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Foreword

Water Exchanges: Arizona's Most Recent Innovation in Water Law and Policy

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Abstract

The words "Arizona" and "progressive" are seldom used in the same sentence but, when it comes to water, Arizona has a distinguished record of innovation in water law and policy. This article explores novel solutions to water shortages recently developed by Arizona water lawyers and managers. It draws on presentations at an Arizona Water Law conference hosted by the Arizona College of Law Rogers College of Law in December 2017. The recurring tool is water exchanges, that is, the substitution of one type of water for another, such as Colorado River water delivered through the Central Arizona Project for groundwater. Exchanges have become a reliable and valuable tool to solve seemingly intractable engineering challenges.

Lest I be perceived as simply a shill for my adopted State, I'll also critique some foibles and missteps in water management. Arizona water managers are chasing a rainbow in pursuing "augmentation" in the form of desalination from ocean water off the coast of California or Mexico.

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I. Introduction

Arizona has a distinguished record of innovation in water law and policy. On December 1, 2017, the University of Arizona, James E. Rogers College of Law hosted an Arizona Water Law and Policy Conference at which presenters addressed the myriad contemporary challenges facing state and local water suppliers. In my mind, the most striking theme that emerged was the creativity shown in devising novel solutions to water shortages. Water exchanges, that is, the substitution of one type of water supply for another (such as Colorado River water delivered through the Central Arizona Project for groundwater) have become a reliable and valuable tool to solve seemingly intractable engineering challenges.

This article will canvass key challenges facing the State of Arizona and comment on why business-as-usual is no longer an option for water managers. I will argue that Arizona has a remarkable track record of innovation in water law, and will use recent water exchanges to illustrate the creativity displayed by water lawyers in devising workable solutions to water shortages. Despite these innovations, there are areas in which Arizona has failed adequately to manage its water. At the end, I'll discuss three failures.

II. Challenges

In 2015-2016, as Maricopa County continued to shake off the effects of the Great Recession, its population growth rate became the highest in the country. The allure of the Southwest remains strong, and demographers predict that the state's population will climb from 6.9 million in 2017 to 8.2 million by 2030.[2] Finding enough water will challenge Arizona's water managers for the foreseeable future.

At the same time, the Earth is getting warmer. The year 2014 was the hottest on record. Then 2015 happened to be hotter, followed by 2016 and 2017 being hotter still.[3] Scientists predict that climate change will result in reduced precipitation for the Southwest in general. Warmer temperatures mean that more precipitation will come in the form of rain rather than snow. This shift may seem trivial, but consider this riddle: "Where does Arizona store its water?" The conventional answer is in lakes behind the dams on the Salt, Gila, and Colorado Rivers. While technically correct, that answer is incomplete. Most of Arizona's water is stored as snowpack in the White Mountains and the Rocky Mountains. Warmer temperatures mean more rain, less snow, more runoff in the shoulder seasons, and, most importantly, more evaporation, which will reduce the amount of water available for cities, industry, and farmers.

For water supplies, Arizona principally relies on three different sources: surface water diverted from the Salt, Verde, and Upper Gila Rivers; groundwater pumped from wells around the state; and Colorado River water delivered to Maricopa, Pinal and Pima Counties through the Central Arizona Project (CAP) canal. Virtually all the surface water

[2] Shonel Sen, *National Population Projections: Growing But Slowing*, STATCHAT (May 11, 2016).
[3] Justin Gillis, *Earth Sets a Temperature Record for the Third Straight Year*, N.Y. TIMES, Jan. 18, 2017.

is committed to existing users under the prior appropriation doctrine. Groundwater supplies have stabilized in the most populous areas of the state, which are governed by the Arizona Groundwater Management Act, though even in Active Management Areas (AMAs), excessive groundwater pumping causes land subsidence. Outside AMAs, the so-called "reasonable use" doctrine governs. An oxymoron, this doctrine allows for the drilling of new wells with essentially no limits on pumping, setting the stage for uncontrolled pumping and plummeting water tables.[4]

In Arizona, when water suppliers have needed more water, business-as-usual has meant increasing diversions from rivers, drilling new wells, and/or building new dams. In 2018, surface water is already committed; groundwater pumping that lowers the water table is, by definition, unsustainable. The major rivers have already been dammed, most repeatedly. It's possible that a couple of small dams may yet be built on small tributaries. But these new impoundments will not significantly increase the state's water supplies. In short, business-as-usual is not a viable option. That proverbial well runs dry.

New water sources are needed, and the hunt is on. "Augmentation," as they call it, can amount to little more than dowsing. Bizarre proposals occasionally crop up to divert a river in British Columbia or tow an iceberg from the Arctic. My favorite surreal solution involves cloud seeding, or "weather modification" as proponents prefer to call it. Cloud seeding involves adding silver iodide to clouds by dropping it from airplanes or shooting it from cannons on the sides of mountains. The idea is to coordinate these events when the humidity is high, with hopes that the silver iodide will sufficiently elevate the humidity to produce rain. Alas, the National Resource Council (NRC) of the National Academies concluded in a report that "there still is no convincing scientific proof of the efficacy of intentional weather modification efforts."[5] The harsh judgment of the NRC has not halted cloud seeding projects around the West.[6] These ventures provide an example of the triumph of hope over experience. Just because it hasn't worked, doesn't mean it won't.

Arizona's most notable augmentation project is the Central Arizona Project. A 330-mile long canal, the CAP delivers Colorado River water from Parker, Arizona across the desert to Phoenix, south to farmers in Pinal County, and on to Tucson.[7] At a cost of more than $4 billion, paid mostly by the federal government, the CAP represents the ultimate in trans-basin diversions. Arizona's largest energy user, the CAP uses 115 giant pumps to lift water 2,900 vertical feet as it traverses the state. Starting with Senator Carl Hayden in the 1920s, the CAP fulfilled the dreams of generations of elected officials in Arizona by fueling Central Arizona's economic growth.

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[4] *See generally*, ROBERT GLENNON, WATER FOLLIES: GROUNDWATER PUMPING AND THE FATE OF AMERICA'S FRESH WATERS (2002).
[5] ROBERT GLENNON, UNQUENCHABLE 141-146 (2009).
[6] See, e.g., Sophie Quinton, *Why Cloud Seeding Is Increasingly Attractive to the Thirsty West*, STATELINE, Feb. 20, 2018.
[7] Robert Glennon, *Coattails of the Past: Using and Financing the Central Arizona Project*, ARIZ. ST. L. J. (1995).

That dream became reality in 1968 when Congress enacted the Colorado River Basin Project Act, which not only authorized the CAP but also appropriated funds to build it. But the funding came with a hitch. California was still smarting over the victory Arizona obtained at the U.S. Supreme Court in *Arizona v. California* in 1963.[8] The Court held that in the Boulder Canyon Project Act of 1928, Congress had divided the Lower Colorado River Basin's water to give California 4.4 million acre feet (MAF), Nevada 0.3 MAF, and Arizona 2.8 MAF, and reserved to Arizona the exclusive beneficial use of the Gila River.[9] The problem for California was that, between 1928 and 1963, it had entered contracts with the Secretary of the Interior to divert 5.3 MAF. Thus, *Arizona v. California* essentially turned the clock back and required California to stop diverting about 900,000 acre-feet of Colorado River water. California would exact a heavy price to right this perceived wrong.

