

ARROYO

2019



WATER, BUSINESS, AND THE BUSINESS OF WATER

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INTRODUCTION

Few pairings provoke as passionate a response as the coupling of water and money; however, water is deeply rooted in our market economy, often in invisible ways. In classic free-market economic theory, price should reflect value, but water's value is obscured by its nature, and by history, cultural attitudes, and related factors. As the economist Adam Smith wrote in the 18th century, "Nothing is more useful than water but scarcely anything can be had in exchange for it." This observation reflects the absence of a market for water in the classical sense, which requires well-defined and easily comparable products.

The relationship of water's price to its value can be complicated and counter-intuitive. Compare, for example, the water prices in Flint, Michigan to those in Phoenix, Arizona. As of 2015, the average water bill for a household in the desert city of Phoenix was approximately two-thirds the average water bill for a

household in Flint, a metropolis less than 40 miles from the Great Lakes. Several factors account for this incongruity. Flint, a city experiencing the urban decline common to many post-industrial midwestern cities, struggled to pay for water infrastructure and services for a dwindling population with a declining tax base and suffered serious public health consequences as a result. Younger western cities experiencing population and economic growth are better able to absorb infrastructure and service costs. As these cities age, however, the need to replace infrastructure and maintain reliability will put upward pressure on water prices.

A discrepancy also exists between the economic return received from different water uses. Disregarding factors such as capital investment, differences in economic returns from water use can be striking. For example the amount of water used to grow \$6,000 worth of lettuce in Yuma County is approximately the same amount used to produce \$13 million worth of microchips in Silicon Valley. Yet, about 70 percent of the

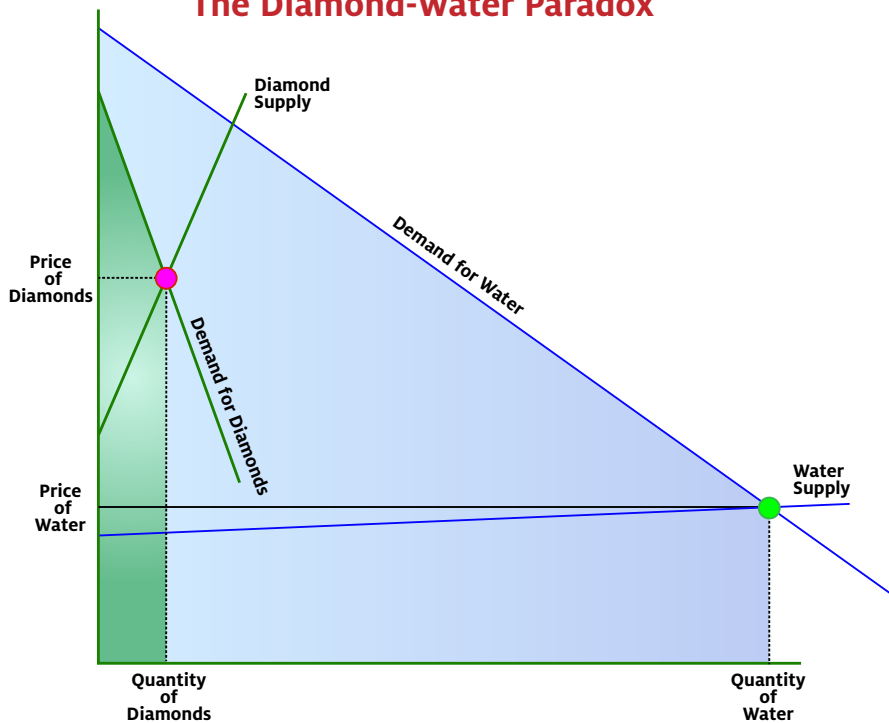


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The Diamond-Water Paradox



The price of water is much lower than the price of diamonds because the supply of water is much greater than the supply of diamonds relative to demand. Modified from: Iowa State University, <http://www2.econ.iastate.edu/classes/econ101/choi/ch10Util.htm>

water used in the Southwest goes to irrigated agriculture. Gross economic benefit comparisons like this, however, fail to account for important non-market values, such as food security, wildlife habitat, ecosystem services, and rural cultures dependent on agricultural water use.

Some economists and other experts maintain that the principal water dilemma in the Southwest and other dry areas worldwide is not one of scarcity, but one of inefficiencies in the use and distribution of water caused largely by failures of water management to respond to market signals. Between market signals and water management responses stand barriers such as centuries-old water laws, strong cultural and societal attitudes regarding water rights, and the unique nature of the water resource itself. The business of water functions within a complex, dynamic, and uncertain space in which market pressures meet entrenched institutional and societal positions and change threatens the status quo.

For Arizona, a nearly 20-year-long drought in the Colorado River watershed, combined with over-allocation of river water supplies, is resulting in an troubling but predictable decline in the elevation in Lake Mead. The Colorado River supplies nearly 40 percent of Arizona's water demand. An official shortage declaration will trigger water reductions and potentially cause the price of water and goods to increase. Despite the state's history of strong and innovative groundwater regulation, reductions in the Colorado River supply is likely to lead to increased pressure on groundwater and could very well produce a policy crisis as more and more areas bump up against resource limits.

Global climate change impacts combined with population growth and changing patterns of land use and water use are resulting in dramatic reductions in water supply worldwide and increasing conflict among water users. It is unsurprising that a recent report listed water among the top five risks to businesses. The report noted a growing awareness among business leaders of their dependence on water and the importance of managing costs, reducing exposure to risk, and creating commercial opportunities through water-related strategies. Reflecting a parallel trend, the public sector is engaging more with the private sector to tackle water issues requiring significant capital expenditure, and governments are incorporating business principles into water policy with the aim of managing water more efficiently. Partnerships among business, government, and civil society are initiating programs that emphasize water sustainability and just distribution of benefits and costs.

Although most people in the Southwest are aware of the challenges to water supply caused by growth and climate, they continue to expect that this life-sustaining resource will flow reliably from their taps. It is the business of water to meet this expectation at minimal cost, while fostering associated benefits, such as economic opportunity, social well-being, public health, and natural landscapes. Given these expectations, understanding water from a business perspective is essential to establishing policies for managing water in a beneficial, efficient, equitable, and sustainable way.

Focusing primarily on Arizona and the greater southwestern region, this *Arroyo* begins with an introduction to water markets and transfers, including the various forms of water transactions, such as buying and selling, short-term and long-term leasing, dry-year options, water banking, and exchanges. These transactions occur between government entities, including Tribal Nations, utilities, and various configurations of government actors, private citizens and citizen groups, businesses, and non-governmental organizations (NGOs). This *Arroyo* also looks at public-private partnerships and other forms of water infrastructure financing, including investments not only in projects, but also in new technologies. It then describes how businesses incorporate both water risk management and corporate water stewardship and responsibility into their business models. Finally, a section on water and economic development examines contributions of creative public-private initiatives that promote civic goals of economic and environmental sustainability.

WATER MARKETS

Economists have long advocated for competitive markets as optimal means to allocate scarce private goods, because they allow the price to be set at the intersection of supply and demand. Water markets may be desirable as a way to mitigate apparent water scarcity resulting from inefficient allocation because they allow buyers with a higher value use for water to purchase or lease water from those with a lower value use. Through this exchange, aggregate economic benefits from water use increase.

The benefits of competitive markets can be substantial—they allow transactions to be tailored to local conditions and needs and give individuals, businesses, and communities a space in which to negotiate their own mutually beneficial deals. Furthermore, in a market, rising demand leads to rising water prices, creating incentives for investment in infrastructure, technology, and conservation. The flexibility provided by a market allows space for adaptive management, as water is not locked into its historical use and can be reallocated to its most economically valuable use.

