LIQUID ASSETS:
Investing for Impact in the Colorado River Basin

SQUIRE PATTON BOGGS

encourage capital

With support from the Walton Family Foundation

WATER IN THE WEST

EXECUTIVE SUMMARY

Over the past 15 years, much of the western United States has been in the grip of persistent local and regional droughts that have caused significant economic, political, and ecological disruption. Although water scarcity has long been a defining theme in the history of the American West, the extent and scale of the issues that are now facing the region are unprecedented. Substantial declines in agricultural production, loss of hydropower, municipal supply shortfalls, and declining reservoir levels have affected many western communities, while record low levels of precipitation and snowpack, low streamflows, higher water temperatures, the advance of drought-tolerant invasive species, and catastrophic wildfire and loss of forest cover have impacted most, if not all, western watersheds. As a result of decades of massive economic expansion in the arid Western States, these water problems are no longer just local or regional problems: they are national problems, affecting critical municipal and industrial centers and agricultural regions that represent a substantial portion of U.S. GDP.

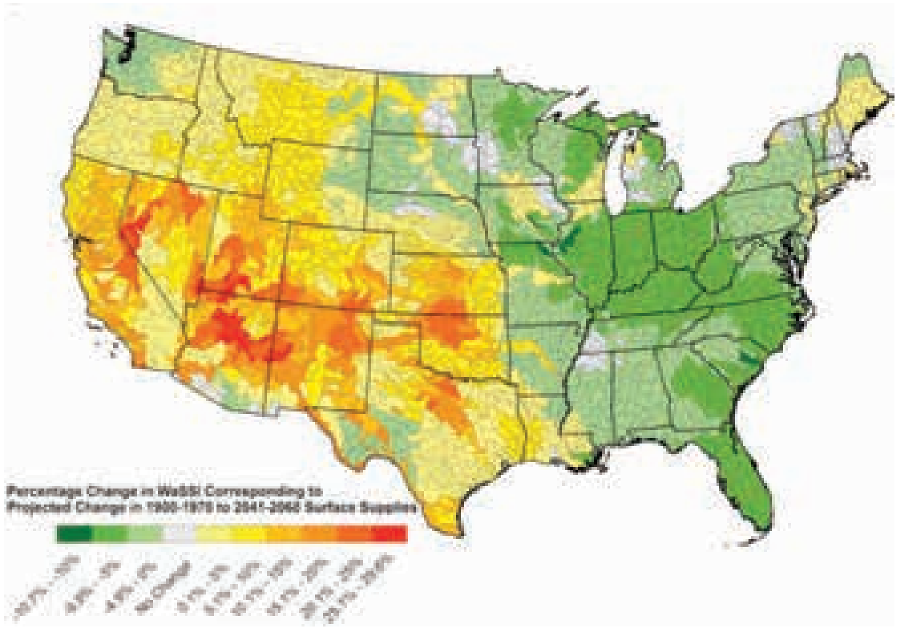

Figure 1. Projected Increase in Surface Water Stress. Map shows projected increases in surface water stress in U.S. watersheds over the next 4-5 decades. Source: K Averyt, et al., "Sectoral Contributions to Surface Water Stress in the Coterminous United States," Environmental Research Letters 8, no. 3 (Sept. 1, 2013).

As these issues have grown in their extent and severity, there has been increasing interest among investors, policymakers, and water managers alike in the potential for use of market-based mechanisms to manage complex, emerging issues around water scarcity and security, and to facilitate the entry of private capital to play a broader role in the management and financing of water resource solutions. This reflects a movement at a global scale towards the use of market-based mechanisms to manage a variety of natural resource issues, and to ensure that the value of ecosystem services to economies and societies are adequately captured in the marketplace. As the role of natural resource management and ecosystem function in supporting economic prosperity has achieved growing levels of recognition, successful markets have been created around a variety of resources and ecological processes. For example, cap-and-trade structures built around air pollutants such as sulfur dioxide, greenhouse gases, mitigation credits under the Clean Water Act, transferable development rights in land use regulation, and approaches such as catch limits and catch-shares in fisheries regulation each provide successful examples of efforts to transform relatively unmanaged, "frontier-style" exploitation of natural resources into a system of marketable rights that can be traded, leased, and otherwise controlled.

Unlike many natural resources, however, water in many parts of the world (and certainly in the American West) is already heavily regulated and governed (or is deliberately unregulated and ungoverned) by a well-developed system of water rights and laws, environmental controls, and governance institutions. In addition, water is somewhat different from many other natural resources in both its essential character, its role in the economy, and its social and political significance. This makes the transfer of water between uses practically, legally, ethically, and environmentally complex.

These differences -- together with significant physical, legal, and cultural barriers to the movement of water and the complex environmental challenges raised by water resource management issues -- have thus far made implementation of market-based strategies in the West far more difficult to achieve than they have been in the context of national water markets that have been adopted in countries such as Australia and Chile. Taken together, these restrictions have significantly limited opportunities for water investment in the past, with the majority of private investment focused on a relatively narrow range of "arbitrage"-driven opportunities to purchase and transfer water to new uses, or playing more traditional roles in support of bond financing for water infrastructure. However, these conditions are rapidly changing – and in light of emerging needs, there are now substantial opportunities for investing within existing regulatory frameworks (e.g. pursuing new approaches, technologies, and best management practices, financing projects with public benefit, etc.), as well as for investing in impact strategies that will realign stakeholder interests towards sustainable management and address broader water management issues, such as controlling growing water risk, reversing declines in watershed health, and other concerns that threaten both human water use and the ecosystem services provided by natural systems.

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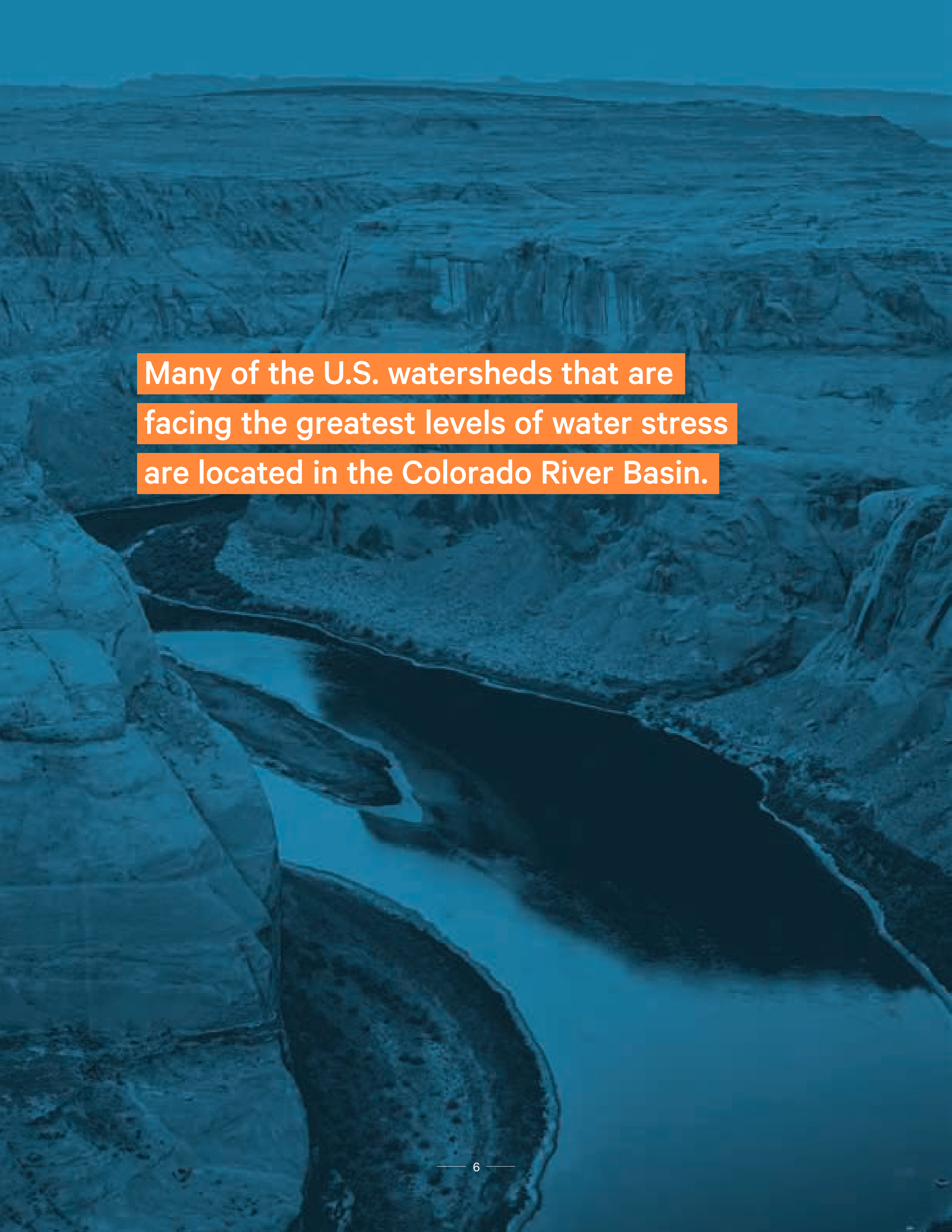
In particular, there are relatively few examples of successful private investments today that have helped to address growing water scarcity issues, particularly with regard to the long-term sustainability of agricultural communities, the financing of water supply and water infrastructure in growth communities, the numerous environmental challenges resulting from altered stream flows, groundwater depletion, declining landscape health, and other critical concerns. There is an urgent need to identify new strategies to meet those challenges, as they are beginning to manifest at a rate and a scale that is outstripping the capacity of traditional federal, state, and charitable enterprises to address. This has created both a significant need and opportunity for private investment – and most particularly, for impact investors who are willing to use private capital in innovative ways to drive fundamental change while seeking to achieve a financial return.

This report reflects the results of an investigation undertaken by Encourage Capital and Squire Patton Boggs, in collaboration with the Walton Family Foundation, to identify potential impact investments that could be successfully deployed to finance water resource solutions, generate related environmental benefits, and create a financial return. This paper outlines eleven promising impact investment strategies that have been grouped into nine separate "investment blueprints" detailed below in Table 1. These strategies are intended for use as generic models in the development and investigation of specific investment opportunities on the ground. Some of these concepts represent a proposed re-tasking of existing investment tools and approaches that have been successfully deployed in other natural resource contexts; others represent unique approaches that combine or build on investment structures that have not previously been used in the context of natural resource management.

While these blueprints could potentially be deployed in many parts of the West, this investigation has focused on the Colorado River Basin, one of the most water-stressed watersheds in the Western United States, and one of the most heavily regulated and developed river systems in the world. Taken together, these blueprints *(outlined in Table 1)*, propose approaches to addressing a variety of complex environmental challenges in the Basin, ranging from improvements to forest, riparian and grassland health, to maintaining adequate instream flows through investments in agricultural lands and improvement of water efficiency in municipal systems,. They also cover the financing and development of environmentally-beneficial municipal infrastructure, as well as investments in new market institutions that could reduce systemic risks to human and environmental users alike.

Watershed Enhancement	A	Forest Health Environmental Impact Bond	Invest in a pay-for-performance vehicle to reduce the risk of wildfires and increase watershed yield via forest thinning, with investors repaid through savings in fire suppression cost and avoided water risk
	B	Riparian Restoration Environmental Impact Bond	Invest in a pay-for-performance vehicle to improve ecosystem health and increase watershed yield through invasive species removal and riparian restoration
Agricultural Water Use	C	Sustainable Ranching	Invest in cattle herds and ranch land to improve grassland health by employing higher-yield and more sustainable grazing practices
	D	Crop Conversion and Infrastructure Upgrades	Invest in agricultural water efficiency via on-farm conversion to higher-value, lower water-use crops and improvements to irrigation infrastructure
	E	Commodity-Indexed Dry-Year Option	Broker deals to better distribute hydrologic and economic risk between water uses with higher and lower tolerance for water supply loss via dry-year options and commodity price hedging
Muni Water Infrastructure	F	System Loss Pay for Performance	Invest in a pay for performance vehicle to upgrade municipal water infrastructure to reduce systems losses
	G	Green Bond with Sustainability Conditions	Provide low-cost financing for municipal water infrastructure tied to environmental and sustainability conditions
Market Development	H	Next Generation Water Trust	Develop an investment-driven next generation water trust to address environmental and system-wide water supply risks
	I	Water Storage Trading	Develop, implement, and operate storage trading markets in surface water reservoirs and groundwater aquifers

Table 1. Overview of the nine investment blueprints, representing the eleven proposed financing solutions detailed in the Liquid Assets: Investing for Impact in the Colorado River Basin report.



Many of the U.S. watersheds that are facing the greatest levels of water stress are located in the Colorado River Basin.

The Colorado River exhibits an extraordinarily broad diversity of federal, state, and institutional structures for water management (which are common to many western states), and engages water uses ranging from the individual diversions and small-scale farming operations that are prevalent in the Basin's higher elevations, to the massive dam and canal infrastructure, sprawling cities, and expansive production agriculture in the Basin's lower reaches. The challenges facing the Basin's users are thus shared in varying degrees by users throughout the West. As such, many of the solutions identified above – discussed in greater detail within this report – could be potentially transferable throughout the West. Some may even be applicable in other parts of the world.

I. The Colorado River Basin and the Law of the River

The Colorado River Basin has long been the iconic core of the historic vision for the West: to "make the desert bloom." Today, the Basin also stands at the center of efforts to manage issues surrounding water scarcity; as shown in Figure 1, many of the U.S. watersheds that are facing the greatest levels of water stress are located within the Colorado River Basin.

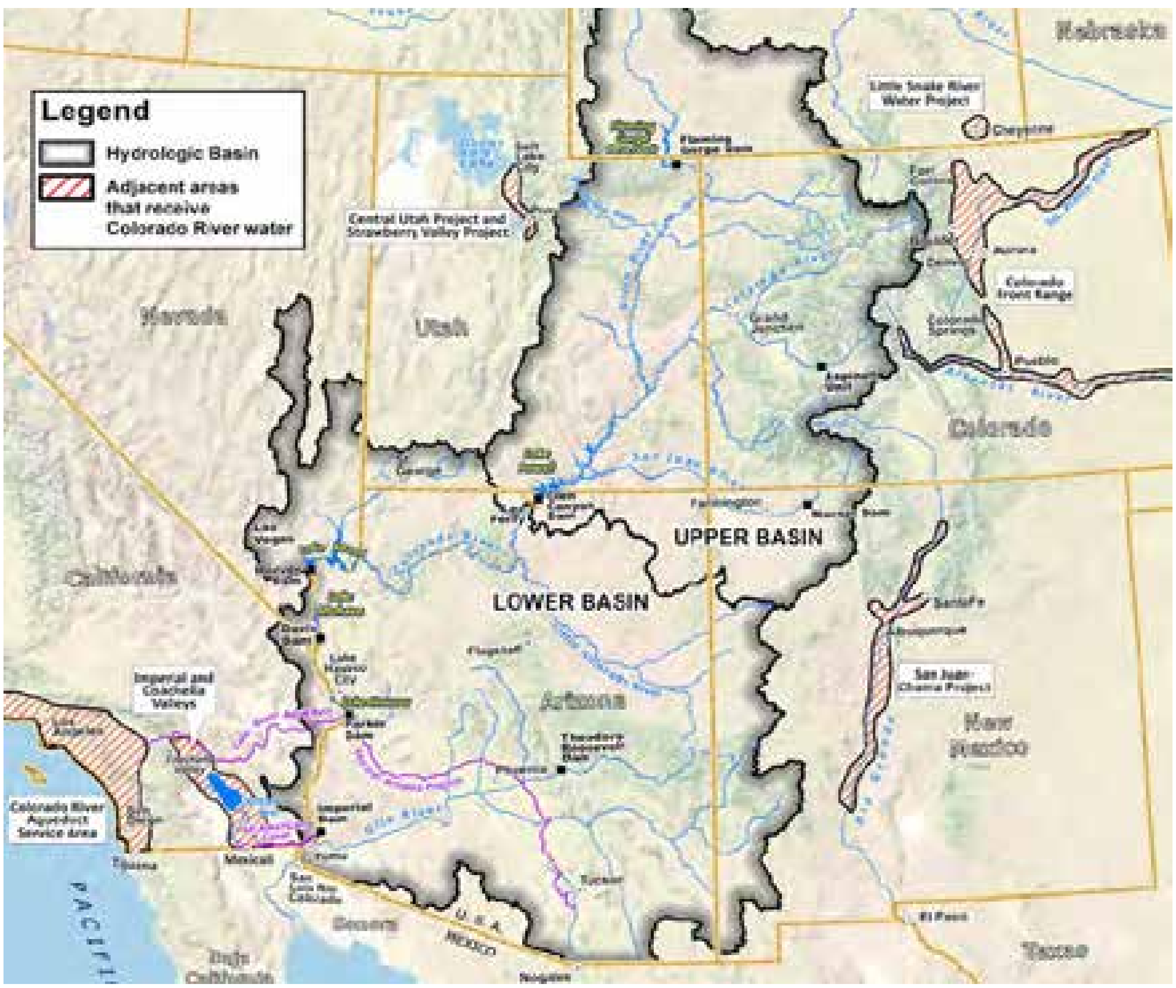


Figure 2. The Colorado River Basin. Source: U.S. Bureau of Reclamation (2012).

Historically, the Colorado was a wildly unpredictable, muddy river, prone to severe drought and intense seasonal flooding. Indeed, the name "coloreado" means "colored" or "red" in Spanish, and was given to the river because of its reddish, muddy color. When the Spaniards first arrived on the banks of the Colorado, the River supported an astonishing array of native fish and aquatic species—including 30 species of fish found nowhere else on Earth. Its delta was a vast, 2-million acre wetland that served as a critical stopover point for migratory birds on the Pacific Flyway, and supported a rich estuarine habitat and a major fishery in the Gulf of California. However, through more than nine decades of large-scale public and private investment, the once-wild Colorado River has been transformed into the most heavily managed and regulated river system in the world. Providing water to seven U.S. states (Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming), and two states in Mexico, and with a basin spanning some 246,000 square miles, the Colorado River now supports more than 35 million people, 4 million acres of irrigated agriculture, and an estimated 20% of U.S. national GDP.

For accounting and management purposes, the U.S. portion of the Colorado River is divided into an Upper and Lower Basin. Within the Colorado River's primary system infrastructure, Lake Powell operates as the primary Upper Basin storage reservoir, and Lake Mead as the primary Lower Basin storage reservoir; however, these major storage and hydropower dams are supported by dozens of other smaller storage and diversion projects. This enormous infrastructure allows essentially every gallon of the Colorado River to be used and reused multiple times along its length, such that the River is completely consumed by the time it reaches its terminus in Mexico. In fact, the River has not reliably reached its former Delta at the head of the Gulf of California since the 1960s.

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The waters of the Colorado River are governed by what is loosely termed the "Law of the River," a complex array of statutes, court decisions and decrees, contracts, interstate compacts, regulations, and treaties generated by a century of ongoing dispute over the allocation of water. At the core of the Law of the River is the 1922 Colorado River Compact ("Compact"), an interstate compact which divides the water of the Colorado River between the Upper Basin – composed of the states of Colorado, Wyoming, Utah, New Mexico, and a small section of Arizona – and the Lower Basin, which includes California, the remainder of Arizona, and Nevada. The Compact allocated to each Basin the right to an annual "beneficial consumptive use" of 7.5 million acre-feet (maf) of Colorado River water; a later 1944 treaty with Mexico also granted Mexico the right to 1.5 maf of water each year. Within the Upper Basin, the water is further divided among the individual states by the Upper Colorado River Basin Compact of 1948. In the Lower Basin, water is divided between the individual states, and among individual water users by the Boulder Canyon Project Act of 1928 ("BCPA"), a decree of the United States Supreme Court in Arizona v. California, and other federal laws, together with federal water delivery contracts issued by the U.S. Bureau of Reclamation ("Reclamation"). These primary provisions of the Law of the River, together with dozens of other smaller agreements, contracts, regulations, and other provisions, drive the operation of the major system reservoirs and diversions.

Within the constraints imposed by these primary federal and interstate controls on the Colorado River, the majority of intrastate water management is driven by state laws governing the appropriation of surface water and/or groundwater management. The variations between state laws create an incredibly diverse set of legal and institutional regimes within the Basin – a diversity common to water management throughout the Western U.S.[1] However, at the highest level, there are several primary legal categories of "water rights" at work in the Colorado River.

Surface water rights: Nearly all western states follow the law of prior appropriation—in essence, a rule of "first in time, first in right." Under the prior appropriation system, the first user to divert water from a stream and put it to beneficial use obtains a right to continue such diversions with a priority senior to all subsequent diverters. This system has tended to concentrate the ownership of water in historic uses (such as agriculture) at the expense of more recent uses (such as industry and cities). Most states allow these rights to be moved to a different place or type of use through a "sever-and-transfer" procedure, although this process can be complex and cumbersome. Importantly, the federal government also has significant "reserved rights" associated with specialized federal lands like parks and national forests; the most significant of these are held by Native American tribes, which in many cases have expansive claims to western rivers, streams, and groundwater basins.

Groundwater rights: State law approaches to the management of groundwater differ significantly from state to state, with some states recognizing the prior appropriation doctrine and its associated system of rights and priorities for both groundwater and surface water (in most cases, groundwater and surface water systems are hydrologically interconnected, such that the use of groundwater can eventually interfere with surface flows). Other states, however, only loosely regulate groundwater use, typically following the "reasonable use" doctrine, which essentially permits open access to groundwater resources by any overlying property owner, even if this harms other users. A few states, such as Arizona, have adopted laws that closely regulate groundwater use in some problematic areas, while leaving groundwater unregulated elsewhere.

