capture sites such as Selden Drain provide riparian habitat for many bird and wildlife species. Finally, detention allows die-off time for potentially harmful microorganisms associated with storm water runoff, improving water quality. This multi-benefit approach has been truly a bright spot in an otherwise bleak drought.

How the Federal Government Can Help

The Congress and the federal government certainly cannot change the hydrology of the West, but there is a role it can play to support family farmers and ranchers. Planning for water shortage in the West must look to the long-term in meeting the needs of agriculture, energy, cities, and the environment. A successful water shortage strategy must include a "portfolio" of water supply enhancements and improvements, such as water reuse, recycling, conservation, water- sensitive land use planning, and water system improvements. New infrastructure and technologies can help stretch water for all uses and boost the economies of Western rural communities.

We offer the following observation and recommendations for the Subcommittee to consider as it further engages on water management innovation and technology matters. We urge Congress to:

1. Give high priority to authorizing and providing sufficient resources to maintain, restore, modernize, and upgrade federal water, weather and climate observation and research programs, with a primary focus on improving coordinated data collection and dissemination.

2. Include Irrigation Modernization and support for agricultural infrastructure in Congressionally authorized infrastructure packages.

3. Support robust and reliable funding for the Environmental Quality Incentives Program (EQIP), the Regional Conservation Partnership Program (RCPP), and the Watershed Protection and Flood Prevention program (P.L. 566). These programs help drive many of the success stories described in this testimony.

4. Encourage agricultural producers to work together with each other and with many applicable Federal and State agencies in a strategic, coordinated fashion. Compel all federal agencies to collaborate in a partnership-based manner with the farmers, ranchers and water managers who are tied to federal watersheds. Source water protection entails partnership-based, landscape-scale restoration of our forests and watersheds in the Western US – and ultimately requires a shift in the policies and mechanisms that the federal government uses to budget and implement treatments and incentivize industry to get the work done.

5. Support incentive funding for land and water management activities on lands to provide flyway habitat benefits in support of activities like those in the Central Valley of California and the Intermountain West Joint Venture, especially multi-benefit flood control and/or water conservation projects.

6. Promote the coordination of regulatory agency permitting to improve the timing and cost of permitting habitat and water conservation projects.

7. Look for opportunities to improve the federal regulatory process by streamlining regulations, improving coordination, reducing duplication, and increasing transparency. Many of our members continue to face challenges with trying to figure out ways to work through and around the different agency processes associated with appraisals, NEPA compliance and other requirements. There are daunting bottlenecks and inefficiencies that occur when funds are coming from multiple federal agencies and are attached to differing mechanisms and approval processes. Clarity on rule development and better coordinated federal permitting processes would reduce permitting timelines and save taxpayer dollars without compromising environmental protections.

8. Expand Reclamation's Water SMART grants program to include a larger (up to $20 million) competitive 50-50 cost-shared grant for small water supply management projects integrated into a regional watershed plan – this could help fund larger water conveyance, storage and conservation infrastructure than currently supported.

9. Find ways to improve coordination of WaterSMART and other water management programs at

Reclamation with existing conservation programs at the USDA's NRCS. This would lead to more effective federal investments in on- and off-farm water management improvements.

10. Support and authorize adequate resources that would allow the USDA-ARS to continue to perform a critical role of translating ASO data into estimates of water supply and runoff in the Western U.S. Current estimates for this program need at USDA-ARS are approximately $2.2 million in additional funding annually for the next 10 years. Support federal funding, support, and cooperation for Reclamation to oversee the continued operation in California and the expansion of ASO technology application throughout the West. The federal sponsorship for additional ASO surveys should focus first on federal irrigation or flood control projects, as prioritized by Reclamation and the U.S. Army Corps of Engineers.

11. Direct Reclamation to make maximum use of existing financing tools for project beneficiaries, including direct loans for extraordinary and emergency maintenance at Reclamation projects, such as those authorized by the Aging Infrastructure title of P.L. 111-11. Efforts must continue to compel Reclamation and the Office of Management and Budget to implement this program, which has been authorized by Congress, and to investigate opportunities to develop similar loan programs that can also help fund new water storage infrastructure projects.

12. Create at Reclamation an affordable loan program, similar to the Water Infrastructure Finance and Innovation Act (WIFIA) included in the WRRDA 2014. New tools like this will be needed to assist in financing major improvements to aging water infrastructure in the coming years. This can help ensure that farmers and ranchers who benefit from these upgrades can afford repayment terms.

13. Direct the DOE to research, develop and demonstrate the value of irrigation modernization, specifically focused on developing new technologies, optimizing and integrating energy resources sited in irrigation districts, better understanding the nexus of water and energy security, and how the agency can utilize their resources to accelerate the pace and scale of irrigation modernization.

Conclusion

In the West, given the many challenges facing the future viability of the West's water supplies, water managers now must manage water as if every year is a drought year. In order for irrigated agriculture to exist into the future, we need to look to innovative technology to enhance management of water supplies and delivery and we must maximize the benefits from the water we have available to meet multiple needs. It is surprisingly easy to use innovation and technology in water management to improve both food production and fish and wildlife habitat.

It is our hope that this testimony delivers the clear message that water managers, ranchers and farmers are technologically-savvy, innovative, resourceful and creative individuals. These innovators should be actively solicited by federal water policy makers to participate in resolving the water conflicts of the West. Irrigators and their local water agencies have responded to the recent Western droughts with determination, resourcefulness and innovation. They also are bringing those attributes to bear in planning for a future where "drought" may be a long-term or even permanent condition. Some of these

actions are intended to address the immediate crisis; others have been implemented as part of the broad portfolio of actions that successful farmers are employing to stay profitable in today's fierce economic and regulatory climate.

If federal agencies are willing to take lessons from how farmers and ranchers are coping with these water resource challenges, the result would likely be better management of water for both economic purposes and environmental uses. We hope the examples highlighted in this testimony will provide your Committee with a more nuanced understanding of the diversity and complexity of western agricultural water management, and the prominent role that technology and innovation will play in finding solutions for the future of the West.

Senator MCSALLY. Great. Thank you.
Ms. Sewald.

STATEMENT OF MARY BETH SEWALD, PRESIDENT AND CEO, LAS VEGAS METRO CHAMBER OF COMMERCE

Ms. SEWALD. Thank you so much. My name is——
Senator MCSALLY. Can you turn your microphone on?
Ms. SEWALD. Oh, sorry.

Thank you very much. My name is Mary Beth Sewald. I'm the President and CEO of the Las Vegas Chamber of Commerce.

Thank you, Chairman McSally. Thank you for your service. Also a special thank you to Ranking Member, Nevada's own, Senator Cortez Masto, for inviting me before the Subcommittee today. I very much appreciate this opportunity.

It is an honor to speak to you on the critically important issue of water and how the Southern Nevada business community, especially through technology and innovation, is playing an invaluable role in ensuring long-term access to water in the West. The Las Vegas Chamber is the largest business association, and the Chamber's mission is to promote a strong and diversified economy that will attract new business enabling existing businesses to expand and support a good quality of life. And that is why the Las Vegas Chamber is so engaged in water management and conservation throughout our entire region.

The Las Vegas Metropolitan area is the second fastest growing city in the nation with the best job growth index. Our population is more than 2 million residents and we welcome more than 42 million visitors annually. Since 2011, the Las Vegas Valley has added 10,000 new businesses and over 180,000 new jobs.

Sustaining this growth and vibrant economy requires our relentless management of water resources. That's why the Chamber has been such an active partner in water issues for decades. Water security is essential for any city. It is something that cities in the West focus upon every single day. We certainly do in Southern Nevada because the Colorado River is our lifeblood. Though Las Vegas receives only 2 percent of the river's total supply, the Colorado River allocation makes up 90 percent of Las Vegas' water supply.

Southern Nevada has experienced drought conditions frequently for more than 20 years, the longest of which began in 2011 and lasted more than 5 years and, at times, reached D4 emergency conditions. Because of ongoing drought conditions, Lake Mead, the reservoir where Nevada gets its Colorado River allocation, has been reduced to 40 percent with water levels having fallen more than 140 feet at Lake Mead since the onset of drought conditions.

As a community, we've come to operate as though drought is our new normal. The new normal equates to extreme steps to conserve. Through these challenges, Southern Nevada has become a global leader in conservation. Even as our population has grown, we have found ways to reduce that water usage and make the most of this precious resource.

We have established strict codes on new homes and commercial buildings, removed unnecessary turf, implemented public awareness campaigns and we strongly encourage everyone to incorporate good water management into their daily lives. And we've been ag-

gressive in experimenting with brand new innovations as well. As a result, in Southern Nevada 99 percent of all indoor water use that reaches the sanitary sewer is captured, treated and reused.

I want to highlight just a few of the very significant ways the business community has been a leader in conservation.

Southern Nevada Water Authority's Water Smart Landscapes programs have yielded remarkable water savings by removing 189 million square feet of grass and conserving over 130 billion gallons of water since the program began in 1999.

The Water Efficient Technologies, or WET, program offers financial incentives to commercial and multi-family property owners to install water efficient devices. In 2019 alone, WET projects have resulted in water savings of nearly 50 million gallons annually.

Also, the Southern Nevada Water Authority and the Southern Nevada Home Builders Association developed a Water Smart home program. This pilot project requires home builders to include water-smart landscaping, water-efficient appliances and meet other requirements to reduce water usage. Water Smart homes use approximately 49 percent less water than homes built between 1990 and 2003.

And finally, the WaterStart program that identifies real challenges facing water agencies and accelerates adoption of private sector innovation. WaterStart has evaluated 278 prototypes and funded 22 pilot projects that have saved end users millions of dollars.

What we've demonstrated in Las Vegas is that private business can be strategic partners in water conservation. In Clark County we have secured our water stability for the next 50 years. Now we look to the future. How can we work together to ensure water delivery for the next 100 years, what new technologies will become available to help tackle those water challenges, and what investments will be needed from the Federal Government either in policy or infrastructure? The Las Vegas Chamber stands ready to collaborate and to serve even more.

I want to thank Chairman McSally and Ranking Member Cortez Masto, both of you, for your leadership on this important issue and for the honor and opportunity to provide this testimony today.

Thank you.

[The prepared statement of Ms. Sewald follows:]

Testimony of Mary Beth Sewald
President and CEO, Las Vegas Metro Chamber of Commerce
Prepared for the Senate Committee on Energy and Natural Resources, Subcommittee on Water and Power

Hearing on the use of technology and innovation to increase water security and enable economic development in the West.
October 30, 2019

I'm Mary Beth Sewald, president and CEO of the Las Vegas Metro Chamber of Commerce. Thank you, Chairman McSally and a special thank you to the Ranking Member, Nevada's own, Senator Cortez Masto, for inviting me before the subcommittee today. I also want to thank Chairman Murkowsi and Ranking Member Manchin of the full committee for having me here.

It is an honor to speak to you on the critically important issue of water and how the Southern Nevada business community, especially through technology and innovation, is playing an invaluable role in ensuring long-term access to water in the West.

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The Las Vegas Chamber is the largest business association in Nevada. The Chamber's mission is to promote a strong and diversified economy that will attract new businesses, enable existing businesses to expand, and support a good quality of life. That's why the Las Vegas Chamber is very engaged in water management and conservation in our region.

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Because of ongoing drought conditions, Lake Mead, the reservoir where Nevada get its Colorado River allocation, has been reduced to 40 percent with water levels having fallen more than 140 feet at Lake Mead since the onset of drought conditions.

As a community, we've come to operate as though drought is our new normal. That new normal equates to extreme steps to conserve. Through these challenges, Southern Nevada has become a global leader in conservation. Even as our population has grown, we have found ways to reduce water usage and make the most of this precious resource. We have established strict codes on new homes and

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Now – we look to the future. How can we work together to ensure water delivery for the next 100 years? What new technologies will become available to help tackle water challenges? And what investments will be needed from the federal government, either in policy or infrastructure? The Las Vegas Chamber stands ready to collaborate and serve even more.

I want to thank Chairman McSally and Ranking Member Cortez Masto for your leadership on this important issue and for the honor and opportunity to provide testimony today before this Subcommittee. I look forward to the Las Vegas Chamber partnering with this committee on future water policy innovation initiatives.

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Senator MCSALLY. Thank you.
Mr. Harper.

STATEMENT OF STEPHEN HARPER, GLOBAL DIRECTOR OF ENVIRONMENT, ENERGY AND SUSTAINABILITY POLICY, INTEL CORPORATION

Mr. HARPER. I will add my thanks to both the Chairwoman and the Ranking Member for this invitation to speak on an important topic. I'm Steve Harper. I direct Intel's global energy environment and sustainability policy activities.

Manufacturing semiconductors is a very water intensive business and thus we place at Intel a very high priority on the security of our water supplies everywhere we operate. We operate internationally, including a major presence in Israel, but of interest to members of the Subcommittee, we have major manufacturing in Arizona, Oregon, New Mexico and also facilities in Colorado.

Unlike many high-tech companies, Intel makes its own products. A majority of Intel's manufacturing and research and development happens here in the United States supporting a total of over 50,000 well-paid employees. And if you count contractors in our supply chain, the total number of jobs supported by Intel's presence in the U.S. is over half a million.

One consequence of our large manufacturing footprint is that, for us, water security is a direct operational priority, not a supply chain issue. Semiconductor manufacturing is perhaps the most complex manufacturing or industrial process there is. While each of our different products has its own set of features, for our most up-to-date CPU chips, we pack over seven billion transistors onto a piece of silicon half the size of your thumbnail.

The manufacturing process that produces that level of compaction and complexity involves using significant amounts of both water and what we call, ultra-pure water. Intel's Arizona facilities employ over 10,000 employees on two campuses. We are in the process currently of investing over $7 billion in adding additional capacity on one of those campuses and building what will be the most advanced semiconductor manufacturing facility in the world.

Water also plays a very important role in our relationship with our communities, both in arid places like New Mexico and Arizona, as well as water rich areas like Portland, Oregon. We've been investing in water conservation projects for years and over the last two decades have saved close to 64 billion gallons of water.

Despite these efforts, our dependence and our need for water is growing, along with the growth of our business and the complexity of our products. This has led us to ask ourselves what more can we and should we be doing, particularly in our operation, in our community relationships? Our onsite water management allows us to return or conserve about 80 percent of the water we initially draw, and we've taken many steps and made a lot of investments to get to that 80 percent figure.

But that leaves us with a 20 percent gap in our water balance, water that is consumed within our operations. To address that gap, in 2017, we announced a new global commitment to restore 100 percent of the water we use by 2025. This means that for every gallon of fresh water we use, we will restore a gallon to our water-

sheds and our communities either through our own operations or collaboration in the community.