Water markets also involve many of the factors that make people wary of competitive markets in general, including asymmetrical information, uncertainty, and problematic distribution of risks and gains. Ideally, willing buyers and sellers have equal information relevant to the transfer, but water transfers can require information about the physical and legal systems that is expensive to acquire. The factors influencing water's value are complex and can be difficult to determine in any specific situation. This makes the risks associated with the transfer uncertain and can lead to transfer arrangements that disproportionately allocate risks and costs.

In addition, the public resource characteristics of water introduce other shortcomings of competitive markets that may produce injustices and unsustainable practices. Costs may be incurred by parties who are not involved in the transfer, such as a downstream water user who receives water of impaired quality or a farm equipment supplier who loses business when farmers no

longer need equipment because agricultural fields are taken out of production. Water markets can also have a multitude of unintended negative consequences if water transfers involve changes in location or use. Environments that rely on natural flows and vulnerable rural economies and cultures may lose the benefits of local water use, such as return flows and economic activity. For this reason, Arizona, like other western states, has an interest in overseeing transfers to mitigate undesirable outcomes and provide legal protections for third parties.

WATER TRANSFERS

Legal and Institutional Context of Water Transfers

A generic process exists for transfers of surface water in most western states. First, prospective traders submit an application to the appropriate state water department, which reviews it for technical accuracy and to determine if it meets all statutory requirements for approval. Next comes the important step of notifying, often through simple publication in a news source, all third parties the department thinks might be affected by the transaction. Notifications give the parties information regarding the transfer and time to object or raise concerns. Rules and statutes may define the specific grounds for objections and thus limit the kinds of objections that can be raised. Objections generally must be addressed before a transfer will be permitted.

The process for transferring groundwater depends on individual state laws and legal precedents. In Arizona, groundwater is appurtenant to the overlying land, meaning that the right is attached to ownership of the land. Exceptions exist within certain areas of the state that have been designated for active groundwater management. Water utility service area rights, for example, are not tied to land ownership. Also, certain statutorily defined groundwater rights may be transferred within actively managed areas. Transfers of groundwater from one basin for use in a different groundwater basin are not permitted, although some exceptions apply.

Asset Class	Description	Active Markets
Surface Water	Common in every western state and entitle the water right holder to use direct flow out of a stream	AZ, CA, CO, NV, NM, WA
Groundwater	Authorized withdrawal and use of water pumped directly from aquifers	AZ, CA, CO, TX
Groundwater Storage	Credits awarded	AZ, CA
Effluent	Treated wastewater generally put to use in irrigation or industrial settings	AZ, CA, CO
Storage	Entitles users to impound or store surface water for use at a later time	CA, CO

Active markets for water resource assets in the western states. Modified from: WestWater Research, http://www.waterexchange.com/wp-content/uploads/2017/01/WMI_2016Q2_011117.pdf

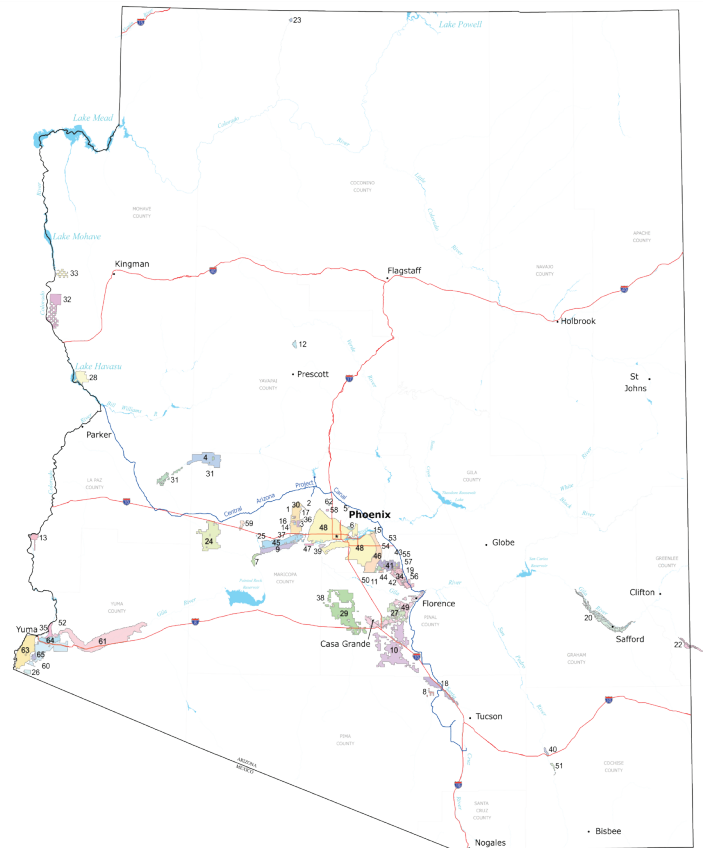
Institutions

Parties interested in transferring water in western states must grapple with both logistical factors related to physically moving water and entrenched legal and institutional impediments that limit water market activities. Water is heavy and bulky relative to its value. The infrastructure and energy costs to move water long distances limit the market for many uses. In addition, the legal and institutional frameworks in which water markets must operate were designed to provide certainty and stability while promoting water development. As a consequence, rights to water are enmeshed in laws, regulation, and customs that make change cumbersome and add costs to water transactions. Transaction costs are all of the costs needed to effectuate a transaction, such as finding buyers or sellers, acquiring information, complying with laws, negotiating contracts, and resolving or mitigating conflicts. It is assumed that reducing transaction costs would stimulate a competitive water market.

Irrigation Districts

Throughout the Southwest, most water (about 70 percent) is used for irrigated agriculture. The majority of irrigation water is delivered through irrigation districts or cooperatives, in which farmers join together to capture, store, and distribute a common water supply. These organizations provide a framework for exchanges between members, thus reducing transaction costs for efficient water distribution.

An irrigation districts (ID) is created pursuant to state laws, as a subdivision of state government, with specified governmental authorities. Because IDs are public institutions formed to serve specific groups of private landowners, their legal structure reveals the mix of public and private traits. The scope and nature of ID authority remains controversial in some areas. While they usually have the powers of taxation, eminent domain, tax exemption, and bond issuance, they also retain prerogatives of private corporations, such as limiting voting to private beneficiaries and allocating shares in proportion to investment. Compulsory assessments served as the basis for issuing bonds to finance irrigation development. Transfers between farmers within an ID are relatively easy because the ID is likely to retain the right to withdraw and distribute the water to district lands before and after the transfer. On the other hand, transfers outside the boundaries of the district are usually more difficult. Individual farmers generally cannot contract with parties outside the district to transfer water without the consent of the district, and the district generally needs the consent of the majority of its members. In the 1920's the federal government dictated that only irrigation districts could contract directly with the U.S.



Arizona's irrigation districts.
Source: Arizona Department of Water Resources

Bureau of Reclamation (Reclamation), and that status made IDs particularly attractive.

Reclamation

Established in 1902, Reclamation is the largest wholesale water supplier and second largest hydropower source in the United States. The agency is responsible for developing major water projects, such as the Salt River Project (SRP) and Central Arizona Project (CAP) in Arizona, the Central Valley Project in California, and the Colorado Big-Thompson Project in Colorado. It supplies approximately 23 percent of the water consumed in the West, including the water to irrigate more than ten million agricultural acres and serve around 31 million people. Hoover Dam, which impounds Colorado River water for the Lower Colorado River Basin in Lake Mead near Las Vegas, Nevada, is a Reclamation project, and the agency is responsible for Colorado River water delivery in the Lower Basin. Thus, Reclamation is frequently involved in Lower Basin water transfers.