Colorado River Delivery Contracts: In the Lower Basin, state law prior-appropriation systems only govern the use of water on Colorado River tributaries (such as the Little Colorado River, the Virgin River, and the Salt, Verde, and Gila River systems). Entitlements to Colorado River mainstem water are administered by the federal government through permanent Reclamation delivery contracts issued pursuant to the BCPA. These contracts are issued to users within each Lower Basin state pursuant to the basic allocations established in the BCPA (4.4 maf to California, 2.8 maf to Arizona, and 0.3 maf to Nevada), and are further governed by a complex set of priorities established in those contracts or by separate agreements among water users.

1 Unlike many other environmental issues and natural resources, water has traditionally been treated in the United States as a matter of state, not federal, law.

II. The Colorado River's Math Problem

The division of Colorado River water under the Compact and the Treaty of 1944 is responsible for a central problem of the Law of the River: it apportions more water than actually exists. Taken together, the Compact and the Treaty jointly allocate at least 16.5 maf of water between the Upper Basin, the Lower Basin, and Mexico. When the Compact was signed in 1922, the annual flow of the river past Lee's Ferry (the dividing line between the Upper and Lower Basins) was estimated to be at least equal to if not substantially larger than this figure. Unfortunately, modern tree-ring studies have demonstrated that the relatively short period of record that was used to estimate Colorado River flows for purposes of the Compact was among the wettest in the past several thousand years.

Until recently, this historic overestimation of available resources had not generated any serious problems, in large part because many of the Basin states and their individual users had not – and in many cases still do not - utilize their full legal allocations of water (in some cases, such as in the case of many Indian tribes, the amounts of these allocations are also still in dispute). However, this situation has been dramatically changing. Since 2003, the ever-increasing demand for Colorado River water has consistently exceeded the naturally available supply, even without considering ongoing overexploitation of groundwater. In other words, there is simply no more "surplus" water to grow into.

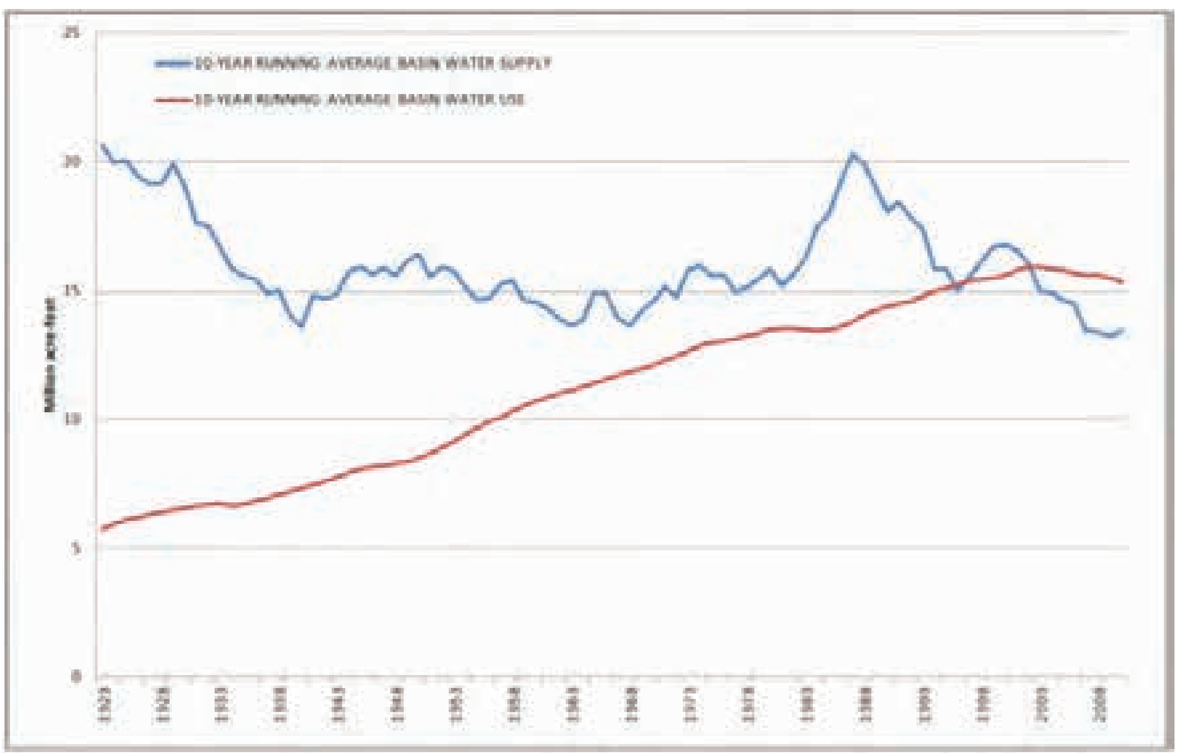

Figure 3. Historic Basin-Wide Supply and Demand. 10-year running averages for surface water supply (blue) and water demand (red) in the Colorado River Basin. As of 2003, surface water demand has exceeded naturally available supply (and the historical average supply) every year. Source: U.S. Bureau of Reclamation (2012).

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For the Upper Basin states, which have the lowest priority under the Compact, this reality effectively limits Upper Basin water development to the amount of water that is actually available after the Upper Basin's delivery obligations to the Lower Basin and to Mexico are met. As a result, the amount of water that is potentially available to the Upper Basin each year is closer to 5.5 maf than to the Compact entitlement of 7.5 maf. Importantly, this reality also means that the Upper Basin bears the primary risk of reductions in Basin yield in the future -- whether those reductions result from drought, climate change, or other critical landscape-scale changes that are impacting water yields.

For the Lower Basin, the "math problem" plays out as an increasing risk of shortages, largely due to the overuse of water available to it under the Compact. BCPA contracts fully allocate Lower Basin water to water users, essentially assuming that other substantial Lower Basin system demands—such as evaporation at Lake Mead and other major reservoirs, phreatophyte use, the Lower Basin's share of the delivery obligations to Mexico, and other demands—will be met either from Lower Basin tributary inflows (which are fairly small) or from excess releases out of the Upper Basin. In practice, this results in an approximate 1.2 maf "deficit" in Lake Mead each year whenever the Upper Basin does not deliver more than the minimum amount it owes under the Compact -- translating to inevitable Lower Basin shortages as excess flows decrease (whether as a result of drought or the continued development of water for use in the Upper Basin).

In no small part due to this "math problem," the Colorado River system is now in the midst of an unprecedented crisis. Over the past 15 years, the River has been experiencing a dramatic multiyear drought that has brought the problems of overallocation and overuse into sharp relief, causing significant declines in hydropower production, localized shortages impacting municipal and agricultural uses, and reduced flows and reservoir levels that have negatively affected wildlife, fish, and recreation. Alarmingly, the principal storage reservoirs for the Colorado River Basin, built to insulate the Southwest against the River's dramatic natural variability, have seen their combined storage decline to a level lower than when Lake Powell first began to fill in the 1960s; Lake Mead has declined to a point not seen since it was first filling in the 1930s. These reservoirs are now rapidly approaching critical elevations that could jeopardize hydropower production at both the Hoover and Glen Canyon Dams, threaten Las Vegas' municipal intakes at Lake Mead, and trigger substantial shortages to central Arizona that could ultimately produce effects similar to those currently being experienced in central California.

Just as importantly, the probability of returning to and maintaining higher reservoir conditions is dropping every year, as a result of: ongoing changes in hydrology (believed to be a combination of climate change impacts, dust on snow, and invasive species), the Lake Mead "deficit" described above, and continued expected growth in water use. For the Upper Basin, this means more and more widespread risks of local water supply shortfalls that threaten human and environmental users alike. In the Lower Basin, this means ever-increasing risks of significant and potentially long-lasting shortages to major water users (particularly in Arizona, which will bear the brunt of initial shortages under current priority rules). Even assuming that the Basin's future hydrology returns to its long-term, lower average—and not the lower levels predicted from climate change—not only are frequent shortages the norm, but the risk of large-scale, catastrophic shortages are also becoming all too real.

III. Beyond the Math Problem

These current challenges also provide a preview of larger, longer-term challenges in the management of shrinking supply and growing water demand. The Colorado River Basin Water Supply and Demand Study ("Basin Study"), completed by the U.S. Bureau of Reclamation and the seven Colorado River Basin states in 2012, evaluated a variety of different future agricultural, municipal, and industrial demand scenarios and then matched them against a series of future water-supply scenarios, including scenarios built from downscaled global climate models. The Basin Study found that without further proactive steps, the long-term projected imbalance in future supply and demand could grow to an average of around 3.2 million acre-feet (approximately 20% of total system yield) over the next five decades.[2] The worst-case scenario suggests a potential annual imbalance of over 8 maf (greater than 50% of projected demand). In areas that face significant future supply-and-demand imbalances – generally driven by growing urban demand – major new investments in water infrastructure, conservation, or water supply acquisitions will be needed.

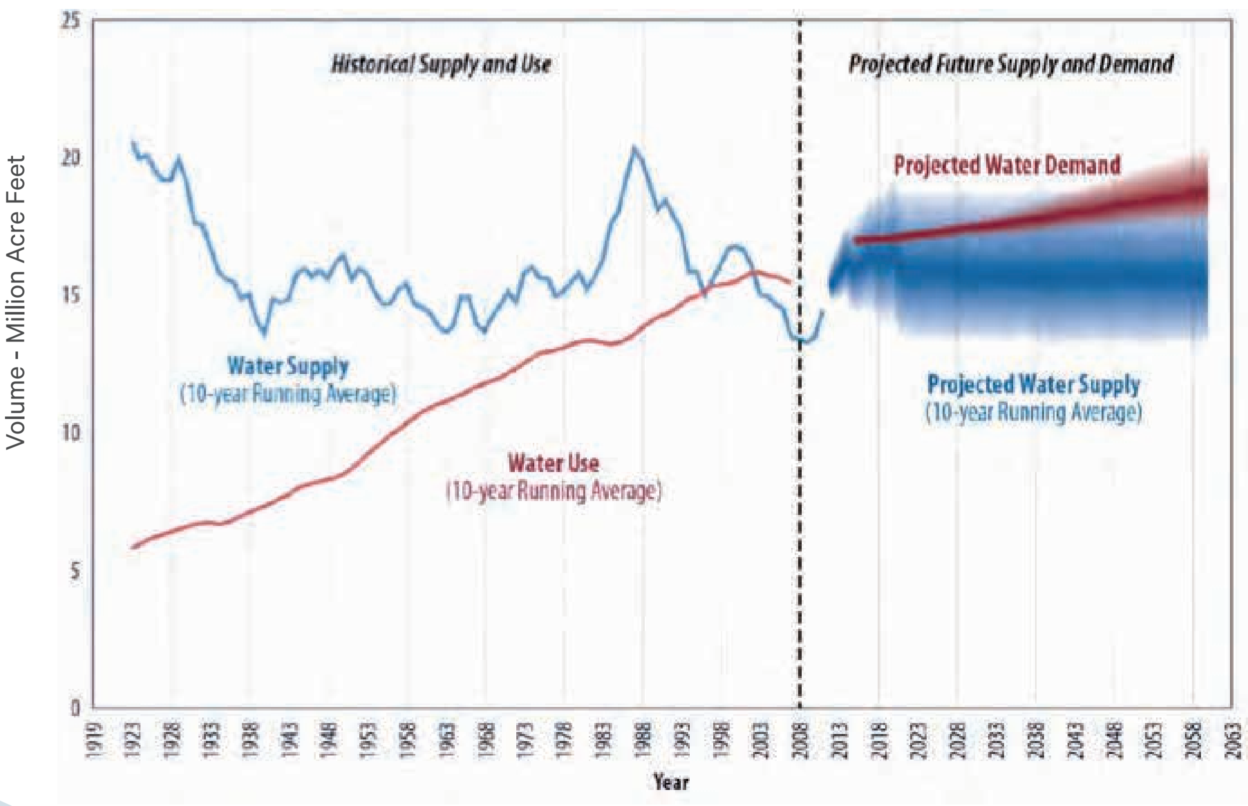


Figure 4. Historic Basin-Wide Supply and Demand. 10-year running averages for water supply (blue) and water demand (red) in the Colorado River Basin, continuing forward from the graph in Figure 3. Shading represents probability (darker areas represent higher probabilities). Projected future demand continues to grow under all scenarios, exceeding available supply by as much as 50% in some scenarios. Source: U.S. Bureau of Reclamation (2012).

2 Bureau of Reclamation, Colorado River Basin Study, 2012.

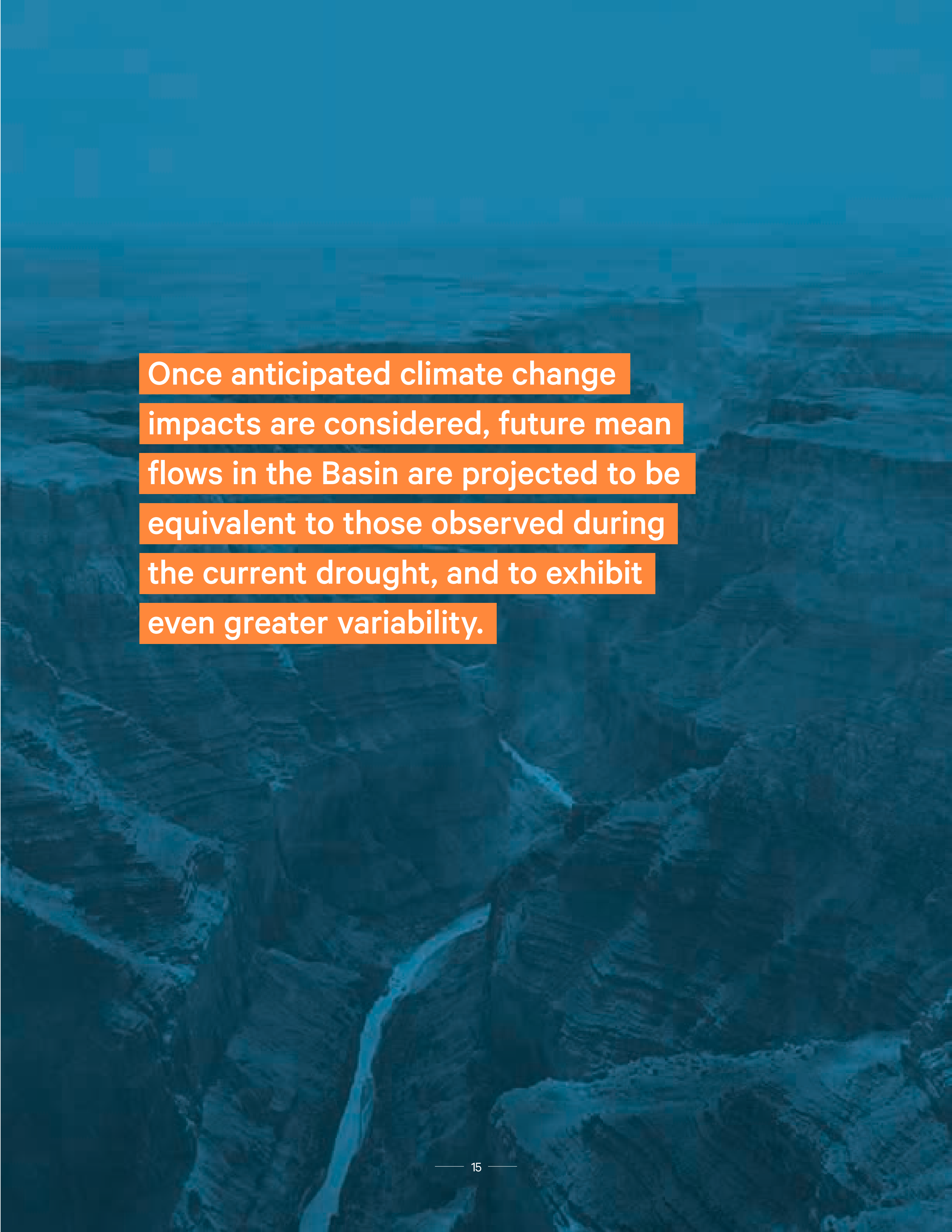
Perhaps even more significantly, on the water supply side, the Study suggests that Basin users can expect both a net reduction in streamflow and increasing variability in water supply over the coming decades. Studies of long-term streamflow in the Basin show that the past century has in fact been unusually wet – and that in the past, the Basin has seen more extreme drought conditions than have occurred within recent experience. Once anticipated climate change impacts are considered, future mean flows in the Basin are projected to be equivalent to those observed during the current drought, and to exhibit even greater variability. This would translate to a significant overall decline in water availability in the Basin, as well as the potential for both larger droughts and larger flood events in coming decades.

These concerns are compounded by another significant issue facing water users in the Basin: the continued, unsustainable use of groundwater resources in many areas. The overexploitation of aquifers, proceeding under the above-described "reasonable use" doctrine and similar open-access policies, has caused widespread groundwater depletion in many parts of the Basin. Recent NASA studies, which used satellite remote sensing technology to evaluate the impact of drought and overuse on water supplies, estimate that, overall, the Colorado River Basin may have lost some 65 cubic kilometers of freshwater storage over the past decade (approximately 53 maf). Nearly 75% of this net water loss to the system was estimated to have occurred as a result of the unsustainable pumping of groundwater. This vast overexploitation of groundwater resources is rapidly eroding the critical buffer against long-term drought that aquifer storage provides, creates significant issues with land subsidence, and risks leaving communities and farmers alike without supply options once aquifer resources have been mined out.

In addition to the direct threat that water shortages pose to municipal, industrial, and agricultural users, water shortages can also create a variety of ancillary economic, political, and perception-driven risks, such as uncertainty in real estate markets and municipal bond markets. They can also weaken the adaptive capacity of local communities. For agricultural users – as the Central Valley of California has recently experienced -- water shortages can precipitate the involuntary fallowing of tens or even hundreds of thousands of acres of productive cropland, and wreak havoc with agricultural enterprises and markets alike. Many of the Basin's farmers, even those growing high-value crops, are highly dependent on annual farming returns and cannot easily weather significant water shortages. Permanent crop farmers—of almond, citrus, and other tree-based crops—can be particularly vulnerable, since even a brief shortage can result in the loss of trees that can take decades to replace. There is also now widespread business recognition of water-related risk across economic sectors, not only among obvious water users, such as utilities, developers, and the mining industry, but also among other water-intensive businesses that either have or are contemplating significant operations in the West.

IV. Environmental Challenges

Some of the most fundamental challenges facing the Basin relate to the future of ecosystem values. The capture of close to 100% of existing flows in the Colorado Basin by dams, diversions, and groundwater use has created a situation where water flows may be significantly reduced or absent during all



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or key portions of the year in many of the Basin's rivers and streams. Adding to these issues are the impacts of dam operations, which can reduce or completely eliminate natural flooding and variations in streamflow by releasing water at a more predictable rate over the course of the year. Waters that were once flood-prone, relatively warm, and sediment rich become steady, cold releases from dams that trap sediment behind them (sediment that once flowed down-river). The lack of sediment can prevent the natural formation of sandbars, riffles, and backwater habitats critical to many species. These poor streamflow conditions tend to inhibit recruitment of native fish and create conditions that favor the success of nonnative aquatic species or cause the outright loss of native species. Of the Basin's 30 endemic warm-water fish species, four are extinct, 12 are listed as endangered, and another four are threatened. Variable streamflow conditions may also cause the loss of riparian vegetation or significant long-term changes to riparian areas, including the spread of undesirable invasive species, such as the now-ubiquitous tamarisk tree.

Where flow-dependent environmental values continue to exist in the Basin, these tend to exist either as a byproduct of the "run of the river" (e.g., because they are located upstream of a use or diversion and are thereby guaranteed to receive water in connection with the delivery of water to a downstream use) or because they are dependent on the "waste" stream from an upstream user, such as municipal effluent, agricultural drainage, or flood releases from reservoirs. Environmental values themselves have few recognized "rights" to water, and where flows are protected, they tend to be designed to maintain only the environmental minimums that are necessary to protect already endangered species.

Groundwater depletions can add to these environmental impacts. The pumping of groundwater in the vicinity of a surface stream can reduce streamflows over time in the same manner as a direct surface diversion, intercepting groundwater that would otherwise have surfaced via springs and seeps as "base flow" in a surface stream, or by directly pulling water away from surface streams. In areas such as California and Arizona where significant levels of groundwater pumping are occurring, substantial regional deficits in groundwater storage can accumulate that will take decades, centuries, or even millennia to replace. This can ultimately disconnect rivers from the groundwater table altogether, transforming perennial rivers and streams into dry channels.

While these may be the most pressing issues, the Basin also faces other environmental challenges. Low flows exacerbate issues with water quality – particularly salt and pollutant loading - resulting from agriculture, industry, and urban development. Salt pollution, for example, results in water that is approximately 10 times more salty at the bottom of the Colorado River than at its headwaters, creating both environmental and economic impacts.[3] Altered stream flows create conditions where invasive species can supplant native vegetation and further contribute to overall declines in water supply. The invasive tamarisk tree, for example, is now estimated to use as much water each year as a large metropolitan area.

A combination of other factors resulting from unsustainable land-use practices and the introduction and spread of invasive species have also led to the deterioration of landscape health throughout the

3 In fully or partially closed systems in the Basin, such as the Salton Sea in California, salinity levels can exceed those found in the ocean, rendering wetland areas incapable of supporting life.