To achieve this goal we are collaborating, as I said, with many community groups in areas, particularly in Oregon and Arizona, working with non-profits and conservation groups. To date, we have funded numerous projects in collaboration with non-profits to achieve this 100 percent goal.

My written testimony talks a little bit about some of the examples, but I'd be glad to go into more detail in the Q and A.

Once completed, these projects will restore close to half a billion gallons of water to the environment each year. Our project partners vary by site, but include the Nature Conservancy, National Forest Foundation, Trout Unlimited and the Arizona Land and Water Trust.

Finally, I would like to move beyond Intel's operations and focus on how our technology, and information technology in general, can be employed to advance water security and economic development.

I was in Denver last week at a workshop that we helped fund and there'll be a report coming out. This was organized by the Environmental Law Institute and Water Foundry to take a look at how artificial intelligence, blockchain, sensor networks and other applications of IT can be used to significantly improve water management and the focus was specifically on the Colorado River Basin.

My written testimony goes into more detail, but basically we're talking big data. We're talking sensor networks. We're talking precision agriculture. Technology that exists today.

In closing, Intel applauds the Subcommittee for examining the importance of water security to companies like Intel, as well as the link between water security and economic development. We urge the Subcommittee to further examine the use of IT technology and applications in the service of improving water management, particularly in the arid regions like the Colorado River Basin.

Through funding basic research, government procurement of smart water technologies, outreach and technical assistance to small- and medium-sized agricultural operations, the Federal Government can do a great deal to advance progress in water management.

Thank you.

[The prepared statement of Mr. Harper follows:]

TESTIMONY OF STEPHEN HARPER, INTEL CORPORATION
BEFORE THE WATER AND POWER SUBCOMMITTEE,
SENATE ENERGY AND NATURAL RESOURCES COMMITTEE
October 30, 2019

Thank you, Chairwoman McSally and the subcommittee, for the opportunity to testify before you on the important topic of water security and economic development. My name is Stephen Harper and I serve as Global Director of Environment, Energy and Sustainability Policy for the Intel Corporation. Manufacturing semiconductors is a water-intensive business and thus Intel places great emphasis on the security of our water supplies everywhere we operate. Intel operates in many locations globally, but of particular interest to the members of this subcommittee, we have major US manufacturing operations in Arizona, Oregon and New Mexico, as well as a facility in Colorado.

Intel is a well-known brand and company, of course, but there are key aspects of our identity that are not widely appreciated. In contrast to many other high-tech companies, which design and market their products but outsource and off-shore their manufacturing, Intel makes its own products. A majority of Intel's manufacturing and research & development occurs in the US, supporting a total of over 50,000 well-paid workers. Counting our own employees and our supplier and partner network, Intel supports over 500,000 jobs throughout the US. One consequence of this large manufacturing footprint is that, for Intel, the security of our water supplies is a direct operational priority, not just a supply chain challenge.

Some of the water used in semiconductor manufacturing is devoted to the same operations, mainly cooling, that typify many industrial operations. More uniquely, semiconductor fabs use large quantities of ultra-pure water (UPW) in various cleaning and rinsing steps as a silicon wafer goes through the many steps it takes to etch the multi-layered circuits that create and connect a chip's transistors. UPW is free of organic and inorganic contaminants and can be used to rinse wafers to remove the residue created by chemical-mechanical polishing processes.

Semiconductor manufacturing is perhaps the world's most technically complex industrial process. While each distinct Intel product has its own features, the i9 CPU chip can contain over 7 billion transistors. The manufacturing process that produces that level of compaction and complexity involves using significant quantities of both water and UPW. And recent advances have involved adding multiple layers of circuitry to our chips, increasing our water usage as each layer requires applying more water in an iterative process.

Intel's operations in Chandler, Arizona are a key part of our global presence. Employing 10,400 workers across two campuses, Intel's Arizona operations manufacture the microprocessors that power data centers, PCs and hundreds of millions of smart and connected devices worldwide. We are in the process of investing more than $7 billion

to complete our latest Fab 42, which is expected to be one of the most advanced semiconductor factories in the world.

Water is an important ingredient not just in Intel's manufacturing process, it also plays a large part in our relationship with local communities. As a company, we've been investing in water conservation projects and setting ambitious water conservation goals for close to two decades, saving close to 64 billion gallons of water since we started tracking our progress in 1998. Last year, we conserved close to one billion gallons of water in Arizona – and we've returned more than 5 billion gallons of water from our manufacturing operations to replenish Arizona's water supply since the mid-1990s.

Although we continue to invest millions of dollars each year to conserve water and increase our water use efficiency – including in Arizona – our water needs are growing along with company growth and manufacturing complexity. This led us to ask – what else should we be doing? The answer was to look at the bigger picture – beyond our own operations – and examine Intel's role in the watersheds where we operate.

Our onsite water management practices allow us to return approximately 80% of the water we use back to our communities – to be reused or to recharge groundwater supplies. In Arizona, a big component of our effort to reclaim and recharge water to the local aquifer is the Ocotillo Brine Reduction Facility (OBRF). The OBRF is a reverse-osmosis (RO) treat operation that processes 1.5 million gallons daily of water that can be used to recharge the aquifer or for reuse elsewhere in the community. Built by Intel, the OBRF is owned and operated by the City of Chandler, with O&M funding coming from Intel. Since its inception, more than 5.1 billion gallons have been recharged into the local aquifer, enough to support 35,000 households for a year. We are also building a facility at our newest Arizona factory that, once operational, will be able to process and treat approximately millions of gallons of wastewater each day for additional reuse on site.

These on-site actions leave us with a 20% gap in our water balance – water that is consumed within our operations, primarily through evaporation in our cooling towers or taken up by plants in landscaping. To address this gap, in 2017 we announced a new global commitment to restore 100% of the water we use by 2025. This means that for every gallon of freshwater we use, we will restore a gallon to our watersheds or communities, through existing water management practices and water conservation investments in our operations as well as supporting local water restoration projects.

To achieve this ambitious goal, we are engaging local community, nonprofit and conservation organizations to identify and fund projects that aim to address local water issues and support the well-being of communities and the environment. To date, Intel has funded seven projects in collaboration with nonprofits to support Arizona watersheds. Once completed, these projects will restore close to half a billion gallons of

water to the environment each year, for around 10 years or more. Our project partners vary by site, but include The Nature Conservancy, National Forest Foundation, Trout Unlimited, and the Arizona Land and Water Trust.

The restoration benefit of each project is quantified by a third party, LimnoTech, and is detailed each year in an annual report published to our www.intel.com/water webpage. To guide us through this process, we relied on support from the Bonneville Environmental Foundation. Their engagement and guidance have been instrumental in our success.

By partnering with these organizations, we hope to support the environment, wildlife, and people who rely on this critical natural resource. We are the first technology company to commit to a goal and initiative of this scale, and we are proud of our long-standing commitment to the environment. While we will remain focused on managing our water use efficiently, we know that broadening our focus beyond our own operations will help us have a greater sustainable impact on the environment. Our hope is that others in the technology industry – or any industry – will join us on this journey. We believe that we all have a responsibility to address the global water challenges that confront us.

Getting back to the subject of this hearing…water security and economic development, water availability is important at our other facilities as well, including in Oregon, even though the Portland metro area tends to be as wet as Phoenix is arid. Intel employs approximately 20,000 in Oregon and we have invested over $40 billion in our operations there over the last 44 years. Following our example in Arizona, we have announced a goal to restore 100% of our global water use by 2025 through internal actions and collaborative community-based projects. Within our own operations we are building a water recycling facility at our Ronler Acres campus to support our manufacturing operations.

Finally, I would like to move beyond how we manage our own operations to ensure security of supply and how we collaborate with our communities and local conservation groups. I would like to close by pivoting to a focus on how our technology, and information technology (IT) generally, can be employed to advance water security and economic development. In a coincidence of timing, that topic was the focus of a workshop co-convened by the Environmental Law Institute (ELI) and Water Foundry last week in Denver. Titled "Digital Technology Opportunities for the Colorado River Basin," this workshop and a preliminary discussion paper were funded by Intel, Microsoft and Blue AB.

The report and workshop identified specific examples of how Artificial Intelligence (AI), Blockchain, sensor networks, and other applications of IT can significantly improve water management, security and resiliency in the increasingly water-stressed Colorado River Basin (CRB). AI systems can be used to improve water basin modeling and forecasting, for example. Blockchain could be used to enable peer-to-peer water

trading, which could materially improve the efficiency of water management in large basins. The availability of more accurate and cheaper sensors could enable dramatic improvements in the real-time monitoring and management of hydrologic systems like the Colorado River Basin. Employed at the tap, sensors could improve the tracking and metering of water use by customers and eventually real-time water quality monitoring. Beyond simply pointing out the potential of these technologies, the report cites current examples or use cases. Employed in various combinations, these technologies begin to comprise what experts are calling the Internet of Water and can help us maintain economic development, business growth and ecosystem health. The deployment of digital water technologies will benefit the state economies of the Colorado River Basin.

IT can also be brought to improve water quality as well as quantity. Exemplary work is being done in that realm by organizations applying remote sensing to analyzing the impact of land uses upon water quality. In the Chesapeake Bay, for example, the Chesapeake Conservancy is combining high-resolution satellite imagery, sophisticated geographic information systems (GIS), and cloud computing to precisely map where water flows off land parcels into the Bay. This enables them to partner with landowners to precisely locate where buffers and other water quality best practices should be located to have maximum impact at minimum cost. Such "precision conservation" technology combined with increasingly available low-cost water sensors hold the promise of making it possible to design point/non-point water quality effluent trading programs, greatly reducing the cost of cleaning up estuaries and other extensive water resources. In another innovative application of IT, the Freshwater Trust in Oregon uses sophisticated stream temperature sensors to enable development of so-called "temperature trading." Such programs employ verified stream temperature reductions created by stream-side tree planting to render unnecessary much more expensive installment of water effluent cooling infrastructure at upstream industrial plants.

Finally, in an application that serves the objectives of both water quality improvement and water quantity conservation, there is burgeoning realm of "precision agriculture." Remote sensing (from satellites, planes and drones) combined with in-field sensors can, for example, help farmers more accurately monitor soil moisture conditions and crop health, enabling the application of the minimum amount of irrigation needed at just the right time to promote maximum crop yields. Similar approaches can be applied to fertilizer and pesticide management. Reduced irrigation carrying reduced amounts of fertilizer and pesticide translate directly into improved conditions in receiving water bodies.

In closing, Intel applauds the Subcommittee for examining the importance of water security to companies like Intel as well as the link of water security to economic development. We urge the Subcommittee to further examine the role of IT applications in the service of improving both the security and quality of water supply, especially in arid regions like the Colorado River Basin. Through funding basic research, procurement and other means, the Federal government can help advance the pace of progress in this field.

Senator MCSALLY. Wonderful, thanks. We will kick off questions, and I will start.

Mr. Harper, thanks for mentioning the workshop last week. I wanted to ask you about that. We are very interested as we have passed the Drought Contingency Plan, now the implementation and where innovation and technology can continue to help the Colorado River Basin states for our future water needs. Is there anything you could share about the status of that effort in a little more detail and anything promising that has come from the discussion so far and what can we do to help?

Mr. HARPER. Well, it's early days and I don't want to over promise, but as somebody who really dislikes going to conferences and workshops that lead to no follow-up, this was actually a very pleasant surprise. And we designed it to be productive.

What came out of it is an agreement to break into three discreet teams which have got the task now of developing specific plans for three types of projects. One is the use of data to enable and improve the financing of smart water technology investments in places like the Colorado Basin. The second is the use of data to facilitate water trading and water leasing in arid regions. And the third, which is the team that I'm part of, is to bring together in one or two locations in specific watersheds teams of people, communities, community groups, farmers, the water district operators and other stakeholders to agree on what data they need collectively to manage the local resource and then to work to develop that database and management tools to use the data to collaboratively manage the resource. And while doing that, develop a game that would allow gamification of water resource management training in other locations. So you get people to, essentially, play the role of the different stakeholders in the management process and use the game to, essentially, in each area it's applied, come to agreement on what data and what systems are needed in each watershed.

So, you know, we'll see where that, where each of those three projects comes out, but that's the direction we're headed.

Senator MCSALLY. Great.

Going back to the research discussion, do you have academic experts that are involved in that conversation? And what about any sort of collaborations, say, with Israel on what they might be able to offer for those efforts so we are not reinventing the——

Mr. HARPER. The answer to the first question is yes. We have a number, given the location it was, primarily folks from places like Colorado State University. But as we move into the lower watershed, particularly, I think, we've worked with ASU. We collaborate with Israel to a great extent where I think we're the largest private employer in Israel and have a long record of collaborating with the Israeli government in innovating water resource innovations there. So the answer is yes to both questions.

Senator MCSALLY. Great. Thanks.

Dr. Sabo, you talked about the importance of research. Again, when it comes to the Drought Contingency Plan, do you see areas of research that focus on innovation that could help with the future of the Colorado River?

Dr. SABO. Thanks for the question, Senator McSally.

Yes, I do. I think, you know, going back to Stephen's comments about big data and sensing, I think knowing where losses are happening is a really important part of the puzzle. And I think Israel is strong in that in the tech realm.

But I think putting a positive spin on that and knowing where you can put resources and managing and evaluating how well that strategy is working, especially in recharge situations is a huge technology we need that probably starts in space with remote sensing and goes all the way to the data technologies that Stephen was talking about. And so, those are two areas that I would say are ripe for the picking in that realm, and that we're good at in Arizona as well.

And then, I think the second is reuse technologies, targeted reuse technologies. Reuse is still cheaper than desal. It's going to be for a while. And understanding the context and the contaminants that need to be removed in certain situations and designing membranes to work for that activity, I think, is still a pretty active area of research. And that's something that could crosscut agencies.

Senator MCSALLY. When it comes to research opportunities, where do you see the gaps right now and what is the federal role through what agencies?

Dr. SABO. That's another good question.

I think, and I'll point you to my written testimony, I've got three, sort of, general areas. One is, I'm going to get my notes out. One is advanced manufacturing. So, I think, having a manufacturing research effort focused on water is key. And it's not just——

Senator MCSALLY. And that is not existing right now?

Dr. SABO. No.

And it's not just how do we do it better? It's how do we create better products that lead to higher resilience and better water management so it's actually, like I said earlier, in the business of water security.

Senator MCSALLY. Okay, I am running out of time. We can come back to the rest of them.

Dr. SABO. Okay.

Senator MCSALLY. But over to Senator Cortez Masto.

Senator CORTEZ MASTO. Thank you, and let me continue on that vein.

First of all, I think from all of us in the West, we wake up always thinking about water, water, water. You don't necessarily always see that on the East Coast because there is so much water, right?

And so, this idea of now everything we do from our economic development to the building to our management of this water infrastructure is key, particularly in Nevada which I call an innovation state. We are moving forward in renewable energies and tech manufacturing and we want to embrace this new technology, but coming with that, obviously, is water usage.