Types of Transfers

Water users commonly transfer water through one of three types of contracts: 1) permanent sales, in which the buyer purchases the legal right to use a certain quantity of water in perpetuity or purchases the land to which a water right is appurtenant; 2) long-term leasing, in which



Reclamation's Hoover Dam and Lake Mead, which supplies Colorado River water to the Lower Basin states. Source: Yale University, <https://e360.yale.edu/features/on-the-water-starved-colorado-river-drought-is-the-new-normal>

rural communities has focused on the potential disappearance of agriculture and accompanying cultures, economies, critical ecosystems, and local food security. For several decades, alternative transfer mechanisms involving leases have predominated.

Long-term Leasing

Like permanent purchases, long-term leases are more common in situations where the lessee has uncertain water supplies and the lessor has historically secure water rights and a relatively steady source, such as a high-priority diversion from a stream with low annual variability. In Arizona, most leasing activity involves CAP water. The appeal of leasing is that it does not result in permanent loss of water rights and therefore preserves

water is transferred annually until the expiration of the contract, often set at 25, 50, or 100 years; and 3) short-term leasing, in which a quantity of water is transferred for a short period of time, usually for a season or a year. Other arrangements, such as dry-year options, can be used to manage risks associated with drought.

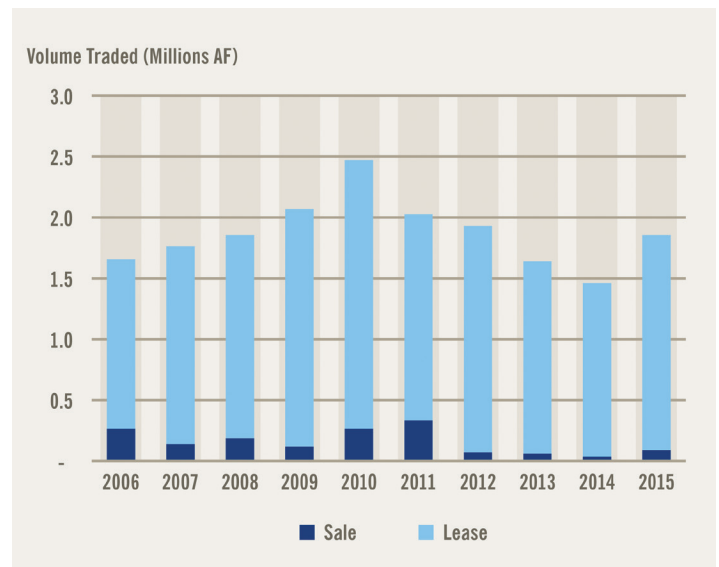
Permanent Transfers

Historically, permanent transfers were the norm and were used by municipalities looking to agriculture for water to augment urban supply. Water rights can be purchased without severing the water from the land when the land is purchased with them. With certain exceptions, surface water transfers involving a change in use must receive state agency approval. Typically, when developers purchase agricultural land on which to develop, the water rights associated with the land provide a water supply for the development and its future homeowners through conversion from agricultural to municipal use. This practice has been fairly common in Arizona, where groundwater management law requires developers within actively managed areas to prove an assured 100-year water supply prior to platting a new development. However, within these areas, the purchase of land with irrigation groundwater rights does not guarantee a determination by the Arizona Department of Water Resources of an assured water supply for the development.

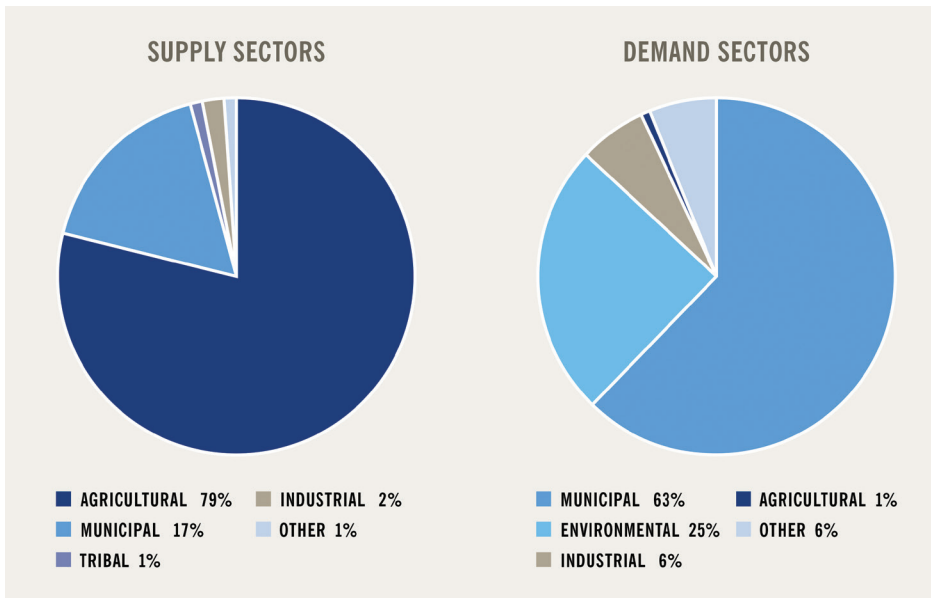
Permanent water rights sales that involve a change in the location of use may involve following or abandoning farmland (“buy and dry”), exchanging one type of water for another, or a lease-back arrangement with a farmer effective during wet years. The “buy and dry” transfer is less common today than in the past. Push-back from

future options for tribes, farmers, rural communities, and natural ecosystems. Long-term leases are more desirable than short-term arrangements when the lessee will base investments, such as development of costly assets for delivery and/or storage, on rights to a reliable water supply. Long-term leasing, therefore, becomes more likely to occur the greater the distance from the original use to the new use.

The down side of long-term leasing is similar to that of permanent transfers. If the price of water rises, the lessor will not benefit, unless there is a price reset provision in the contract. Lessors cannot use the water for the period of the lease even if their needs increase or



Volume of water leased and permanently transferred in the 12 western U.S. states 2006-2015. Source: WestWater Research, http://www.waterexchange.com/wp-content/uploads/2017/01/WMI_2016Q2_011117.pdf



Percentage of total water traded in the Western states by sector in 2015. (Supply Sectors=water sources, Demand Sectors=water recipients) Source: WestWater Research, http://www.waterexchange.com/wp-content/uploads/2017/01/WMI_2016Q2_011117.pdf

their capacity to do so improves. Even 100-year leases end, and termination of a long-term lease can leave the lessee scrambling for water.

Short-term Leasing

In a short-term lease, a lessor transfers water rights to a lessee for a short period of time, usually a season or one year. Short-term leases are the most common form of water transfer in all of the western states, largely because of their flexibility. Increasingly, short-term leasing occurs through spot markets, which involve single-year water transfers taking place in real time. Spot markets allow for the formation of futures markets in which water is leased on a short-term basis for the following year. While mainly used in drought years, spot markets are also used in wet years to purchase water to put into reservoirs as multiple year or “carry-over” storage.

Dry-year Options

Dry-year options are a form of lease in which the lessee makes yearly payments to secure a water supply in case of shortages due to drought. In dry years, the lessor makes water available to the lessee, for example, by fallowing agricultural fields. When wetter conditions return, the lessor is once again able to use the water. In an option-based arrangement, the lessee will negotiate in advance with the lessor to define the events or conditions that will trigger the exercise of the option. The desirability of these arrangements depends on the circumstances. Not all farmers have identical water needs. While crops that are planted anew each year

can be replanted easily after a fallow season, other crops, such as tree nuts, are not so easily replaced. During the 2014 California drought, most of the state’s fruit and nut tree growers had to scramble for last-minute, short-term water contracts. Some, however, had hedged against this very contingency by purchasing dry year options years earlier. The investment in future water paid for itself in 2014.