Basin. This has significant implications for both water availability and river health in the Basin. These issues are particularly pronounced in forested headwaters regions, where the history of fire suppression, combined with prolonged drought and expansion of pine bark beetle infestations, has dramatically increased the risk of catastrophic wildfire and led to substantially reduced watershed yields. Grassland ecosystems throughout the Basin are also substantially altered at a landscape scale as a result of a legacy of unsustainable grazing practices, ongoing drought, and encroachment of woody plants and shrubs. All of this, coupled with a veritable plaque of invasive species, is impacting both groundwater aquifers and stream flows.

Adding to these already daunting challenges are the impacts of climate change, which appear to be already detectable in the Colorado River Basin. Data collected in recent decades show significantly increased average temperatures; intensified drought conditions; changes in landscape-scale vegetation; and altered precipitation patterns, evaporation rates, and the timing of runoff from Basin headwaters. For example, increases in the amount of winter precipitation falling as rain rather than snow in the high country, combined with dust pollution that darkens mountain snowpack, have led to changes in evaporative loss and increased use of water by vegetation that affect downstream environmental and human users. Loss of snowpack has also led to less runoff during the spring and summer months, which has both impacted reservoir storage and lowered streamflow during the hottest months of the year, when aquatic systems are most stressed.

V. The Case for Private Capital

These growing challenges and water supply risks for human and environmental users mean the Basin's users must begin moving deliberately to reduce the physical, ecological, and economic fragility of critical systems—and must ensure that planning for urban, agricultural, and ecological needs anticipates the potential for increasingly variable water supplies. This, in turn, means designing systems of water use to be able to both survive and thrive in the face of variability and the inevitable disruption in water supply. In other words, humans on the Colorado River will need to design systems which permit water to be used – and moved – more flexibly to serve changing conditions, values, and demands. To accomplish this, there is a significant need to design and build new institutions that will increase the flexibility and adaptive capacity in the system, at the same time that they help individual water users adjust to changing conditions from year to year and help to protect critical economic and ecosystem values from the growing risks associated with deep levels of uncertainty in water supply. Importantly, these new approaches should also be relevant – and potentially transferable – throughout the West or even to other water-stressed parts of the world.

Growing recognition of this need has already led to a series of important policy developments over the past decade, including a 2007 agreement among the Basin states and Reclamation with regard to shortage management, the recent Minute 319 agreement between the U.S. and Mexico, and a number of "contingency planning" measures under discussion or implementation in the Upper and Lower Basins, such as a proposed Upper Basin Water Bank, and a new demonstration program to conserve water for system benefit known as the Colorado River System Conservation Program. However, the recognition of the need for

	Delta	Mead to Imperial	Lower Basin Tributaries	Mainstem to Mead	Collector Tributaries	High-Order Tributaries	Headwaters
Forest Health Issues	N/A	N/A	Serious	OK	OK	Concern	Serious
Poor Grassland Health	N/A	N/A	Serious	N/A	Concern	Concern	Serious
Invasive Riparian Vegetation	Serious	Serious	Serious	Serious	Serious	Concern	Concern
Habitat Destruction Due to Channelization	Serious	Serious	N/A	N/A	OK	Concern	OK
Invasive/Non-Native Aquatic Species (Fish, Mollusks)	N/A	Serious	Serious	Serious	Serious	Concern	Concern
Dust on Snow	N/A	N/A	N/A	N/A	N/A	Concern	Serious
Fish Barriers due to	N/A	N/A	N/A	N/A	Concern	Concern	Serious
Depleted Stream Flow from Groundwater Pumping	Serious	OK	Serious	OK	OK	Concern	Serious
Out-of-Basin Diversions	Concern	Concern	OK	OK	Concern	Serious	Serious
Changes in Stream Flow due to Dam Operations	Serious	Serious	Concern	Serious	Serious	Concern	OK
Changes in Water Temperature	Serious	Serious	Concern	Serious	Serious	OK	OK
Shortage Risks Due to Local Run-off Shortfalls	OK	OK	Serious	OK	OK	Concern	Serious
Shortage Risks due to Structural Deficit	Serious	Serious	OK	OK	OK	OK	OK
High Salinity	Serious	Concern	Concern	OK	OK	OK	OK

Serious
Concern
OK
N/A

Table 2. Environmental challenges and geographies impacted within the Colorado River Basin.

greater flexibility and adaptability has also led to a significant increase in interest among water managers, policymakers, and academics alike in the deployment of greater amounts of private capital through the use of market mechanisms and other investment-driven approaches.

Although much of the historic water development and water infrastructure of the West—including the vast network of existing dams, delivery canals, irrigation projects, and other projects—has been constructed with and subsidized by enormous investments of public resources (largely federal and state tax dollars and low-interest government loans), private investment, particularly in the form of traditional tax-exempt bond financing, has long played a critical role in water management, including in helping finance the vast majority of municipal water delivery systems. The role for private capital in meeting these needs is likely to be even more significant in the future, as federal and state funding sources and support for large-scale water-related infrastructure has been declining since the 1980s. At the same time, legislative appropriations to support agencies responsible for managing water supplies have shrunk in many Western States, substantially contracting the scope of government activities and the government's capacity to support water resource management, even where this could threaten long-term economic vitality.

> The role for private capital in meeting these needs is likely to be even more significant in the future, as federal and state support continues to decline.

In this respect, although physical unavailability of water will clearly be a defining element of the future of economic development and ecosystem protection in the Colorado River Basin, the most pressing issue in many cases will not necessarily relate to the unavailability of water resources, but rather will be about how to pay for the infrastructure, water rights, and institutions needed to manage and distribute scarce supplies. Rapid growth has left many small and medium-size urban areas and rural development areas facing significant accumulated infrastructure deficits and/or rapidly aging infrastructure. Farming communities have also become increasingly marginal when it comes to water security. The development of agriculture in most parts of the Basin was enabled by significant state and federal public works, but with these sources of funding increasingly constrained, agricultural communities must cope with less and less support to finance the rehabilitation or improvement of infrastructure and the deployment of new management techniques. All of this points to a need for more expansive, flexible, direct, and creative types of private investment in water resource management in the future.

VI. Thinking Beyond Water Markets

There has been an extensive literature in recent years about the potential for the development of "water markets" that would allow water to be more readily traded between buyers and sellers in the manner of a commodity. However, for a market to function, willing buyers and sellers must exist and be able to interact with each other to facilitate the trade in the resources, goods, or services in question. Markets also require the establishment of physical, economic, or legal conditions and incentives to allow transfers to occur, and are fundamentally premised on supportive physical and legal infrastructure – the practical conditions and rules that make exchange possible. For this reason, a critical factor in the success of the majority of nontraditional natural resource markets involving ecosystem services has been the establishment of a regulatory environment that both provides for property rights and forces (or at least encourages) participation in the market. As noted above, however, water exhibits important differences from many other natural resources, both in terms of the nature and depth of existing institutions of property rights and regulations, and in terms of its physical character, role in the economy, and social and political significance.

Not the least of these issues are the significant physical infrastructure and costs associated with the movement of water at any significant scale from one place to another, as well as the environmental impacts that can be associated with removing water from natural streams or changing the timing and volume of flows. Even where physical infrastructure already exists, changes in the diversion and disposition of water can generate significant economic and environmental costs. It is also critical to recognize that water transactions that propose to change the use of water will also inevitably confront a broad water culture in the West that has been built around access to water via subsidized, large-scale public water infrastructure, and that regards current and future access to local water supplies as a "birthright" that is essential to future economic prosperity. This culture is understandably hostile toward entities (particularly outsiders) who are engaged in "speculation" that could threaten future access to resources.

Even in areas where the political and environmental conditions for water transactions are relatively favorable, most transactions will face significant legal and regulatory hurdles. Both the Law of the River and state-level regimes for surface water and groundwater management create significant barriers to water trade, including historic water rights laws that create uncertainty in the nature of property ownership in water (i.e. unadjudicated and uncertain water rights, together with forfeiture rules), and third-party impact doctrines that limit transferability. Given the legal character of most types of "water rights" in the Basin and the complex laws and regulations that govern the ownership and control of water across states and water management districts, what would normally be understood to be market "enabling conditions" are present in only a few areas within the Colorado River Basin.

Although some of these existing rules are designed to inhibit transfers in order to protect local resources from expropriation, many reflect the very real complications created by the inherent interconnectedness of water across rivers, streams, and groundwater basins. The Colorado River is no exception. With the same water used and re-used multiple times along the length of the River, a change in the use of water at one location can automatically impact the availability of water to downstream users. As a result of these complications, in most cases, creating active, robust water markets will envtail large-scale reforms that would take decades and would implicate major, controversial policy issues involving a broad range of opposed interests.

However, trading opportunities are broadening in the Basin. Some states, for example, now expressly permit short- or long-term leasing of water rights. In other states, forbearance or dry-year option agreements (where one user agrees to temporarily forbear use for the benefit of another), creative sever-and-transfer arrangements or changes in points of diversion, the construction and operation of shared infrastructure within districts, or local or regional water settlements may provide substitute means to accomplish similar outcomes. Water banks and trusts can provide increased flexibility and allow for the protection of instream flows; land use controls, interjurisdictional agreements, and settlements can help to provide basic controls needed to facilitate transactions. Even on the heavily-controlled mainstem of the Colorado River, recent agreements among the Basin states now permit some limited mechanisms for interstate storage and release of water among Lower Basin states, as well as the storage and transfer of conserved water among users in individual states. A recent agreement (known as Minute 319) has authorized a first-ever "water exchange" between U.S. and Mexican water users, based on investments in water conservation in the Mexicali Valley.

It is also important to note that the record of direct water investing in the West (where it has occurred) has been at best mixed. Significant investments in water resources—particularly in the form of investments in agricultural lands with associated water rights—have been and are continuing to take place; in particular, a growing number of investment entities are presently engaged in the acquisition and management of agricultural lands with the expectation of repurposing some or all of the associated historic water rights for future urban or other higher-value uses. A basic (and readily defensible) thesis of these investments is that the growing and ever-more-publicized disparities and disconnects in water pricing between historic agricultural users and growing, recent urban users (which in some places have urban users paying hundreds or even thousands of times more money for water) will inevitably drive transactions to occur in spite of current legal or practical obstacles. However, it is also important to recognize that many of these types of investments have failed in the face of unrealistic expectations around investment return, the time and costs associated with meeting regulatory requirements, and/or the failure to appreciate the political, legal, and cultural nuances and sensitivities surrounding water resource management.

> Hydrologic systems can be expected to behave in ever-more-unpredictable ways and produce ever-increasing risks of significant, uncontrollable physical water shortages.

In addition, many successful investments have been in the form of relatively straightforward buy-low, sell-high transactions in which investors have inserted themselves as a bridge (or in other cases just as intermediaries) between a historic agricultural user and a future urban buyer. While these types of investments may well provide opportunities for investment returns and create more appropriate pricing signals for water, their actual value as a water management tool and associated public benefit is often murky. At best, they provide a vehicle to drive transfers from agricultural to urban use to address supply / demand imbalances in the urban sector; however, this addresses only a narrow band of growing issues, and may create associated environmental problems. Challenges associated with the long-term sustainability of agricultural communities, the financing of needed water supply and water infrastructure in growth communities, the numerous environmental challenges facing Basin users as a result of altered stream flows, groundwater depletion, and declining landscape health, and other critical needs are unlikely to be addressed through these investments (or may be worsened by them). At present, few examples exist of private-sector approaches to these broader issues in the Basin.

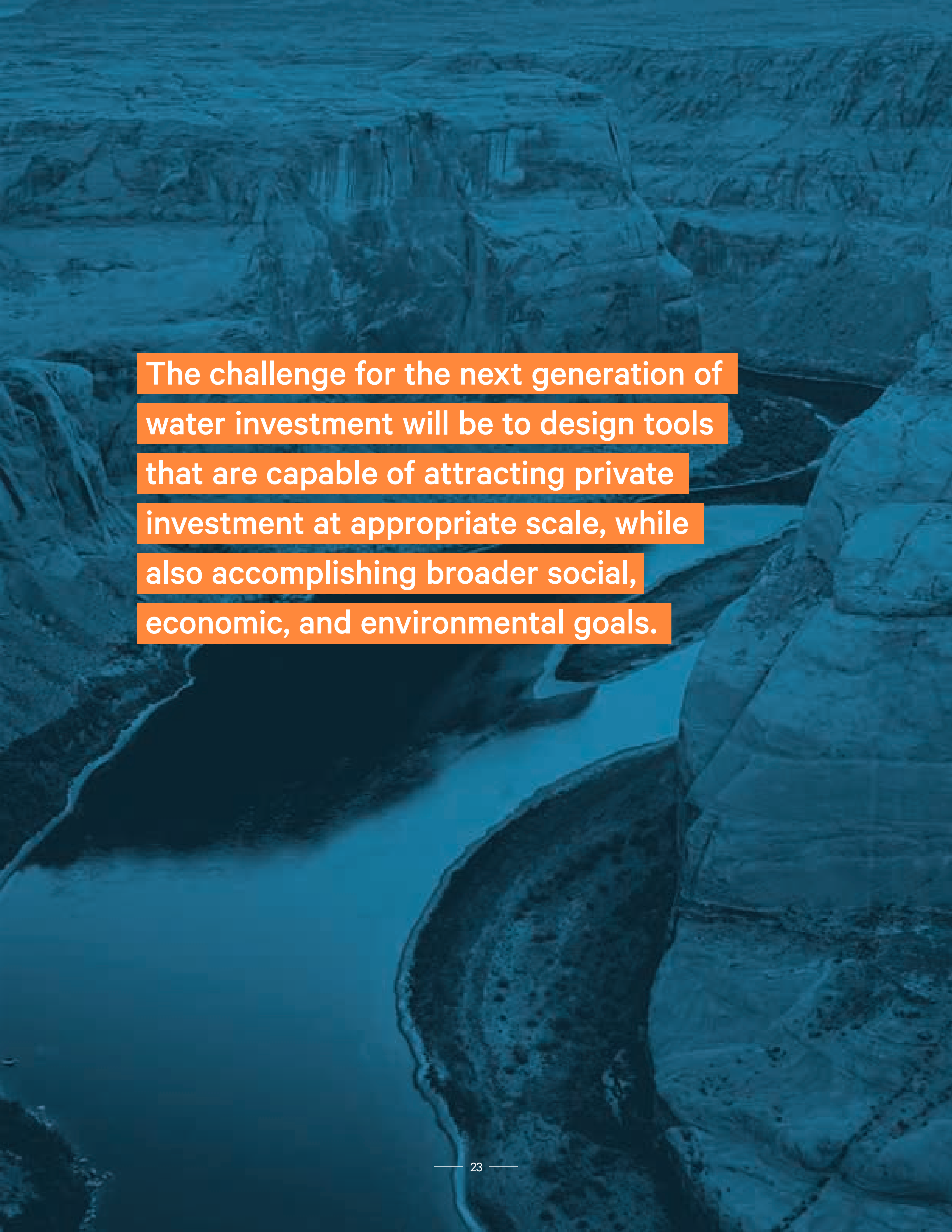
VII. The Case for Impact Investment

The challenge for the next generation of water investment will be to design tools that are capable of attracting private investment at appropriate scale, while also accomplishing broader social, economic, and environmental goals. These tools will need to accomplish more than a simple reallocation of water resources from low-to-high value uses and the creation of reasonable investment returns; they will need to contribute to the management of growing systemic risk across sectors in the Basin, and they will also need to reflect a different kind of thinking about the management of water as a finite resource.

As noted above, like many western water management systems, the Colorado River system has long been dominated by centrally managed water infrastructure planned around a "stationarity" principle, with water management based on rigid, priority-driven allocations, with risks managed largely through publicly-funded infrastructure. Let's call this the "big engineering, grey infrastructure" approach to water management. While this approach was central to achieving the remarkable development of agriculture, industry, and cities in the Basin, this approach is also proving to be inherently slow-moving, heavily subsidized, and fragile in the face of changing hydrologies and natural systems that depart from historical experience.

It is also notable that, consistent with this original stationarity principle, the Basin's water problems frequently tend to be framed as a problem of simple allocation—typically as a supply/demand imbalance "gap" that could be addressed by allowing transfers of water from lower-value to higher-value uses. Similarly, thinking about environmental problems has also tended to be somewhat "static"; most of the Basin's applicable federal and state environmental laws, for example, are set up to defend a presumed status quo in natural systems—essentially, trying to preserve (or restore) a natural ecosystem and its associated species as it exists today, or as it existed in the past. But the emerging impacts of climate change, landscape change, and the exploitation of water resources are creating conditions where systems can be expected to behave in ever-more-unpredictable ways and produce ever-increasing risks of significant, uncontrollable physical water shortages, and a situation where ecosystems are literally moving out from underneath us. What is needed is a more adaptive, a more fluid and "green infrastructure" approach to water management.

In this context, the widespread focus on simple reallocation of water between users is missing both the fundamental emerging threat to water managers and the environment in the West, as well as a key opportunity for investment. Market mechanisms and investment-driven transactions can obviously provide a tool for reallocation of scarce resources, but they can be, and in some cases have been, also used to develop sophisticated risk management and distribution strategies; strategies such as financial hedging, innovative insurance mechanisms, and the creative use of futures and options. Given the importance of risk management to the future of the Basin, adapting and modifying these types of risk management tools to address water management and ecosystem risks represents both a key need and perhaps the most significant investment opportunity on the Colorado River.



The challenge for the next generation of water investment will be to design tools that are capable of attracting private investment at appropriate scale, while also accomplishing broader social, economic, and environmental goals.

Given the close interconnections between water user and ecosystem risks, the development of tools that work to address systemic risk also provides an important opportunity to integrate economic and ecosystem values into the management of water. By addressing risk in water management and priorities for human use, while at the same time addressing the risks to continued provision of important ecosystem services by natural systems and robustly integrating economic and ecological systems, investors can gain a powerful tool to transform markets in a manner that will ensure long-term returns as well as attain sustainability goals for both human society and the natural world. Properly designed, the water management systems of the future could help to internalize the ecological externalities that have been at the heart of the environmental problems on the Colorado.

Given the close interconnections between water user and ecosystem risks, the development of tools that work to address systemic risk also provides an important opportunity to integrate economic and ecosystem values into the management of water.

Although the current regulatory environment is not necessarily friendly to water transfers in all places, it nevertheless offers significant opportunities for impact investment. Indeed, given the uncertain character of future water markets, the present lack of water market structures actually represents a potentially important opportunity to advance the interests of ecosystem protection and other public values through structured investments. Although the barriers to water transactions must be carefully managed, in many parts of the Basin there are a range of potential workarounds that can be employed to effectively permit certain types of market-style transactions. In fact, in the context of a highly restricted "market," impact investments are more likely to succeed than strict arm's-lengvth investment transactions, since impact investments provide the potential for public benefits that justify needed regulatory relief and/or more readily satisfy regulatory requirements related to environmental protection, avoidance of unacceptable third-party impacts, and other considerations.

VIII. Summary of Investment Tools

Below are a number of potential water-based impact investments that could be successfully deployed in various contexts within the Colorado River Basin (and potentially more broadly in the West) to provide innovative approaches to financing water resource solutions while also generating linked environmental benefits. Eleven of these strategies, representing some of the most promising that were evaluated, have been grouped into nine separate "investment blueprints" [4] that are intended for use as generic models for the development and investigation of specific investment opportunities on the ground. Some of these concepts represent a proposed "re-tooling" of existing investment structures and approaches that have been successfully deployed in other natural resource contexts; others represent essentially unique approaches that combine or improvise upon investment structures that have not previously been used in natural resource management.

4 Two of the eleven described tools represent variations on the same essential structure, and are therefore presented together.

The water investments discussed in this report have the potential to address a variety of complex environmental challenges in the Basin, from improvements to forest, riparian and grassland health, to maintaining adequate instream flows through investments in agricultural lands and improvement of water efficiency in municipal systems. They also cover the financing and development of environmentally-beneficial municipal infrastructure, as well as investments in new market institutions that could reduce systemic risks to human and environmental users alike. In many cases, the ability of a particular investment to achieve the desired outcome will depend upon specific contractual or other investment conditions; in other cases, the outcomes will be driven more heavily by the relative location within the system at which the investment is pursued. For example, investments in efficiency that result in the transfer of water downstream will have different potential benefits and tradeoffs than a similar investment undertaken along an off-stream canal.

For each tool described above, the report provides a description and explanation of the environmental challenge and context that the approach is designed for, the specific structure of the investment, and the expected environmental benefit that could be obtained from its application, together with a generic case study describing how the tool would work and a hypothetical financial model demonstrating the potential revenue and return profile of the investment. The nine blueprints are grouped into four broad general categories: tools related to (a) watershed enhancement; (b) agricultural water use; (c) municipal water use; and (d) market development. Table 3 below provides a summary of the environmental benefits that could be associated with each of these investment tools. A brief summary and outline of each of these tools is provided in the pages following, with more detailed blueprints of each tool can be found in the main body of the report.