In exchange for its congressional delegation's support for funding the CAP, California insisted that it receive the highest priority in the event of a shortage on the Colorado River. In other words, if less water became available than was allocated, California's supplies would be reduced last. The second priority was for Nevada's 0.3 and Arizona's 1.4 MAF for uses along the River. The lowest priority went to Arizona's 1.4 MAF for the CAP.[10] At the time, Arizona was happy to make this concession, as it was believed that the Colorado River annually carried 18 or 20 MAF. Subsequent tree-ring studies at the University of Arizona, however, determined that the mean annual flow is only 14 MAF.[11]

This creates a huge problem of math for Arizona. The Colorado River Compact of 1922 allocated 7.5 MAF to the Upper Basin and another 7.5 to the Lower Basin. The 1944 Mexican – United States Treaty allocated 1.5 MAF to the Republic of Mexico. That totals 16.5 MAF. But things get worse for Arizona. Evaporation losses off Lakes Mead and Powell annually amount to about 1.6 MAF; climate change is predicted to lower Colorado River flows by nine to 25 percent. In short, paper rights to water annually exceed wet water in the River by millions of acre-feet.[12] If water rights holders take their full allocations every year, Lakes Mead and Powell will eventually dry up.

As a first step toward addressing these shortages, in 2007 the Secretary of the Interior approved shortages guidelines agreed to by the seven Colorado River Basin states. The agreement specified quantities of water that each of the Lower Basin States would lose if the level in Lake Mead dropped below 1075, 1050, and 1025 feet above sea level.[13]

III. Necessity is the Mother of Invention

[8] *See* Arizona v. California*, 376 U.S. 340, 343 (1964)*.
[9] *See* Boulder Canyon Project Act of 1928, Pub. L. No. 642 (codified as amended in 43 U.S.C.A. § 617).
[10] Colorado River Basin Project Act, 43 U.S.C. §§ 1501-1556 (1968).
[11] Robert Glennon, *A Problem of Math*, GRAND CANYON TR. ADVOC. (2016) http://www.grandcanyontrust.org/advocatemag/spring-summer-2016/problem-math.
[12] *Id*.
[13] DEP'T OF THE INTERIOR, COLORADO RIVER INTERIM GUIDELINES FOR LOWER BASIN SHORTAGES AND COORDINATED OPERATIONS FOR LAKE POWELL AND LAKE MEAD (2007).

As the proverb goes, necessity is the mother of invention. A critical need often drives innovation. An arid climate, a surging population, and declining groundwater tables drove Arizona to be creative. Although one seldom sees the words "Arizona" and "progressive" in the same sentence, when it comes to water, Arizona has often been at the cutting edge of legal and policy reform. Fear of a water-scarce future has inspired some innovative responses.

Arizona Groundwater Management Act

Though Arizona may be a leader and innovator today, it has not always been so. The 1980 Arizona Groundwater Management Act came about because Arizona in the 1970s was over-pumping its aquifers by two million acre-feet per year, causing land subsidence and driving up energy costs.[14] The situation was so dire that the Carter Administration threatened to withhold funding for the CAP unless Arizona got its house in order. Several years of gnashing of teeth and Governor Bruce Babbitt's skillful use of the bully pulpit persuaded the Arizona Legislature to pass historic legislation. To paraphrase Winston Churchill's comment on the United States, Arizona will always do the right thing -- after it has explored every other option.

The act operates like a ratchet, a wrench that has bite only in one direction, to reduce pumping. A complicated piece of legislation, the Act protected Arizona's groundwater by accomplishing four key things. First, it banned drilling new wells in areas of the State suffering the greatest water table declines. Then, it protected all existing pumpers but started a process to reduce the quantity pumped by existing users until aquifers reached "safe yield," or a balance between inflow and outflow. Third, it made groundwater rights transferrable, allowing new users to purchase water rights from existing pumpers. Fourth, it requires developers, cities, and towns to show that they have an "assured water supply" before they can get permits to break ground for new projects.[15]

After 37 years, the Act seems a success that can serve as a model for combating unsustainable pumping in any part of the world. Take California, for example. That paragon of progressive legislation has virtually failed to regulate groundwater pumping. Land subsidence in the Central Valley has caused the surface of the earth to drop in some places by 25 feet or more. In 2014, the California Legislature enacted the Sustainable Groundwater Management Act, to much fanfare and beating of breasts I might add.[16] Let's see, that's 34 years after its much-maligned neighbor to the East. Oh, and the California law only put in place a process to set rules and limits on pumping. As of 2018, it's still permissible to drill new wells almost anywhere in California. Other states and

[14] *See* A.R.S. § 45-401.
[15] Robert Glennon, "*Because That's Where the Water Is": Retiring Current Water Uses to Achieve the Safe-Yield Objective of the Arizona Groundwater Management Act*, ARIZ. L. REV, (1991).
[16] *See, e.g.*, Chris Austin, *Groundwater Problems and Prospects, Pt. 2: The Story Behind the Passage of the Sustainable Groundwater Mgm't Act*, MAVEN'S NOTEBOOK, Mar. 19, 2015.

parts of the world, however, have followed Arizona's lead in developing innovative legislative and policy solutions to the problem of groundwater management.[17]

Aquifer Storage and Recovery Programs

Arizona finally realized that its aquifers, empty after years of unsustainable groundwater pumping now provided natural spaces to store water. During the years when Arizona's cities and farmers did not use their entire allotment of CAP water, that water could be stored underground for future recovery. The same insight applied equally to water treated by municipalities. Instead of simply sending the water downstream, dump it in constructed recharge basins on top of aquifers and let gravity do its work. In both situations, Arizona devised clever storage solutions that cost little and eliminated the evaporation associated with surface reservoirs by creating and using underground storage mechanisms.[18]

A third Aquifer Storage and Recovery (ASR) program, called "in lieu" recharge, involves a bit of smoke and mirrors.[19] The term "in lieu" is what's known as a legal fiction, a description that isn't quite accurate. With "in lieu" recharge, for example, there is no recharge. Zero. Zip. Nada. Here's an example of how it works: when excess CAP water is available, a water user in Tucson contracts with a farmer in Marana, just outside Tucson, whose farm is located near the CAP canal. The farmer agrees to reduce her groundwater pumping and use CAP water instead; the Tucson user gets credits to pump the groundwater that the farmer would have pumped.[20] It's a form of water exchange, substituting one type of water for another. The net effect does not reduce overall water use but does keep more water in the ground for future needs.