There has been a theme here that I am interested in exploring a little bit more, data collection, not enough of it, and this idea that the data is going to be helpful for us initially to determine, really, how we manage our water infrastructure and the needs. But I am curious, as we identify and we have talked about it in different fac-

tions, the data that is needed. It is true, each location is going to be a little bit different on what that data tells us. Is that correct?

Ms. Hoffmann, because you talked a little bit about it. I like the idea of the holistic approach, but I think it is one thing to say and it is another to get everybody in the room together to start focusing on it and bringing everybody together. How do we do that? Because I think the data is important. It is going to be unique to each geographic location, but, how do we get people to start thinking that way and bringing them together? What can we do?

Ms. HOFFMANN. Thank you, Senator, for your question.

I absolutely agree with you. I think that data collection, a lot of times we'll collect basin-wide data or we have these huge gaps in data. So I think, investing in data collection about groundwater tables, water conservation efforts and things like that will be really helpful.

But I would love to see every single irrigation district or water delivery system in the Western United States know what their system is, how much water they're losing, where the opportunities are because then we can start to layer in the technologies that will best serve that particular district and we can start to sort through the regulatory pathway and the financing pathway to actually make that dream a reality. And it also gets us out of this contentious and sometimes, frequently, litigious conversation about what people think is possible from what would happen if you modernized the system.

And when we go in, we bring, you know, we spend about $250,000 per district that we work with to invest in data collection alone. We find that to be such a key piece because then we can actually have conversations, real conversations, with people who, frankly, should be strategic partners and not adversaries, to say here's what would happen if we did this together. And so, we've found that to be such a game changer in the conversation. Those strategic partners understand what the impacts are of modernizing that system. And we've seen everybody from the Sierra Club to the League of Women Voters to, you know, working hand in hand with the Deschutes Basin Board of Control in the Deschutes Basin in Oregon to modernize the irrigation systems because they understand that that's the single best victory that they could get from an environmental perspective. It's completely changed the conversation in that basin.

And so, I think that data is such a critical part of having a ground-truthing and having a real conversation about the art of the possible.

Senator CORTEZ MASTO. Thank you.

Mr. Harper, you talked about the three goals that from the, I think, it was a conference that was held. Is that the goal as well to identify and bring the stakeholders together to start talking about who those stakeholders should be in the room and how they start collecting the data that's necessary for their geographic locations?

Mr. HARPER. Absolutely. And it's not just collecting the data. It's, you know, data needs to be turned into information.

Senator CORTEZ MASTO. Correct.

Mr. HARPER. And it has to be information that is presented in a way that allows people to make informed decisions about the resource management questions they face.

And so, that's why one of the projects that we're looking at coming out of the workshop is starting in one or two specific watersheds within the Colorado Basin, pull all of the stakeholders together, talk about what data they need, what data already exists, what form they need the data presented in, identify, you know, on a big Venn diagram what's the overall system look like, what are the pieces that each stakeholder needs—whether it's an information display design, whether it's a dashboard or some other kind of approach that presents the data in a way—that is intuitive to each stakeholder group?

And then I want to say one more thing. I think we think, and this has been tried on the Chesapeake, the University of Virginia did something called the Bay Game where they created a board game where stakeholders that have interest in improving the health of the Chesapeake Bay could play different roles. So a local community group could play a farm organization. A farm organization could play the part of the state water quality official. And by trading roles and learning, okay, what makes the other person, why does the other person view the world the way they do? And that also can be used to identify what are the total Venn diagram of data that are needed for that particular resource management challenge.

So, that's something that, I think, is worth trying. And we're going to try to do that and see whether it's applicable and generalizable to other watersheds.

Senator CORTEZ MASTO. Thank you.

Madam Chair, I know my time is up. Can I just ask Mary Beth Sewald a follow-up question from the business community perspective? Do you see a role, I mean, in what we are talking about here and how the business community can come to the table as well?

Ms. SEWALD. Absolutely. Thank you for the question, Senator Cortez Masto.

The business community in Southern Nevada is extremely engaged at every level from federal, state, local. We've also hosted and co-hosted national and international panels and events with Israel as well. And there are a lot of technologies in Southern Nevada that have been implemented.

There are three main companies there that are working on technologies. The board game isn't one that we've tried yet, but I think that's a great idea. So absolutely, from ground zero the Las Vegas Chamber and the entire business community is extremely involved in this technology and innovation.

Senator CORTEZ MASTO. Thank you.

Senator MCSALLY. That board game is interesting. It is wherever you stand, depends upon where you sit. Maybe we should do that up here?

Senator CORTEZ MASTO. Here in Congress we need that.

[Laughter.]

Senator MCSALLY. That would be dangerous.

But anyway, okay, I digress.

Mr. Lang, thanks for coming all the way from Israel to participate in this discussion. One of the reasons we wanted your expertise here is to be able to discuss where we could better collaborate and learn from each other, learn from Israel and not just in the area of technologies but best practices. Some things may apply, some things may not. You guys have shown more centralized management, which is great. That is not going to apply in a lot of other areas.

But what else can be done for additional collaboration moving forward? And is there anything this Committee can do to help in that collaboration between Israel and the United States?

Mr. LANG. Well, there's a long and good history between Israel and the United States, it being the first country that ever signed the free trade agreement with the U.S. And most of the activity of Israeli companies overseas is firstly in the U.S. The U.S. market is the first market they look to.

But sometimes when we talk about the level state here and we talk about public tenders, I think that the Buy American Act is, kind of, restrictive for the Israeli companies trying to move forward in order to introduce their technology.

Maybe you should consider something like a clear message regarding the states that say competition should be equal, especially with a trade partner such as Israel which is—and taking into account that at the end of the day no Israeli company is working alone here. It always with a local partner and usually the next step is operating an activity in the U.S. We have a lot of cases like this. So maybe a clearer message regarding that can help in increasing the cooperation, especially with the public sector.

Senator MCSALLY. Great. Thank you.

Dr. Sabo, I know you do a lot of work with other countries as well, so do you have any perspective on how we can better collaborate and cooperate with Israel and other countries on water technology and water security?

Dr. SABO. Thank you for the question.

Just to address the Israeli part of that question first. I think the first and largest thing that we can get from Israel is to try to study how they created the innovation ecosystem that led to the business of water security in Israel and try to replicate it. And I think Nevada is doing a great job doing that already.

But it needs to be more regional than that for a market to happen, so it needs to happen across states. So that's the first thing, I think.

The second thing is, I work in a lot of transboundary water areas. And I think one of the things that we can export in these sorts of situations like the Mekong, the Indus River, the Amazon River, is our know-how on interstate water management, particularly from interagency collaboration.

So I work with the Army Corps of Engineers. I work with the Bureau. I work with the USGS. I work with NASA. All of these agencies, the State Department, all of these agencies are relevant there and that knowledge could be exported to help secure the business environment for manufacturing in other places in the world.

Senator MCSALLY. Great. Thanks.

I wanted also to focus on desalination. This is, it seems to me, the technology that, if the cost could be brought down more, could be really game changing for us in the West.

Mr. Lang, is there anything you could share about what Israel has learned about deploying that, and Dr. Sabo, on research in order to have breakthroughs in technology to make it more cost competitive?

Mr. LANG. Yes. Actually, we are focusing these days, especially in energy efficiency. And as I said in my opening remarks, I think the base for all is the good infrastructure. On top of that come the other layers of system management, data collection, but you have to have first a very good infrastructure. And when I say infrastructure, I mean, good pipes. I mean, very efficient pumping equipment. Our pumps, for example, is 90 percent efficiency in energy. It's pretty much the highest that they have in the world. So when you have that and you install a part of that, all that, all the current technologies we chose there, we didn't invent anything new. It's integration, good integration of all parts on top of a good infrastructure. That's the secret, I think.

Senator MCSALLY. Great.

Dr. Sabo, anything to add?

Dr. SABO. I mean, I would concur with that. I think there are a lot of great technologies that don't get used because at the end of the day you need a train of technologies to make things work and you need an end goal for that train of technologies.

And so, an example would be how do we recycle water from oil and gas industry and use it for agriculture? We need a whole other thought process to get that whole tech train going.

Senator MCSALLY. Okay, great.

Senator Cortez Masto.

Senator CORTEZ MASTO. Thank you.

Mr. Lang, I have been to Israel twice, and I was really struck by how the arid parts of Israel remind me of my home town in Southern Nevada, right?

I appreciate your comments because I do know that in Nevada, and particularly in the past, we've had delegations from our governors to our mayors visiting Israel, opening those doors to how we promote and work together on so many crucial issues that we have in common, like this issue of water security. So, thank you.

I am curious, I want to open this up to both you and Dr. Sabo, though. One of the areas that I am interested in is natural infrastructure. And I think, Dr. Sabo, you mentioned that drought resilient water infrastructure is a key factor in providing adequate drinking water and protecting communities from floods.

Natural infrastructure, I think, is an example of an innovative drought resilient tool that provides benefits for safeguarding water. I just want you to talk a little bit about, if you don't mind, why are nature-based solutions, such as natural infrastructure, an important component of water infrastructure and storage portfolio for what we are talking about today?

Dr. SABO. Thank you for the question. I think, well, I'll give an example first of natural infrastructure in the context that you brought up which is drought resilience and flood management. Wetlands have been drained and removed from landscapes all

across the United States. They are natural places for recharge of aquifers and they also slow down flood peaks. So, they do both at the same time.

I think the barrier to implementing them is that there has been very little research done on the price point of green infrastructure compared to grey. Do green projects pencil out in terms of the benefits they deliver and the cost that you put in them? And so, that's, kind of, where we are with it.

My own personal take is that some combination of grey and green is much better than green in itself, so, some combination of natural in both. But certainly, we need to look to things like wetlands, forests and aquifers as parts of our infrastructure portfolio.

Senator CORTEZ MASTO. Thank you.

And we also, part of the conversation earlier, I think many of you mentioned was reforms in finance and financing opportunities. Talk to us about here at the federal level what we should be thinking about. When we identify and appropriate funds to support financing, what, when you talk about reforms, what should, what can we do at a federal level to incentivize it or condition it to the extent that we are forcing communities to come together to really focus on water as part of the integral infrastructure package? What should we be, what do we need to know at a federal level when we are crafting those financial opportunities? And I will just open it up to the panel.

Ms. HOFFMANN. Thank you very much for the question, Senator Cortez Masto.

One of the things that we have been looking at is really the demonstration side, and it also gets to the cost side. Like, if we're not grid connecting technologies and we're not inserting them into districts, then we can't start to scale those across the Western United States and bring those price points down.

And so, one of the things that we're looking at is partnering with the United States Department of Energy. So, we have power shutdowns right now that are happening in California when it's too dry and it's too windy and it's too hot because they're trying to prevent wildfires. That's a really good thing.

The community's only pieces of infrastructure that have backup generation are the hospitals being on diesel generators. And in Hood River County in Oregon, along an irrigation district, you have a water treatment facility, you have a gas station, you have the fairgrounds which can serve as an emergency response housing facility for the community.

And so, what we want to do is partner with the Department of Energy and understand if we were to install ten megawatts of in-conduit hydropower paired with solar and battery technology, how do we integrate those into the water system and how do we optimize those technologies for community benefit? Then, when the big grid needs to come offline, power, we can still provide power to certain facilities in our communities through these systems.

And so, I think it's about, I think that's one of the places where like, intentional focus on understanding what the regulatory barriers for the programmatic support. Like if we can do the demonstration project, we'll learn what doesn't work. And then, we'll understand how to come back and structure a program that can

then scale that across the Western United States or help to scale it across the West.

Senator CORTEZ MASTO. Thank you. Thank you.

Senator MCSALLY. Senator Cantwell.

Senator CANTWELL. Thank you, Madam Chair, and I thank both you and the Ranking Member for holding this important hearing. It is reminding me, making me feel old, actually, but times in which predecessors of yours, representing Western states, have brought these same issues up. I firmly believe that it is time for innovative decision-making and policy at the federal level as it comes to water.

We know what is happening. We are having warming temperatures. It is challenging us, and we need better strategies. We need better investment, but we need better strategies.

So one of the issues we have been dealing with in a rollover at the Commerce Committee is this issue of making sure we have good weather forecasting information. We are concerned that some over at the FCC are trying to steal or sell Spectrum and that would leave us short in giving us the right weather forecasting information. And we feel like if that is done and we don't really have good weather forecasting information, that might leave us short on a whole lot of ideas, obviously, preparation and response to a storm or conditions, obviously, like the ones we are dealing with in California today. It is very important to know what wind speed and other things are going to be.

But I was going to ask, maybe Dr. Sabo or Mr. Lang, if you had a better judgment about weather forecasting when it came to rain. What policies would you be able to put in place that would help you?

Dr. SABO. I mean, this is, in many ways, the multimillion-dollar question.

But yes, this is the, when we think about forecasting climate, when we think about climate impacts on natural resources, rainfall is the hardest thing to predict. I think it starts in space and I think there are NASA missions that are addressing the rainfall issue now. So, I think that's, I mean, so I don't go totally out of my area of expertise, I think that's probably where I'd start is in space. And it sounds far reaching, but that's where we measure the stuff.

Senator CANTWELL. So you are saying that having better, accurate measurements might give us a strategy discussion that would, it would be, basically, a better road map, you are saying?

Dr. SABO. Yeah, yes.

Senator CANTWELL. Good.

Mr. Lang.

Mr. LANG. Actually, I don't have anything to add, because we're not focusing on that and my activity is focusing much on the infrastructure and the layers on top of that, less on the weather forecasting.

We use the weather forecasting that we get from the National Bureau of Forecasting in Israel. It seems that it works fine in Israel. I don't know.

Senator CANTWELL. Well, you probably don't have the same debate going on with somebody trying to—we want both NASA and

NOAA to have the accurate information for weather forecasting. That is what we know.

I am curious as to, we are a very intense hydro system. That is where 70 percent or so of our electricity comes from. So when you have less snowpack, you have less hydro and it affects. So even a one-degree temperature change means less snowpack. It means bigger challenges to us.

One thing that we have heard a lot about, and there are people here from the Yakima Basin project, is how we integrate a holistic approach to water resource management. We have been able to move forward because a diverse group of people that don't usually agree got together and agreed these are the most important things to do right now. And we think that is important because we think the legal battles that get us hung up for years are just really not cost-effective in helping us deal with these issues.

But one thing that, for us, I think, is something to be discussed is aquifer recharge. And I don't know if there is anybody on the panel who wants to talk about that or suggest, but you know, Israel, you have taken this very aggressive move on desalinization and we feel there is some low-hanging fruit. If I am not going to be able to store water on Mount Rainier or Mount Baker because you are going to have more snowmelt, then what can we do to store that same source that is dropping to Earth. What more can I do to store that in a place that might be able to be used in these other conditions?