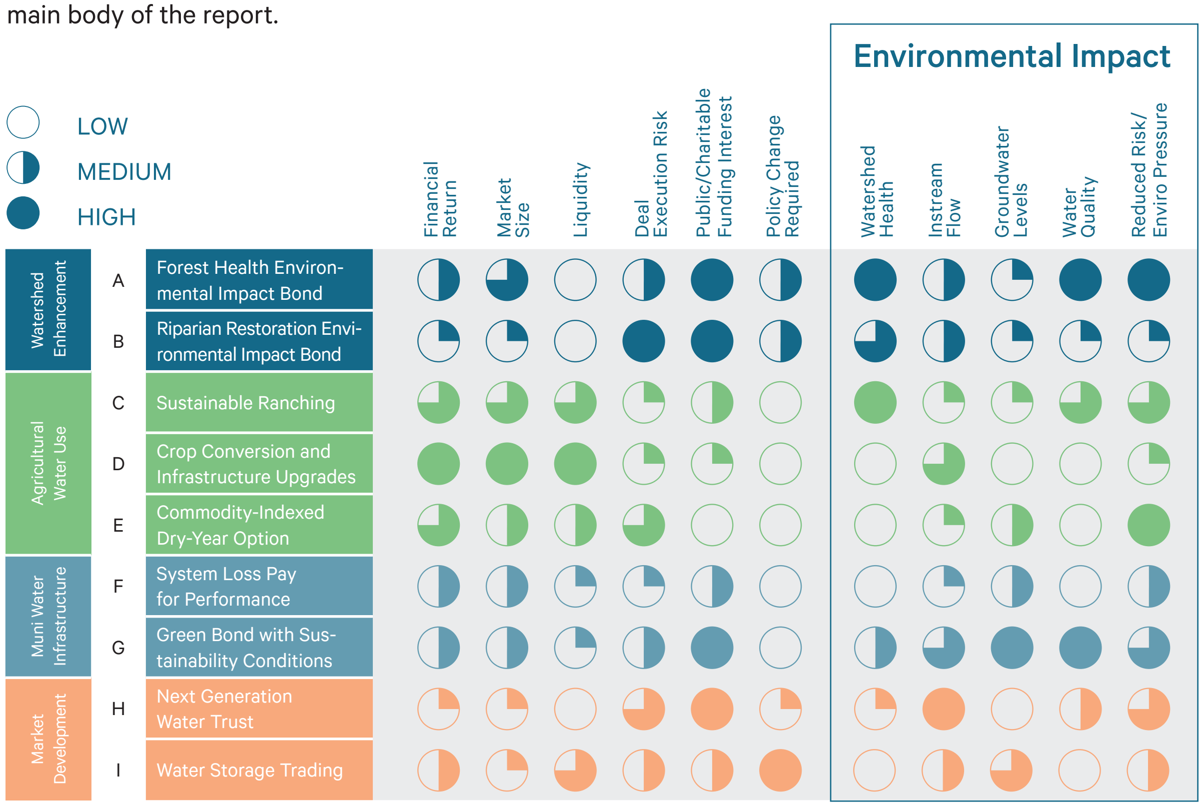


Table 3. Summary of investment tools and relative assessment of performance.

LIQUID ASSETS:
Investing for Impact in the Colorado River Basin

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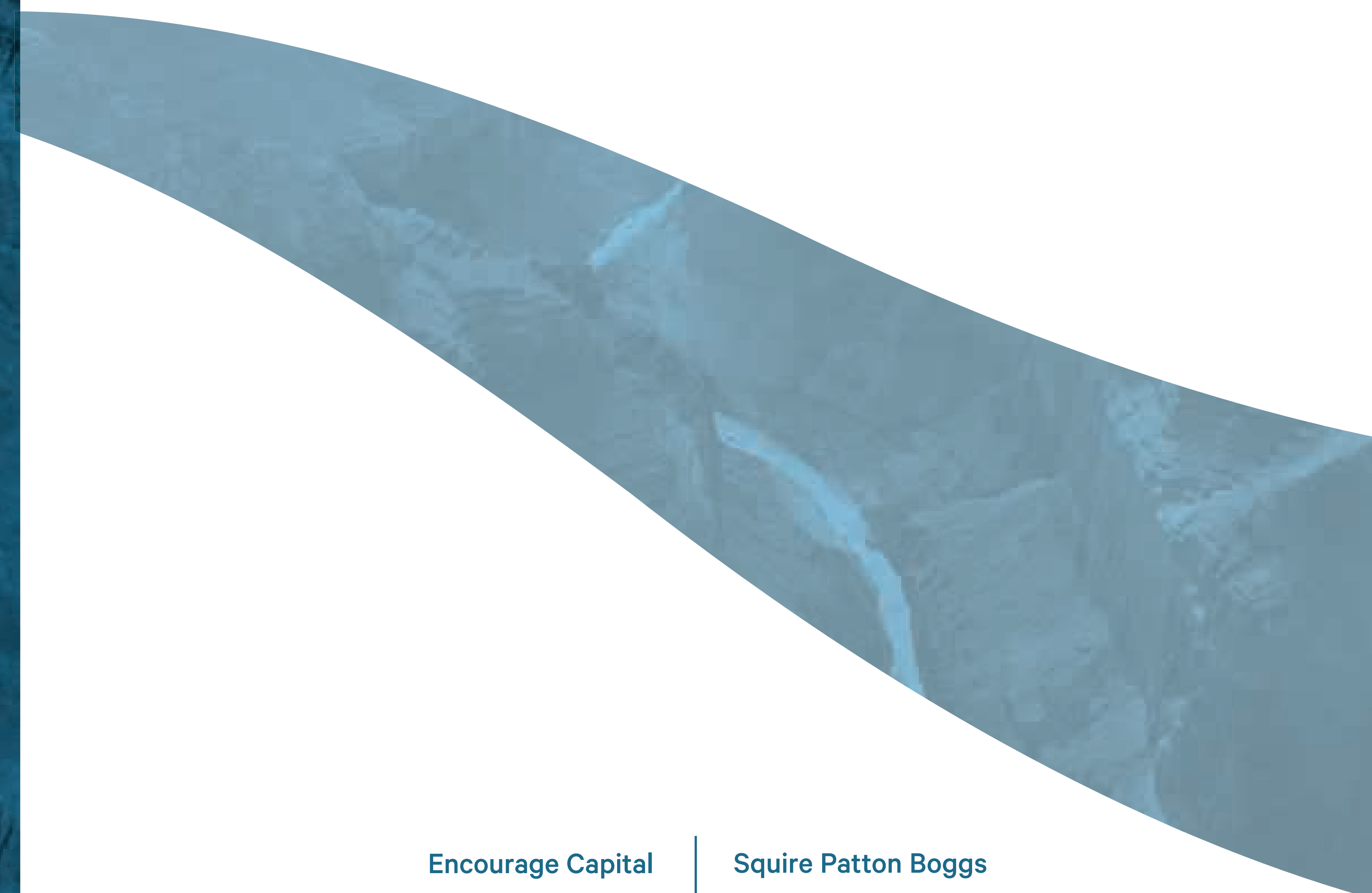

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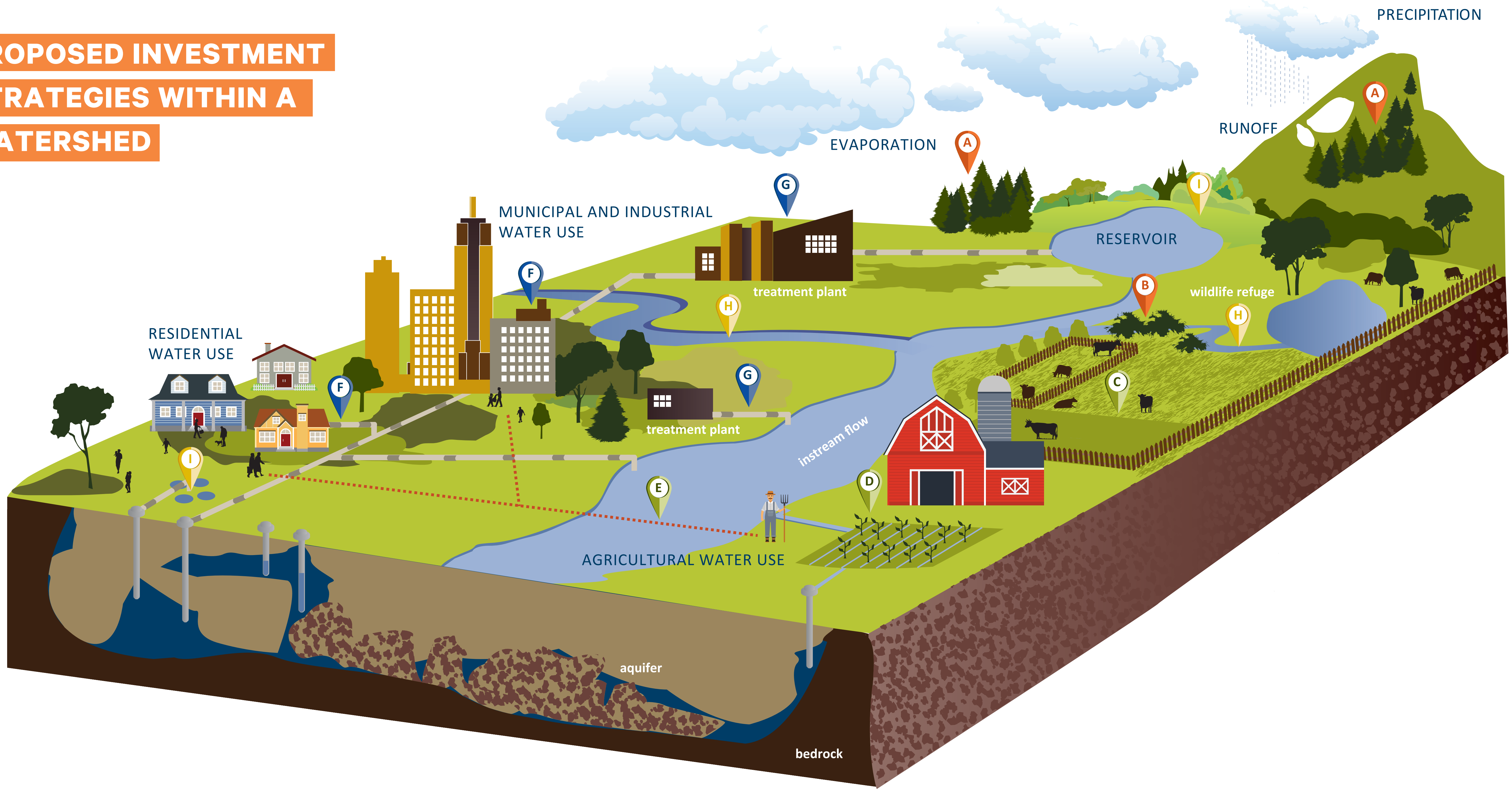
PROPOSED INVESTMENT STRATEGIES WITHIN A WATERSHED



WATERSHED ENHANCEMENT

A **Forest Health Environmental Impact Bond**
Invest in a pay-for-performance vehicle to reduce the risk of wildfires and increase watershed yield via forest thinning, with investors repaid through savings in fire suppression cost and avoided water risk

B **Riparian Restoration Environmental Impact Bond**
Invest in a pay-for-performance vehicle to improve ecosystem health and increase watershed yield through invasive species removal and riparian restoration

AGRICULTURAL WATER USE

C **Holistic Management of Working Lands**
Invest in cattle herds and ranch land to improve grassland health by employing higher-yield and more sustainable grazing practices.

D **Crop Conversion and Infrastructure Upgrades**
Invest in agricultural water efficiency via on-farm conversion to higher-value, lower water-use crops and improvements to irrigation infrastructure.

E **Commodity-Indexed Dry-Year Option**
Broker deals to better distribute hydrologic and economic risk between water uses with higher and lower tolerance for water supply loss via dry-year options and commodity price hedging

MUNICIPAL USE AND WATER INFRASTRUCTURE

F **System Loss Pay for Performance**
Invest in a pay for performance vehicle to upgrade municipal water infrastructure to reduce systems losses

G **Green Bond with Sustainability Conditions**
Provide low-cost financing for municipal water infrastructure tied to environmental and sustainability conditions

MARKET DEVELOPMENT

H **Next Generation Water Trust**
Develop an investment-driven next generation water trust to address environmental and system-wide water supply risks

I **Water Storage Trading**
Develop, implement, and operate storage trading markets in surface water reservoirs and groundwater aquifers

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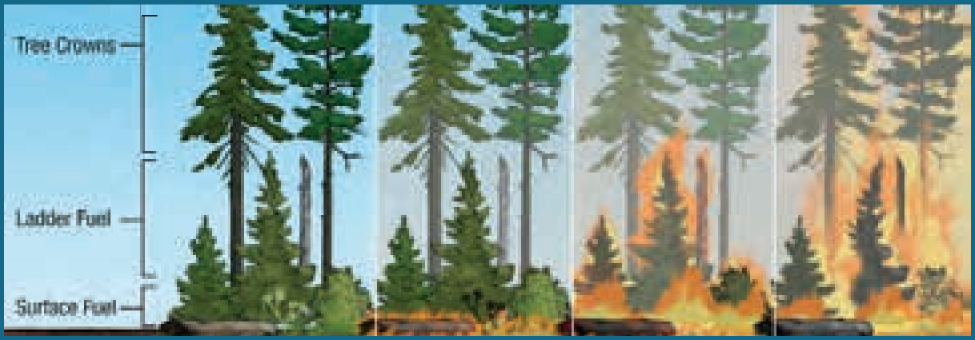
1. Watershed Enhancement:

Forest Health Treatments via Environmental Impact Bond

In the absence of human interference, North American forests once burned naturally at regular intervals, removing downed and small diameter trees, disposing of accumulated forest litter, and returning nutrients to the soil. However, as a result of more than a century of total fire suppression and unsustainable forest management practices, virtually all western forests—including those of the Colorado River Basin—are now blanketed with excess vegetation. According to recent research by The Nature Conservancy, the Arizona Rural Policy Institute, and others, preventative fuel-reduction forest treatments, including thinning and preventative fires, can improve forest health, reduce fire risk, and potentially increase watershed yields by up to 20% or more, benefiting both headwater streams and aquifers as well as downstream water users.

More critically, these forest treatments also help to reduce the potential for the large, intense, and catastrophically destructive wildfires that are occurring with increasing frequency in unhealthy Western forests. These fires destroy vast tracts of land and badly damage watersheds due to post-fire flood and erosion (unlike the lower-intensity burns that predominated in natural forest cycles before European settlement). Although interest and funding for preventative forest treatments is growing, and there is now clear evidence of the significant cost savings associated with undertaking preventative treatments, available government funding for forest health treatment tends to be consumed in annual fire suppression expenses.



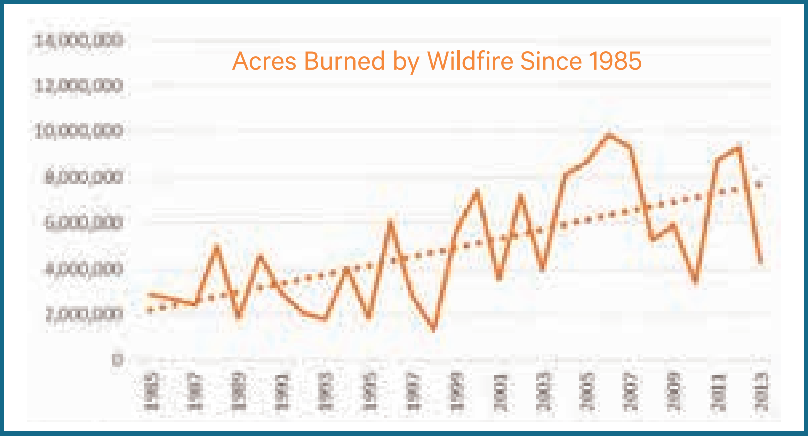
In a forest where fires rarely happen, fuel builds up: There's surface fuel (grass, logs, woody debris, brush); Ladder fuel (shrubs, small tress, smags); and tree crowns

1 Surface fires spread quickly through brush and woody debris.

2 Ladder fuels allow the fire to move up toward the forest canopy.

3 Tree crown fires are so intense, they're difficult to control.

Where forest fires have been suppressed and there has been little to no active treatment, fires can become catastrophic due to overgrowth.
Credit: Adam Cole, Nelson Hsu/NPR, http://www.npr.org/2012/08/23/159373770/the-new-normal-for-wildfires-forest-killing-megablazes



Acres of land burned by wildfires in the U.S. (solid line) with corresponding trend line (dotted line).
Source: "Federal Firefighting Costs," National Interagency Fire Center, accessed December 14, 2014 www.nifc.gov/fireInfo/fireInfo_documents/SuppCosts.pdf

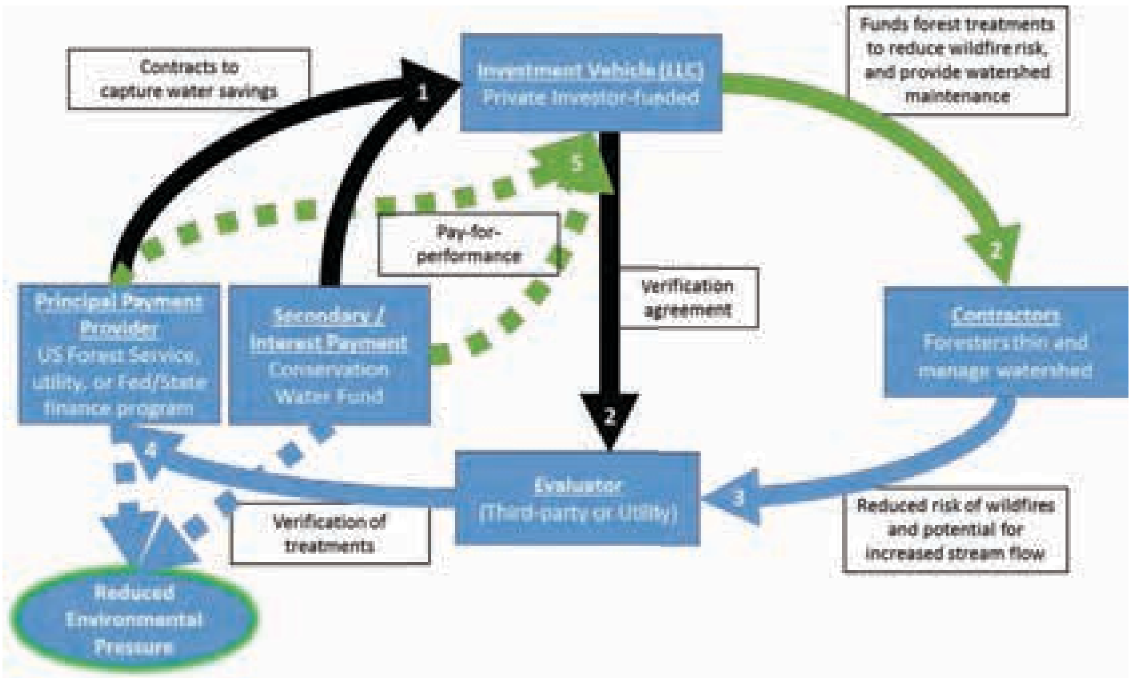


Figure 5. Structure of Forest Management and Wildfire Reduction Environmental Impact Bond.

This "environmental impact bond" ("EIB"), modeled after the "social impact bonds" that have been pioneered in various social service settings, utilizes private capital to provide the large, up-front investments that will be needed to bring forest health improvement investments to an appropriate scale. These investments would be made in watersheds exhibiting poor existing forest health conditions and a recognized increased fire risk under a performance-based repayment agreement with local forest management agencies. Once prevention treatment objectives are met and evaluated by a third party, the beneficiary (in this case, the forest management agency, with potential assistance from a "Watershed Conservation Fund" supported by specific downstream users) would repay the investors for the costs of work completed and return a portion of the resulting future fire suppression savings, as well as small payments for the risk reduction and increased yield of water in the targeted watershed. This breaks the cycle of underfunding for watershed health initiatives, saving the government and end-users money, enhancing watershed yields, and protecting water supplies.

2. Watershed Enhancement

Tamarisk Removal and Riparian Restoration

Prior to the nineteenth century, native cottonwood and willow trees lined rivers throughout the Colorado River Basin, supporting abundant wildlife in the form of resident and migratory birds, fish, amphibians, rodents, reptiles, and mammals. However, human intervention in the Basin, including the creation of dams and diversions, groundwater pumping, and cattle grazing, has dramatically impacted natural riparian habitat through reductions in water flow, changes in groundwater levels, direct disturbance, and alteration of natural flow patterns. The growing presence of invasive species such as the tamarisk tree (also known as saltcedar), an invasive shrub that establishes in riparian areas, has been a critical feature of these ecological and hydrological impacts.

Tamarisk in particular has proven to be extremely resilient to harsh conditions and has rapidly outcompeted native species like cottonwood and willow where natural flood cycles have been disrupted. Tamarisk is now the second most abundant plant on river corridors, covering some 250,000 acres in the Colorado River Basin, and the expansion of the tree is responsible for damaging wildlife habitat and increasing salinity. Because tamarisk colonize upland areas in addition to growing along stream channels, tamarisk-infested riparian areas also consume more water than healthy areas dominated by native species, lowering water tables and reducing the contributions of floodplain aquifers to surface flow. Removing tamarisk (and other similar invasives, like Russian olive) and restoring native species can produce both important environmental benefits for wildlife and potentially save significant amounts of water.

A number of successful tamarisk removal strategies are currently being employed throughout the Basin, and more recent watershed-wide planning efforts have created the opportunity for much broader interventions to control invasives. However, capacity and funding is not presently available at sufficient scale to increase ecological resiliency overall or realize the potential for water savings from restoration. Similar to the performance-based environmental impact bond for forest management, this "environmental impact bond" would utilize a pay-for-performance mechanism in order to bring private capital to bear to significantly scale up invasive species removal and riparian restoration efforts. Watersheds exhibiting extensive tamarisk, Russian olive, and other invasives infestation would be targeted, ideally where these could contribute water savings to downstream users; investors that fund riparian restoration projects would receive compensatory payments on a per-acre basis if restoration projects achieve predetermined objectives (with overall compensation levels based on the average water yield that recent research has suggested are associated with tamarisk removal and restoration of native vegetation).

Healthy cottonwood-willow forest on Gila River.
Credit: National Geographic, Sandra Postel.

Tamarisk tree.
Credit: National Park Service.