Arizona Water Bank

Closely associated with the ASR program is the Arizona Water Bank. Created in 1996 by Rita Pearson, then-director of the Arizona Department of Water Resources (DWR), and Mike Pearce, then-chief counsel to DWR, the concept is elegant and motivated, seemingly, by lofty aspirations to conserve water for future use. The Bank was created to store Arizona's unused Colorado River water. In essence, the Bank provides banking services to holders of CAP contracts to store water in aquifers; the stored water generates credits for future recovery. A credit holder can use its credits to authorize withdrawals, or sell the credits to other entities that need water. The Bank was a sensible,

[17] *See, e.g.*, Groundwater Mgm't Working Group, *Sustainable Water Future Program of Future Earth*, http://water-future.org/working_groups/groundwater-management/.
[18] ARIZ. REV. STAT. ANN. §§ 45.801.01–45.898.01.
[19] When lawyers start talking about "in lieu" anything, it's time to get a solid grasp on your wallet.
[20] See City of Tucson, *Water Use and Water Law: Mining, Agriculture, and the CAP (A History)*, https://www.tucsonaz.gov/water/water-law (last visited Apr. 24, 2018).

original idea that helped the state secure future water supplies. Since its creation, the Bank has stored more than three MAF of Arizona's unused CAP allocation.[21]

Coincidentally or intentionally, the Bank had another consequence. It effectively hung our water-greedy neighbor to the West up by thumbscrews. During the 1990s when Arizona was only using 500,000 or 600,000 acre-feet of its 1.4 MAF CAP entitlement, California entered into contracts with the Secretary of the Interior to use the remainder.[22] Thanks to the Arizona Water Bank storing unused water, California suddenly lost hundreds of thousands of acre-feet of water. An innocent proposal to secure water for the future had dramatic consequences for California and pushed it to enter into negotiations with the other Basin States to develop shortage guidelines. If this backstory were known at the time, I think Arizonans would have elected Rita their governor.

Reuse of Water

Water issues do not only affect Arizona. Before Congress passed the 1972 Clean Water Act, cities along the Mississippi River routinely dumped their raw sewage into the river. Chicago even reversed the flow of a tributary to ensure that its sewage ended up in the Mississippi and not Lake Michigan. By one estimate, Mississippi River water has been used and reused five or six times between its headwaters in Minnesota and its delta in Louisiana.[23]

The Clean Water Act spurred an enormous infusion of federal funds, helping cities build treatment plants to end the era of spewing sewage into rivers. Problems still exist, of course –some cities' plants can get overwhelmed by heavy deluges during rain storms and dump raw sewage into nearby rivers. But today, our rivers no longer spontaneously combust. A marked improvement indeed.

By the 1980s, the quality of water from treatment plants had improved so dramatically that businesses began to appreciate the economic value of treated water. A great example is the Palo Verde Nuclear Generating Plant, near Phoenix, Arizona. The company arranged to buy treated water from the City of Phoenix to use as cooling water in its power plant. It now uses 20 billion gallons per year for this purpose.

Today, Arizona is one of the leading states in reusing water.[24] We use it to water golf courses, parks, cemeteries, and highway medians. We don't drink it, yet. But we could. [More on direct potable reuse later.] The technology is available to make it perfectly safe. Have you ever thought about what astronauts drink while in space? Reclaimed water is heavily treated but not to potable standards. It offers a perfectly fine

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[21] 2015 ARIZ. WATER BANKING AUTHORITY ANN. REP. (Jul. 1, 2016); *see also* Noah Silber-Coats & Susanna Eden, *Ariz. Water Banking, Recharge, and Recovery*, ARROYO, 2017, at 8-9. The number hits 4 MAF if we include 600,000 acre-feet of Nevada's water stored in Arizona by AWBA.

[22] Arizona v. California, 376 U.S. at 343.

[23] *See* Glennon, *supra* note 5, at 68.

[24] Michael A. Fulton, Arizona's Leadership in Wastewater Reuse, presentation to the W. States Water Council (Oct. 10, 2014), https://legacy.azdeq.gov/environ/water/apec/download/101014_fulton_wwreuse.pdf.

supply for farmers. For example, Pima County provides reclaimed water to farmers in Marana in exchange for the farmers agreeing to reduce their groundwater pumping.[25]

Reclaimed water is not a silver bullet. It's expensive. It requires a separate system of pipes, often purple in color, to keep the reclaimed system separate from the potable system. But the critical advantage is that the water is in hand. Even better, the supply of reclaimed water increases with population. All things considered, potable reuse will likely be a key part of maintaining the water supply needed to support economic and population growth in the Southwest.

Water Harvesting

Brad Lancaster lives in Tucson, Arizona and is a passionate advocate for water harvesting.[26] He conveys his message with charisma and conviction, possessing an evangelical fervor any preacher would envy.[27] The idea is simple enough: water that runs off rooftops, parking lots, streets, and other hardscapes can and should be collected and used for watering gardens and trees. Outdoor landscaping is the largest residential water use; thus water harvesting can substantially reduce the use of potable water for landscaping. In a way, this is another form of water exchange: untreated rainwater for potable water. This saves the cost of having to treat water to potable quality when the use does not require it.

Some western states, including Colorado and Utah, have resisted allowing water harvesting on the theory that water flowing down streets will eventually reach a stream or river. Capturing that water might reduce streamflow and interfere with senior prior appropriators. The problem with this theory is that most precipitation in the arid West does not percolate into the ground and recharge an aquifer, not does it ever reach a watercourse. It evaporates before it can be put to human use.[28] Water harvesting offers a relatively inexpensive way to use rain from the sky, rather than water from the tap, to meet at least some of our water needs.

Conservation

Until recently, whenever I visited Phoenix, I saw water running down the street. Phoenicians love their lawns; but that's changing. Phoenix has made extraordinary progress in water conservation. The City uses less water now than it did in the 1980s, even though the population has ballooned by hundreds of thousands of people. Tucson, too, has enjoyed similar success (see the figure below).

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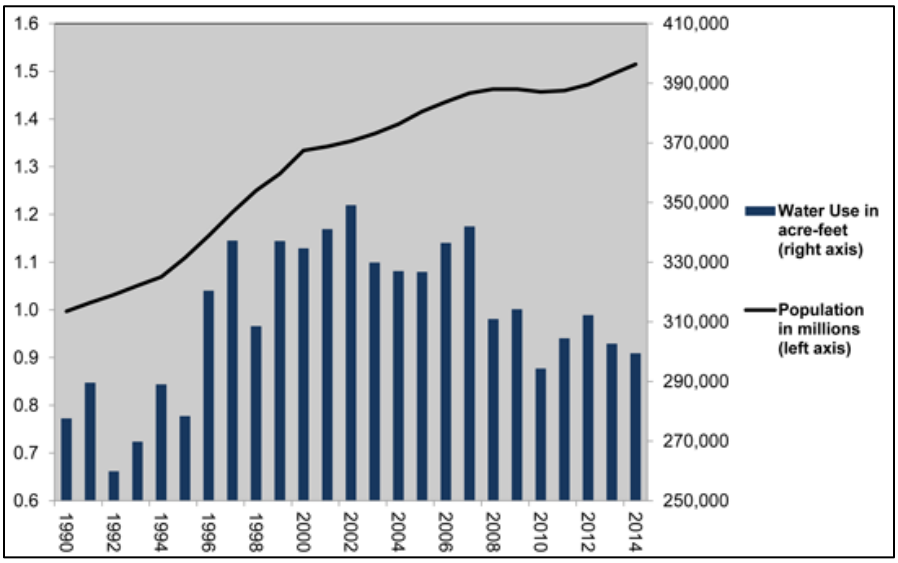
[25] Patty Machelor, *Organic white Sonora Wheat makes comeback in area*, ARIZ. DAILY STAR, Mar. 21, 2015.
[26] *See generally*, BRAD LANCASTER, RAINWATER HARVESTING FOR DRYLANDS AND BEYOND (2007).
[27] *See* Glennon, *supra* note 5, at 183.
[28] *See* U.S. Geological Survey, *Rain and Precipitation*, https://water.usgs.gov/edu/earthrain.html (last visited May 8, 2018).