Yes, Mr. Harper?

Mr. HARPER. Let me speak to that briefly, thank you, Senator.

In my testimony I highlighted the fact that we're doing a number of, essentially, recharge projects with community groups and local communities in the Colorado Basin and also in Oregon. Many of those are aquifer recharge in their focus, and a lot of them are very, very simple. They're low-tech. They involve simple things like where there's a runoff chute amassing stones to slow the water down, and as the water runoff gets slowed down, more of it seeps into the ground and into the local aquifer. Some of it, you know, that's an example of green infrastructure, although it's also hard because of the stones. But it's not your traditional high-tech, high investment approach.

There are a number of other ways you can do it through drip irrigation systems which is really, is obviously, pioneered. But the more water that actually stays in an aquifer, it doesn't have to be pumped up, or the more water that actually goes into the plant, the less there is need to withdraw and draw down.

But I want to emphasize some very simple techniques like, for example, improving the efficiency of irrigation ditches and, you know, sometimes there's water recharge that is unintended because it's leakage. And that may be a good thing in the short run, but in the long run you want to have water go where you intend for it to go. So I would emphasize low-tech approaches.

And the other thing I wanted to say, just briefly, the emphasis is on the West here, but while there aren't water insufficiencies in the East to the same extent there are on the West, the technologies that I highlighted earlier and have been talked about by other wit-

nesses can be used on the water quality front, not just water supply front.

We've done some work in the Chesapeake working with the Chesapeake Conservancy using very high-resolution aerial images, GIS systems and sophisticated computer programming, cloud computing capability to do extremely accurate rendering of the landscape in the Chesapeake. Why is that important? It's important because you could track land use and you can track where the water flows off of farm land carrying nutrients into the rivers and the bay itself. And if you can pinpoint those areas, you can address them with conservation in a much more efficient way. And they're currently looking at working with the Denver Water Department. Chesapeake, Denver, two very different areas. Why does the Denver Water Department want to use this technology? They're not so much interested in forecasting weather. They're interested in forecasting demand and they want to know from a year-to-year basis what the landscape looks like in the metro area so that they can better forecast what the demand for water is going to be.

Are people putting in more lawns or putting in arid landscapes? Is land getting converted more rapidly than they think, therefore creating more hard landscapes and more runoff? That's another example of where the technology and sensors can be used both for water quality in the East and water quantity in the West.

Senator CANTWELL. Thank you.

I know I am way over my time, but I thought that was very helpful. I am a big fan of satellite imagery for these purposes. I think it is just more data and information to tell us about usage and efficiency. I think we just have to realize temperatures are warmer. We are going to be more challenged. We need new strategies.

Thank you.

Senator MCSALLY. Great. Thanks.

I have a couple more quick questions.

I appreciate many of the witnesses talking about the value of infrastructure. Our focus of the hearing is on technology, but technology by itself is not going to solve all these issues. We do have very aging infrastructure.

This Committee has been very focused on this issue. We have some pieces of legislation moving forward to include modernizing the financing. That was something that came to my attention when I was in Yuma talking to the agriculture community there and for facilities like the Imperial Dam how they are held back from being able to invest in infrastructure because of the financing setup that they have. So we hope to move legislation forward and get it through the Senate and the House.

But I did want to, Ms. Hoffmann, go back to some of what you said on this topic of infrastructure. When you talked about how digging to put in a pipeline and then digging to do broadband and then digging for transmission, that shouldn't be three separate projects. Of course it shouldn't be three separate projects. That is like master of the obvious, right, for efficiency and effectiveness. Why, in goodness, would it be three separate projects? Is it government bureaucracy, different agencies not talking to each other? I mean, anyone listening would say, of course it needs to be better

coordinated and you do all three at once. So share the frustrations and the barriers and what could be done in order to fix that.

Ms. HOFFMANN. Thank you so much for your question, Madam Chair. I request to sit and hide under the table. Just kidding.

It's a difficult question, and I think it has to do with managing any project whether it's wholly private sector or it's public-private or it's public, as these projects are, is incredibly difficult getting the financing to match up, getting through all of the regulatory permitting processes and doing that in a timely manner, stacking capital, understanding the benefits.

And so, I think those, like the heart of our irrigation modernization program, just to modernize the water delivery system for water purposes is really hard because you're pulling in grants from the Federal Government, hoping that those match up with the state, hoping that you don't have to get a loan that you then have to pay interest on because your grant didn't come through in time. So those are some of the challenges.

Co-location of infrastructure, what we're finding because of the significant decrease in cost. If we can match up the federal program like the ReConnect Program, for example, which can pay for the installation of fiber optic. And as we are converting irrigation systems, we're just co-locating and building that in. If you build it, they will come.

There are internet service providers in these areas who are ready to invest, or transmission—if you're installing in-conduit hydro and you have to pay wheeling rates but you can install your own transmission line to get closer to the substation to the customer where you're actually selling that power, the cost of building that is so much cheaper than the wheeling rate that you would pay over the 20-year life of the contract.

And so, I think part of it is holistically understanding the system. And we're building into our methodology, fiber optic and transmission. And getting out ahead of the problem so then you can then—it's not the problem—getting out ahead of the solution so you can understand how to sequence, how to permit, how to stack capital, and how we actually do this will help us understand then how we can scale.

Senator MCSALLY. Great. Thanks.

Last question, Mr. Harper. You talked about Intel's presence in Arizona and your initiatives, specifically your great presence in Chandler, about how manufacturing can really work in a desert environment and we really appreciate the partnership that you've had in Arizona. And you talked about moving toward 100 percent recharge.

Can you share just a little bit before we go on, kind of, a path forward to get to that 100 percent and what types of initiatives are ongoing?

Mr. HARPER. Well, in my written testimony I said we had seven projects. I actually looked last night, and it's now up to ten projects and they're upstream from Chandler. They're in the tributary watersheds. But they vary dramatically and most of them are relatively small and relatively low-tech.

But for example, my favorite is in, I call it Verdé, but I guess locally it's the Verde Watershed. There's a project there where we

worked with community groups and the farmers to change the crops that they grow from alfalfa which is very water intensive to barley. And the first question the farmers asked when that was proposed is, is there a market for barley?

So what we've done is we've worked with local business folks to develop a couple of local breweries. And actually, we helped create the market for this replacement crop which not only is a lot less water intensive, but it grows in the wintertime as opposed to the summertime and there's obviously more water available. So the net net of that has been quite positive.

So a number of other projects, soft and hard, in terms of infrastructure. The important thing is we're working with a company called LimnoTech based in Michigan, and they basically are the accountant. They basically do the analysis to make sure that at the end of the day when we take credit for X amount of water recharge, that there's hard analysis behind that and somebody can come in from outside and say, is this really delivering what Intel says it is? And the answer is going to be either yes or no, but it's going to be based upon real data.

Senator MCSALLY. Great. Thank you. I really appreciate everybody's testimony today.

Senator Cortez Masto, any final word?

Senator CORTEZ MASTO. Thank you, no. I just so appreciate the hearing today, and all of you coming here. This has been a great conversation.

Clearly, there is a lot of work we can do and continue to do. And I think the technology is going to give, provide, us opportunities.

I am really interested in the space between the clear connection between water and energy use, and I do know that our global water demand and energy consumption continue to increase and we have to figure out how we work together to sustain both.

Thank you for the conversation. This has been very, very informative. I appreciate you all coming here.

Senator MCSALLY. Alright, thank you.

I, as well, really appreciate all of our witnesses for all your hard work in this area and traveling here and sharing your expertise. Lots of opportunity. Challenges equal opportunity, right? And lots of opportunity in front of us.

So thanks so much.

Questions may be submitted for the record before the close of business on Friday. The record will remain open for two weeks, and any responses you make will be a part of that record.

Thanks again.

The hearing is now adjourned.

[Whereupon, at 11:14 a.m. the hearing was adjourned.]

APPENDIX MATERIAL SUBMITTED

U.S. Senate Committee on Energy and Natural Resources
Subcommittee on Water and Power
October 30, 2019 Hearing: ***The Use of Technology and Innovation to Increase Water Security and Enable Economic Development in the West***
Questions for the Record Submitted to Ms. Margi Hoffmann

Questions from Senator Martha McSally

Questions: Ms. Hoffmann, preserving agriculture while figuring out ways to deal with more and more competition for water resources is tremendously important, and I appreciated learning about the good work you are doing. It is important to recognize that opportunities for adopting water technology may not always be as easy in rural communities where investments in broadband is also needed. In your experience, is insufficient support infrastructure like broadband an impediment to implementing technology solutions to water management in some of the areas you work in? How can irrigation modernization and rural broadband efforts, or the location of other infrastructure, be better coordinated and how can the Subcommittee help make that happen?

Answers: Thank you, Chair McSally, for the questions and the opportunity to include this information for the official record.

In short, definitely. There are many elements associated with improving water use on agricultural operations. The Farmers Conservation Alliance (FCA) has historically focused on improving the delivery of water through modernizing irrigation district infrastructure. However, in the last several years, we have begun to also focus on those improvements made possible through the co-location of broadband infrastructure, such as precision agriculture and smart water systems for crops and livestock. FCA now recognizes broadband as integral to maximizing water efficiencies in agriculture. Further, smart technologies on-farm and within districts can improve water quality and conditions for threatened aquatic species by enabling precision application of fertilizer, dynamic real-time water testing, smart fish screen technology, and other methods.

Additionally, FCA sees the implementation of irrigation modernization projects (which generally include large-scale installation of pipelines along historically open irrigation canals) as significant opportunities for new rural infrastructure. While mobilized for pipeline installation, irrigation districts could also install fiber optic cable and electricity transmission/distribution lines (or at least conduit that facilitates the pulling of these lines later). This new infrastructure can be installed for literally pennies on the dollar, compared to installing these lines as stand-alone projects.

Co-locating infrastructure is difficult to do because a project developer needs to line up project timelines for both irrigation modernization and fiber optic or transmission lines. There are ways that the Federal Government can encourage co-location efforts which significantly decrease the cost of installation in the following ways:

1. Provide early stage and planning funds for rural entities, such as irrigation districts, counties, cities and/or electrical cooperatives, to plan for the co-location of infrastructure, including, but not limited to, water delivery, fiber optic and buried electrical transmission lines;
2. Include incentives within existing irrigation infrastructure and broadband programs for projects that include the co-location of infrastructure (without preventing significant stand-alone projects from moving forward, as needed);

U.S. Senate Committee on Energy and Natural Resources
Subcommittee on Water and Power
October 30, 2019 Hearing: ***The Use of Technology and Innovation to Increase Water Security and Enable Economic Development in the West***
Questions for the Record Submitted to Ms. Margi Hoffmann

3. Encourage internet service and mobile communications providers to support rural connectivity through an incentive program that encourages partnerships with irrigation districts and other rural governmental entities to serve rural communities; and
4. Clarify that any irrigation district right of way granted by the federal government, such as those through the Carey and Homestead Acts, are able to co-locate infrastructure projects that serve a public benefit as long as the main purpose of installing infrastructure is to improve the water delivery system.

U.S. Senate Committee on Energy and Natural Resources
Subcommittee on Water and Power
October 30, 2019 Hearing: ***The Use of Technology and Innovation to Increase Water Security and Enable Economic Development in the West***
Questions for the Record Submitted to Mr. Stephen Harper

Questions from Senator Martha McSally

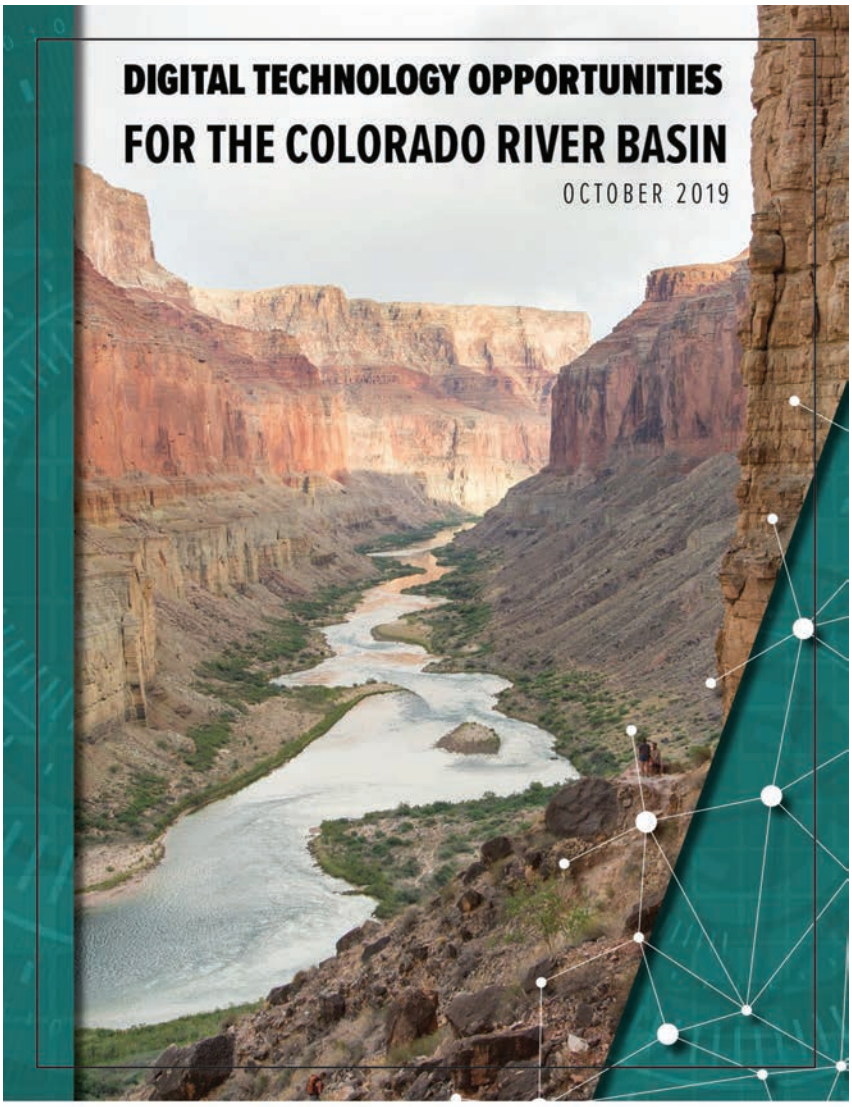
Question 1: Mr. Harper, thank you for the update on the recent forum looking at the use of technology to address water challenges in the Colorado River Basin. Can you please share any additional information about the outcomes of that meeting, next steps and how the Subcommittee can aid in your efforts?

A1: See attached draft report which served as the basis for the workshop. This report will be updated based upon the workshop discussions.