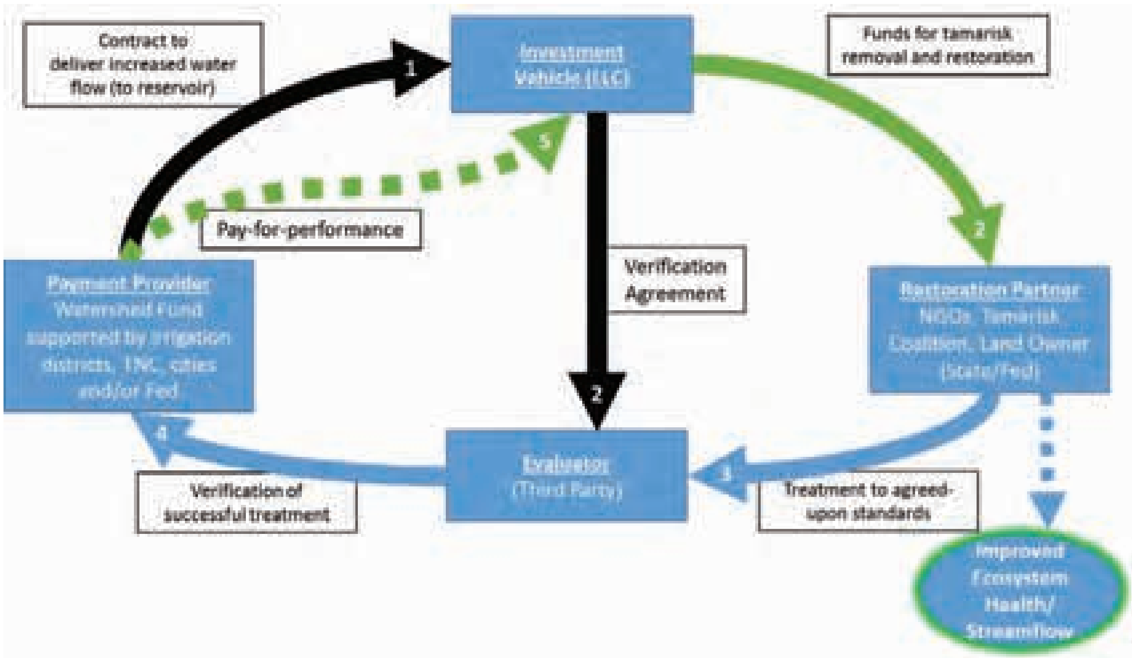


Figure 6. Structure of the Riparian Restoration Environmental Impact Bond.

Because the water and habitat benefits from such enhancements would necessarily be distributed across the system (and would not clearly traceable to a single user), similar to the funding sources for the forest health EIB, the revenue stream for a riparian restoration EIB would necessarily need to be provided by public or government sources (or via cooperative arrangements among downstream water users like the current Colorado River System Conservation Program or The Colorado River Basin Salinity Control Program) that would be willing to pay for system-level benefits This would require the creation of a "Watershed Conservation Fund" to make contributions toward these types of restoration treatments -- funded by government agencies, downstream users who could expect a relative low cost-per-acre-foot benefit to system water supplies, and local communities and businesses who would benefit from improved river access and associated recreation opportunities. Local communities could also commit interested volunteers and/or provide labor in connection with local employment programs to address temporary labor needs and help to reduce the net costs of restoration activities.

3. Holistic Management of Working Ranch Lands

Improving Soil and Grasslands Health

Livestock production has a deep and widespread influence on the ecology and hydrology of the Colorado River Basin, both as a result of the use of water for feed production (nearly 80% of all Upper Basin water use) and as a result of the impacts of grazing, which occurs throughout the Upper and Lower Basins on the vast majority of private and public lands. Where grasslands are maintained in good condition, grazing and the deposition of manure are a critical part of the ecosystem, helping to build soil, improve water infiltration, and increase nutrient cycling. However, grazing practices involving cattle (and to a lesser extent sheep) have caused extensive landscape changes due to selective pressures on specific types of grasses and edible plants, the spread of undesirable invasives and inedible plants, disturbance from trampling in grasslands and riparian areas, water pollution, and other factors. Very few examples of healthy, native grasslands remain anywhere in the Basin; many have disappeared altogether.

Although the impacts of these changes on the Basin's hydrology are difficult to quantify precisely, grazing practices are widely understood to have led to increased desertification of grasslands, erosion and changes in surface runoff, lowered water tables, and the loss of wetlands, cienegas, and springs. Grazing practices have also led to the spread of juniper and other tree species (such as mesquite), which can also lower groundwater levels, into former grassland areas. Poor grassland health has additionally contributed to the emerging issue of "dust on snow," in which dust deposits on mountain snow packs leads to the snow melting faster and earlier in the season, increasing evaporative losses and losses due to early growth of vegetation (believed to have caused an approximate 5% reduction in total runoff Basin-wide).

Some emerging range management strategies suggest significant potential for private investment in holistic "regenerative agriculture" techniques. Essentially, these are targeted approaches to livestock production that can improve grassland conditions and increase net livestock yields across rangelands. For example, intensive rotational livestock grazing (which grew out of the 1980s-era "Savory method" and other holistic management approaches) actively manages livestock to graze on a confined plot of land for a short period and then move elsewhere, allowing grasses to recover while opening up soils and leaving animal manure behind to build soil nutrients. These practices have substantially improved grasslands condition, soil moisture, and other values while allowing larger livestock yields.

Cattle grazing on grasslands.
Courtesy: National Resources Conservation Service.

Creosote-dominated landscape in New Mexico resulting from historic overgrazing.
Courtesy U.S. Bureau of Land Management

Same area five years later, restored to healthy grassland through Bureau of Land Management's Restore New Mexico project.
Courtesy U.S. Bureau of Land Management.

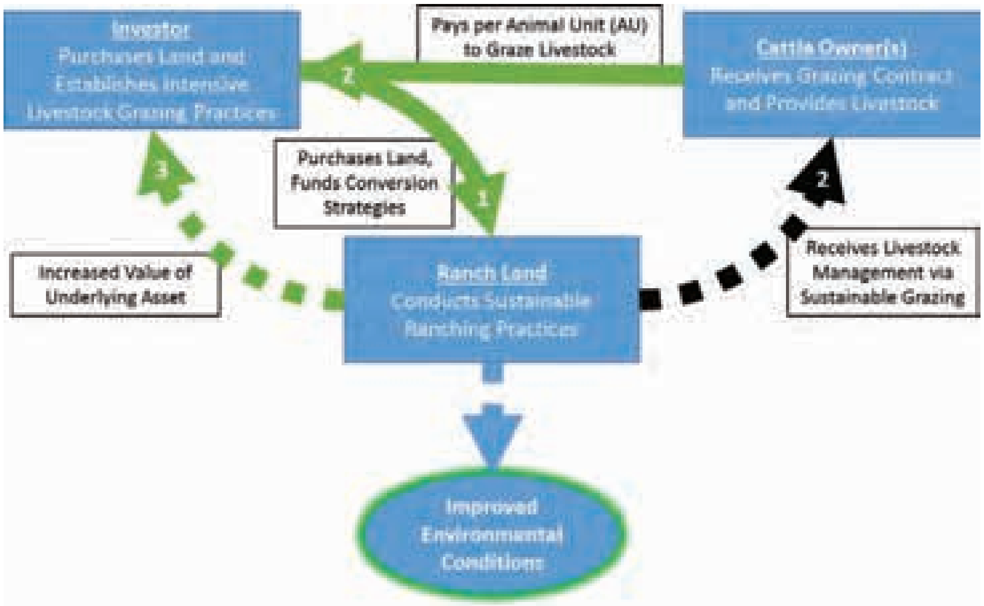


Figure 7. Structure of Holistic Management of Working Ranch Lands via Cattle Ownership

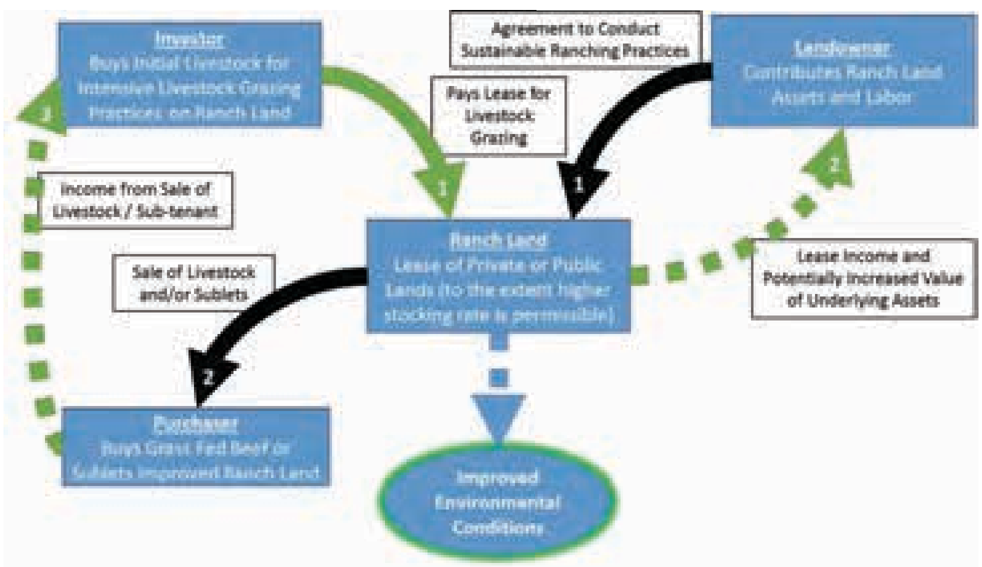


Figure 8. Structure of Holistic Management of Working Ranch Lands via Land Ownership

This financial vehicle is structured to make investments in improving grasslands condition and soil health through changes to the management of working ranch lands. This vehicle seeks to provide capital for ranches to convert to sustainable ranching practices on both private lands and public leased lands through a joint venture between an investor and an existing ranch owner/operator, or alternatively through the direct purchase of underutilized ranch lands and/or cattle herds. Investor returns would be generated from increased quantity and quality of livestock outputs in connection with improved forage and livestock capacity on restored lands (and in the case of direct purchase, the appreciation of underlying land assets). Improvements in grassland condition and soil health would be expected to produce both direct and indirect environmental and economic benefits through contributions to watershed yield, decreases in pollutant loading, and the appreciation on underlying land values. Additionally, the joint venture strategy could help to facilitate the entry of young farmers into the livestock industry or help keep existing owner-operators on their land.

4. Maximizing Agricultural Water Efficiency

Financing Crop Conversion, Enhanced Farm Management, and Infrastructure Upgrades

As in other parts of the West, agriculture accounts for approximately 70% of the developed water use in the Colorado River Basin, and the water rights held by agricultural water users tend be those with the highest legal priorities. Agricultural water use varies widely in both efficiency and relative economic value, and much of the Basin 's irrigation infrastructure is also significantly dated and inefficient. For example, outside of the high-value production agriculture that takes place in many of the Lower Basin states, flood irrigation – often supported by leaky earthen ditches – remains the predominant method of irrigation in most of the Basin..

This has made lower-value agricultural uses an obvious target for future water transfers to meet urban and industrial demands, as well as a source of water to support higher-value permanent croplands. However, even in areas producing lower-value outputs, agricultural lands and farm economies have critical economic, political, and cultural significance in many parts of the Basin, setting up important tensions among and between agricultural communities and urban water users. In particular, "buy and dry" strategies that have taken existing agricultural lands out of production to free up water have been extremely controversial due to their long-term impacts on local economies. However, alternative approaches—such as the conversion of existing farmland to the production of less water-intensive (and in many cases higher-value) crops, the use of deficit irrigation techniques on compatible crops, together with the introduction of water use efficiency improvements and approaches such as land leveling, drip irrigation, use of cover crops, and conservation tillage techniques—create potential opportunities to improve agricultural outputs in both returns per acre and returns per unit of water. At the same time, these more sustainable approaches to agriculture can potentially reduce the consumptive use of water by agricultural uses without changing the amount of land in production, generating water savings that could be transferred to other uses.

Crop (in thousands of acres)	AZ	CA	CO	NV	NM	UT	WY
Total Forage (harvested)	325	1,670	1,297	531	343	762	1,054
Total Forage (irrigated)	323	1,347	969	510	303	677	772
% of total forage irrigated	99%	81%	75%	96%	88%	89%	73%
Alfalfa hay (harvested)	272	874	654	344	222	566	547
Alfalfa hay (irrigated)	271	832	561	344	222	566	547
% of alfalfa hay irrigated	100%	95%	86%	100%	100%	100%	100%
Other tame hay (harvested)	44	670	688	181	104	166	498
Other tame hay (irrigated)	42	377	380	168	72	89	218
% of tame hay irrigated	95%	56%	55%	93%	69%	54%	44%
Wheat (harvested)	103	492	2,182	18	87	138	132
Wheat (irrigated)	103	383	126	18	37	45	17
% of wheat irrigated	100%	78%	6%	100%	43%	33%	13%
Total Harvested (forage, alfalfa, hay, wheat)	**744**	**3,706**	**4,821**	**1,074**	**756**	**1,632**	**2,231**
Total Irrigated (forage, alfalfa, hay, wheat)	**739**	**2,939**	**2,036**	**1,040**	**634**	**1,377**	**1,554**
% of total irrigated	**99%**	**79%**	**42%**	**97%**	**84%**	**84%**	**70%**

Table 4. Colorado River Basin Major Crops and Acreages (Note: Crop data is state-wide: both within and beyond the Colorado River Basin).

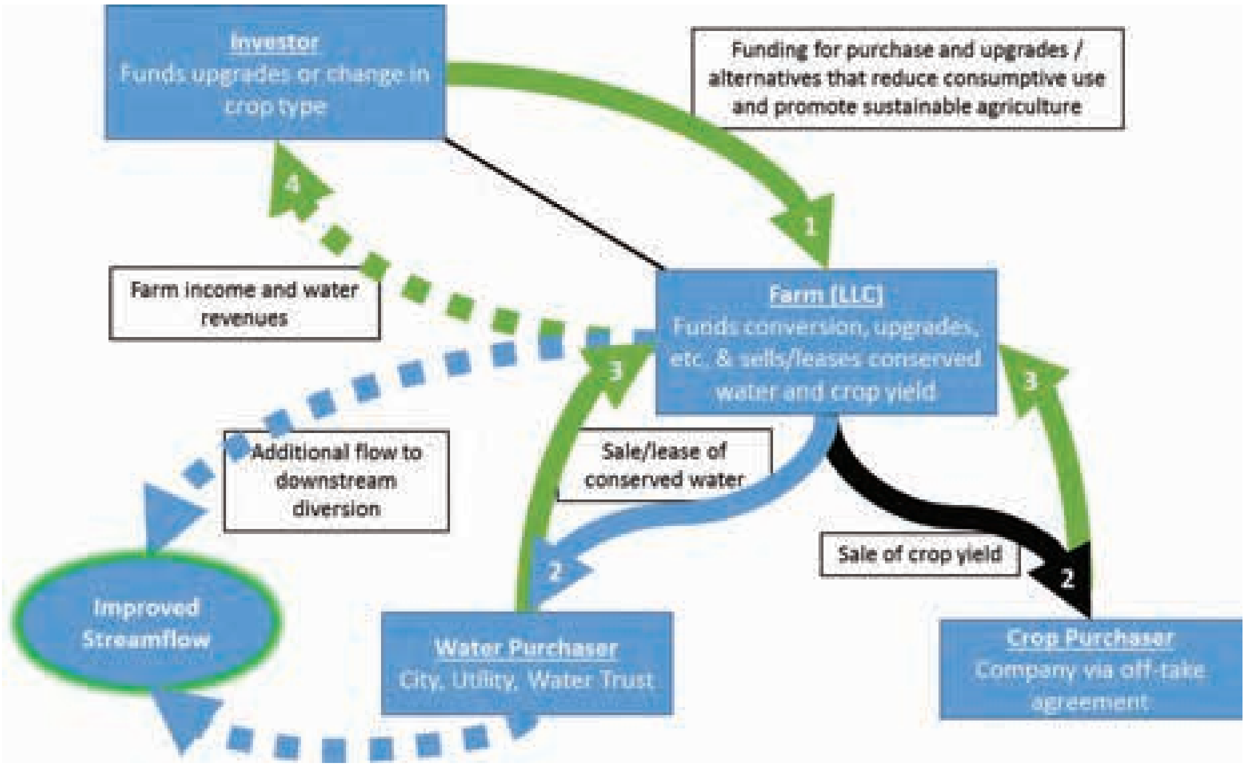


Figure 9. Structure of the Crop Conversion and Infrastructure Upgrade Direct Investment Model.

Given the challenges that many farmers will face in financing these types of improvements, there appears to be significant potential for the deployment of private capital solutions to finance improvements in agricultural water use, combining specific crop conversions towards lower water use, more drought-tolerant crops with irrigation infrastructure upgrades and enhanced land management techniques to increase overall efficiency. Repayment of these investments could be generated by a combination of enhanced farm revenues, potentially supported by off-take or long-term supply contracts for specialized crops that are not already widely produced in the region, and the monetization of water savings via the sale or lease of conserved water to downstream users.

A variety of potential deal structures could potentially support this approach, including direct investment strategies involving the direct purchase and upgrade of farmland by an investor (who could then capture the upside of both enhanced farm and water revenues, as well as the appreciation of the farmland assets), or a joint venture investment model in which an existing farmer and investor work together to achieve those outcomes through the contribution of farmland and labor (farmer) and needed capital (investor), and share in the resulting revenues. At the farm level, these types of investments could also be structured to facilitate the entry of young farmers as partners in the investment, allowing them to finance their acquisition of farmland in areas with aging farm populations (where the costs of an outright farm purchase by a young farmer are effectively out of reach). Similar joint venture investments could also be undertaken at the level of the irrigation district between a district and an investor, with the district organizing investments at the individual farm level to achieve those outcomes.

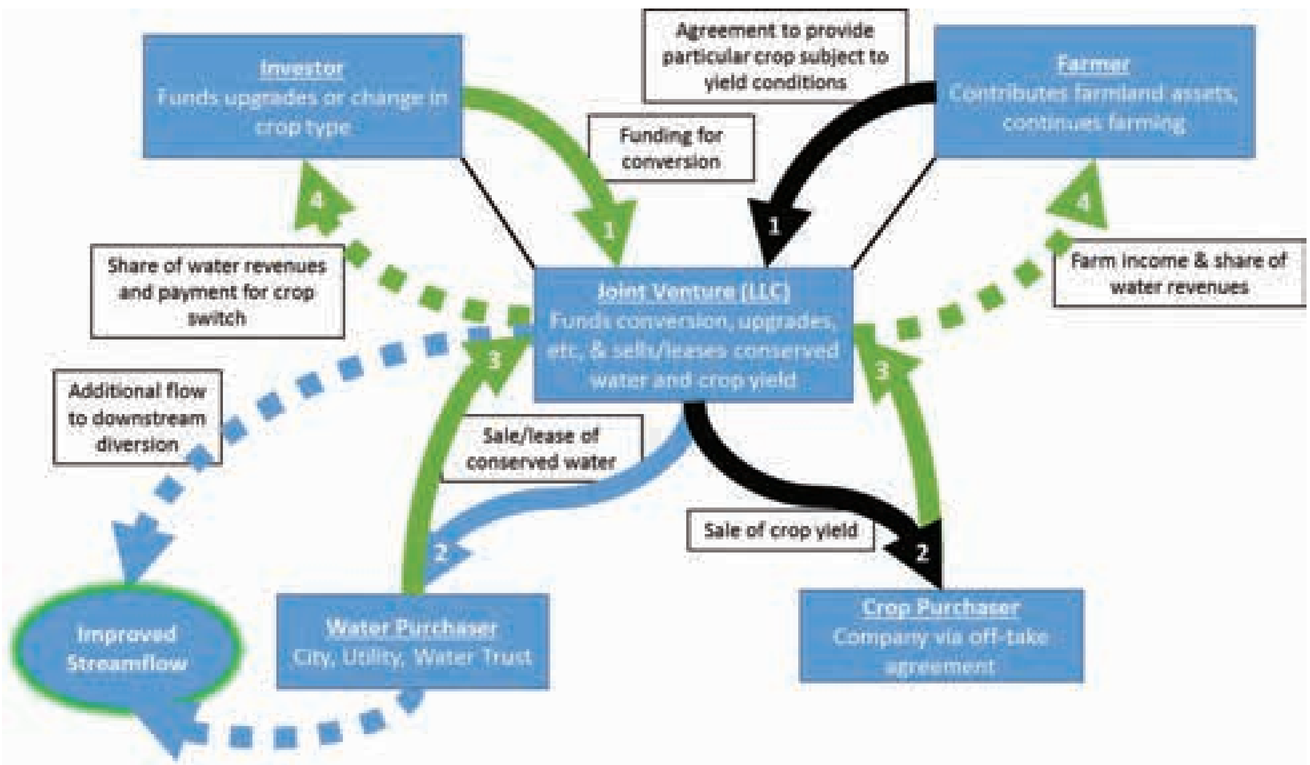


Figure 10. Structure of the Crop Conversion and Infrastructure Upgrade Joint Venture Model.