Several factors have contributed to these surprising results. The Great Recession of 2008 created financial pressure that led many people to reduce their consumption. Other people, behind on their mortgages, vacated their homes and moved away or into apartments, and thus reduced their use or stopped using water.

Additionally, government rules and regulations incentivize water conservation. The Clean Air and Clean Water Acts prompted power plants and industry to take a hard look at ways to reduce emissions, which often involved using water more efficiently. EPA's Water Sense program set water conservation standards for appliances and fixtures, from toilets to shower heads and faucets to washing machines.[29] As new homes deployed high-efficiency fixtures and existing homes replaced old high-use ones, per capita per day water use dropped. The home construction industry built homes with smaller yards and deployed xeriscaping[30] rather than lawns.

For an example of recent innovation, consider the transformation of Maricopa County's East Valley. The Salt River Project (SRP) started as an irrigation district for farmers. In the mid-twentieth century, SRP still flood-irrigated agricultural fields – a highly inefficient method compared to drip or pivot irrigation. As farmland was converted to housing subdivisions, SRP continued the old practice of flooding what had become lawns. Many East Valley homes still have berms around the perimeter of the lot, with drainage pipes that allow the water to flow from one lawn to the next. More recently, SRP has used rebates to encourage conservation. SRP pays homeowners and businesses to rip out lawns; offers financial incentives to install high-efficiency toilets, showerheads, and washing machines; and subsidizes smart irrigation controllers.[31]

[29] U.S. Envt'l Protection Agency, *WaterSense*, https://www.epa.gov/watersense (last visited May 8, 2018).
[30] Dry landscaping designed specifically for areas susceptible to drought or where water conservation is practiced.
[31] Salt River Proj., *Save With SRP*, http://www.savewithsrp.com/ (last visited May 8, 2018).

Sensible price signals helped drive conservation in Tucson, which adopted tiered block rates that increased with use, sending strong conservation signals. Tucson also adjusted the rates seasonally, charging higher rates during the summer when water consumption rises as homeowners fill swimming pools and water lush landscapes. Tucson's rate structure focused homeowners' attention on their discretionary water uses.

As these examples illustrate, Arizona has led the nation with innovative programs to conserve water.

IV. The Innovation Continues

The articles in this Symposium, generated from a conference held on December 1, 2017 at the University of Arizona, James E. Rogers College of Law, offer fresh examples of the creativity of Arizona lawyers and water managers to craft workable solutions to water shortage problems.

Tucson/Phoenix Exchange and System Use Agreement

A wonderful example is the Tucson/Phoenix Exchange and the System Use Agreement, crafted in 2017. Tucson Water's wellfields have the capacity to store twice as much water as the utility needs.[32] Phoenix, in contrast, has currently unused CAP water, but lacks places to store it because the Phoenix metropolitan area is so built out. Phoenix could, in theory, find places to build recharge basins. But building the accompanying distribution network would be a costly endeavor. Tucson Water, on the other hand, has already built a substantial distribution network.

With this background, lawyers and water managers for both cities began a conversation. Suppose that Phoenix's CAP allocation was delivered to Tucson Water. Tucson Water would recharge it for Phoenix, who would in turn get water storage credits.[33] When Phoenix needs that water, it simply can take water that would have formed Tucson's CAP allocation straight from the CAP canal in Phoenix before it ever reaches Tucson. Tucson Water would then obtain credits to pump Phoenix's CAP water stored in Tucson Water's recharge basins. This Tucson/Phoenix exchange saved Phoenix the considerable costs of building a distribution system. Furthermore, Phoenix pays Tucson each year to store its water, amounting to a considerable financial benefit for Tucson, which also gets a secure supply for the future.

The second part of this arrangement involved the Central Arizona Water Control District (CAWCD) board agreeing to allow the CAP canal to be used in ways never imagined when the canal was built.[34] The System Use Agreement allows CAWCD to

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[32] Chris Avery, . *New Flexibility on the Central Arizona Project Canal: The Tucson/Phoenix Exchange and the System Use Agreement*, 8 ARIZ. J. ENVTL. L. & POL'Y 117 [update page number] (2018).
[33] *See* ARIZ. REV. STAT. ANN. §§ 45.801.01–45.898.01.
[34] *See* Cent. Ariz. Proj., *CAP System Use Agreement*, https://www.cap-az.com/departments/planning/service-area-planning/cap-system-use-agreement (last visited May 8, 2018).

deliver Tucson/Phoenix Exchange water through the CAP canal. This novel arrangement benefits Phoenix, demonstrates cooperation between the state's two largest cities, and, most importantly, introduces flexibility into how the CAP canal is managed for the benefit of its users.

Is our future to drink treated effluent?

As water shortages become more severe, the question begs: shouldn't we treat municipal wastewater to potable standards? When newspaper reporters get a whiff of such proposals, headlines follow proclaiming that the idiots on the city council are thinking of making you drink wastewater. "Toilet to tap" is a tough sell. But not impossible.

In 2007, the Orange County Water District in Southern California brought online a plant that treats sewage with traditional microfiltration, then further cleanses it with reverse osmosis, and disinfects it with ultraviolet light and peroxide. The result is water as pure as distilled water. Even then, the District recharges the water into local aquifers, and extracts it later for delivery to consumers. This process, known as *indirect* potable reuse (IPR), obscures the reality that customers are drinking water that came from toilets, showers, and washing machines. The additional step of recharging and extracting the water was probably unnecessary as a matter of public health, but absolutely critical to public acceptance. Even then, the District held 1,200 public meetings over three years to make the case for IPR.[35]

Rob McCandless, a senior engineer with Brown & Caldwell, tackles directly the issue of *direct* potable reuse (DPR). We need to prepare for it but do so cautiously with great attention to the details of implementation.[36] Arizona took a major step forward when ADEQ rescinded its rule prohibiting DPR, effective in 2018. McClandless argues that a DPR system must address three main concerns: 1) Pathogen control (of viruses, protozoa, and bacteria); 2) Chemical control (regulated and unregulated chemicals, such as pharmaceuticals in the water supply); and 3) Treatment technologies and monitoring processes. The risks to human health are so serious, and could spread so rapidly, that a DPR system must have sophisticated monitoring that enables instant identification of out-of-specification water and immediate diversion of that water from the potable system.