Tribal Water Transactions

Indian water rights, which were disregarded through much of U.S. history, are extensive and largely undeveloped, making their future use both a source of great uncertainty and an opportunity for innovative market arrangements. Indian water rights are reserved rights dating back to the date

the federal government established the reservation or earlier, giving many western tribes water rights senior to those of non-Indian users. According to the legal doctrine established in the 1908 Supreme Court case, *Winters v. United States*, the quantity of water reserved is the amount required to fulfil the “purpose of the reservation.” Once the quantity is determined, these water rights can be used for any purpose consistent with establishing a viable homeland, including economic development.

Quantification of these rights may require judicial action but is often achieved through settlements negotiated by the tribes, the federal government, the states, water districts, water companies, and other water users. One common issue addressed by settlements is



Opening celebration of the GRIC Managed Aquifer Recharge Site #5 Interpretive Trail, March 1, 2019. Source: GRIN/Roberto A. Jackson, <http://www.gricnews.org/view/download.php/pdf-archives/2019-pdf-archive/march-12-2019-pdf>

the extent to which the tribe is permitted to engage in water transactions, which include leasing, banking, transferring, and exchange agreements. As of 2017, 21 out of 32 congressionally authorized settlements have permitted some form of marketing of tribal water, although the extent to which this is permitted or restricted varies widely among settlements. Absent congressional authorization, tribes cannot permanently dispose of water rights. Legal issues surround whether, to whom, and where Indian water rights can be leased. For example, the Ute settlement, enacted in 1988, uniquely prohibits the tribe from leasing water into or in the Lower Colorado River Basin.

The 2004 water settlement with the Gila River Indian Community (GRIC) provided an annual water entitlement of 653,000 acre-feet, approximately half of which is CAP water. Because the infrastructure GRIC needed to use the CAP water would not be complete until 2030, the community made arrangements to develop long-term water storage credits that they could market to buyers, such as municipalities and industries. The sale of water storage credits has enabled the community to use some of its water entitlement to pay for restoring its agricultural heritage and reconnecting with the Gila River. A major irrigation project, riverbed Managed Aquifer Recharge, and an interpretive trail are contributing to these goals. In January 2019, a limited liability corporation created by GRIC and SRP, signed an agreement to sell 445,375 acre-feet of water storage credits to the Central Arizona Groundwater Replenishment District—the entity responsible for replenishing groundwater used by new and expanding development in central Arizona. The GRIC also signed a 25-year agreement to provide the same entity with a total of 33,185 acre-feet per year of CAP water through an exchange and a lease.

The Colorado River Indian Tribes (CRIT), which includes members of the Mohave, Chemehuevi, Hopi, and Navajo tribes, hold rights to more than 662,000 acre-feet of Colorado River water for reservation lands in Arizona. The decree quantifying CRIT's water rights mandated that water be used on the reservation and provided no authority to lease water. In late 2018, CRIT, the State of Arizona, and an NGO agreed in principle to an arrangement under which CRIT would fallow enough land to conserve 50,000 acre-feet of water per year in Lake Mead in exchange for funding from Arizona and the NGO. The conserved water would remain in the lake to help Arizona implement a multi-state Colorado River Basin drought contingency agreement, ratified in early 2019. A fallowing plan, however, is not the same as leasing water off-reservation, for which the CRIT Tribal Council would have to obtain congressional approval. In January 2019, CRIT voters approved a referendum giving tribal leaders the go-ahead to seek federal legislation authorizing CRIT to lease part of its Arizona water allocation for off-reservation use.

Water Speculation

Treating water as an investment with the intention of profiting from subsequent sale of the resource is speculation. In Arizona, speculators can buy land with water rights, store water in permitted recharge projects to create marketable credits, or buy existing credits. To profit from these activities, companies can sell the land with water rights, navigate the legal process to transfer the water rights, or sell the credits. Profits, however, are not assured. Western surface water law was explicitly designed to prevent speculators from locking up water that could be used. In order to perfect a water right, the appropriator must put the water to a beneficial use. When someone acquires a surface water right for speculative purposes, the water must continue to be used for its original purpose or legally transferred to a new use. Otherwise, the right is subject to forfeiture. No beneficial use requirement impedes speculation in groundwater; however, most inter-basin water transportation is prohibited. One exception in Arizona is transportation out of the Harquahala Basin, where a group of investors has been buying land for the purpose of marketing groundwater to entities in actively managed areas. To date, this Harquahala Valley Water Project group has been unable to realize their hoped-for returns, although that may change as drought and Colorado River water shortage looms.

Water Banking

In Arizona, water banking refers to any water storage strategy in which one party stores or “banks” water either for themselves or for others. The Arizona Water Banking Authority stores excess CAP water for water users defined in statute. The water is stored in aquifers through permitted recharge projects. The stored water will be recovered and made available in the future to mitigate reductions in Colorado River supplies during shortages. A water bank also may act as a broker between buyers and sellers. Ideally, such a water bank facilitates transactions that would not otherwise take place, introducing buyers and sellers to one another, setting fair and impartial minimum prices, mediating negotiations, incentivizing conservation, and providing critical water information.

Although it operated on a somewhat different model, the California Drought Water Bank can serve as an example. A series of laws enacted by the California Legislature since the early 1980s was intended to implement a strategy for encouraging water conservation by allowing existing users to sell saved water. When the state experienced the most severe drought in its history at the beginning of the 1990s, the California Department of Water Resources was directed to create an Emergency Drought Water Bank. Water users willing to forego use of a portion of their supplies could sell water to the Department, which in turn would remarket the water

to buyers according to specific allocation rules geared toward critical needs. California's Emergency Drought Water Bank was active in 1991, 1992, 1994, and 2009 and was generally considered a success, despite challenges by advocates of voluntary exchanges to the use of emergency powers to reallocate water. California policy has since moved toward a voluntary exchange model.

Wheeling and Exchanges

Water wheeling increases resource efficiency by using an existing conveyance system to move water. The use of existing infrastructure is usually extended to effectuate a water transfer or convey a legally available water supply to the owner who lacks the conveyance infrastructure needed to use it. One example of a water wheeling agreement involved a private water company, Vail Water Company (VWC), with a contract for an allotment of CAP water. Vail, Arizona is 45 miles from the end of the CAP canal. Building the necessary infrastructure to deliver the CAP water to Vail would have been extremely difficult and prohibitively expensive. On the other hand, Tucson's water conveyance facilities were only two miles away from VWC facilities. Instead of building a 45-mile long conveyance system, VWC worked with Tucson on a plan whereby Tucson Water wheels Vail's CAP water, through Tucson Water's conveyance system, directly to a new two-mile long pipeline to VWC's facilities.

Similarly, Goodyear, Arizona also was looking for a way to take its CAP water allotment. Goodyear, which is located 35 miles south and 45 miles east of the CAP canal, determined that building a water pipeline from the canal to the city would cost \$200 million plus additional millions to purchase easements. Instead the city contacted SRP, whose delivery system intersects the CAP canal near Granite Reef Dam in the East Valley and delivers SRP water to Avondale, five miles from Goodyear. SRP cannot deliver water to Goodyear, which is outside its service area. SRP agreed, however, to wheel Goodyear's CAP water to Avondale through an SRP canal. Goodyear will build a pipeline to carry the water from there to a new drinking water treatment plant. The first phase of this project will cost an estimated \$110 million.