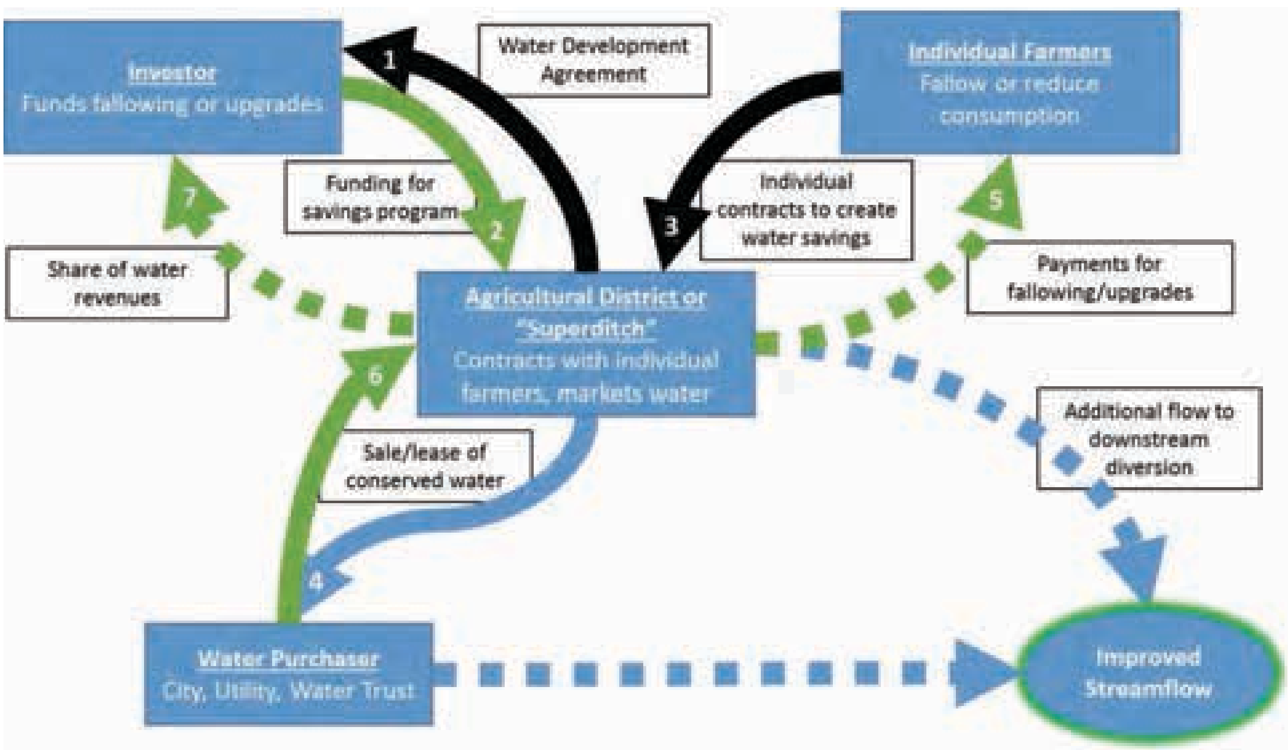


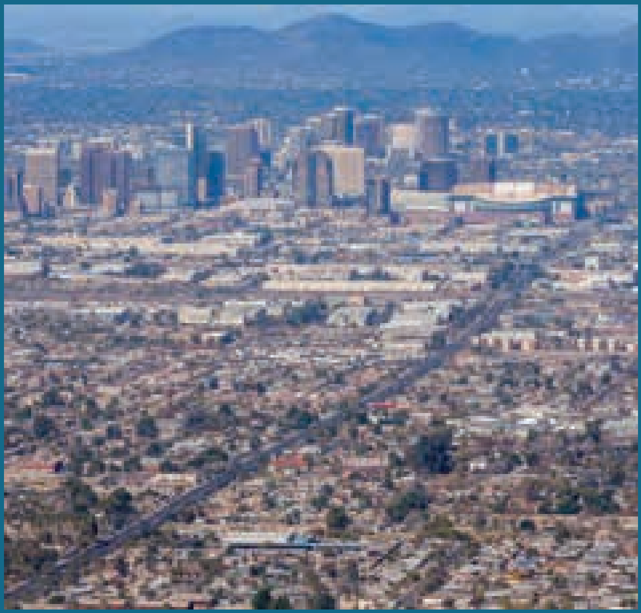
Figure 11. Structure of the District-Level Crop Conversion and Infrastructure Upgrade Water Development Agreement Investment Model

5. Sharing Water Supply Risk

Brokering Commodity-Indexed Dry-Year Options

As discussed above, water users in the Colorado River Basin are facing significantly increased risks of shortage over the coming decades as the long-term effects of legal overallocation, physical overuse of water, and growing changes in hydrology manifest throughout the Colorado River Basin. Recent forecast modeling has made it increasingly clear that, even with significant system-level investments in the management of shortage risks, water users in the Colorado River Basin must be prepared to deal with substantially increased levels of uncertainty and risks of water shortages that cannot be fully controlled. Under the current priority system for the allocation of shortage risks, this issue disproportionately impacts "low-priority" users whose water rights or delivery contracts are more recent in origin. Because of the history of development in the Basin, this frequently means that some of the greatest risks of shortage exposure fall to municipal and industrial users, as well as the Basin's more recent agricultural developments (such as agricultural districts served by the Central Arizona Project).

This leaves a variety of municipal and agricultural users potentially exposed to water supply shortfalls in areas that either (a) lack significant storage to buffer against drought events; (b) could experience sustained, below-average runoff that exhausts local storage; and/or (c) lack substantial redundancy in their water supply portfolios (or that have redundant supplies which could also be threatened). This growing uncertainty means that water users with "hardened" demands -- such as municipal users without significant new opportunities for near-term water conservation, water-intensive industry, or permanent crop producers that have a low tolerance for water supply interruption -- must be prepared to take actions and make investments that will reduce the physical, ecological, and/or economic fragility of their water supply systems in the face of future disruptions in water supply.



Downtown Phoenix Arizona
Source: Stocksy

Furrow irrigation using siphon tubes, Colorado.
Photo courtesy USDA Natural Resources Conservation Service.

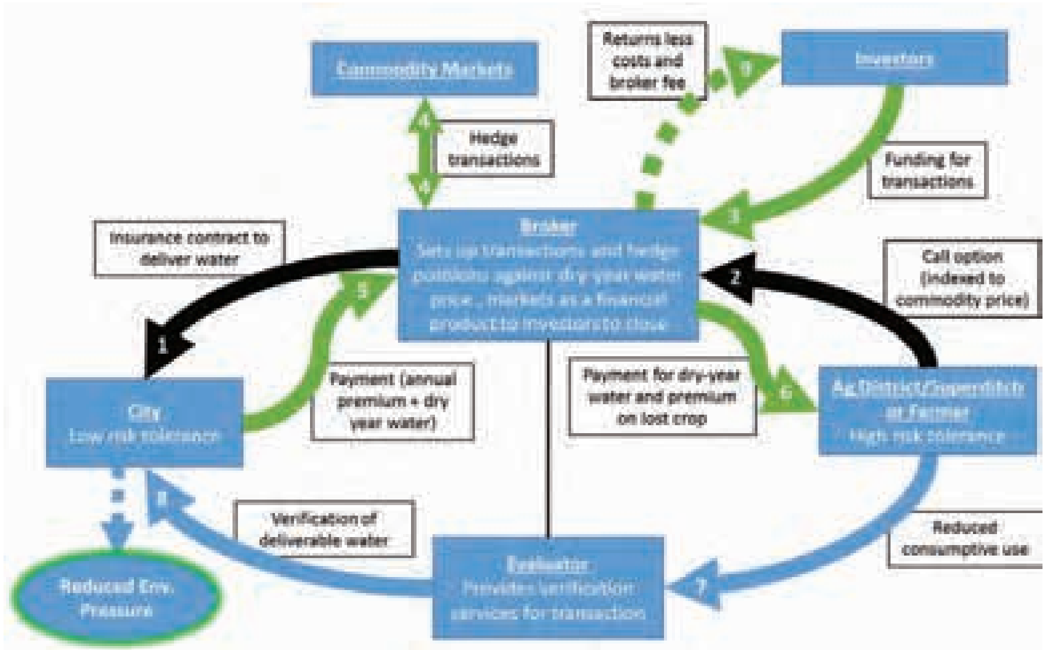


Figure 12. Structure of Commodity-Indexed Dry-Year Option.

So called "dry year options" provide a mechanism for water sharing in which a user with low tolerance for water supply disruption, such as a municipality or permanent crop farmer (the "option buyer"), pays a user with a higher tolerance for this disruption, such as a forage crop or row crop farmer (the "option seller") to utilize or share their water supply during shortage conditions. While these agreements can be attractive to both parties if they achieve water supply certainty for the option buyer while guaranteeing the option seller a higher price for the water than could have been realized growing crops, these agreements have been difficult to implement in practice -- in part because they typically shift all of the economic risks associated with these agreements to one party.

Managing this uncertainty provides a potential role for private investment to facilitate these types of agreements between parties by utilizing a more creative approach to hydrologic and economic risk sharing, referred to here as a "commodity-indexed dry year option." This proposed approach would utilize a dry year option agreement in which the price that would be paid to the option seller (in the event of a shortage to the option buyer) is indexed to the commodity prices associated with the crops that could be grown on that property, blended with a commodity price hedge mechanism. Under an agreement between the option buyer, the option seller, and a third-party investor, the option buyer agrees to pay the investor a known price to maintain the option and/or to pay for the water when the option is exercised, while the investor agrees to pay the option seller the commodity-indexed price for the water when it is exercised (plus some premium to maintain or exercise the option). The investor would then purchase commodity call option contracts in relevant indexed commodities to hedge upside commodity price risks, and, depending on the interests of the farmer, buy put option contracts in relevant indexed commodities to hedge downside commodity price risks.

This approach allows for simultaneous mitigation of physical hydrologic risk and water pricing risk to a municipal, agricultural, or industrial water user with low tolerance for water supply variability, while also limiting overall economic risks to an agricultural user with a higher tolerance for water supply variability. By facilitating the pre-negotiation of economically manageable water sharing arrangements and managing risks to both users, this tool could also work to limit the ecological risks and pressures that would otherwise be associated with sudden, catastrophic shortfalls to low-tolerance users -- who might otherwise be forced to exploit ecologically-important or otherwise unsustainable water supplies in the absence of other options.

6. Municipal Water Conservation

Using Pay-for-Performance to Address Non-Revenue Water

Implementation of municipal conservation efforts will be an important component of addressing supply and demand imbalances on the Colorado River, and in controlling the impact of increasing municipal water needs on the Basin's ecosystems and infrastructure (municipal use is projected to be the largest source of water supply demand growth in the Basin). However, conservation efforts can create their own unique set of challenges for municipal water suppliers, such as "demand hardening" that reduces system resiliency and reductions in the availability of effluent supplies used to supply secondary users. Most significantly, however, in many cases investments in conservation efforts tend to be "revenue negative" to the municipal provider itself, since reductions in customer water use will typically reduce revenue to the utility without generating proportionate reductions in operating costs, or result in stranded costs or issues with oversized infrastructure. Although these issues should not prevent investments in municipal conservation, they can make it difficult to design a privately-funded investment model for water conservation that would be attractive to municipal providers.

One obvious "no-regrets" form of conservation investment relates to the management of "system loss" – essentially, water losses within municipal water systems that occur as a result of leaks and water line breaks, unmapped infrastructure (particularly in older and rapid-growth areas), and unmetered connections – also referred to as "non-revenue water." The fact that non-revenue water is never received at a metered connection results in utilities having to divert and treat more water than they can sell. This means that controlling system loss is almost always revenue-positive to the water supplier, and can be used to reduce municipal diversions, groundwater pumping (even in closed-loop systems) and water treatment loads and costs -- all while increasing or maintaining system revenues.

Water system losses can be very significant; for example, a national survey of major U.S. metropolitan water providers showed loss rates as high as 30% for some suppliers. Major Basin municipalities have demonstrated that these losses can be controlled through proper investment, and as a whole have already achieved relatively low loss rates in comparison to most U.S. cities. However, control over system losses is generally more problematic for smaller, less-capitalized water suppliers, such as small- to mid-size municipalities as well as many private water providers, since they are less likely to have reserves that allow them to invest in infrastructure replacement on an ongoing basis. Many smaller municipalities also lack ready access to municipal bond markets and other traditional financing approaches to finance large-scale system upgrades, relying much more directly on annual cash flows from rate-based income to provide capital for system improvements and repairs.

This proposed investment would assist capital-constrained municipal water providers (either public or private) in reducing their water utility system losses using a pay-for-performance mechanism, thereby reducing net municipal water diversions and reducing future pressures on water resources in the local watershed from new growth. The investor, either independently or in a joint venture with a technology provider/ technical partner, would finance up front investments in system loss reduction. (These improvements could include the installation of various types of new leak detection and system monitoring technologies, the conduct of a comprehensive system audit to identify sources of non-revenue water, and the completion of needed infrastructure upgrades and repairs.) The investor and/or technical partner would then receive an agreed-upon return from the water provider based on the actual efficiency performance of those investments in reducing system losses on a per-unit or costs-saved basis. Because the performance payments would be

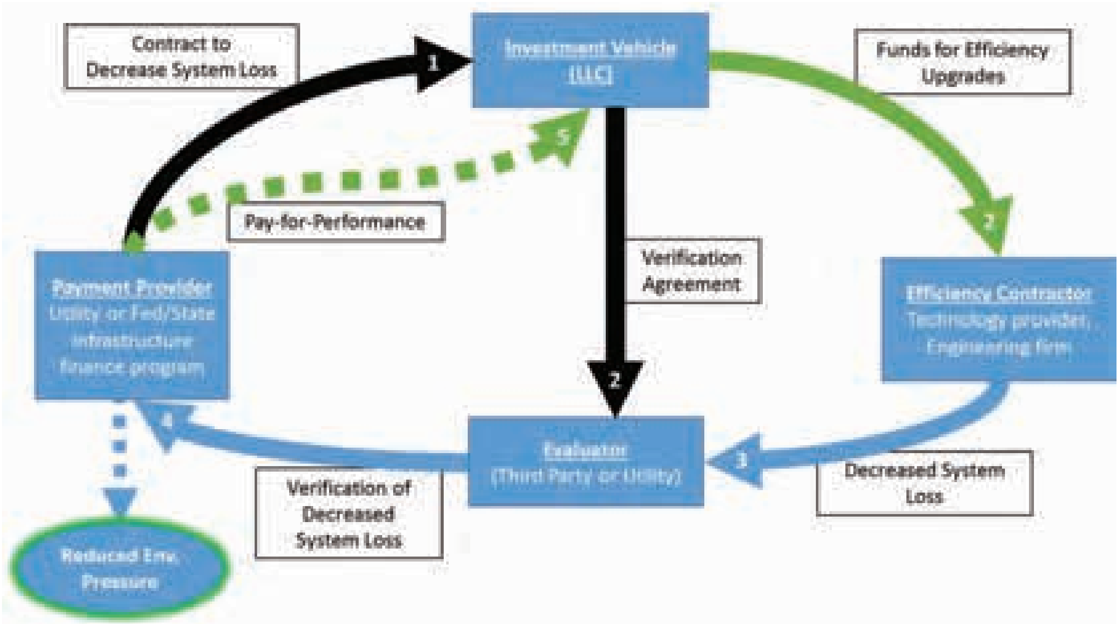


Figure 13. Structure of Investor-Only Model for System Loss Pay-for-Performance.

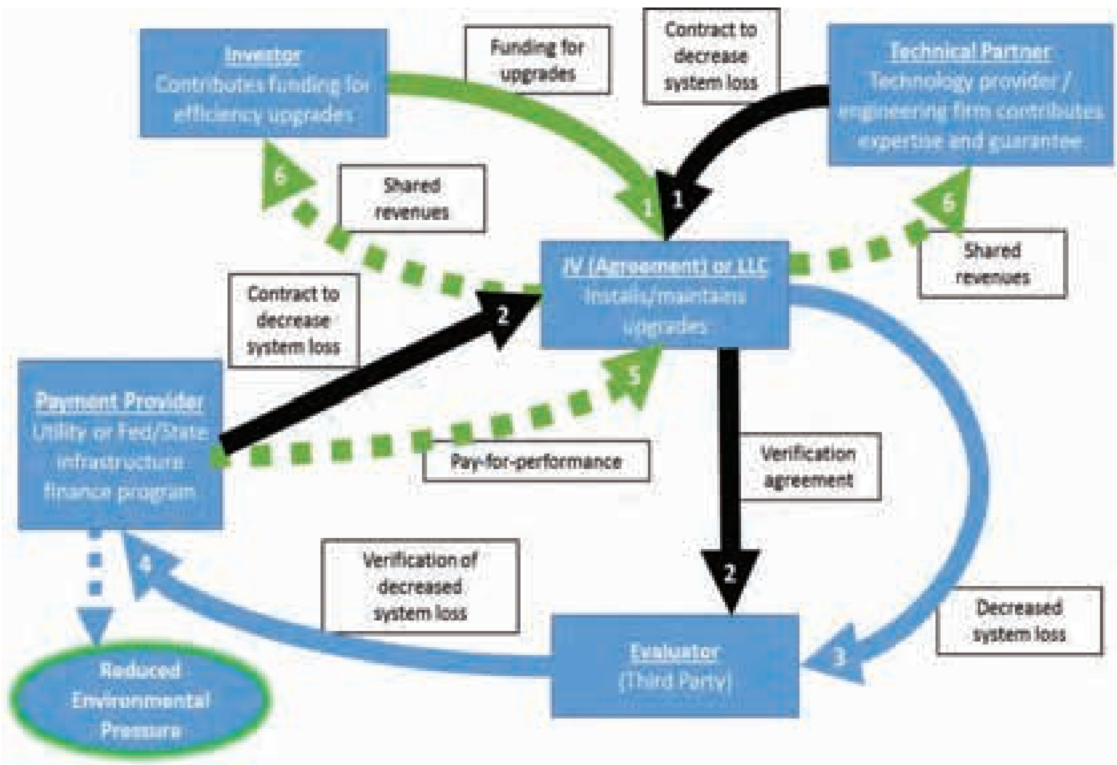


Figure 14. Structure of Joint Venture Model for System Loss Pay-for-Performance.

supported out of the revenue savings and enhancements the utility receives as a result of the efficiency upgrades, the water provider could thus achieve the reduction in system loss at no actual cost (or even see net increases in revenue) while shifting the risks of nonperformance to the third party investor/partner.

7. Financing Sustainable Water Infrastructure

Municipal Green Bonds with Environmental and Sustainability Conditions

Although the physical unavailability of water will clearly be a factor in the future of economic development for many communities, in many of the West's cities, towns, and rural areas, the bigger issue will be how to pay for the infrastructure, water rights, and new institutions needed to manage scarce supplies. As supply and demand imbalances continue to grow throughout the Colorado River Basin, many communities are facing significant infrastructure needs associated with access to and delivery of sustainable and reliable water supplies in the face of growing scarcity and water risk – including needs for consolidation and repair of aging or poorly-planned infrastructure, reuse and conservation projects, water supply enhancements, control of groundwater depletion and investments in recharge activities, and environmental mitigation and green infrastructure alternatives. Over the next 20 years, total infrastructure needs for drinking water facilities in the six Colorado River Basin states, excluding California, was estimated by U.S. EPA at $25.5 billion as of 2011; California alone had an estimated $45.5 billion need for infrastructure investments. At the same time, federal and state-level funding for water infrastructure – once a mainstay of Western development – has been declining since the 1980s.

These challenges appear to be particularly acute in small- to medium-sized growing communities in the West. While larger cities have ready access to capital via traditional municipal bond financing (and for the most part do not project significant future increases in water demand), some of the most significant water resource problems are developing in areas of the Basin with the least ability to pay for their own water supply and infrastructure needs. Rapid growth in these areas has often created significant accumulated deficits in water infrastructure, as well as widespread dependence on unsustainable groundwater "mining" that is depleting local aquifers and generating significant environmental issues. Facing a legacy of accumulated pre-recession fiscal and infrastructure debt, limited local revenues, and frequently local resistance to rate and tax increases, these same communities are frequently unable to access traditional bond financing on attractive terms to pay for solutions -- or are pushed to invest in cheaper, less sustainable infrastructure because they cannot afford to invest in more sustainable or desirable alternatives.

Given the vast backlog of infrastructure needs and significant projected growth in water demands in these communities, it is critical that new municipal water infrastructure be built with an appropriate focus on environmental impacts and opportunities. The failure to address infrastructure needs, as well as the manner in which these investments are made, can create significant environmental problems from water pollution, the depletion of stream flows from diversions to augment water supplies, long-term destruction of streams and riparian areas due to reliance on unsustainable groundwater pumping, and the risk of future emergency interventions to address water supply shortfalls that could override important environmental considerations. Similarly, failures to invest in proper environmental mitigation or to install green infrastructure options can represent huge missed opportunities and commit communities to long-term, less-sustainable paths to growth.