Indian Water Rights Settlements

Water exchanges also come into play in negotiations over water rights for Indian tribes. Federal reserved water rights for Indian tribes with reservations in Arizona pose a huge problem for the State. In Arizona, there are 22 federally-recognized tribes with claims to surface water from rivers running through the reservations. But, under the prior

[35] *See* Glennon, *supra* note 5, at 166-69.
[36] Robert McCandless et al., *Potable Reuse: A New Frontier for Arizona's Water Resources*, 8 ARIZ. J. ENVTL. L. & POL'Y [update page number] (2018). . For a major recent report prepared for California, *see* WATEREUSE, AM. WATER WORKS ASS'N, WATER ENV'T FED'N & NAT'L WATER RES. INST., FRAMEWORK FOR DIRECT POTABLE REUSE (2016).

appropriation doctrine, non-Indians are currently using most of the water. Moreover, many reservations were created before non-Indians began to use the water. The U.S. Supreme Court has held that the tribal rights obtain the priority date when the reservation was established, regardless of whether the tribe has used the water.[37] In other words, the quantification of tribal rights threatens to displace existing uses of water, which would cause tremendous economic dislocation.

Pat Sigl, a water rights attorney with the Salt River Project, explores recent settlements of Indian federal reserved rights.[38] Water exchanges have been a useful tool in achieving many of these settlements. Under such a scenario, a tribe waives its right to surface water from a particular river in exchange for getting Colorado River water delivered through the CAP. It's a creative solution to what seemed an intractable problem. And it's made sweeter to tribes by a slug of federal money that enables them to modernize irrigation infrastructure or fund other construction projects. Sigl notes that 13 of the 22 tribes now have adjudicated rights or full or partial settlements, which required congressional authorization and appropriation. These settlements give security to the water rights of both tribes and non-Indians.

A second pattern in these settlements has been congressional authorization for the tribes to sell or lease their CAP water for use off the reservation. The Gila River Water Storage Project is one recent example. In 2013, the Gila River Indian Community (GRIC) and the Salt River Project entered into an agreement. GRIC agreed to store two MAF of its CAP rights in aquifers administered by SRP. This agreement also opens 30,000 acre-feet per year of GRIC's CAP water to lease by Phoenix Valley cities. Such provisions monetize some of GRIC's water rights and diversify its financial portfolio with leases that stretch over periods of time up to 100 years. Sigl powerfully argues that tribal water leases have dramatically benefited Maricopa County. As of 2017, seven tribes have leased 182,000 acre-feet of water – eight percent of the water used in the County in 2016. Eight percent of the County's Gross Domestic Product is $19 billion.

Yogi Berra warned against making predictions, especially about the future. Yet, I hazard to predict that the future holds more settlements involving water exchanges, sales, and leases. In 2017, the Colorado River Indian Tribes (CRIT), whose reservation abuts the River near Parker, Arizona, suggested that it wanted to explore selling or leasing some of its water for off-reservation use.[39] CRIT is the proverbial 800-pound gorilla; the tribe has adjudicated water rights to 720,000 acre-feet of Colorado River water. That's more than 25 percent of the State of Arizona's entire allotment of 2.8 MAF. I predict that CRIT will play an enormous role in Arizona's water future.

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[37] Winters v. United States, 207 U.S. 564 (1908); Cappaert v. United States, 426 U.S. 128 (1976); Arizona v. San Carlos Apache Tribe, 463 U.S. 545 (1983); Arizona v. California, 460 U.S. 605 (1983).

[38] Patrick Sigl withdrew his article from the Symposium, but his presentation from the Arizona Water Law & Policy Conference in December 2017 is available in the Archives of the Arizona Journal of Environmental Law & Policy website.

[39] Ryan Randazzo, *Western Arizona tribes could lease Colorado River water to areas thirsty for development*, THE REPUBLIC, Oct. 15, 2017.

The Water-Energy Nexus

Most people are surprised when they learn that the largest consumer of electricity in Arizona is the Central Arizona Water Conservation District (CAWCD). It takes enormous amounts of power to pump CAP water from Parker uphill to Phoenix and then further uphill to Tucson. I was one of the early writers about the connection between water and power in my 2009 book, *Unquenchable: America's Water Crisis and What To Do About It.*[40] It takes a lot of power to move, pump, clean, and deliver water. In California, 20 percent of all the electricity used in the state is for that purpose. Conversely, it takes a lot of water to produce energy, especially ethanol and thermal solar power.[41] This symbiotic relationship, now known as the water-energy nexus, creates challenges for water and energy producers.

Michelle De Blasi, a partner at Fennemore Craig in Phoenix, tackles some of these thorny problems in her article, *Energy Consumption and the Energy-Water Nexus in the Southwestern U.S.*[42] The challenges are formidable as the energy business has experienced a sea change with the surfeit of natural gas available, thanks to fracking and directional drilling. The price of natural gas has plummeted; even coal is no longer competitive with natural gas.[43]

The Arizona Corporation Commission has developed rules to reduce water loss by encouraging investment in new infrastructure and utilization of new technology to identify leaks. Arizona Public Service, the largest electric utility in Arizona, has developed a demand side management plan, implemented water-efficient technologies at its power plants, and retired inefficient coal-burning plants. In a similar vein, Tucson Electric Power has reduced its water consumption and dramatically moved away from coal-fired power plants.[44]

The energy landscape has experienced a sea change almost overnight. For years, CAWCD's board lobbied heavily against proposed federal regulations, which would have required expensive retrofitting of the Navajo Generating Station (NGS), near Page, Arizona. The board feared it would drive up costs for consumers of CAP water.[45] But as natural gas prices dropped, the board changed its policy. In 2017, it supported closing the NGS, because it now had access to natural gas at prices lower than the coal-fired energy

[40] Glennon, *supra* note 5, at 23.
[41] *Id*. at 59–61; Robert Glennon & Andrew Reeves, *Solar Energy's Cloudy Future*, 1 ARIZ. J. ENVTL. L. & POL'Y, 91 (2010).
[42] Michelle De Blasi & Lauren A. Ferrigni, *The Energy-Water Nexus—How Policymaking is Shaping Generation and Usage Profiles in the Regional Southwest*, 8 ARIZ. J. ENVTL. L. & POL'Y [update page number] (2018).
[43] *Id.*; Robert Glennon, *Storm Clouds Over Solar Energy*, 25 SOLAR TODAY 22 (Apr. 2011).
[44] De Blasi & Ferringni, *supra* note 43.
[45] Tony Davis, *EPA approves modified Navajo power plant cleanup plan*, ARIZ. DAILY STAR, Jul. 29, 2014.

produced at NGS.[46] Once a relatively obscure subject, the water-energy nexus is now an area of significant scholarly and practical research at the University of Arizona. It is certain to remain a critical piece of natural resource management and planning.

Drought Contingency Planning in the Lower Colorado River Basin

In the twentieth century, Arizona spoke with one voice on water. From Carl Hayden, Barry Goldwater and Stu and Mo Udall, to Jon Kyl and John McCain, the message was unified: we need a CAP, and we want the federal government to help Arizona secure water for growth.[47] The cooperation extended across the State and included virtually every elected official, whether state, county, or municipal.

That harmony shattered in 2017 for complicated reasons. Space won't permit me to explore them carefully. But any narrative of the feud that developed between DWR and CAWCD must start with the gutting of DWR by the State Legislature after the 2008 Recession. Hobbled by the lack of funding, DWR withdrew into a shell, shelved progressive programs, and closed its Active Management Area (AMA) offices. Into that vacuum stepped CAWCD with more resources and an obvious need to continue collaboration and negotiation with the other Colorado River Basin states, especially the Lower Basin States of California and Nevada.