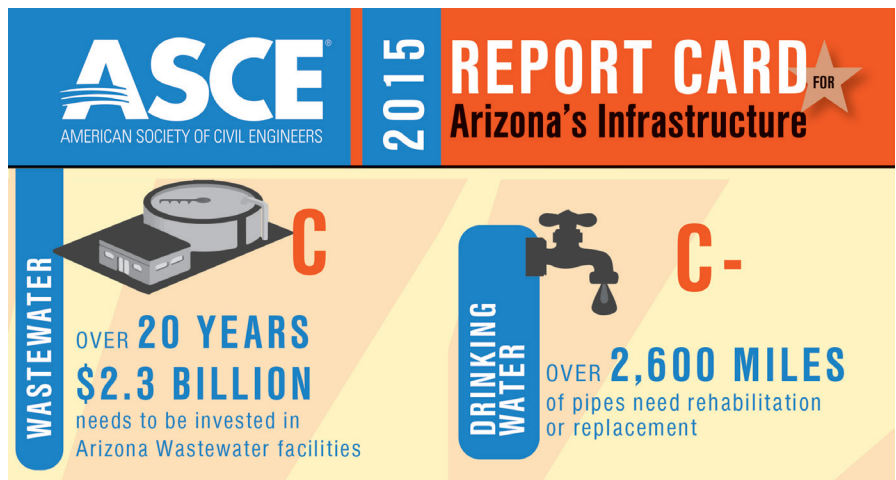
The recent CAP System Use Agreement is an agreement between CAP and Reclamation that provides a comprehensive framework designed to allow the CAP canal to be used in new and flexible ways. The agreement defines key provisions and formalizes wheeling requirements. The agreement permitted implementation of a prior arrangement in which the City of Phoenix stores a portion of its CAP water in the Tucson

area in recharge facilities belonging to Tucson and the adjacent Metropolitan Domestic Water Improvement District (Metro Water). When the water is needed by Phoenix in the future, this exchange agreement allows that city to take water from the CAP canal and allows Tucson and Metro Water to take an equivalent amount from Phoenix's Tucson area water storage accounts.

INFRASTRUCTURE FINANCING

The modern business of water is impossible without vast, complex, and costly infrastructure. Infrastructure makes water services possible, including extraction, storage, impoundment, treatment, delivery, and wastewater collection and treatment. For context, the 2017 infrastructure report card by the American Society of Civil Engineers awarded a grade of D to America's drinking water systems and gave America's wastewater systems a D+. It estimated infrastructure costs such as capital expenditures for expanding, upgrading, or replacing drinking water and wastewater facilities at \$12.6 billion. Over 40 percent of water distribution infrastructure in the United States (dams, pipes, reservoirs, aqueducts, etc.) is more than 40 years old. In fact, some key structures, such as the Johnson Canyon Dam near Williams, Arizona, are more than 100 years old.

The rate payer is a key element of water and wastewater infrastructure financing because the income assurance provided by a utility's customer base enables it to finance infrastructure projects, whether with



ASCE 2015 Report Card for Arizona's Drinking Water and Wastewater Infrastructure. Source: ASCE, <https://www.infrastructurereportcard.org/wp-content/uploads/2016/10/AZ-Report-Card-5.13.15-FINALWEB2.pdf>

borrowed or internally generated funds. Water utilities that serve the public may be run by local or regional public entities such as cities or special districts, or by private companies operating as public service corporations. In either case, rates are based on the cost of service, which

includes capital costs, operating expenses, and reserves. Private companies also have the opportunity to receive a reasonable return on investment, which in Arizona is regulated by the Arizona Corporation Commission (ACC). Rate increases for both public and private water utilities may lag costs because voters, city councils, and the ACC are reluctant to approve them without a compelling reason. Where the community is willing and able to pay for reliable water and wastewater service, a utility will maintain its ability to fund needed infrastructure. Where the need for infrastructure investment and corresponding service cost is greater than the community can support, infrastructural repair and replacement may be neglected. Federal and state programs exist to help disadvantaged or distressed towns or cities, although funding is limited.

Federal Programs

In 2014, the Obama Administration established the Water Infrastructure and Resiliency Finance Center at the EPA to encourage and promote leading-edge financing structures for drinking water and wastewater infrastructure. The Water Infrastructure Finance and Innovation Act (WIFIA) established a water financing program that provides selected water infrastructure projects with long-term credit assistance in the form of loans for up to 49 percent of total projected costs, with low interest rates and a flexible repayment structure.

Another infrastructure financing mechanism is the State Revolving Fund (SRF) Program. The Clean Water State Revolving Fund was created in 1987 and its success sparked the initiation of the Drinking Water State Revolving Fund in 1996. Capitalized by federal appropriations, SFRs are the single largest source of federal lending assistance for water infrastructure. Largely delivered as loans, debt obligation purchases, and bond security, SRF assistance has provided close to \$150 billion in financial support. Loan repayments support new projects, hence the revolving nature of the program. In Arizona, the Water Infrastructure Finance Authority (WIFA) administers both the Clean Water SRF and Drinking Water SRF. WIFA has been successful in helping to fund over \$1 billion in water and wastewater infrastructure at below-market rates for more than 25 years.

The Obama Administration also intended the Water Infrastructure and Resiliency Finance Center to help municipalities learn how to access private financing and management for their local water infrastructure project needs.

Public Private Partnerships

Private sector financing solutions are attractive to local and regional governments because 1) the magnitude of upfront investments needed to deal with aging infrastructure, regulatory compliance, demographic

Rachel Murray



Rachel Lynn Murray, a Ph.D. student in Arid Land Resource Sciences, was the 2018 Summer Writing Intern at the WRRRC, contributing substantially to the research and writing of this 2019 *Arroyo*. Her master's thesis documented research on irrigation management in Himalayan India's Sikkim communities and the impact of government assistance programs. She will be returning to South Asia for her Ph.D. dissertation research.

changes, and a changing climate may overburden their taxpayers and ratepayers, and 2) access to safe drinking water for every citizen is non-negotiable. The hope is that partnerships with the private sector can help overcome financial limitations to modernizing aging infrastructure and optimizing service.

Motives also have been growing within the private sectors to invest in public utilities. In 2016, Charles Schwab upgraded the utilities sector's status from "underperform" to "market-perform", explaining that escalating trade rhetoric and a near-term peak in growth was pushing investors into low-risk sectors like utilities despite their low returns.

Broadly defined, a public-private partnership (P3) is a contractual arrangement between a public agency and one or more private sector entities for the provision of a public good. In many countries the term has evolved to mean any contractual framework that allows for greater private sector participation in what is traditionally public infrastructure. P3s have been formed over a broad range of private participation levels, from simple design and build contracts to complex design-build-finance-operate agreements. Water projects require long-term investment horizons. For these projects, private equity funds may finance project development and bear early project development risks. Once a project is developed and operating, the private entity may sell the project to an entity in the business of operating long-term projects for inflation-protected returns. More than two-thirds of the states in the United States have enacted legislation enabling P3s.

Water Treatment

In the case of the highly lauded Lake Pleasant Water Treatment Plant, Phoenix partnered with a designer (Black and Veatch), a builder (McCarthy Building Company), and an operator (American Water Services) to actualize the nation's first large-scale Design-Build-Operate (DBO) water treatment plant. The city issued tax exempt revenue bonds as its primary means of raising funds to pay design, construction, and development costs such as consulting and legal fees. Integrating design with



Phoenix's Lake Pleasant Water Treatment Plant administration building designed in the style of Frank Lloyd Wright. Source: McCarthy Building Companies, Inc., <https://www.mccarthy.com/projects/lake-pleasant-water-treatment-plant>

operation reduced a six-year project to four years, while phased permitting agreements allowed construction to begin two months early, saving Phoenix \$30 million. The plant included what was at the time (2007) the most advanced technology, and flexible design enabled the plant to meet all water quality requirements, regardless of the incoming water quality. Moreover, with this DBO model, the city was able to attract a design firm that specialized in matching the architecture to the natural environment in the style of Frank Lloyd Wright.