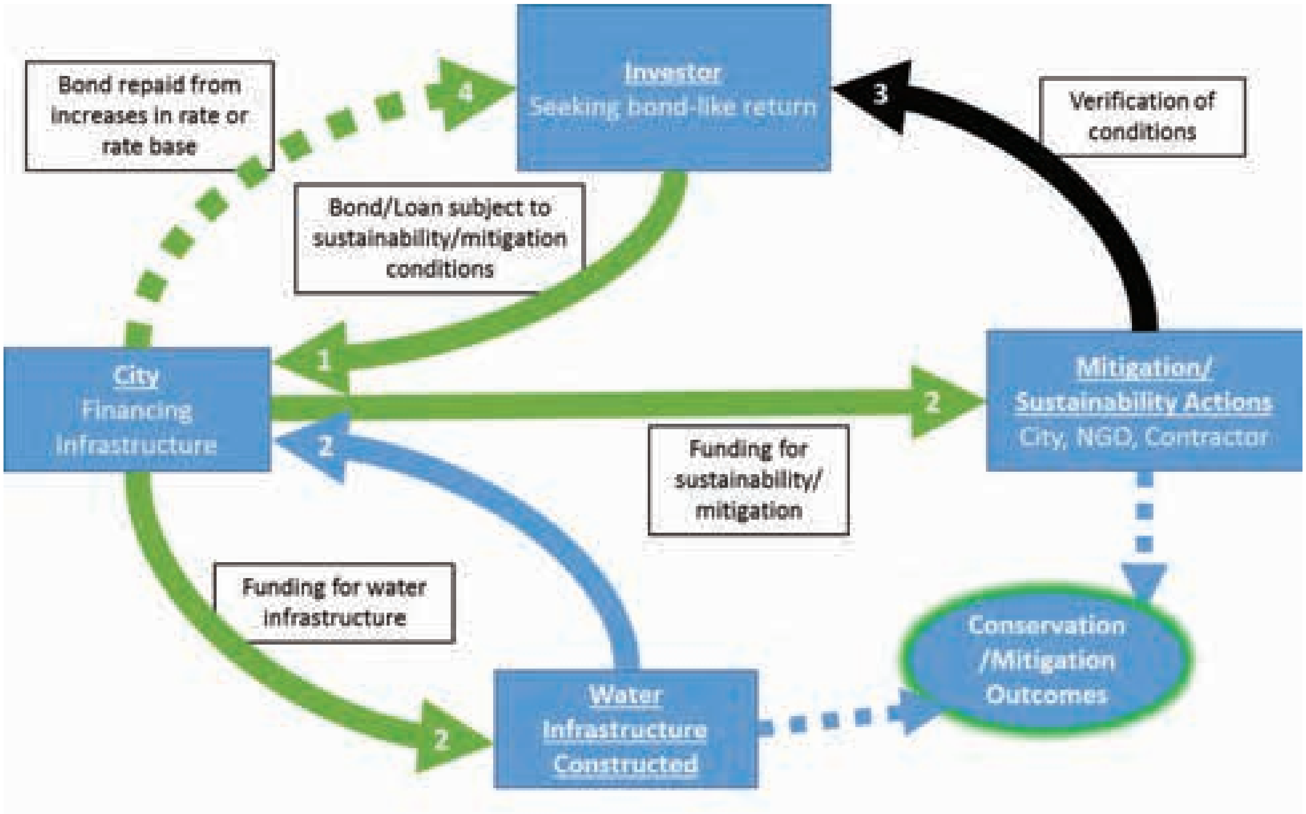


Figure 15. Structure of Green Bond with Sustainability Conditions.

There is a clear opportunity to utilize private capital to bridge these infrastructure funding gaps and help to encourage the development of environmentally-beneficial municipal infrastructure, implementation of sustainability policies, and/or implementation of enhanced environmental mitigation requirements. The suggested approach would utilize a modified version of a traditional municipal "project" or "double-barrel" bond, combining applicable characteristics of (i) green-labeled municipal bonds, but with actual environmental conditions;[5] (ii) project bonds in regard to the focus on an individual project and ring-fenced repayment; and (iii) double-barrel bonds by featuring an enhanced credit quality as a result of rate-payer funding or general obligation backing from multiple, cooperating entities. This type of arrangement would provide investor financing to build needed municipal water infrastructure, but with the implementation of sustainability measures as express conditions on access to financing (such as control of local groundwater overdraft or coordination among jurisdictions on regional water management), environmentally-beneficial projects (such as above-the-minimum mitigation activities or the construction of environmentally-beneficial infrastructure) and other environmental/social commitments. These conditions, oversight mechanisms, and the agreements associated with each could also be structured to help guarantee the repayment of the bond, e.g., by engaging multiple jurisdictions in responsibility for infrastructure or ensuring the long-term sustainability of new growth needed to repay the bond.

5 Current green bond issuances are generally self-labeled by issuers and underwriters. While the underlying projects supported by these debt fundraisings are often environmentally less harmful than traditional "gray" infrastructure alternatives, the net environmental benefit of many of these projects is essentially nonexistent, as they are essentially traditional infrastructure projects that would have been built anyway.

8. Next Generation Water Trusts

Facilitating Water Trade and Controlling Watershed Risks

As discussed above, environmental values have few recognized "rights" to water in the Colorado River Basin; where flow requirements do exist, they rarely extend beyond the bare minimum necessary to prevent the extinction of a particular endangered species, and do not necessarily protect any broader range of environmental and/or recreational values that may be associated with flows in that particular reach. One institution that has recently emerged in many Western states to address ecological water needs is the "water trust"; typically a 501(c)(3) non-profit organization organized in a manner similar to the more familiar "land trust" (although in some states, water trusts are housed in state water agencies). Water trusts are typically used to acquire water rights via outright purchases, leases, dry-year options, donations, or investments in water conservation in partnership with traditional users, with the rights dedicated to maintain minimum flows for the benefit of fish, vegetation, and wildlife, particularly during low-flow periods when those flows might otherwise be jeopardized.

Although water trusts have been successful in some areas, they face significant limitations in many parts of the West due to their typical reliance on an external regulatory driver (such as the Endangered Species Act) that generates ongoing requirements for flow mitigation, an ongoing public revenue stream (such as hydropower revenue) to fund mitigation activities, and/or robust water market enabling conditions (i.e. instream flow transfer laws, short-term leasing, groundwater controls, etc.). The absence of these enabling conditions in many parts of the West has significantly limited the scale of water trust activities, particularly in areas where the only source of funding is the limited support available from philanthropic sources.

Most water trusts are focused on the maintenance and protection of a single dimension of value in the watershed – environmental flows. However, many areas face a growing suite of "system-level" risks resulting from growth in water demand, legal overallocation, groundwater pumping, climate risks, and other factors that threaten not only environmental values, but also important economic values related to farming, energy, industry, and municipal use. Many of these users may have few options to respond to supply shortfalls that could result from these system-level risks, and cannot expect more traditional, capital-intensive approaches like the construction of new publicly-financed dams, canals, or groundwater wells to resolve them. In many areas, therefore, there is a growing need for new, locally-governed and controlled institutions that can engage proactively to increase water flexibility in the face of changes in water availability, help users adapt year-to-year, and manage growing systemic risks. For example, in overallocated systems, having a portion of the water use in the system dedicated to uses that can be flexibly turned "on" or "off" without causing economic or ecological disruption, and/or dedicated to ensuring flows needed to support economic and environmental uses with substantially "hardened demand" (e.g. municipal users, permanent crops, and fish) could be key to improving system resiliency for the benefit of human and environmental users alike.

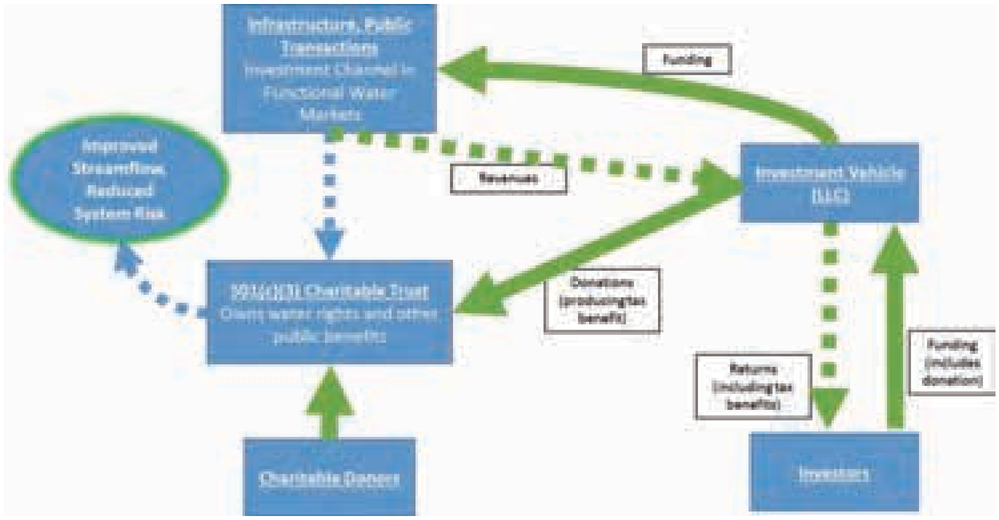


Figure 16. Structure of Proposed Investment-Friendly Water Trust.

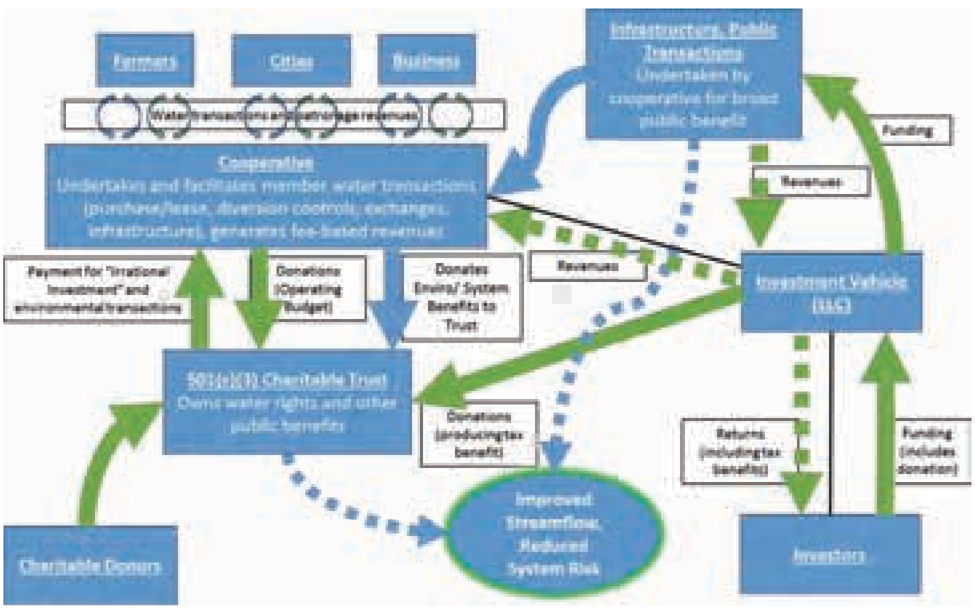


Figure 17. Structure of Proposed Cooperative Trust.

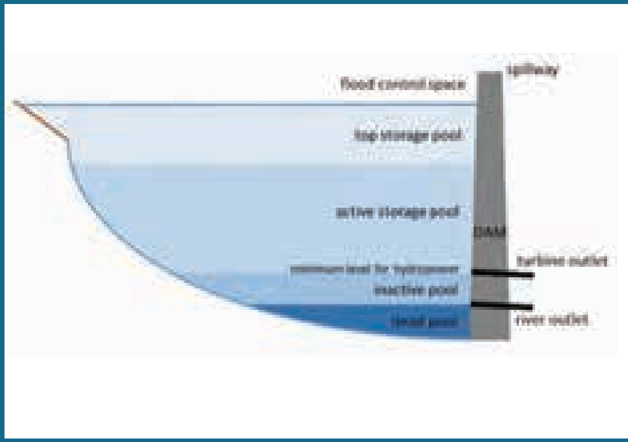
This investment vehicle proposes to achieve specific reductions in ecosystem and economic risks that would be achieved through a broad-purpose, next-generation "water trust" that would make specific investments in water resources and water infrastructure to reduce risks to both human and environmental users. In environments where substantial market enabling conditions already exist, this could be undertaken via the "investment-friendly" water trust structure, which would use a combination of secured loans and linked charitable donations to invest in water resources that would be repaid through revenue streams generated via the strategic deployment of trust assets. In areas without these conditions, the alternative "cooperative trust" structure would function as both a "market maker" to facilitate water transactions within a local watershed and as an "investment-friendly" water trust to finance, create and capture the public benefits needed to reduce human and environmental risks. These approaches would build on the successes of existing western water trust and water bank institutions, but broaden their potential scale and geographic scope by opening an investment-driven strategy that manages a greater range of system risks and generates corresponding revenues, while providing beneficial "market-maker" functions in geographies with limited trading opportunities.

9. Water Storage Trading

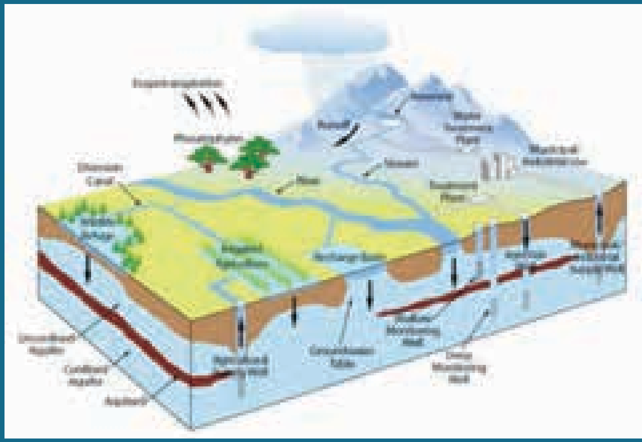
Creating Markets to Improve Groundwater and Surface Water Management

Reservoir storage has been a critical component of the management and delivery of reliable water supplies in the context of an arid and unpredictable Colorado River Basin. Similarly, groundwater pumping has played an equally significant if not even greater role in the development of the West, allowing access to stored water in underground aquifers in areas where surface water supplies would otherwise have been inadequate. In fact, many Basin cities and towns, agricultural users, industry, and other uses are either partially or completely dependent on groundwater for their survival. However, a combination of overuse of water and growing hydrologic variability is threatening both of these storage systems, with surface water reservoirs being driven to historic lows that threaten significant shortages, and groundwater use rapidly depleting or even exhausting critical groundwater reserves and threatening a number of the Basin's remaining perennial stream systems.

Many of these issues relate to the fact that under current approaches and rules, there are perverse incentives associated with use of both surface water storage and groundwater storage. For example, rights to the use of water from many surface water reservoirs are operated on a "use-it-or-lose-it" basis, with unused water defaulting to another user, or counting against a user's ability to capture and store water the following year – creating few incentives to conserve water in the reservoir during dry periods. Groundwater storage rules based on "reasonable use" and similar doctrines that permit open access to groundwater resources create even more damaging perverse incentives, driving substantial over-pumping and long-term groundwater declines that can damage surface water resources and erode vital groundwater reserves that could otherwise help to mitigate against future drought and shortage risks.



Distribution of reservoir water allocations; a proposed trading approach would allow users to "carry over" unused water as storage credits within a new "top storage" pool; this water could be traded to other users (and spills first in the event that the space is needed for flood control).



Example of a more sophisticated approach to aquifer management that reflects the active maintenance of multiple values associated with an aquifer through controls on groundwater use, monitoring activities, and active recharge through injection wells, recharge basins, and use of "natural recharge infrastructure" via wetlands and stream flow. Image courtesy of California Department of Water Resources.

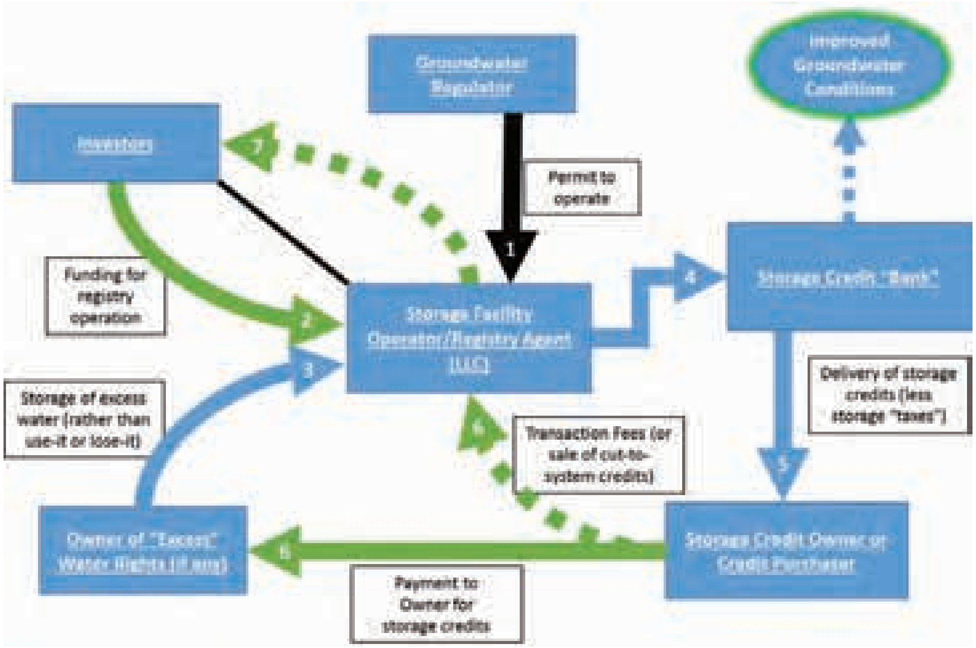


Figure 18. Structure of Underground Storage Trading Mechanism

Changing these rules to enable simple trading can help to protect reservoir levels during dry periods to hedge against the risks of serious shortages, and create incentives to recharge and maintain groundwater in storage in a manner that will protect strategic groundwater reserves and connected surface water systems. For example, allowing individual water entitlement holders to "carry over" their unused water in surface water reservoirs from season-to-season and year-to-year (typically as so-called "top storage") allows users to make investments in additional conservation efforts and keep water in storage to ensure that they will have a full allocation during a subsequent year. Enabling simple trading of these carryover storage "credits" between users can also vastly expand potential water trading opportunities and help to establish rational pricing for water, while incentivizing conservation activity by allowing users to conserve, store, and trade seasonally available water year-to-year or over multiple years. In environments where states or local jurisdictions have acted to close off open-access doctrines, create water rights in groundwater, and/or create "offset" programs where new groundwater pumping must be justified based on reductions in other existing withdrawals, similar opportunities to trade in groundwater rights and storage credits can help to incentivize storage activity and rationalize groundwater use. Several existing "water banks" (public, private, and non-profit) provide these types of services in certain jurisdictions, allowing surface water trading, groundwater trading, or both.

However, these institutions have only developed in a few places, in part because the operation of such a "water exchange" or "water bank" can be outside of the typical capacities and responsibilities of already overburdened reservoir operators and groundwater regulators. To provide for the broader deployment of storage trading solutions in western reservoirs and groundwater basins, this investment tool would utilize private capital to develop, implement, and operate storage trading facilities in both surface water reservoirs and aquifers (in environments where federal, state, or local regulations and policies have created the essential enabling conditions for storage trading). By allowing for the development and trade in storage credits among water users, storage facilities would provide a variety of physical and price hedging options and tools to water users to manage physical risks and control speculation, as well as insurance-type arrangements to cover water users and/or critical ecological values. This would be done while providing a return to the storage facility operator and underlying investors via transaction fees and a "tax" on storage transactions, together with the direct marketing of storage credits and services developed in the facility. By managing risks to water users, this tool can limit the ecological risks and pressures that would otherwise be associated with sudden catastrophic supply shortfalls, incentivize changes in water withdrawals in a manner that will protect stream flows, and develop water supplies that can be used to meet ecological needs.