As an outsider, I thought the waters seemed calm as Arizona's water managers began to negotiate a Lower Colorado River Drought Conservation Plan (Conservation Plan) with California and Nevada about how to keep Lake Mead from dropping below 1075 feet. This critical level would trigger cutbacks to Arizona and, to a lesser extent, Nevada. But the cuts would not apply to California because, as discussed above, California secured the highest priority in case of shortages. Even California is not immune, though, if the situation becomes dire, as climate change projections suggest it may be. Below elevation 1025 feet, the Secretary of the Interior has enormous discretion to cut back the water supply to *all* Lower Basin states.[48]

In the spring of 2017, CAWCD roiled the waters when it announced that there was no urgency to adopt the Conservation Plan because a good snowpack in the Colorado Rockies that winter meant that the level of Lake Powell would likely rise and, as a result, the Upper Basin States would need to release more water to Lake Mead. Newspapers quickly reported that CAWCD saw no need to "over-conserve."[49]

The absurdity of CAWCD's tepid message on conservation, combined with the lingering lament that DWR no longer played a key role in interstate negotiations, brought

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[46] Tony Davis, *Tucson Water customers' bills won't rise as fast if Northern Arizona coal plant closes*, ARIZ. DAILY STAR, Feb. 16, 2017.
[47] Glennon, *supra* note 7.
[48] *Supra* note 11, §7(B)(4).
[49] *See* Tony Davis, *Big snowstorms put Colorado River drought plan on ice*, A.Z DAILY STAR (Mar. 19, 2017); *see also* Daniel Rothberg, *States Accuse Arizona water agency of gaming Lake Mead, undermining Colorado River Drought Plans*, THE NEVADA INDEPENDENT (Apr. 17, 2018) for the most recent update on the situation.

the dirty linen into public view with some testy *Arizona Republic* op-eds.[50] DWR's director Tom Buschatzke appropriately argued that the goal of conservation should not be put on hold because the Rockies enjoyed one winter with a lot of snow. The "problem of math" is a long-term problem not solved by a few winter snowstorms. As it turned out, the expected high flows did not materialize and the Department of the Interior now forecasts that the level of Lake Mead may drop below 1075 by 2019.[51]

The intrastate struggle turned into an interstate one in 2018 when the Upper Basin States accused CAWCD of manipulating its orders for water from Lake Mead in order to trigger a requirement that the Upper Basin release more water from Lake Powell.[52] CAWCD provided amunition to the Upper Basin States by posting a graph on its website that established a "'SWEETSPOT'" of Lake Mead levels that would maximize the water released from Lake Powell.[53]

In their article, Tom Buschatzke and Nicole Klobas, a lawyer at DWR, walk us through the various conservation plans. It is instructive that California was ready to take shortages – at the 1025 level, obviously fearing what an unknown Secretary might require of California in the absence of an agreement. The problem, as Buschatske and Klobas elaborate, is what's being called a "structural deficit" (the math problem I explained above). The Conservation Plan and an even more aggressive Arizona proposal, dubbed Conservation Plan Plus, involve creative ways to encourage various users to reduce their consumption and leave the unused water in Lake Mead. The plans are complicated, but each involves creating financial incentives for users to refrain from using their water rights. In essence, these conservation plans exchange excessive water use today for increased water security tomorrow.[54]

Failure to clarify water rights creates disincentives to economic development

Most Western states, including Arizona, rely on the prior appropriation doctrine to determine who holds water rights. Under such a scheme, the first person to use water for a beneficial purpose has the right to continue using that water for that purpose. When the West was first being developed, the prior appropriation doctrine encouraged rapid settlement and economic development because it created an incentive to start using water as quickly as possible. But today, a lack of clarity around appropriated water rights creates disincentives for economic development. This is the issue that Mark McGinnis and Jeff Heilman of Salmon, Lewis, and Weldon present in their paper, titled *United*

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[50] Tom Buschatzke, *Arizona water director: I won't support CAP board's drought plan*, THE REPUBLIC, Apr. 30, 2017.
[51] Tony Davis, *Dismal forecast for Lake Powell runoff heightens future CAP shortage risk*, A.Z. DAILY STAR (Apr. 8, 2018).
[52] *See* Tony Davis, *Four States … say that CAP keeps too much for AZ*, ARIZONA DAILY STAR, Apr. 16, 2018; Daniel Rothberg, *States accuse Arizona water agency*, THE NEVADA INDEPENDENT (Apr. 17, 2018).
[53] John Fleck, *Is the CAP gaming reservoir levels*, www.inkstain.net/fleck. April 9, 2018. CAWCD quickly took down the graph.
[54] Thomas Buschatzke & Nicole D. Klobas, *Ensuring Arizona's Future Today: The Lower Basin Drought Contingency Plan and its Implementation in Arizona***,** 8 ARIZ. J. ENVTL. L. & POL'Y [update page number] (2018).

States v. Gila Valley Irrigation District, the Application of Statutory Forfeiture to Pre-1919 Water Rights, and its Potential Ramifications.[55] Despite the seemingly dry title, their article raises interesting and important questions about the security of prior appropriation rights.

The issue they identify is whether Arizona's statute on forfeiture, which requires non-use for five years, applies to pre-1919 prior appropriation rights. McGinnis and Heilman explain that most lawyers did not think forfeiture for pre-1919 rights was possible until a U.S. Court of Appeals for the Ninth Circuit decision in 2017.[56] The federal court interpreted an Arizona Supreme Court decision[57] as holding that forfeiture could apply to pre-1919 water rights.

This problem arose due to an unartfully drafted Arizona statute that proclaimed that forfeiture does not apply to pre-1919 rights. That should settle the problem, right? No, because the Arizona Supreme Court held that the Legislature violates separation of powers if it tries retroactively to change the law as applied to vested water rights.[58] Here's the wrinkle: forfeiture is statutory and there was no forfeiture statute in Arizona until 1919. Did the Arizona statute change anything? The Legislature proclaimed that forfeiture did not apply to pre-1919 rights but there was no forfeiture statute until 1919.

McGinnis and Heilman are appropriately concerned about the implications for water rights if forfeiture applies to pre-1919 rights. The oldest or most senior appropriation rights are the most valuable, trumping as they do all later or junior rights. But if some set of pre-1919 rights were not used for five years, then the forfeiture doctrine applies – regardless of intent. With these older rights void, more junior appropriators improve their place in line.

Think of the prior appropriation doctrine as a tall building. If the foundation rests on sand, the entire edifice is wobbly, even if the upper floors are built with steel girders. Modern appropriation rights have a paper record with DWR that documents every aspect of the right. But appropriation rights before the creation of DWR often rest on sketchy records or oral testimony. It is generally understood that a water rights claimant has the burden to demonstrate continuous water use, which may be impossible for rights older than a century. The Colorado Supreme Court recently placed very high standards on claimants who want to change the use of a prior appropriation right to demonstrate that they historically used their full appropriation right.[59] Arizona can ill afford to cast further doubt on the security of prior appropriation rights, as such a move would introduce additional uncertainty into water rights adjudications.