The other direct next steps from the workshop focus on three specific workstreams, each of which is the focal point of a workgroup of workshop participants – (1) development of a comprehensive database and data dashboard focused on data needs of stakeholders in one CRB watershed; (2) leveraging data and analytical tools to accelerate investment in CRB water projects; and (3) using data to establish a market for trading water rights.

Question 2: Mr. Harper, can please share your insight on how businesses are analyzing and engaging on this issue when considering locating facilities, and how does a region's adoption of technology and traditional water infrastructure factor into decision making about siting facilities?

A2: Availability of water is a critical factor that we evaluate when selecting where to site and grow our operations. A new semiconductor factory is a $5-7 billion investment. It is critical that we have strong confidence in the future availability of water to ensure long-term success of our investment. Regional investment in water infrastructure and adoption of water-related technology is a strong positive factor as we assess our options for future investment and expansion.


DIGITAL TECHNOLOGY OPPORTUNITIES
FOR THE COLORADO RIVER BASIN
OCTOBER 2019

The Environmental Law Institute (ELI) works to shape the fields of environmental law, policy, and management, domestically and abroad. ELI celebrates 50 years as an internationally recognized, nonpartisan research and education center working to strengthen environmental protection by seeking new and innovative approaches to improve governance of all resources.

Water Foundry has extensive experience in developing water strategies for global clients in the public and private sectors. Water Foundry has been at the forefront in working with; the world's most recognized brands on quantifying the business value of water, innovate water technology startups, quantifying the economic value of water, and developing data visualization tools to better understand supply demand scenarios and potential interventions to "close the gap." These engagements and tools are designed to inform business and public policy decisions.

This report was a joint effort between ELI and Water Foundry staff and was funded by Intel, Microsoft, and Blue AB.

CONTENTS

1. BACKGROUND

The American West, including the cities of Las Vegas, Nevada; Los Angeles, California; Phoenix, Arizona; and Denver, Colorado, falling under the reaches of the greater Colorado River Basin (CRB), is now among the world's water stressed regions facing the environmental, economic, and social challenges of increased water scarcity.

The region formed and flourished with the pulse of seasonal floods providing ecosystems with nutrients and nursery habitat, the rush of spring runoff bringing new waters to downstream wetlands, and the corrosive power of heavy flows carving out immense landscapes.[1] The terrestrial and aquatic of the region all evolved with a dependency on the Colorado River, yet with the river's waters now dammed, stored, and allocated for human use, many species are finding their homes and populations threatened.[2] Birds are losing migratory habitat,[3] native fish are facing increased predation and pressures from invasive species,[4] and many species (e.g., macroinvertebrates,[5] birds, fishes) are losing breeding grounds due to altered river dynamics.

In addition to its environmental role, the economic importance of the CRB cannot be overstated: the Colorado River supports $1.4 trillion in annual economic activity and 16 million jobs in California, Arizona, Nevada, Utah, Colorado, New Mexico, and Wyoming which is equivalent to about 1/12 of the total gross domestic product in the U.S.[6] It is estimated that if 10 percent of the river's water were unavailable (a decline quite possible under projected climate change scenarios of 10 to 30 percent flow reductions by 2050[7]) there would be a loss of $143 billion in economic activity and 1.6 million jobs, in just one year.

The CRB supplies more than 1 in 10 Americans with some, if not all, of their water for municipal use, including drinking water.[8] The Basin provides irrigation to more than 5.5 million acres of land and is essential as a physical, economic and cultural resource to at least 22 federally recognized tribes. In addition, dams across the Colorado River Basin support 4,200 megawatts of electrical generating capacity, providing power to millions of people and some of the U.S.'s largest cities. It has become clear, however, that under current and projected conditions, the Colorado River is no longer able to meet the demands of its many users. Challenges are emerging that will require the acceptance of a new reality among stakeholders in the CRB.

For this reason, the CRB is seen as a strategic "testbed" to determine the feasibility of emerging and novel digital technological solutions for the water sector. This report is intended to profile the potential opportunities of emerging digital technologies to address the water quality and quantity challenges faced by public and private entities in the Basin. Three digital technologies in particular have been identified as having the greatest potential to manage increasing water demand, ensure water quality, and to build resilience to climate change; these are Artificial Intelligence (AI), blockchain and sensor networks, alone or in combination.[9] This report is not intended to provide an exhaustive list of water

[1] (Environment and Ecology of the Colorado River Basin 2012)
[2] (Building a New Future for the Colorado River 2016)
[3] (Water and Birds in the Arid West: Habitats in Decline 2017)
[4] (Increasing Drought Favors Nonnative Fishes in Dryland River: evidence from a Multispecies Demographic Model 2019)
[5] (Flow Management for Hydropower Extirpates Aquatic Insects, Undermining River Food Webs 2016)
[6] (Economic Importance of the Colorado River 2019)
[7] (Colorado River 2017)
[8] (Drought in the Colorado River Basin n.d.)
[9] (Harnessing the Fourth Industrial Revolution for Water 2018)

challenges or digital technology solutions for the CRB, but will serve as a point of departure for the potential to adopt, scale and commercialize digital technology as a part of the solution to address water scarcity in this region and others.

2. COLORADO RIVER BASIN

The CRB is one of the most productive and influential, economically and environmentally, yet conflicted regions of the United States. Known as the "river of the west," the Basin spans about 8 percent of the continental U.S. and encompasses seven states, with its northernmost borders stretching into Wyoming, across Colorado and Utah, and down into Nevada, southern California, Arizona and New Mexico. From there, the basin expands into northern Mexico where the Colorado River reaches toward the Gulf of California.[10] Water in the Basin originates as snowmelt high in the Rocky and Wasatch Mountains and as it flows along the Colorado River's over 1400 miles, the landscape and climate varies from high alpine forests to barren desert, with everything from rural farms to massive metropolitan areas found in between.

(USGS 2019)

The Colorado River is the lifeblood of ecosystems across the west, home to numerous endangered species and the carving force behind ancient canyons. In the last century, however, the river has come to support more than just ecosystems and now includes communities and industries that have grown and flourished across the Basin as well. Water from the Colorado River has enabled agriculture, utilities, industry and recreation to thrive, yet that water, famous for the rafting, hydropower and irrigation opportunities it provides, has become infamous in its scarcity. Heavily managed, over-allocated, and threatened by ongoing climate change, the Colorado River has become an icon of controversy. Exploring the Basin's many water management policies and governing bodies provides a foundation for understanding the challenges now faced across the region and the opportunities for action that those challenges provide.

2.1 River Governance

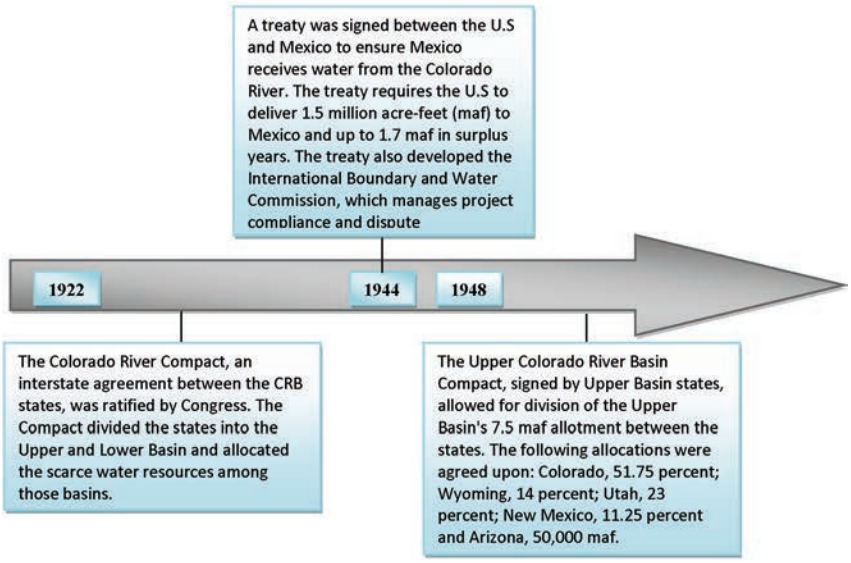
Most western states maintain that all waters are owned by the state, and allow water rights to be allocated in association with a given property and beneficial use. For the most part, western states follow the Law of Prior Appropriation (the first in time, first in right principle), wherein those who first established a claim to and beneficial use of water had a right to use such water. Any entity or individual obtaining a permit thereafter is then only able to utilize their water right after senior water rights holders' allocations are fulfilled.

[10] (Colorado River 2017)

Despite internal processes for each state's management of water resources, as the West continued to develop in the early 1900s, a collection of statutes, court decisions and decrees, interstate agreements, and international treaties emerged from disputes over the allocation of the Colorado River's water.[11] Loosely described as the "Law of the River," a collection of the primary basin-wide agreements governing the CRB are described below along with the organizations developed to aid in the Basin's management.

2.1.1 Basin-wide Agreements

Although far from a complete list of laws governing the CRB, the primary agreements governing water usage across the Basin include the following.



2.1.2 Basin-wide Organizations

Working with the foundations laid by the Law of the River, several associations and other groups have emerged to facilitate discussions, share information, uphold group interests, pursue conservation efforts, and generally aid in managing the waters of the CRB. These organizations are developing unique partnerships to address the challenges experienced in the CRB. Table 1 below summarizes the mission and efforts of such organizations.

[11] (Liquid Assets: Investing for Impact in the Colorado River Basin 2015)

Table 1: Organizations involved in overseeing the CRB

Organization	Mission
Western Governors' Association (WGA)	The WGA is made up of governors from the 19 Western states and 3 U.S. territories. Established in 1984, the WGA is an instrument for bipartisan policy, information exchange and collective action among western states. In addition to other interests, the WGA aids governors and their states in addressing water quality, water supply and drought management issues.[12] In 2014, the WGA launched the Western Governors' Drought Forum to foster regional dialogue and sharing of best practices on drought policy, preparedness and management.[13]
Western States Water Council (WSWC)	The WSWC, although created in 1965, now operates under and is held accountable to the Western Governors' Association. The WSWC consists of representatives appointed by governors of 18 western states and with a purpose similar to that of the WGA: to establish interstate cooperation and information exchange, maintain state interests and accommodate federal prerogatives, and provide analysis and evaluation of federal and state developments as it pertains to the management of water resources.
Ten Tribes Partnership	The Ten Tribes Partnership was developed in 1992 when ten of the CRB tribes came together to participate in discussions regarding CRB water. The tribes' goal was to attain an equal seat at the table for bargaining over CRB water, to assist member tribes in establishing and developing their water right, and to ensure other river uses do not interfere with their ability to utilize each tribe's respective water rights.[14] The Partnership has been active in advocating for accurate representation of tribal water rights and has expressed interest in voluntary water transfers via water banking or leasing and other market opportunities in the CRB.
Bureau of Reclamation	The Bureau of Reclamation was established in 1902 by President Theodore Roosevelt to design, install, and manage water projects to store and transport water in the arid western United States. Regions 3 and 4 of the Bureau of Reclamation manage the Lower and Upper CRB respectively, ensuring the Law of the River is observed. The Secretary of the Interior acts as Watermaster of the Lower Colorado Region, managing the delivery of all water below the Hoover Dam.[15]

2.1.3 Current and Emerging Partnerships

Many unique partnerships are also at play in the CRB, using the expertise, networks and resources of NGOs, foundations, corporations and other environmental organizations to initiate change and address a variety of problems across the CRB. Below, a few organizations developing key partnerships in the CRB are described in Table 2.

Table 2: Organizations developing key partnerships in the CRB

Organization	Partnership
The Nature Conservancy (TNC)	TNC has been instrumental in deploying water conservation projects on the ground, working with federal agencies, local farmers, and community leaders alike. TNC's partnership with the Grand Valley Water Users Association in Colorado has led to a pilot project testing a large scale approach to a water bank. Project participants are reducing irrigation, generating one billion gallons of water savings to improve river flows in the region. In another TNC effort, the NGO is working with federal funding and local partners to develop a network of projects, including groundwater recharge, to protect Arizona's San Pedro River – the region's longest undammed river and a hotspot for migratory birds and wildlife. TNC also works with a wetlands preserve near Moab, Utah to develop and manage critical nursery habitat for the endangered razorback sucker, as well as elected officials and community leaders across Arizona to manage the Salt and

[12] (Western Governors' Association 2012)
[13] (What is the Western States Water Council? 2015)
[14] (Ten Tribes 2018)
[15] (Bureau of Reclamation 2018)

	Verde Rivers (both a part of the CRB) which are significant water supplies to the state's people, including the Phoenix area.[16]
Bonneville Environmental Foundation (BEF)	The BEF works with its partners, bringing together the public, corporations and conservation organizations to raise awareness on and restore flows to vital freshwater ecosystems through their Change the Course initiative. Beginning in 2014, the Change the Course pilot project in the CRB saw 130,000 individuals over the course of three years pledge to conserve water, resulting in four billion gallons of water being restored to the Basin's depleted river systems.

Additional organizations such as the Gates Family Foundation, Encourage Capital, and the Walton Family Foundation have specific interest in the CRB and are funding projects and developing partnerships related to water conservation and market based solutions across the region (see Section 4.3). Likewise, the Audubon Society, recognizing the importance of the CRB for bird migration and habitat, works with water users, farmers, and other stakeholders to protect critical habitat and develop long-term water-management solutions in the Basin. Other such partnerships continue to emerge across the Basin as stakeholders begin to realize the scale, severity, and urgency of challenges within the CRB.

Several private sector companies are also promoting water stewardship through new partnerships in the CRB. For example, Intel has partnered with NGOs, agencies, and local communities in the CRB to promote the use of low water use crops, install advanced irrigation systems, capture snowmelt and runoff, and improve water quality. In addition, some food and beverage companies such as MillerCoors and ABInBev are encouraging water stewardship in their supply chains, working with local farmers in the CRB to support the use of water conserving practices and technologies.

2.2 Challenges

Despite (yet partially as a result of) the elaborate water management policies agreed upon and implemented across the CRB, numerous challenges have emerged that now pose a threat to the complex arrangement of water supply and demand (and quality) in the Basin. The many uses of and high demand for the Colorado River's water are only increasing, adding stress to an already limited resource. Exacerbated by climate change, this stress will only continue – becoming the new norm in coming decades. In addition, new data provided by modern science have highlighted errors in the quantification of the average annual flow which was based on a small sample size during a particularly wet period that ultimately led to incorrect water allocations in the CRB. Understanding these challenges and the impacts they have on stakeholders in the region is a necessary first step for exploring the implementation of digital technologies and its implications for addressing water management issues in the CRB.