Water Service

The water utility for Rialto, California, endured decades of deferred maintenance, routine main breaks, and serious contamination issues and resultant lawsuits. Cumbersome debt made worse by the recession, as well as federal compliance problems, exacerbated the situation. In 2012, the city entered a 30-year, \$300 million P3 with Veolia Water, Ullico (an insurance and investment company), and Table Rock Capital, to form Rialto Water Services (RWS). The contract made Veolia, responsible for operations, management, fee collection, and an upgrade to be accomplished in the first five years of the agreement. RWS receives a monthly payment for debt service and returns on equity, operations and maintenance, and service fees. In return, Rialto received a substantial upfront payment and future rental payments and had all of its debt discharged. Moreover, the city was relieved of all responsibility for future needed capital improvements and the risks and responsibilities of operating and maintaining the system.

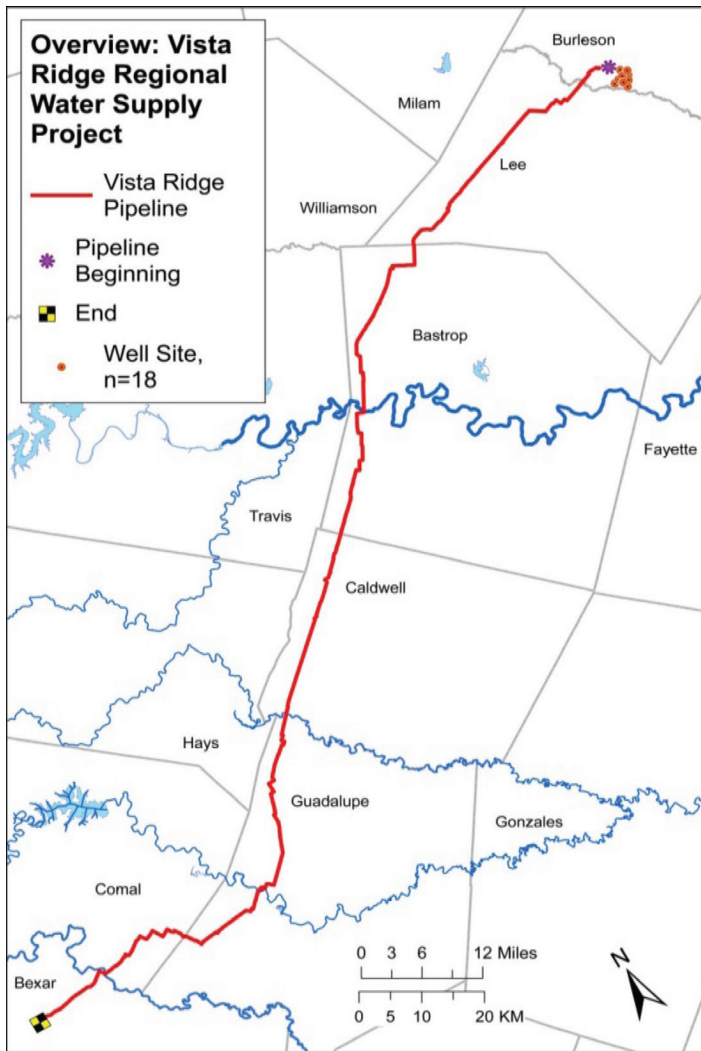
Rialto rate-payers saw their rates increase by around 115 percent in the first four years of the concession agreement. Table Rock Capital explained that rates had been kept artificially low for nearly a decade. Such rate shock could have been mitigated by including a more gradual schedule of rate increases in the agreement.

Desalination

In 2018, San Diego County, home to 3.3 million people, experienced the second driest year on record since 1850, receiving only 3.3 inches of rain. By then, however, the Claude "Bud" Lewis Carlsbad Desalination Plant, the largest desalination plant in the United States, had been operating for three years. Developed through a P3 between San Diego County Water Authority (SDCWA) and Poseidon Water, a Boston-based private water infrastructure development firm, the project originated in 1998 and began delivering water under a 30-year Water Purchase Agreement in 2015. The agreement addressed the SDCWA's main concerns about financing and ratepayer protection by transferring full financial risk (construction cost overruns, permitting, non-performance, etc.) to Poseidon. SDCWA guaranteed the purchase of at least 48,000 acre-feet of produced water annually. Any water over this amount, up to the facility maximum of 56,000 acre-feet, can be purchased at a discounted rate, incentivizing SDCWA to maximize its use of the plant. After 30 years, SDCWA has the option of purchasing the plant for one dollar.

Augmentation

In 2020, residents of San Antonio, Texas will begin receiving millions of gallons of water a day from what is being heralded as one of the largest water sector P3s in the United States, the Vista Ridge Pipeline Project. The city's public water utility, San Antonio Water System (SAWS), issued a request for proposals for the delivery of supplemental water to meet San Antonio's growing water demand. The city did not specify where the water would come from or by what means it would be delivered. Avoiding all development risk, SAWS only offered to pay for a minimum amount of water every year for 30 years. The city awarded a consortium of private construction



San Antonio's 142-mile Vista Ridge Pipeline. Source: U.S. Fish and Wildlife Service, https://www.fws.gov/southwest/es/Documents/R2ES/BO_VistaRidge_16Mar2017.pdf

firm the contract to design, build, and operate a system featuring a 142-mile long transmission pipeline with a capacity of 16.3 billion gallons a year. The success of San Antonio's strategy demonstrates that private investors are looking for prudent investments and are able to undertake the risks of these kinds of projects for a price that ratepayers are willing to pay.

Other Financial Strategies

Business Activity Assets

Local and regional agencies traditionally raise funds for infrastructure projects through bonds, which are paid off a little at a time over many years. Because conventional infrastructure is an asset they own, they can raise capital on its value. Investments that promote conservation, such as green infrastructure projects and rainwater capture rebates, historically have not been recognized as assets for purposes of accounting. This changed in May 2018, when the Government Accountability Standards Board clarified what it would consider "business type

activities" to be counted as assets. The clarification explicitly gives permission for public agencies to use bonds to fund distributed infrastructure projects. This opens the door for utilities to raise capital for initiatives like constructed wetlands, cash-for-grass payments, leak detection devices, and rebates for graywater reuse, high efficiency toilets or fixtures, and smart irrigation controllers.

Grants

In the Tri-City area of southern Gila County, Arizona, nearly 90 percent of existing properties have failing, failed, or substandard septic systems and cesspools and are in violation of federal and state requirements. Residents formed the Tri-City Regional Sanitary District in 2011 and began studying wastewater collection and treatment alternatives. In consultation with the U.S. Department of Agriculture-Rural Development (USDA-RD), the district decided to build a new collection and treatment system. A USDA-RD grant made it possible for the project to proceed. The first phase of the three-phase, \$70-million project is scheduled for 2019-21. The USDA-RD funding for Phase I totals \$28 million, split 60 percent grant and 40 percent loan.

Water Rates and Fees

Increased conservation has led to declining water use, creating the need for utilities to make up lost revenue. Utilities are looking to alternative rate structuring to increase their revenue resiliency in the face of demand fluctuations and align revenue stability with the promotion of efficient water use. Pricing models based on average peak rates of individual customers or, some have suggested, cell phone plan models, can build cost recovery into the base charges, lower the bills for low-peaking customers, and significantly increase the bills for high-peaking customers. In practice, these pricing models can lead to revenue volatility; consequently they have found limited use. Mechanisms that decouple revenue from the amount of water sold can not only reduce volatility, but also promote efficiency by removing the utilities' incentive to increase sales. They can, however, reduce the customers' incentive to conserve water.

Operational Efficiency

In the water sector, innovations capitalizing on business strategies for resource conservation, recovery, and reuse are improving the bottom line for utilities.