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[55] Mark A. McGinnis & R. Jeffrey Heilman, *United States v. Gila Valley Irrigation District: The Application of Statutory Forfeiture to Pre-1919 Water Rights in Arizona, and its Potential Ramifications*, 8 ARIZ. J. ENVTL. L. & POL'Y [update page number] (2018).
[56] United States v. Gila Valley Irrigation District, 859 F.3d 789 (9th Cir. 2017).
[57] San Carlos Apache Tribe v. Superior Court ex rel. County of Maricopa, 972 P.2d 179 (Ariz. 1999).
[58] *Id*. at 186.
[59] *See* Santa Fe Trail Ranches Prop. Owners Ass'n. v. Simpson, 990 P.2d 46 (Colo. 1999); Ready Mixed Concrete Co. v. Farmers Reservoir & Irrigation Co., et. al., 115 P.3d 638 (Colo. 2005).

Reforming Arizona's General Stream Adjudications

The sad reality in Arizona is how few appropriated rights have been adjudicated. Without a court decree, users of surface water have merely a claim of right recorded in DWR's database. The lack of precise, quantified water rights undermines the value of the rights and introduces uncertainty into any transaction to sell or lease a right. A potential buyer of a farm, for example, may hesitate to purchase it if the water rights remain uncertain. At the least, it will drive up transaction costs as both parties retain lawyers and hydrologists to appraise the putative water rights.

In 1974, it looked as though Arizona would redress this problem when SRP filed for a General Adjudication of the Gila River and its tributaries.[60] But four-plus decades later, only a few rights have been finally resolved. A major problem is that the Arizona Supreme Court has divided water into surface and ground, though every hydrologist knows that the two are inseparable. Worse, the Court has ruled that some groundwater is really surface water if a well is pumping "subflow."[61] The Court has defined subflow as water pumped from the younger Holocene floodplain alluvium.[62] Pegging legal rights to a geologic formation is fraught with problems, especially the need to have a factual inquiry for every claim.

The glacial pace of progress in the Gila General Adjudication makes Charles Dickens' *Bleak House* look like a paragon of legal efficiency. Over the years, intrepid souls have tried, without success, to reform the system. Now, Rhett Larson, a law professor at Arizona State University, Sandra Day O'Connor College of Law, offers provocative ideas on how to expedite Arizona's general adjudications.[63] He concedes that the legal landscape contains a minefield of constitutional objections to streamlining the process. Still, the cost to Arizona's economy demands the effort. The State's efforts to attract new businesses to Arizona are undercut when businesses find out that water rights are not all that secure.

One of Larson's sensible suggestions is that the State Legislature increase resources for Maricopa County Superior Court, which has jurisdiction over the general adjudications. Enable the presiding judge to dedicate the general adjudication judge solely to her general adjudication caseload. Bump up the budget for the Special Master who serves as a finder of fact in many watersheds. Finally, DWR as the technical arm of the court needs adequate resources to prepare reports essential for the court to resolve disputes.

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[60] *See* Joseph M. Feller, *The Adjudication That Ate Arizona Water Law*, 49 ARIZ. L. REV. 405 (2007).
[61] Robert Glennon & Thomas Maddock, *In Search of Subflow: Arizona's Futile Effort to Separate Groundwater from Surface Water*, 35 ARIZ. L. REV. 567 (1994).
[62] *Id*.
[63] Rhett B. Larson, *Overcoming Constitutional Obstacles to the Resolution of General Stream Adjudications*, 8 ARIZ. J. ENVTL. L. & POL'Y [update page number] (2018). .

Another of Larson's proposals urges DWR to propose a delineation of subflow that the general adjudication court would adopt, which would clearly define the boundaries of subflow. Once that happened, the burden of proof would shift to those who challenge the DWR boundaries.

Larson's proposals deserve careful consideration. In 2016, Governor Ducey proclaimed: "if there's one thing Arizona is best in the nation at – it's water."[64] In the world of water, one thing we haven't done well is the adjudication of water rights.

V. Failures

The General Adjudications qualify as exhibit 1. But there are other water management failures in Arizona's recent history that merit mention. These failures can provide guideposts toward future reform that Arizona must undertake if it is to remain a national leader in water law and policy.

Augmentation proposals

In 2014, DWR released a long-awaited report, *Arizona's Next Century: A Strategic Vision for Water Supply Sustainability.* A tremendous amount of hard work and energy went into thinking about and developing an assessment and a prescription for what the state can and should do for the next 100 years. That's why it puzzled me to see augmentation play an important role in the solutions section.

Arizona has benefited from augmentation, principally the CAP. But other plans to find and import new sources of water strike me as unrealistic. In 2012, the U.S. Bureau of Reclamation released an important study, the *Colorado River Basin Water Supply and Demand Study.*[65] Reclamation is most famous for augmenting supplies by building massive dams throughout the West in the twentieth century.[66] This study, by contrast, concluded that none of various proposed mega-projects involving trans-basin or inter-state canals or pipelines satisfied basic cost-benefit analysis. The water management tools found to be viable and relatively inexpensive were conservation and reuse.

One form of augmentation that is enjoying a lot of attention is seawater desalination. Important water managers and officials in Arizona are on record endorsing the idea that a desalination plant along the Pacific Coast or in the Sea of Cortez could be an important component in Arizona's future supplies. Let's unpack these options.

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[64] *See* Robert Glennon, *2 not-so-smart things Arizona has done in the name of water*, ARIZONA REPUBLIC (Apr. 18, 2018), https://www.azcentral.com/story/opinion/op-ed/2018/04/18/arizona-water-supply-desalination-desert-rivers-glennon/501468002/.

[65] U.S. DEP'T OF INT., Bureau of Recl., Colorado River Basin Supply and Demand Study, Dec. 2012 available at https://www.usbr.gov/watersmart//bsp/docs/finalreport/ColoradoRiver/CRBS_Executive_Summary_FINAL.pdf; *see also* Robert Glennon & Peter Culp, *West Must Strive for Water Sustainability*, THE ARIZONA REPUBLIC (2012).

[66] MARC REISNER, CADILLAC DESERT: THE AMERICAN WEST AND ITS DISAPPEARING WATER (1993).

California recently brought online a massive desalination plant, Poseidon's Carlsbad Desalination Plant. From start to finish, the permitting and construction took 16 years. The plant was very controversial and ran into financial challenges that ballooned the ultimate costs.[67] California has its own set of water supply challenges, yet Arizona water managers think that California interests will allow Arizona use of its coastline to produce potable water to be consumed out-of-state. California's environmental community resists desalination plants because the brine stream they produce wreaks havoc in sensitive inter-tidal ecosystems.[68] Assuming that Arizona could get approval to build a plant on the California Coast, how would Arizona convey the water to Phoenix and Tucson? Here, there is a partial answer: a water exchange. California would use the potable water generated at the desalination facility and Arizona would take some of California's Colorado River water at Parker and deliver it via the CAP. Pretty clever. But there remains a challenge confronting the other proposed location for a plant, the Sea of Cortez.

Mexico as a location for a proposed desalination plant seems strikingly perplexing, coming as it does from a state that, in the 1930s, supported the building of an "All-American Canal" precisely to keep Mexico's hands off "our" Colorado River water. We enjoy better relations now, or at least we did until Mr. Trump became President and railed against NAFTA and "illegal" immigration. So maybe Mexico would go along with the idea. And, as with the California coastal proposal, a water exchange could let Mexico use the new potable supply and Arizona divert some of Mexico's Colorado River water into the CAP.