2.2.1 Water Demand

Water from the CRB has historically been used to meet the needs of western society across a variety of sectors. Agriculture, industry, municipalities, etc. all tap into the CRB's most valuable resource at different levels but with a shared voracity. According to the U.S. Geological Survey, as shown in Figure 1, 59 and 69 percent of water in the Upper and Lower Colorado River Basins, respectively, is used for hydrologic power generation.[17] In total, over 11,000 GWh of hydroelectric power was generated from dams in the CRB and more than 170,000 GWh were produced using water withdrawn for thermoelectric power generation in the CRB in 2010. Water from the CRB provides the electricity to power metropolises across the west as well as rural areas and Native American reservations.

[16] (Colorado River Basin 2019)
[17] (Estimates of Water Use and Trends in the Colorado River Basin, Southwestern United States, 1985-2010 2018)

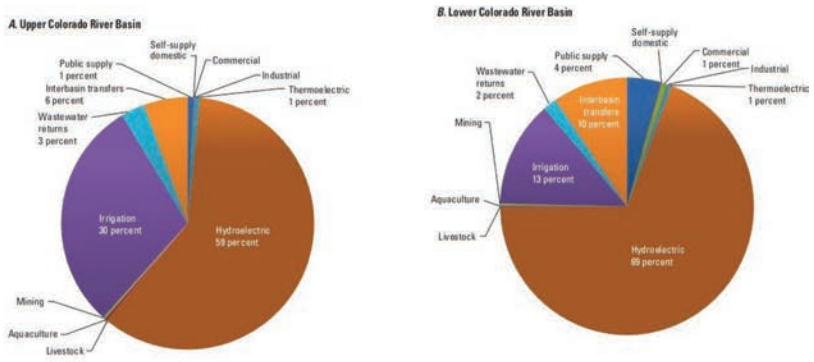


Figure 1: Percentage of total estimated water withdrawals for the upper (A) and lower (B) CRB (U.S.G.S.)[18]

Of water withdrawn or diverted from the Basin, however, the agricultural sector is by far the largest consumer, making up over 70 percent of all CRB consumptive uses.[19] Water is primarily used to irrigate pasture and forage crops for horses and cattle, yet the Colorado River's waters also support alfalfa, vegetable, wheat, and cotton crops among others.[20] Following agriculture on the list of heavy CRB water uses are interbasin transfers (Some Colorado River water is exported from the Basin into Southern California, the eastern Colorado Front, and west of the Wasatch Range in Utah.[21]) and municipal deliveries – deliveries to the residential, commercial, industrial, and institutional sectors. The Colorado River and its tributaries are the primary source of water for some of the largest cities in the west including Phoenix and Tucson, Arizona and Las Vegas, Nevada, and also contribute to the water supply of Los Angeles, San Diego, Denver, and Tijuana, enabling major metropolises to grow on what in many cases would be otherwise uninhabitable land.

Water from the CRB, however, is used in more ways than direct consumption and power production. The CRB also supports a thriving tourism and recreation industry. People both from within the basin and around the world come to the CRB to engage in fishing, hiking, boating, rafting, swimming, or simply relaxing along its river banks and reservoirs. A 2012 study determined such recreational activity along the river generates $17.0 billion in retail sales (recreational equipment and travel expenses) and that the value of spending resulting from recreational activities associated with the CRB totaled $25.6 billion.[22]

Between recreation, agriculture, energy production, and municipal and industrial supply, water use and demand in the CRB have been steadily increasing since the establishment of the Colorado River Compact in the early 1900's. It has become clear, however, that under current and projected conditions, the Colorado River is no longer able to meet the demands of its many users (Figure 2). Challenges are emerging that will require the acceptance of a new reality amongst CRB stakeholders.

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[18] Ibid
[19] (Municipal Deliveries of Colorado River Basin Water 2011)
[20] (Water to Supply the Land: Irrigated Agriculture in the Colorado River Basin 2013)
[21] (Drought in the Colorado River Basin n.d.)
[22] (Economic Contributions of Outdoor Recreation on the Colorado River & its Tributaries 2012)

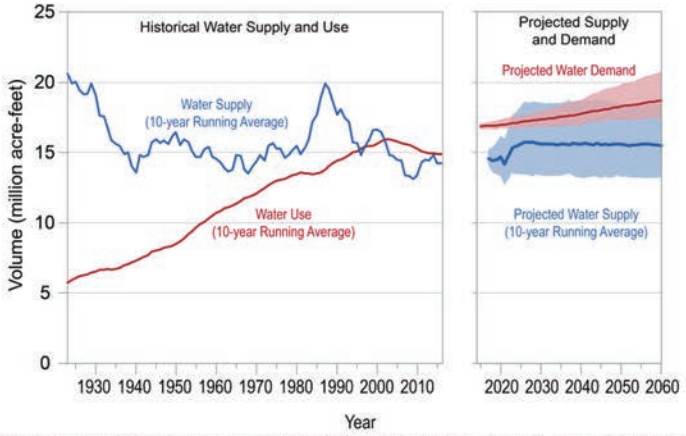

Figure 2: Historical and projected water supply in the Colorado River Basin shown in comparison to water demand[23]

2.2.2 Water Supply

For the last 19 years, the CRB has been in an extended period of drought – a prolonged period of abnormally low rainfall, leading to a shortage of water. Or so we thought. Complications from the overallocation of its waters in tandem with the escalating effects of climate change have instead replicated drought conditions, creating a new normal of water stress and scarcity. In the CRB, climate change is expected to increase the risk for prolonged, multi-decadal droughts. Higher temperatures leading to increased evaporation in combination with decreased snowfall are also projected to decrease flows and reservoir levels in the CRB.[23] Ultimately, the effects of climate change will exacerbate water shortages already felt in the region and will further complicate requirements under the Law of the River.

Obligated to fulfill the requirements of the Colorado River Compact and the Treaty of 1944, the Upper Basin has been forced to release water from Lake Mead and Lake Powell (the reservoirs behind Hoover and Glen Canyon Dams). When full, the Lakes hold 80 percent of the storage potential in the CRB. However, in recent decades water levels have dropped to near-critical lows. As of July 2019, their reservoirs are respectively only at 39 and 57 percent capacity.[24] The declining water levels have already impacted hydropower production and recreation and have drastic implications for both the water and energy supply of millions of people, not to mention the impacts on a trillion dollar economy and the environment.

In 2007 and again in early 2019, the CRB states came together to address the water shortages and develop plans (the 2007 Shortage Guidelines and 2019 Drought Contingency Plans) for temporarily managing water resources under drought conditions. The agreements created guidelines for reservoir management and incentives for decreased use of water rights during the drought conditions.[25]

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[23] (The 21st Century Colorado River Hot Drought and Implications for the Future 2016)
[24] (Lower Colorado Water Supply Report 2019)
[25] Ibid at 7

However, what these new agreements don't recognize, is that the water shortages are not in fact, the result of a drought. The conditions are normal, and they are here to stay.

At the time the Colorado River Compact was signed in 1922, annual water flow at Lee's Ferry, based on the previous sixteen years of data, was estimated to be 18.0 maf. Later, when the U.S.-Mexico Treaty was executed in 1944, the average annual flow was 16.3 maf.[26] Actual flow, based on new data from the last several centuries, places the annual average closer to 13.5 maf.[27] Tree ring studies have since shown that the 20-year time period used to estimate historic flows prior to the signing of the Colorado River Compact were among the wettest of the last several thousand years.[28] To put it bluntly, the volumes of water promised by law to the respective Basin countries and states (7.5 maf to both the Upper and Lower Basin plus 1.5 maf promised to Mexico) do not actually (or at least normally) exist. The water scarcity experienced across the west is not the result of drought, it was written into the Colorado River Compact itself.

Until the turn of the century, the over-allocation of the CRB was not immediately evident as the Upper Basin, several tribes, and the state of Arizona were not using their full allocations. Since 2003, however, human use of water in the CRB has exceeded natural supply, with shortfalls in availability falling on the Upper Basin (the Upper Basin remains legally obligated to provide its downstream counterparts with their allotted water supply despite scarcity conditions).[29] Now throw climate change in the mix and the situation gets a lot more complicated. Climate change is already contributing to the variability in annual flows, increases the potential for drought and flood events, and will add to the overall decline in water availability. Nevertheless, the requirements set forth by the Law of the River remain and any challenges or risks that ensue (e.g., increasing costs of water, mandatory cutbacks in water usage, etc.) will fall on water users.

2.2.3 Water Quality

Water scarcity and over-allocation are not the only challenges facing the Colorado River Basin. The water quality of the region has also been of rising concern. Mining and irrigation in the west have led to the leaching of heavy metals, primarily selenium and mercury, from tailings piles and soil into the Basin's rivers. Herbicide and pesticide runoff from agriculture and storm water runoff from urban areas are another continued threat Basin-wide. Although a majority of salt runoff (47 percent) is from natural sources in the CRB, water used for irrigation dissolves additional salts in underlying soils which then crystallize due to evapotranspiration and are later washed into bodies of water in runoff.[30] Irrigation therefore accounts for 37 percent of salt runoff into the CRB and is becoming a source of concern due to the potential for increased salinity to damage water infrastructure and impact crop success, ecosystem health, and drinking water quality.[31]

Understanding these different challenges, their impacts on the CRB and how they will continue to manifest in the coming decades is critical for stakeholders to maintain business continuity and growth. Continued private and public collaboration will be necessary to address the water scarcity and over-

[26] Ibid at 20
[27] (Sharing the Colorado River Water: History, Public Policy and the Colorado River 1997)
[28] Ibid at 7
[29] Ibid
[30] (Salinity in the Colorado River Basin 2016)
[31] (Salinity 2019)

allocation issues in a timely, effective manner while ensuring the interests of stakeholders and the health of the Colorado River system remain at the center of all projects and partnerships.

3. DIGITAL TECHNOLOGICAL SOLUTIONS

Society is currently undergoing a digital revolution through which digital technologies are already transforming the transportation, energy, and retail sectors among others. Similarly, there are numerous possibilities for digital technologies to transform the way water is managed. Several papers have been produced on this topic, including *Harnessing the Fourth Industrial Revolution for Water*, published by the World Economic Forum in 2018 and *Digital Water: Industry Leaders Chart the Transformation Journey*, published by the International Water Association and Xylem in June 2019. As water infrastructure ages, demand grows, and the various stressors from climate change continue, embracing the digital revolution will be critical to ensuring adequate water quality and supplies throughout the region. Utilizing digital technologies such as AI, blockchain, and sensor networks may be particularly beneficial for addressing the unique challenges in the CRB. An overview of each digital technology is provided below with an array of case studies on their applications in the water sector.

3.1 Artificial Intelligence

In contrast to early software decision support system, AI technology is dynamic. Systems programmed with AI use pattern recognition mechanisms to "learn" as they receive new data inputs, replicating some of the sophistication of human learning. In this way, AI technologies offer numerous potential benefits for sustainable water management including forecasting the availability of water resources under changing hydrologic and climatic conditions, improved asset management, planning for future water consumption needs by extrapolating from current usage patterns and more efficiently operating distribution networks.

AI-enabled platforms can also offer customers real-time information on water consumption and quality in addition to expediting bill-pay. These platforms can educate consumers on the environmental and social impetus for conservation in addition to the personal financial benefits of careful usage. Utilizing AI technologies to their full potential will require comprehensive, quality data sets, meaning as AI technologies are adopted, secure data management platforms must also be developed.

3.2 Blockchain

Blockchain is a digital ledger that decentralizes, encrypts, and divides data into parcels. Blocks of data are added together, forming a chain of information. Blockchain differs from traditional ledgers or databases in that the chain of blocks is not stored centrally, but copied and distributed in a computer network. By eliminating the intermediaries that are traditionally required to validate transactions among parties, blockchain technologies add a layer of security to transactions and optimize processes that require storing, sending, accessing, or verifying information.[32]

The distributed, secure and transparent nature of blockchain technology lends itself to a variety of novel applications within the water sector including peer-to-peer water rights trading, creative and democratic

[32] (GEF Novel Entities, 2018)

financing for water projects, the establishment of cryptocurrency-enabled smart meters, the aggregation and distribution of water data the deployment of smart-contracts and more.

3.3 Sensor Networks

Sensor networks – wireless and infrastructure-less configurations of sensors – offer enormous potential to precisely monitor physical and environmental conditions, passing data through their network in real-time. Wireless sensors can be deployed to monitor variables including pressure, temperature, pH, pollution, flow rate, equipment performance and more.[33] A network of sensors may contain hundreds or thousands of sensor nodes, allowing the data retrieved from such networks to provide a more comprehensive and nuanced characterization of the studied landscape than traditional monitoring techniques. Moreover, this infrastructure allows for the study of an area (e.g., infrastructure, water source, etc.) over time and at close intervals.

Sensor networks can be utilized in the application of digital twin technologies wherein real-time data is paired with virtual reality technologies to generate a working replica of physical systems. The digital twin simulates infrastructure functions to help visualize and monitor current conditions and predict real-world scenarios.[34]

Within the CRB, deploying a network or networks of wireless sensors could enable water professionals and the public alike to achieve a better understanding of the availability, demand and use of hydrologic resources. This information is invaluable to devising conservation and distribution strategies. Wireless sensors could also be deployed at the tap to collect more accurate and near real-time data on water usage. This information, if illustrated appropriately, can then be used as an educational tool to encourage consumers to adopt conservation-conscious behavior. Sensor data can also be used to monitor and better plan around peak usage times, as well as to quickly detect and remedy problems with water quality or delivery infrastructure.[35]

3.4 Technology Use Cases

AI, blockchain and sensor network technologies have already been applied in water resource management to varying degrees. In the following case studies, we identify innovative projects employing these digital technologies to alleviate stress on water resources and infrastructure and to increase data-driven, efficient, and sustainable stewardship of available resources.

Use Case 1: Blockchain and Wireless Sensing to Facilitate Trading of Groundwater Shares in California's Sacramento-San Joaquin River Basin

Technologies: **Blockchain Platform, SweetSense Sensors**

In 2014, California signed into law the Sustainable Groundwater Management Act (SGMA), which required planning for and implementation of local sustainable groundwater management. In response to this, IBM Research, The Freshwater Trust, a non-profit working to protect and restore freshwater ecosystems, and SweetSense Inc., a provider of low-cost satellite-connected sensors, partnered to develop pilot technologies to

[33] (Harnessing the Fourth Industrial Revolution for Water 2018)
[34] (Digital Water: Industry Leaders Chart the Transformation Journey 2019)
[35] (One Day For a Digital Water Future 2016)

monitor groundwater use in one of the largest and most at-risk aquifers in North America: northern California's Sacramento-San Joaquin River Basin. The partners are funded jointly by the Water Foundation and the Gordon and Betty Moore Foundation.

Still in development, the collaboration endeavors to demonstrate how remote Internet of Things (IoT) sensors and blockchain-enabled applications can provide an accurate measure of groundwater usage and, further, allow water consumers to trade usage rights in furtherance of water conservation goals.