Resource Recovery

As basic resource prices increase, resource recovery from waste can improve utility balance sheets.

CORPORATE WATER SUSTAINABILITY

While public and private water and wastewater utilities have adopted innovative business practices, other businesses have acknowledged the importance of water sustainability to their corporate trajectory.

Business Risk

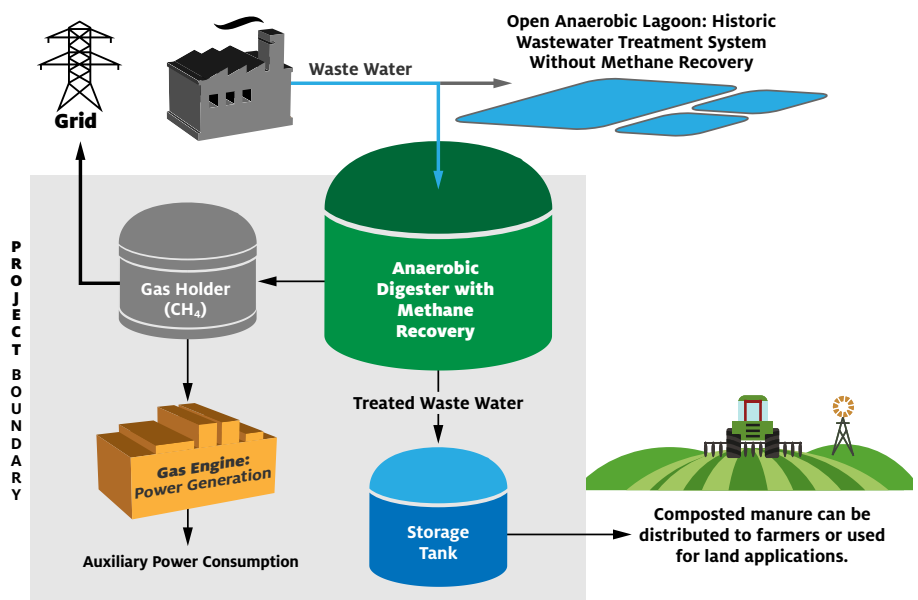
Businesses, which typically seek to manage risk, are becoming aware of their exposure to multiple risks associated with water availability and use. Threats posed by water contamination, wild fires, surface and groundwater depletion, and environmental degradation affecting the health and well-being of customers are taken into account in corporate risk calculations. Less tangible risks, such as meeting customer and stakeholder expectations, also can have an impact on the bottom line. In general, members of the business world have become increasingly cognizant of the substantial risks that their dependence on water poses for both their economic growth and their reputations. Approximately 50 percent of the stocks within the four major U.S. stock indices are in industries that report a medium to high water risk. The 2017 Carbon Disclosure Project's Water Disclosure Report analyzed response data from 742 of the world's largest publicly listed companies, which reported 3,770 water risks threatening their supply-chain security, licenses to operate, and ability to grow. These companies recognized that water scarcity and stress, drought, flooding, and climate change are their top risk drivers, and they identified higher operating costs, supply chain distribution, water supply distribution, constraints to growth, and brand damage as their top five risks.

Wastewater treatment plants can capture methane gas, which is a byproduct of sludge decomposition, for use as a renewable energy source. Sludge also contains valuable metals and minerals that the utility might extract and sell. A year's worth of sludge from a city of a million residents can produce \$13 million in valuable metals, including gold and silver. In addition, sludge can be mined for phosphorus and nitrogen for use in fertilizers, as well as bioplastics and cellulose-based products for use in other industries. Biogas generation at municipal wastewater utilities in Gresham, Oregon, and Oakland, California, actually produce more energy than they use, saving the cities hundreds of thousands of dollars each year. The sewerage district in Madison, Wisconsin, teamed with a technology firm to recover phosphorus from the city's wastewater and transform it into environmentally friendly fertilizer, which they trademarked and now sell to a Canadian company.

Technological Innovation

Technological breakthroughs, often in the hands of startup entrepreneurs and investors, are developing opportunities for customers, particularly utilities, to optimize their operations. These innovations save money on energy, chemicals, treatment, and time. For example, Imagine H2O, a water technology accelerator, recruits approximately a dozen startups each year for work on the water technology theme of the year. In 2016 and 2017, Imagine H2O focused on water data, bringing in companies that created acoustic sensing and artificial intelligence (AI). Acoustic sensing uses sonar as a cheaper, easier method for detecting problems in pipes buried deep underground. AI uses cloud-based applications to create virtual reproductions of physical infrastructure on which to simulate potential impacts of alternative control decisions.

Water technology innovators, however, face a number of challenges that have restrained investment from both venture capital and corporate research and development. Startups face a long sales cycle, as regulated water utilities tend to avoid risk, in part, because of the connection water has to public health and safety. This long road to return on investment occurs in a sector in which fragmentation in technological standards, regulations, and geographies make scaling up difficult. In response to these challenges, some government programs are encouraging water technology innovation by offering incubation facilities, demonstration sites, and even financial backing for commercialization.



Power and fertilizer production from wastewater turns waste into revenue. Modified from: Green Clean Guide, <https://greencleanguide.com/methane-emission-and-carbon-revenue/>

Companies reported that they are now taking concrete water risk management action in areas such as governance, measuring and monitoring, risk assessment, targets and goals, and supply chain engagement. For example, Nestlé has begun assigning a comprehensive water value for its operational decision making. To spur more efficient use at its factories in water scarce regions, Nestlé assigns a value of \$5 per cubic meter where it operates in arid regions—five times the value assigned to water where it is readily available.

Reducing mounting water-related business risks is the major driver of conservation activities, not just for water-intensive sectors such as the food and beverage industry, but also for businesses with water-intensive supply chains, such as the sale of consumer goods. Firms have used substitutes for water-intensive inputs and invested in water-efficient technologies and water recycling. Financial incentives for investment in water saving practices are substantial. U.S. sewer rates rose 65 percent between 2000 and 2014, while water rates increased 55 percent. General U.S. inflation during the same period was only 34 percent.

In 2017, computing technology giant Intel announced plans to invest over \$7 billion in an advanced semiconductor factory in Chandler, Arizona, where it already operates two campuses. While Intel’s freshwater withdrawals in the state in 2018 totaled approximately 3.7 billion gallons, it returned approximately 3.2 billion gallons to the aquifer. A recharge facility uses reverse osmosis to efficiently treat wastewater before returning it to the aquifer. In addition, Intel purchases a portion of Chandler’s effluent and reuses it for scrubbers, cooling towers, and landscaping. It also invests in a combination of internal water reuse technologies. These efforts return approximately 75 percent of the water that Intel uses at its Chandler facilities to the aquifer and approximately 25 percent is reused on-site.

Corporate Stewardship

Corporate water stewardship refers to how companies understand and mitigate the impact of their water use on ecosystems and communities. Avoiding brand damage and responding to customer demand are two important motives for companies to engage in water stewardship. In addition, many companies include community engagement as a corporate objective. Ideally,

	PHYSICAL RISK	REGULATORY RISK	REPUTATION RISK
Basin-related risk Linked to location	Water quantity (scarcity, flooding, droughts) and quality (pollution) within the river basin and the impacts this might have on society and the environment.	Strength and enforcement of water regulations and the consequences of restrictions by public institutions; either felt through direct regulatory action or from neglect, blockages or failure.	Perceptions around water use, pollution and behaviour that may have negative impacts on the company brand and influence purchasing decisions. Public perceptions can emerge rapidly when local aquatic systems and community access to water are affected.
Company-related risk Linked to behavior	Water quantity and quality issues related to the performance of the company and its supply chain.	The potential for changes in pricing, supply, rights, standards and license to operate for a particular company or sector.	When the actions of the company are poorly executed, understood or communicated with local stakeholders and where perceptions and brand suffer as a consequence.