Four problems remain. First, Mexico does not need water in the Sea of Cortez. It uses its Colorado River allotment in Mexicali, some 50 miles or so back upriver. So, Arizona would need to build a canal and pumping stations and find enough power to move the water uphill to Mexicali. Second, and this problem applies as well to the California coastal plant, the CAP canal at its maximum, pumping 24/7 for 365 days a year, can deliver 1.8 MAF.[69] Of that, 1.4 MAF is the state's CAP allotment. That leaves 400,000 acre-feet of extra capacity. Nothing to sneeze at, but in the bigger picture, not that much water.

Third, will Arizonans be willing to pay to build a desalination plant (estimated cost: $1 billion); a 50-mile canal, pumping stations, and an electric power plant (my guess: $500 to 800 million); and to expand the capacity of the CAP (let's say: $3 to 5 hundred million)? I think I know the answer. Even though water is the State's lifeblood, Arizonans are notoriously tight-fisted when it comes to water. We don't want to pay for water projects. We think that's the role of the federal government: to deliver wheelbarrows of money for water projects and then leave us alone, because we are, after all, independent westerners.

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[67] Ry Rivard, *The Desalination Plant is Finished But the Debate Over It Isn't*, VOICE OF SAN DIEGO, Aug. 30, 2016.
[68] Glennon, *supra* note 5, at 155-56.
[69] W. Michael Hanemann, *The Central Arizona Project* at 1 (Oct. 2002), available at https://ageconsearch.umn.edu/bitstream/25124/1/wp020937.pdf (last visited May 8, 2018).

Fourth, Arizona is not alone in seeking to locate desalination plants in California and Mexico. The Southern Nevada Water Authority is exploring the use of ocean desalination to enhance the supply for its rapidly growing metropolis.[70] In California, the Natural Resource Agency has solicited proposals under its Sea to Sea program to combat the Salton Sea from shrinking further. The agency received 11 responses, all of which involve augmenting the Salton Sea with water imported from Mexico or California.[71]

Our Dwindling Rivers

Another thing Arizona hasn't done so well is to protect its environment. Arizona has failed to appreciate that free-flowing rivers are one of its most alluring attractions.

As Arizona grew, its rivers suffered. The Gila River and its main tributaries, the Salt and Verde Rivers, were once perennial streams that collectively carried large volumes of water across Arizona to the junction with the Colorado in Yuma. Not anymore. Diversions for irrigation and municipal water uses have completely dried up or reduced to a trickle the flow of these rivers once they reach Phoenix. Anyone who has driven Interstate 10 between Phoenix and Tucson has seen the absurd highway sign at a bridge over the "Gila River," which is no longer a river but is instead a dry wash with a few shrubs. Across the State, other rivers have suffered, including the Santa Cruz and Rillito in Tucson. At risk is the San Pedro River in Southeast Arizona. A world-famous birding area, Congress designated a section of the San Pedro River a National Riparian Conservation Area in 1988.[72]

Rivers in a desert are extraordinarily rare. They are so unexpected in an arid environment. Riparian habitats support cottonwood and willow galleries, nurture wildlife, and provide nesting places for birds from across not only North America but also migrant species from Central and South America.

Over time, diversions of surface water and, especially, pumping of groundwater hydrologically connected to river flows, have decimated our rivers and streams. Other western states, including Colorado, Oregon, and Washington, have acted aggressively to protect existing flows and find creative ways to replenish diminished flows. Arizona has done precious little, until fairly recently**.**

In 1996, Tucson Water and the Pima County Regional Flood Control District collaborated to create Sweetwater Wetlands Park along the Santa Cruz River. Reclaimed wastewater filters through recharge basins, creating wildlife habitat as it recharges the

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[70] *See* Matt Weiser, *Desalination in Las Vegas? Faraway Ocean Could Aid Future Water Needs*, WATER DEEPLY (Apr. 17, 2018), https://www.newsdeeply.com/water/articles/2018/04/17/desalination-in-las-vegas-faraway-ocean-could-aid-future-water-needs.

[71] *See* Samuel Metz, *10 questions about the 11 proposals to save the Salton Sea*, THE DESERT SUN (Apr. 16, 2018), https://www.desertsun.com/story/news/politics/2018/04/16/ten-questions-eleven-proposals-save-salton-sea/516602002/.

[72] *See* Glennon, *Water Follies*, 51-69.

aquifer. Since the 1970s, effluent from Pima County's wastewater treatment plants has created riparian habitat in the Santa Cruz River north of Tucson. A $600 million upgrade to the plants, completed in 2013, has eliminated odors and greatly improved water quality. The water quality is so high that, in November 2017, fish surveys confirmed the presence of the Gila topminnow, an endangered species that hasn't been seen in the river for more than 70 years.[73] In 2016, Tucson Water unveiled a plan, called "Agua Dulce," to restore flows in the Santa Cruz through downtown Tucson.[74] A pipe would pump treated effluent uphill to the south side of Tucson, where it would be discharged into the river, which runs from south to north.

In Maricopa County, the city of Phoenix has spent $120 million to restore riparian habitat along the Salt River between 24th Street and 19th Avenue.[75] At that location, the Audubon Society has documented more than 200 bird species, a ten-fold increase over eight years.[76] Using treated wastewater, the city has also restored 700 acres of habitat at its Tres Rios Wetlands project on the west side at 91st Avenue.[77] The crown jewel in the restoration of the Salt River is Tempe Town Lake, which has become a tourist destination with a $1.5 billion economic impact.[78]

These recent successes have rekindled hopes for the Rio Salado Project, which would restore 45 miles of the Salt River from east Mesa to Buckeye. As reported by Jessica Boehm in the Republic on December 24, 2017, Senator John McCain has enthusiastically embraced the idea, as have other state, local, and tribal leaders.[79] Finding the resources for a restoration project of this scale will not be easy. But what an amazing achievement it would be. Perhaps the stars are aligned for Arizona, again, to develop innovative solutions to managing its water.

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[73] Sonoran Inst., *Endangered Fish Returns to Santa Cruz River Near Tucson*, Dec. 13, 2017, available at https://sonoraninstitute.org/2017/gila-topminnow-return-tucson/ (last visited May 8, 2018).
[74] *See* City of Tucson, *Tucson Water Has a Plan to Make the Santa Cruz River Flow* (Nov. 6, 2016), https://www.tucsonaz.gov/newsnet/tucson-water-has-plan-make-santa-cruz-river-flow; see also, Tony Davis, *Santa Cruz could flow again through downtown Tucson*, A.Z. DAILY STAR (Nov. 11, 2016).
[75] Jessica Boehm, *Sen. John McCain's legacy project: Develop 45 miles of the Rio Salado*, ARIZONA REPUBLIC (Dec. 24, 2017), https://www.azcentral.com/story/news/local/phoenix/2017/12/24/john-mccain-legacy-project-develop-45-miles-rio-salado-arizona-state-university-phoenix-tempe-mesa/915158001/.
[76] Boehm, *Sen. John McCain's legacy project*.
[77] *Id*.
[78] *Id*.
[79] *Id*.