The project will be piloted in a portion of the River Basin that provides water to the San Francisco Bay Area, as well as coastal and southern California. The area, situated in the Sacramento-San Joaquin River Delta, supports numerous protected plant, fish, and animal species and is used heavily for agriculture. Sensors provided by SweetSense will transmit water extraction data to the IBM Blockchain Platform hosted in the IBM Cloud. The blockchain uses "smart contracts," through which transactions are automatically executed when certain conditions are matched.[36]

The project will launch a web-based "dashboard," through which water consumers, like farmers, as well as investors and regulators, will be able to monitor and track groundwater usage. When individual users require water in excess of their designated share, they can purchase groundwater shares at a market-regulated rate from other users who opt not to maximize their own usage. The hopeful output of the project is a data-driven, transparent, and scalable platform through which water usage shares can be traded in a way that helps meet both stewardship goals and usage needs.[37]

Use Case 2: Wireless Sensing to Measure Snowpack in the Sierra Nevada Mountains

Technologies: **Smartmesh IP**

Mountains have been called natural 'water towers' because of their ability to effectively store fresh water in the snowpack that accumulates over the winter at higher altitudes. It is estimated that meltwater accounts for 50 percent of the world's fresh water and 75 percent of the water in the American West. For decades estimating snowpack was an arduous and dangerous process which often involved sending people into the mountains with poles to measure snowpack depth.[38]

Since 2011, a network of sensor stations have been operating in the Sierra Nevada mountains, which provide approximately 2/3 of California's water through the snowmelt process. This hydrological observatory now consists of almost 1,000 sensors, which measure snow depth, temperature, solar radiation, and relative humidity, interconnected in 14 low-power, mesh networks. These sensor nodes are strategically placed at different elevations, slopes, and canopies over a 2,000 km^2 area, representing one of the largest, river-basin wide, hydrological monitoring networks in the world. Over the course of one year, the sensors provide well over 40 million unique measurements, which are analyzed by a machine learning algorithm to continually improve data quality. Outputs from predictive models are being used by the California Energy Commission to improve the prediction of hydropower availability based on snowpack meltwater. [39]

[36](IBM Newsroom 2019)
[37] (WIRED 2019)
[38] (Technical Report: The design and evaluation of a basin-scale wireless sensor network for mountain hydrology 2017)
[39] (A Machine Learning Based Connectivity Model for Complex Terrain Large-Scale Low-Power Wireless Deployments 2017)

Use Case 3: Deploying a Network of Adaptive Sensor Platforms to Monitor the Water Quality Of Lake George in New York

Technologies: **IoT Smart Sensor Network**

In 1791, Thomas Jefferson visited Lake George and declared it, "the most beautiful water I ever saw." Today a wide variety of stressors, including road salt, nutrient run-off, and invasive species (including Zebra mussels and Asian clams) threaten the lake's water quality. Launched in 2013, the Jefferson Project is a partnership between Rensselaer Polytechnic Institute (RPI), IBM, and a local NGO, the FUND for Lake George. The project involves more than 30 RPI faculty and senior researchers and 18 IBM scientists.

The project takes an integrated approach by combining traditional sampling, advanced sensor sampling, experimenting, and computer modeling. Data on the lake and its tributaries are gathered by traditional sampling of the chemistry and food web as well as a network of 52 sensor platforms comprised of more than 500 sensors. These sensors collect nine terabytes of physical and chemical data annually as part of an IoT Smart Sensor Network. Some of these sensor platforms are designed and built "in-house." Machine learning algorithms support 'adaptive sampling' to optimize when and where the sampling takes place. The data feed models of the weather, lake circulation, hydrology, and food webs. Every morning, IBM's supercomputers deliver high-resolution forecasts every 10 minutes for a 36-hour period. Experimental venues range from highly controlled lab experiment to large in-lake mesocosm experiments that examine the separate and combined effects of different anthropogenic stressors. New work includes the development of low-cost phosphate sensors and a new 'Scenario Engine' that will enable policy makers to better understand feedback loops and future conditions of the lake under different potential policy scenarios. The project also emphasizes moving from science to real-world solutions, producing insights into the need to reduce road salt pollution, the impacts of excess nutrients, and the consequences of invasive species[40].

Use Case 4: Water Drones to Measure Water Pollution in the Volga River, Russia

Technologies: **Libelium IoT Smart Water platform, Blockchain and Sensors**

Airalab Rus, Libelium and the Tolyatti State University co-developed the "Drone on the Volga" project. They each brought a unique set of skills and technology to build a solar-and battery powered water drone with built in sensors to measure water quality parameters and an onboard computer which allows for communication with an open source platform and network (Robonomics)[41]. Robonomics uses blockchain technology that allows citizens/public users to request, negotiate and pay for a service from the drone. Water temperature, pH, dissolved oxygen, water conductivity, ions of NH4+ and NO3- are just a few measurements recorded in a public blockchain, using the Ethereum blockchain platform, ensuring data transparency. The technologies combined in the project aimed to demonstrate how decentralized environmental monitoring could occur with limited oversight.

[40] (The Jefferson Project at Lake George, Advancing Science and technology for Freshwater Ecosystem Protection, ND)
[41] (Drones, Sensors and Blockchain for Water Quality Control in the Volga River to Promote Trustworthy Data and Transparency 2018)

Use Case 5 & 6: Artificial Intelligence to Optimize Utility Processes

Technologies: **CSIRO's FLECK™ Sensors**

Use Case 5 - Australia's Lake Wivenhoe Catchment Area

In 2009, the Commonwealth Scientific and Industrial Research Organization (CSIRO), an independent Australian federal government agency responsible for scientific research, and a Queensland local water authority, SEQWater, partnered to pilot one the first applications of sensor network technology to monitor water quality and quantity. They developed a monitoring program in the Lake Wivenhoe catchment area, which supplied water to the region's then more than 1.5 million residents. [42]

The partnership of agencies deployed approximately 120 sensor nodes – CSIRO's FLECK™ smart wireless sensor technology – on Lake Wivenhoe and in the surrounding catchment to monitor environmental conditions, including water quality, supply and flows. Among these, 40 nodes were set afloat on the lake to monitor water temperature profiles at different depths. Temperatures detectable from these floating nodes correlated with pollution levels in the lake, thus illuminating to authorities when and where to treat water downstream. Land-based nodes in the network provided comprehensive data on the behaviors of livestock and other animals in the catchment region that might contribute to the pollution of its waterways.[43]

Use Case 6 – Singapore's Smart Water Grid

In 2016, Singapore implemented a Smart Water Grid system to support its Public Utilities Board (PUB)'s goals of providing quality water to customers while simultaneously encouraging water-saving behavior.

PUB, which delivers more than 430 million gallons of water to customers each day, called upon SUEZ Environment, a French utility company specialized in waste management and water treatment, for its expertise in smart water technologies. The parties agreed to jointly develop technologies targeted at protecting water resources by harnessing data and effective decision support mechanisms. In conjunction with this commitment, Suez opened a Singapore-based Innovation Center, composed of 15 research scientists and engineers to support project development.[44]

One of the primary products of this collaboration has been the deployment of a network of wireless sensors across the island to gather real-time monitoring data from throughout the water distribution system. This network of wireless sensors gathers information on usage rates, pressure and water quality within the delivery infrastructure and can identify emerging leaks.[45] The data gathered via the network of sensors allows authorities to more effectively model for future demand on water resources, reduce non-revenue water due to infrastructure failures, optimize energy usage, and provide quality water with fewer disruptions to service.[46] The data unlocked via the new sensor network is helping the PUB more efficiently use and conserve water resources. The data can also be translated into educational tools to encourage water-saving behavior among customers.[47]

[42] (Wireless Sensor Networks for Water Management that supports Differentiated Services 2013)
[43] (CSIRO Wivenhoe Water Quality Monitoring 2016)
[44] (Suez environment opens a new regional business hub in Singapore pursuing its development in the smart water market 2015
[45] (Managing the water distribution network with a smart water grid 2016)
[46] (Singapores smart water grid nd)
[47] (Singapore and Suez partner on smart water grid project 2015)

Use Case 7 & 8: Artificial Intelligence to Optimize Utility Processes

Technologies: Artificial Intelligence Platform

Use Case 7 – United Utilities in England

EMAGIN, a Canadian tech company out of the Toronto-Waterloo Region corridor, merges expertise in process engineering and digital technology to provide process optimization tools to businesses.[48] Specifically, the company harnesses the power of AI to predict and optimize utility operations.[49]

EMAGIN's signature product is a Hybrid Adaptive Real-Time Virtual Intelligence system (HARVI). The HARVI platform employs AI to streamline activities to be as efficient, effective, and smooth as possible. HARVI can also generate real-time predictions of asset performance, helping to predict events that might disrupt service.[50] In the water sector, this platform can allow a utility to predict and quickly remedy infrastructure degradation or failures, thereby reducing non revenue water and ensuring safe, reliable water supplies to consumers. The technology can also be used to assist a utility in planning for high demand or loading events.

In 2018, United Utilities in England partnered with EMAGIN, implementing the company's HARVI technology to optimize its services. Initial implementation of the AI-enabled optimization technology resulted in a 22% energy savings. HARVI is scheduled to be fully implemented throughout the water utility's operations by the end of 2019.[51]

Use Case 8 – JEA: Water, Sewer and Electric Provider for Jacksonville, Florida

JEA is a community-owned utility serving an estimated 478,000 electric, 357,000 water, 279,000 sewer customers and 15,000 reclaimed water customers[52]. JEA is considered one of the early adopters of artificial intelligence to operate a production well field. JEA changed its standard operating procedures once it became clear that there aquifer withdrawals in the St. Johns River Water Management District were unsustainable.

With the help of Idea Integration, JEA installed a new system, Optimized System Controls of Aquifer Resources (OSCAR). The system monitors and regulates the water pumped from the aquifer by evaluating data in real time, providing water for immediate use as opposed to storing water for later use. OSCAR regulates the pumping of water from the aquifer by integrating data from a variety of sources, including weather related data[53].

This system, supported by supplementary software allows operations staff to develop daily forecasting schedules, allowing for efficient pumping across all wells within the grid. This means that wells located nearest to where the demand is, will be pumped first and supplemented with water from wells further away. In addition, the system also allows for flow adjustments from wells, ensuring that wells are not depleted. There have been significant benefits of the system, optimized well production, reservoir storage, pump and energy efficiency and lower operational costs.

[48] (EMAGIN website nd)
[49] (How Digital Technology Can Be the Fundamental Agent of Change in the Modernization of Global Water Infrastructure 2018)
[50] (EMAGIN website nd)
[51] (United Utilities Becomes the First Water Utility to Adopt AI 2018)
[52] (JEA website, nd)
[53] (Artificial Intelligence helps JEA Optimize Water Resources 2006)

Use Case 9: Aqaix Employs Artificial Intelligence and Blockchain Technology to Develop Financing for Water Projects

Technologies: Artificial Intelligence, Blockchain

Aqaix, a Silicon Valley startup, seeks to transform how projects within the water space are financed, with the ultimate goal of bringing more capital to projects advancing conservation, groundwater recharge and storm water retention, among others.[54] The "Software as a Service" company seeks to integrate data and the power of digital technologies like AI and blockchain to facilitate de-risked investment in projects.[55]

In February 2019, Aqaix announced a partnership with QStone Capital, an emerging water investment advisory boutique focused on wastewater treatment and technology. QStone has specialized in bringing capital to novel water treatment endeavors, primarily in India and the Middle East. The partnership of Aqaix and QStone Capital seeks to blend the companies' expertise, respectively, in applying smart software to facilitate water investment and executing innovative water project finance and development. The two companies share a vision of mobilizing private capital to the under-funded water sector, supporting water conservation, and sustainable development.[56]

These case studies highlight a few ways in which digital technologies are being utilized around the world to address water quality and quantity challenges. As shown above, transformative water management often requires new partnerships and the combined use of several innovative technologies. Although many digital water projects are still in proof-of-concept stages, the following section illuminates the continued growth of the digital water market as well as the funding sources available to accelerate projects around water conservation and quality.

4 EMERGING DIGITAL TECHNOLOGY OPPORTUNITIES

Several emerging opportunities in the areas of digital technology and financing are providing hope for water resource management in the CRB. As the market for digital solutions expands, new digital technologies are developing with the potential for addressing some of the many water challenges faced by Basin states. Uptake of such digital technologies is already occurring across the CRB, laying the foundation for future pilot projects and a scaling of digital water technologies. By utilizing financing opportunities available for water sustainability projects and pursuing innovative financing strategies, water sustainability may soon be a reality in the CRB.

4.1 Market Expansion

The CRB is not unique in its thirst for limited water resources. As the benefits and necessity of water conservation have become clearer, the digital technology market has been expanding to provide new solutions. Digital technologies are now emerging to fill niches across the water sector with not only new innovations, but innovative ways of using established technologies as well. Many such digital technologies have implications for water conservation and sustainable management and are already being deployed by utilities, industries, and in agriculture alike. Below (Table 3) are examples of

[54] (Aquaix and QStone Capital to Develop Software and Source Opportunities in Water Finance 2019)
[55] (Water Action Hub 2019)
[56] Ibid at 20

technology and solutions providers highlighted in the press for their emerging potential as the market expands.

Table 3: Platforms and applications emerging as the market expands for digital water technologies

Platform	Application
Apana: uses meters and sensors connected through the Internet of Things to monitor water infrastructure in real time. The technology is paired with artificial intelligence that analyzes the data generated for anomalies, identifying leaks, breaks, and other malfunctioning equipment and sending notifications to managers.	*Acoustic Sensing Technologies*: uses sonar to detect and asses leaks or pipe breaks deep underground; combines hardware, software and data analytics to survey pipelines.
Gybe: uses satellite imagery and proprietary ground-based hardware to aid in the management, conservation, and restoration of aquatic ecosystems. Gybe products provide insights on water quality (e.g., nutrient and sediment pollution, the onset and severity of harmful algal blooms, land use, and more) by processing broad ranges of data from multiple sensors and satellites.	*Arable Labs*: has developed an irrigation management tool that combines precipitation, radiation, evapotranspiration, humidity, temperature, soil moisture, water stress, and other variables to help farmers prioritize irrigation efforts by sharing data from solar powered remote sensors directly to a smart phone or tablet application.
Hydromodel Host: groundwater management tool for planners, water managers, and aquifer users that utilizes cloud services to automatically upload field data and run simulations of scenarios under complex conditions to assess the impact of future demand, calculate maximum extraction volumes to ensure sustainability, understand the impacts of climate change, assess the impact of land use, and more	*Crop Metrics*: uses field probes to collect data on soil moisture which is then paired with crop models and weather data and used to drive irrigation scheduling. Data and recommendations are stored in the cloud and shared to users via a mobile app. Coming in 2020, machine learning will also be used to adjust pivot application rates based on real-time crop and weather conditions.
WaterChain: uses blockchain and distributed ledger technologies to open funding for developing smarter water treatment facilities. WaterChain utilizes smart contracts and cryptocurrencies to accelerate water projects in order to better address the global drinking water crisis.	*Flo*: in-home sensor that continuously checks for leaks, alerting home-owners to issues through an app; allows users to set conservation goals, monitor consumption, and remotely shut off water in the event of a leak or pipe burst.
Water Ledger: developed by Civic Ledger using the public blockchain Ethereum. Water Ledger has been used by the Australian government to verify water trades, update records of trades in the state registry, and identify the location of water trades.	*Fracta*: uses artificial intelligence and machine learning to assess the condition and risk associated with utility drinking water distribution mains. The Fracta software performs Likelihood of Failure, Consequence of Failure, and Business Risk Exposure assessments for utilities through a SaaS system and cloud applications.
	Plutoshift: algorithms designed to analyze existing data from SCADA systems, sensors, and meters in order to provide insights regarding excess resources consumption (e.g., chemicals for treatment of wastewater – industrial or municipal), process optimization for energy efficiency or water conservation, and equipment maintenance.
	Utilis: uses sensors on satellites with a signal that can penetrate the first few meters the Earth to collect data which is then analyzed to pinpoint leaks in utilities' underground infrastructure.