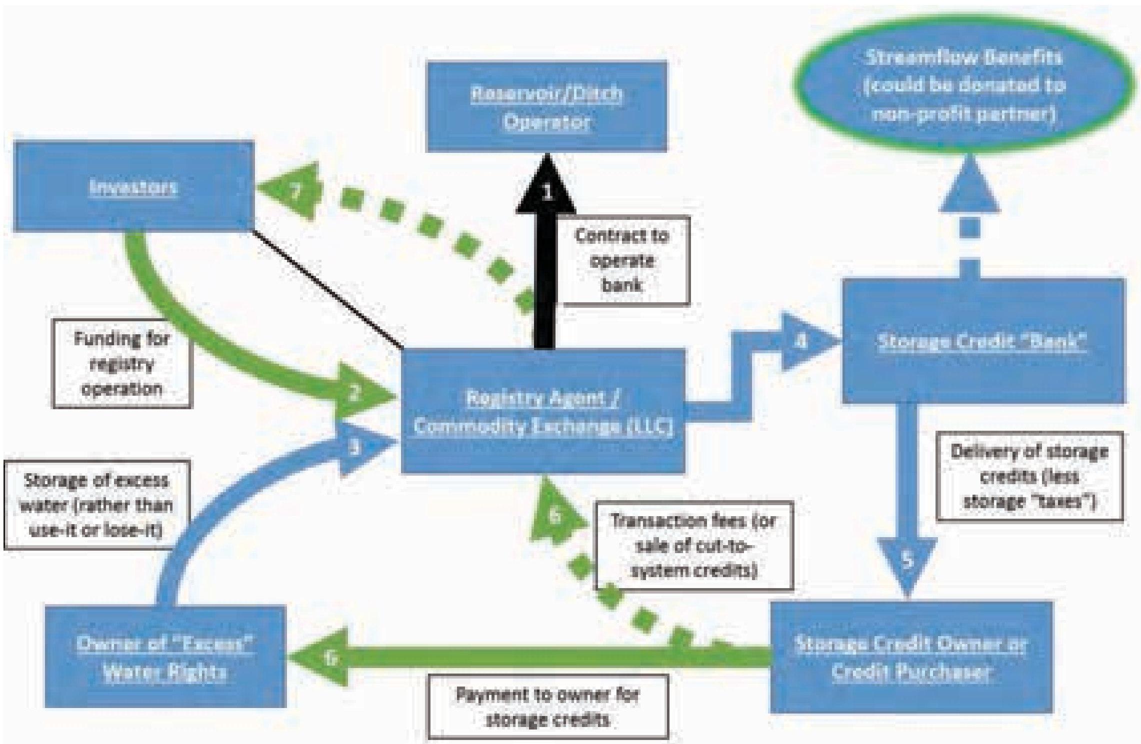
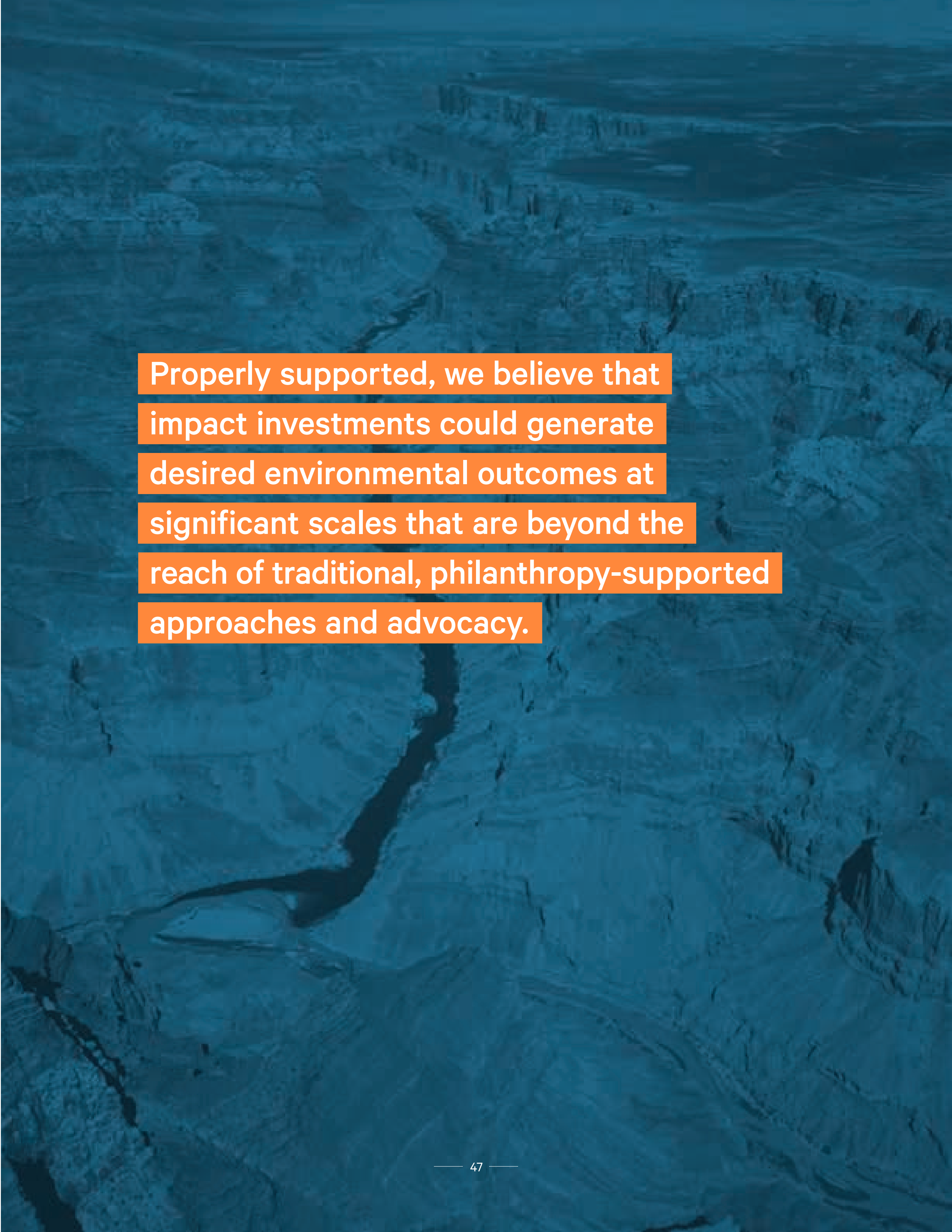


Figure 19. Structure of Reservoir Storage Trading Mechanism.



Properly supported, we believe that impact investments could generate desired environmental outcomes at significant scales that are beyond the reach of traditional, philanthropy-supported approaches and advocacy.

Relative Assessment of Key Metrics for Private Capital Investors and NGO Partners

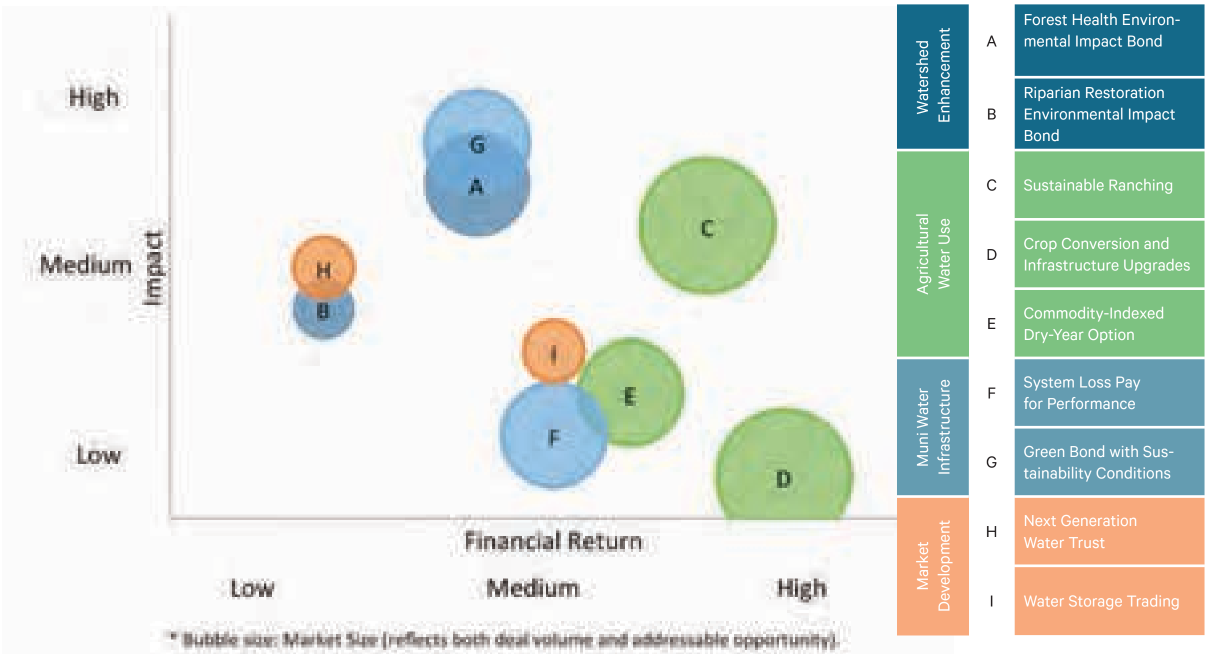


Figure 20. Private capital investor key metrics chart showing relative expected characteristics of each blueprint in terms of expected environmental benefits/impact, potential financial returns, and anticipated market size. Y axis: Expected Impact, X axis: Financial Return, Bubble size: Market Size of Opportunity.

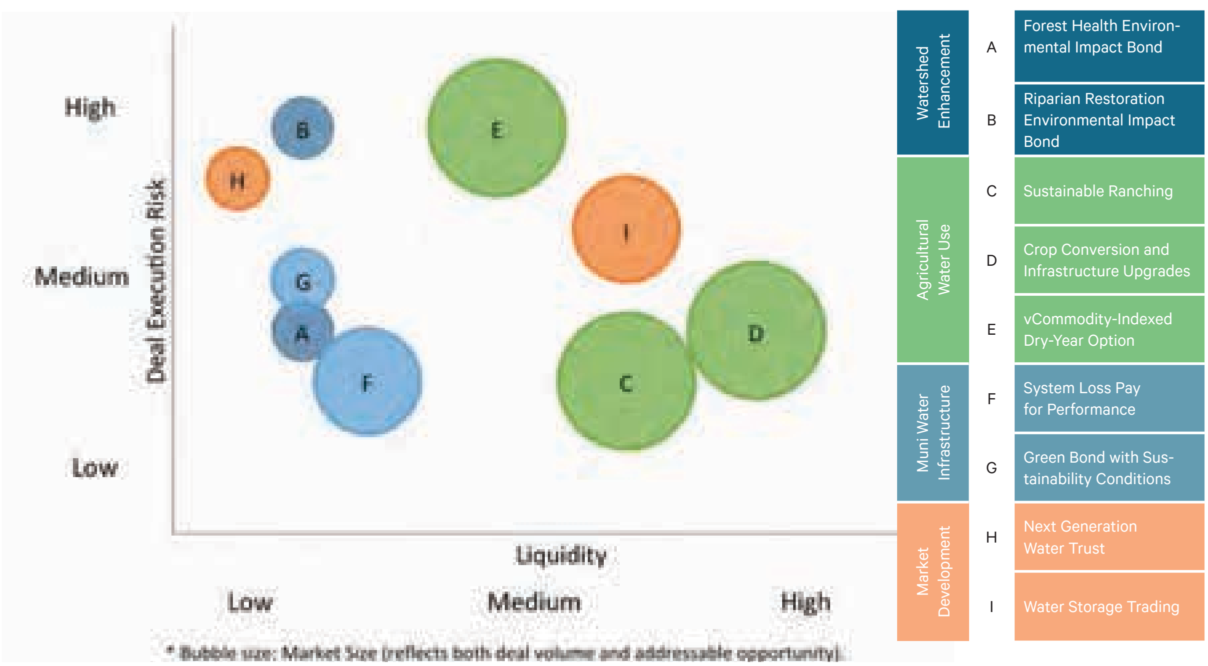


Figure 21. Private capital investor key metrics chart showing relative expected characteristics of each blueprint in terms of difficulty and risk in execution, expected level of liquidity, and potential financial returns. Y axis: Deal Execution Risk, X axis: Investor Liquidity, Bubble size: Potential Financial Return.

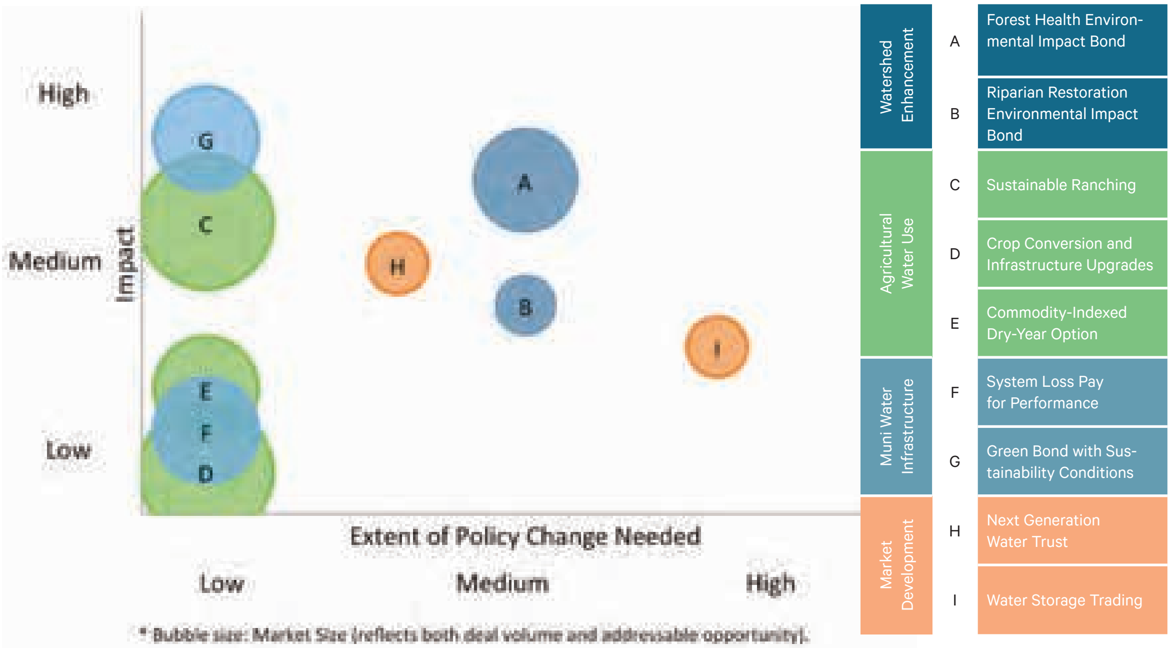


Figure 22. NGO partner key metrics chart showing relative expected characteristics of each blueprint in terms of expected environmental benefits/impact, the degree to which policy changes involving public participants and/or regulators are anticipated to be needed in order to create enabling conditions (if any), and anticipated market size . Y axis: Expected Impact, X axis: Policy Change Needed, Bubble size: Market Size Opportunity.

Key Recommendations for Capacity-Building

In most cases, the identification of specific investment opportunities will require substantial upfront investigation, as well as the availability and engagement of local capacity and knowledge on the ground, such as local NGOs or other parties that are capable of both identifying local opportunities that could fit within the identified blueprints and assessing the unique economic, user, and environmental risks and issues that could be addressed transactionally. In most cases, because of the lack of transparent data and information with regard to potential opportunities, the absence of existing market-enabling conditions that would allow for relatively simple transactions with low transaction costs, and the absence of regulatory requirements that could drive appropriate environmental outcomes in the absence of outside guidance, it is unrealistic to expect that investment opportunities and transactions will be developed organically by investors themselves.

It will also be critical to gather together or define environmental objectives in a particular region as clearly as possible in order to provide guidance for future investment design (for example, flow targets in particular stream reaches such as those provided by TNC's pending "Flow Road Map"), as well as clear criteria for the design of monitoring efforts and/or more specific environmental, social, economic, or other targets that may be built into a particular investment. These types of investments in planning, modeling, and goal-setting will be critical to ensure that impact investments produce outcomes that are both desirable and compatible with larger strategic goals for the region. This implies both continued support for NGOs and other partners on the ground to continue planning and traditional conservation advocacy work, as well as some level of "training" and coordination between entities seeking to set up deals and local NGOs to recognize opportunities and take advantage of established local relationships and trust needed to allow an investment to move forward.

Once opportunities are identified, many transactions will also require substantial due diligence in terms of legal and regulatory requirements, appraisals, engineering feasibility studies, and similar activities, and investment in outreach and discussions with potential parties to a transaction in order to set up transactions to the point where a pro forma term sheet or offering memorandum could be presented to potential investors. Although this process could potentially become independently-supported via the eventual creation of an organized fund around particular strategies, it will almost certainly be necessary to undertake one or more pilot transactions as a proof of concept and to establish a reliable deal "pipeline" before this would be feasible. In addition, a number of proposed investment structures may require, or could at least substantially benefit from, formation of "watershed conservation funds" or similar public funding mechanisms (once a demonstrated proof of concept has been secured) that could support investments in activities that produce generalized, distributed benefits in a watershed instead of creating value for particular single users.

> Developing and supporting capacity in the form of a deal-finding and deal-arranger team(s) will be essential to facilitating large-scale private impact investment.

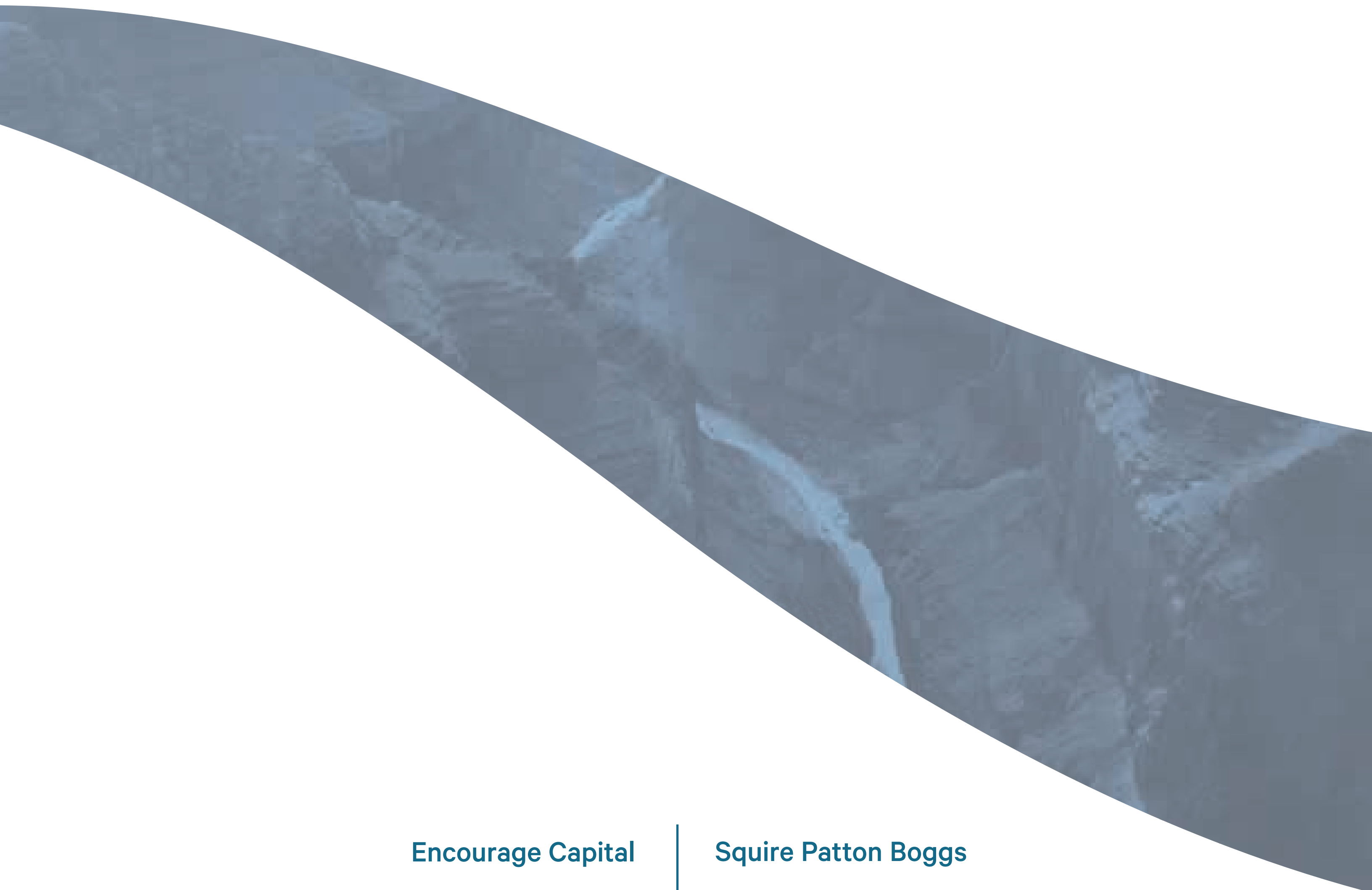
Given the attendant costs, uncertainties, and potentially significant timelines required to identify potential opportunities, undertake required due diligence, establish environmental criteria, and develop the deal terms for particular investments, it is unrealistic to expect many investments to occur (or to expect that investments will align with environmental interests and goals) without up-front support from either public or charitable sources willing to provide concessionary or low-return capital for this purpose. As such, developing and supporting capacity in the form of a deal-finding and deal-arranger team or teams that could operate in the Basin will, in our view, be essential to facilitating any large-scale private impact investment activity. For example, establishing a deal team(s) that included a partner(s) that can interface with local NGOs and organizations, a technical consultant to undertake required modeling, mapping, and monitoring, legal support to diligence and structure transactions, and financial professionals that can ground-truth potential investments and bring (and sell) opportunities to the financial markets could be a way to rapidly identify and catalyze a series of like-kind investments and establish a reliable deal pipeline. One potentially efficient approach to funding this type of team would be to support its work with a program-related investment style "revolving fund" that could be used to pay the costs of deal-finding and deal-development over time, with the costs of successful transactions repaid into the fund from the "arranger fees" charged into the transaction. [5]

Finally, a basic objective of a larger impact investment program in the Basin can--and should--be to demonstrate the value of certain types of transactions in a manner that will contribute to longer-term policy reforms. The demonstration of impact transactions represents a potentially powerful tool for shaping the eventual development of water markets in the Basin in a way that will both honor and facilitate the achievement of broader environmental and social goals. In addition, given that substantial reforms of water management are likely to take decades to accomplish, pilot demonstration transactions may provide the best way to "lead the way" toward those larger reforms, providing an alternative to the pursuit of large-scale, difficult reforms in isolation through traditional policy advocacy.

However, continued investment in policy advocacy toward several important near-term reforms—such as changes in legal rules to enable short-term water transactions, the establishment of market-exchange platforms to facilitate water trading (such as water bank and trusts), continued efforts to control groundwater open-access issues that undermine the development of water markets, and investments in monitoring and information collection in data-poor environments—will also help to further expand opportunities for investment in the Basin. There appears to be strong current interest among federal leadership and agency staff in promoting strategies that will help bring private capital to bear on water management issues in the West, which suggests the potential for public-private collaboration related to proposed investment blueprints, policy reform and/or funding needs, and specific impact investment opportunities that could jump-start demonstration-scale impact investments in various parts of the Basin.

There is strong potential for impact investment in the Basin - but for these investments to be practically deployed, and to ensure the achievement of environmental benefits that could be derived from them, there will clearly need to be significant upfront investments in deal development and ground-level capacity. However, addressing those needs would also provide a powerful means for the Walton Family Foundation and other charitable actors to amplify relatively small investments of charitable money into large-scale impacts funded by outside private capital. Properly supported, we believe that such impact investment is positioned to generate desired environmental outcomes at significant scales that are presently beyond the reach of traditional, philanthropy-supported approaches and advocacy. Success at this level could also create momentum for regulatory reforms, and could powerfully shape the development of water markets as they begin to emerge in the Basin.

5 It may also make sense to invest in some level of centralized opportunity exchange, such as the West Coast Infrastructure Exchange used to generate a pipeline for public infrastructure projects in California, Oregon, Washington and the province of British Columbia.



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