Water risks faced by businesses, 2012. Source: World Wildlife Fund, http://awsassets.panda.org/downloads/ws_briefing_booklet_lr_spreads.pdf

corporate water stewardship involves the sustainability of water use across the entire chain of supply, production, and distribution.

Supply Chain Conservation

Walmart has been working with the Environmental Defense Fund (EDF) in a decade-long partnership to drive sustainability across the supply chain. While the retail sector uses little water relative to other industries, its supply chains, particularly farming and consumer product manufacturing, use significant quantities. In fact, 90 percent of Walmart’s environmental footprint is in the supply chain. The non-profit EDF provided expertise in science, economics, and partnerships for Walmart, the world’s largest private employer, and Walmart demonstrated an openness to innovate on a large scale. As a result of this partnership, Walmart has developed a water sustainability index, which it includes in its supplier evaluations, allowing it to challenge suppliers to become more water efficient and to strengthen relationships with suppliers who are good water stewards.

Good corporate stewards create, carry out, and report a plan for consumption and pollution reduction, and pursue collective action and community involvement. Intel is moving steadily towards its goal of restoring 100 percent of its global water consumption by 2025 through support of a diverse array of watershed and river basin restoration and management projects in multiple western states. Along with water-intensive sectors like beverage and microprocessor industries, companies that define themselves by their environmental ethos (e.g. Tom’s, Seventh Generation, Aveda) and companies whose customers identify themselves as environmentally conscious (e.g. REI, Cliff, Patagonia) involve themselves in water restoration.



Beers produced from the Verde Valley's barley, malted by Sinagua Malt. Source: Good Food Finder, <https://www.goodfoodfinderaz.com/news/local-farm-to-beer-partnerships-are-brewing-in-arizona>

Stream Restoration

Since 2012, Coca Cola has been working in partnership with The Nature Conservancy and the Bonneville Environmental Foundation on a project to conserve and restore the Verde Valley watershed. Bonneville connects businesses with relevant water education and stewardship projects that meet their good neighbor goals in their communities. Coca Cola, along with a number of public and private partners, contributes to the multi-faceted Salt and Verde Alliance, which worked with landowners to install automated diversion gates along the Verde River that leave more water in the river, allowing it to flow year-round. The Alliance also has installed drip irrigation and leak prevention measures, such as replacing a section of gravel irrigation ditch with 1,800 feet of pipe, to cut down on water losses.

Local companies also are designing their business practices to promote conservation and community building. In Arizona, a Camp Verde startup, Sinagua Malt, had that in mind when it began working to create a local market for malted barley. Until 2016, no one in the state was producing malt—the key ingredient in most beers—forcing local brewers to source it from out of state. Barley for malt is grown in the winter and is harvested in the spring. Growing barley in the Verde Valley instead of alfalfa, for example, shifts water use to the low-demand winter season from the high-demand summer season, which reduces the seasonal stress on streamflow in the Verde River. Conversion of just 10 percent of the 6,000 acres of cropland in the Verde Valley to barley could lower summertime irrigation by nearly 200 million gallons—water that would remain in the river. In 2016, Sinagua Malt partnered with The Nature Conservancy, a local farmer, and three local breweries. The following year the

project demonstrated the feasibility of the concept with a harvest of 144 acres of barley that was processed into malt by Sinagua Malt, sold to the brewers, and used to produce local beers. In 2018, Intel agreed to provide funding to help scale up barley conversion in the Verde Valley.

WATER AND ECONOMIC DEVELOPMENT

Water plays an enormous role in economic development; numerous studies have found correlations between water-related investments and economic growth. For example, an Arizona State University W.P. Carey School of Business study found that Colorado River water, delivered through the CAP, generated more than \$1 trillion for Arizona from 1986 through 2010. This translates into roughly 40 percent of the total Arizona gross state product over the latter part of the study period. Although the study has been criticized for overgenerous assumptions, it illustrates the scale of water's impact on the economy.

Local governments in particular have an interest in facilitating innovation where economic activity is coupled with water sustainability. Tucson has initiated a program that offers incentives for development that locates where water infrastructure is lacking. The Water Infrastructure Incentive program offers up to \$2 million for projects that meet economic and sustainability criteria, including water sustainability. With a budget of up to \$2.5 million per year, the program aims to spur investment by businesses that will bring high-paying jobs to the area. Water sustainability criteria include minimizing potable water use through improved process water efficiencies, rainwater harvesting, use of reclaimed water, or on-site reuse.

Tucson also has plans to make the Santa Cruz River flow again through downtown for the first time in 70 years, as part of the Santa Cruz River Heritage Project. In hopes of bringing people back to the urban center and spurring economic activity, the city will release up to 3.5 million gallons per day of treated effluent from Pima County's Agua Nueva Water Reclamation Facility into the river upstream of downtown. Reconnecting the city with its river is seen as an added stimulus to the ongoing urban renaissance.

In Yuma, Arizona, the Yuma National Heritage Area provided a framework for private development in a restored center for Colorado River tourism that integrates commercial and park development. The component projects generated \$30 million in private investment that both enhances the quality of life for Yuma's citizens and promotes tourism. Similarly, efforts to restore the Verde River turned the "Dirty Verde" into a national water-based tourism destination.

Investments in water have been vital to Tribal economies. In addition to the GRIC and CRIT, other native communities have benefitted economically from water



Bike path along Yuma's restored National Heritage Area wetlands.
Source: U.S. National Park Service, <https://www.nps.gov/articles/yumawetlands.htm>

settlements. In fall 2017, Arizona senators introduced a bill to ratify the water rights settlement agreement of the Hualapai Tribe, whose lands encompass part of the Grand Canyon. The bill recognized the tribe's right to 4,000 acre-feet of Colorado River Water and allocates \$173 million to help build a 70-mile pipeline from the Colorado River up to Peach Springs, the Hualapai capital and a tribally owned resort area. For the settlement, Arizona has agreed to a "firm" 557.5 acre-feet of water at an estimated cost to the state of \$3.2 million. Joseph Kalt, an economics professor at both Harvard and the University of Arizona, stated that the project would pay for itself many times over with the resulting jobs, wages, business revenue, and taxes. Kalt estimated that building the pipeline will result in more than 10,000 jobs per year for the region and more than \$6.2 billion in income over the 50-years life of the project. The 2017 bill did not advance, but on May 1, 2019, new bills to ratify the settlement were introduced in both houses of congress.

CONCLUSION

Although fresh water falls from the sky on everyone and cycles continuously through rivers and aquifers, providing water for the multitude of uses that support our way of life involves business in one way or another. It is easy to ignore or underrate this involvement, but continued access to safe and reliable water may depend on marshalling the strengths of business to solve the challenges of water scarcity, misallocation, and environmental degradation. Water markets are one avenue for potential gains. Market design and appropriate government involvement can provide for social justice and sustainability while capturing the economic efficiency benefits of competitive markets. Partnerships that capitalize on the complementary strengths of the public and private sectors also can deliver gains.

Technological and Financial innovation will be essential to closing the gap between existing water and wastewater infrastructure and current and future needs. As businesses are awakening to water-related risks and changing cultural norms, many are responding by adopting sustainability goals that minimize their water footprints by reducing use and investing in restoration projects. NGOs have a role in facilitating the entry of business into this unaccustomed pursuit.

Because water is a key component of economic well-being, communities are focusing attention on their water resources to promote development goals. Regardless of whether water is considered a commodity, a public good, or a fundamental human right, the challenges of capturing, storing, distributing, and reusing it guarantee that there will be a business of water.

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