With the emergence of new digital technologies and market expansion in the digital water realm, there are a plethora of opportunities for adopting and scaling digital solutions. As the following section elaborates, many of these digital technologies are already being adopted across the CRB to address some of the many water challenges the region faces.

4.2 Regional Potential for Digital Technology

The adoption of digital technologies in the water sector has been slower than in other sectors (e.g., energy and transportation); nonetheless, a scaling of digital solutions is critical for addressing the water scarcity challenges faced by the CRB both now and in the future. Albeit far from widespread, digital technologies have begun to be adopted in the pursuit of water conservation in the CRB. As discussed in Section 3, pilot projects are currently underway in California.

Similar to drought stricken California, the desert metropolis of Las Vegas faces the challenges of water scarcity paired with a high demand for water from residents as well as the city's infamous resorts and casinos. Leaks and major water losses can be disastrous for utilities and ratepayers alike, thus the Las Vegas Valley Water District has worked with solutions providers to deploy sensors and IoT infrastructure across their service lines to aid in leak detection. [57] In addition, some of the city's casinos are taking conservation into their own hands. Atlantis Casino Resort Spa has adopted smart water-metering and AI to detect leaks, preventing damage and reducing water loss.[58] Smart meters from WINT Water Intelligence are installed throughout the resort's facilities and are linked to a cloud-computing service. The system tracks water flows, identifying anomalies and alerting resort managers to any issues.

Meanwhile, in Arizona, sensors are used at the ASU Smart Devil football stadium to monitor sinks and automatically shut off water that is left running.[59] Whereas custodial staff previously required several days to perform maintenance on all the stadium's bathrooms, water loss can now be addressed within minutes, aiding campus conservation efforts.

In addition to initiatives taken by the private sector, digital technologies have been explored by state legislatures in the region as viable tools for addressing water challenges. In early 2019, Coloradan state legislators proposed a bill that would task the Colorado Water Institute with exploring the use of blockchain technology in water rights management, citing potential benefits such as database management and data tracking for more informed decision making.[60] The bill also explored the potential for developing and operating a water market with the use of blockchain. Although the bill did not advance, it shows that conversations around digital water are widespread and occurring at a high level in CRB states.

4.3 Funding Opportunities

Many financing opportunities exist for funding digital water projects in the CRB and a combination of such opportunities will need to be pursued by project developers to implement and scale solutions to the Basin's water challenges. Opportunities range from strategic partnerships with foundations and corporations (as discussed previously in Section 2.1.3) to grants and green bonds. Although the following section is not a comprehensive list of financing opportunities, it provides a foundation from which interested parties can begin exploring sources of funding for digital water projects.

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[57] (Las Vegas Utility Refuses to Gamble with Water Mains 2017)
[58] (Nevada Casino Resort Uses AI to Manage Water Consumption 2019)
[59] (Arizona State University Embed Sensors Deep into Student Life 2017)
[60] (Colorado Senator Wants to Study Blockchain for Water Rights Management 2019)

Whereas many corporations are taking sustainability initiatives into their own hands within their operations and supply chains, corporations are also taking a new approach to investing in digital water solutions. According to a recent article in Forbes magazine, corporations are beginning to invest directly in water technology start-ups, eventually becoming acquirers once the start-up is established.[61] The corporation can then help to accelerate the development of the young company through their more established marketing and distribution networks. Veolia, SUEZ, GE, and others have played a role as strategic investors in start-ups, and in this way are helping to finance and scale digital water solutions.

In addition to investing in start-ups, digital water projects can more directly be financed by one of several foundations with missions focused on water, conservation, sustainability, climate change and more. A list of foundations with interests in water and/or the CRB are provided below:

- Walton Family Foundation: has a focus on conserving oceans, coasts and rivers all while promoting healthy economies and communities. The WFF is committed to finding solutions that benefit nature and people and supports efforts specific to the CRB, including developing a water bank, securing funding for agriculture and urban water conservation and restoring river flows in targeted areas throughout the CRB.

- The Gates Family Foundation: has specific ties to Colorado and seeks to advance new tools, processes and ideas to realize a long-term, sustainable balance between water demands. Prioritizes projects that promote cross-sector cooperation and market-based tools, connect land use and water conservation, support instream flows and healthy rivers and develop better water data and analysis.

- Encourage Capital: has built a community of investors, foundations, market-leading companies, and non-profits to deploy private capital into solutions for world challenges. Encourage Capital recognizes the opportunity for investments in the CRB and is developing strategies for conserving water through infrastructure and land management projects.

- The Rockefeller Foundation: promotes the well-being of humanity through projects pertaining to sustainable agriculture and climate change resilience among others.

- Pisces Foundation: supports smart water management in cities, using technology to protect water, increasing peer-to-peer sharing, smart water management on farms, and developing modern water policies.

- The Ford Foundation: seeks to improve natural resource governance, challenge irresponsible natural resource extraction, and support climate change policies and investments that benefit rural and indigenous communities.

Several financing opportunities also exist through the US federal government. For example, the US Bureau of Reclamation offers WaterSMART Water and Energy Efficiency Grants through which it provides 50/50 cost share funding to irrigation and water districts, tribes, states, and other entities' water or power delivery authority. Grants are used to conserve and use water more efficiently, mitigate conflict risk, increase hydropower production, and otherwise promote water supply reliability in the western United States. The selection process focuses on projects that can be completed in 2 to 3 years.

[61] (Capital Flowing to Water Technology Startups From Big Corporations 2019)

Other federal grants are available through the EPA, US Department of Agriculture, and US Department of Housing and Urban Development including the Clean Water State Revolving Fund, Drinking Water State Revolving Fund, USDA Rural Development Water and Environmental Program, and more. An extensive list of government funding sources and other resources can be found at: https://www.epa.gov/waterfinancecenter/effective-funding-frameworks-water-infrastructure.

In addition to federal grants, green bonds are another means to finance digital water and sustainability initiatives. A green bond is a bond whose proceeds are used to fund environmental projects, often issued by the government or private companies. The World Resources Institute is one organization working to build the frameworks for issuing green bonds to pilot source water protection projects; support conservation, restoration and enhanced water stewardship; and to finance green-gray infrastructure projects.

Other innovative financing methods are emerging as well such as the WaterWorks Fund which has designed a platform for entities to fundraise and individuals to invest in sustainable water solutions. The platform was developed to support the UN Sustainability Goal #6 regarding clean water and sanitation and to promote healthy waters, watersheds and communities. Likewise, the Water Funder Initiative has initiated a campaign to accelerate progress toward a sustainable water future in the CRB and is leveraging funding from private and public partners to improve water distribution in the West, drive data-informed decision making, improve water governance, and accelerate innovation.

No single financing opportunity will provide the funding necessary to address the water quality and quantity challenges in the CRB. Rather, meeting the shortfalls in regional infrastructure and technology investments will require corporations and private entities to invest more in water conservation and efficiency initiatives, increased private investment, new partnerships, grants, and green bonds among other financing strategies. By leveraging new technologies, seeking innovative partnerships, and developing broad financing portfolios it is possible to achieve sustainable water management in the CRB, ensuring water quality and quantity needs are met for nature and society alike.

Digital technologies are already being developed in the CRB as a solution to water challenges, yet uptake of such solutions must accelerate and be further scaled across the region if the issues of water scarcity and quality are to truly be tackled. As the science fiction author William Gibson wrote, "The future is already here. It's just not evenly distributed yet." Technologies to address the region's water challenges exist – it will now require innovative funding portfolios for investing in, piloting, and scaling technologies across the CRB.

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Written Statement on Technology and Innovation to Increase Water Security for Economic Development in the West

Committee on Energy and Natural Resources

Subcommittee on Water and Power

October 30th, 2019

Patricia Sinicropi

Executive Director

WateReuse Association

Thank you for providing the opportunity to submit written testimony on the use of technology and innovation to increase water security and enable economic development in the West. I submit today on behalf of the WateReuse Association and its members to highlight the importance of water reuse and recycling across the nation and the West.

The WateReuse Association is a not-for-profit trade association for water utilities, businesses, industrial and commercial enterprises, non-profit organizations, and research entities that engage in and on water recycling. WateReuse and its state and regional sections represent more than 250 water utilities serving over 60 million customers, and over 350 businesses, research institutions, and organizations across the county. Our mission is to engage our members in a movement for safe and sustainable water supplies, to promote acceptance and support of recycled water, and to advocate for policies and funding that increase water reuse.

Safe and reliable water supplies for human use, agriculture, business, industry, recreation, and healthy ecosystems are critical to our nation's communities and economy. Because of various pressures, 80 percent of U.S. states anticipate water shortages in some parts of their states in the next decade. Communities, agriculture, and businesses are looking to diversify their supply portfolios to meet current and future needs. Water reuse (also commonly known as water recycling or water reclamation) represents a major opportunity to assure the quality of and supplement existing water supplies from sources such as industrial process water, agricultural return flows, municipal wastewater, oil and gas produced water, and stormwater.

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Water is critical to our nation's health, strength, security, and resilience, but the solutions available to manage water and its availability are often complex. Water reuse can be an important tool to enhance the availability and effective use of water resources. There are various names for integrated and collaborative water management approaches (e.g., "One Water" and "Total Water Solutions"). Regardless of the terminology, the concept works to replace the traditional, fragmented, approach often applied to water resources management with broader, more comprehensive solutions and strategies to meet diverse water quality and quantity needs. Because implementing water reuse often cuts across federal, state, and regional water programs and may involve multiple local jurisdictions, the decision to recycle water often requires some degree of integrated planning. EPA has kicked off a National Water Reuse Plan which works to bring federal agencies together to work with state, local, and private sectors to remove hurdles and bring innovation to the water reuse arena.

As you know, there has been a water reuse paradigm shift. For decades, drinking water and wastewater services have been siloed. Water supply is pumped from ground or surface water, and treated to comply with Safe Drinking Water Act. Wastewater is collected, moved quickly downstream, treated to acceptable standards, and disposed of without harming the environment. As we move forward, however, the trend for the future includes managing resources to maximize value for communities, citizens, the environment, and the private sector. "Waste" water and its constituents, such as nutrients, are now seen as a resource. The idea is to use a holistic "one water" approach to water management.

Today, water is recycled from coast-to-coast. For example, 6.5 billion gallons of recycled water is used for Idaho's agriculture. 92% of the recycled water Idaho produces is used to irrigate crops, a beneficial use that keeps 2000 tons of nitrogen and 500 tons of phosphorus out of Idaho rivers and streams. General Motors captures and reuses stormwater for cooling towers at the Detroit-Hamtramck assembly plant, saving $2 million a year. Gillette Stadium in Foxboro, Massachusetts, home to the New England Patriots, uses on-site, decentralized water recycling to meet its water demands. This NFL team generates $4 million annually for the local economy.

Orange County, California uses recycling to supply drinking water for 850,000 taps and one-third of its homes and businesses. In Nevada's desert, a planned 13 mile pipeline will provide 1.3 billion gallons of recycled water annually to Tahoe Reno Industrial Center, home of Tesla, Switch, and Google, as well as 20,000 new jobs. The Snowbowl, a ski resort in Arizona's San Francisco Peaks, uses recycled water for its slopes, sustaining a $35 million tourism industry. Recycled water replenishes the Upper Trinity River in Texas and man-made wetlands--restoring a natural habitat for migratory birds and supplying drinking water for the Dallas/Ft. Worth area.

For non-potable reuse, 100 million gallons a year of Class A water is used to meet seasonal demands in Washington State. Uses include municipal parks, schools and athletic fields, golf courses, wetland recharge and restoration.

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For direct potable reuse, the Big Spring Water Supply Augmentation Project in Texas blends advanced treated recycled water with lakes to produce a high-quality drinking water. It uses microfiltration, reverse osmosis and ultraviolet disinfection, and blends 16 MGD of advanced treated water with 21 MGD of traditional sources. In El Paso, Texas, its advanced water purification facilities are direct-to-distribution. When completed, the facility will produce up to 10 million gallons per day of water. It is unlike other potable reuse systems in the United States because the purified water will not go through a drinking water treatment plant.

Reuse is starting to mean new things, as well. For example, at the Santa Monica, California Stormwater Reuse Urban Runoff Recycling Facility, 500,000 gallons of dry season urban runoff are treated daily which eliminates pollution of Santa Monica Bay and produces high quality water for reuse in landscape irrigation.

And on the industrial side, there is Industrial Water Reuse at Frito Lay Snack Food Plant in Casa Grande Arizona. The plant runs almost entirely on recycled water while producing nearly zero waste. Wastewater is treated onsite with membrane bioreactors, granular activated carbon, ultraviolet light disinfection, and reverse osmosis technologies. The water meets EPA primary and secondary drinking standards for food contact.

We believe this is an exciting time for water reuse as the field is growing both on the public and private side driving innovation and new technologies to increase our water reliability, water security and driving the economies of our cities and states in the West and across the county. Water reuse has evolved from early irrigation applications to potable to industrial and on-site decentralized systems. There is a growing field of research and development around energy efficiency and brine management. We see a diverse water management portfolio developing across the country, which is increasing our water resilience. With industrial reuse, potable reuse, decentralized reuse, green infrastructure, purple pipe irrigation and tertiary treatment, watersheds across the country are significantly growing their water management portfolios. It is an exciting time for water innovation, and we're pleased to answer any questions you may have.

For more information, please contact the WateReuse Association's Policy Director, Greg Fogel, at gfogel@watereuse.org.