



CONSERVATION FINANCE & IMPACT INVESTING FOR U.S. WATER

A REPORT FROM THE 2016
ASPEN-NICHOLAS WATER FORUM



For all inquiries, please contact:

Energy & Environment Program
The Aspen Institute
One Dupont Circle, NW
Suite 700
Washington, DC 20036
Phone: 202.736.2933
energyandenvironment@aspeninstitute.org

Nicholas Institute for Environmental Policy Solutions
P.O. Box 90335
Duke University
Durham, NC 27708
Phone: 919.613.8709
nicholasinstitute@duke.edu

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The Aspen Institute
One Dupont Circle, NW
Suite 700
Washington, DC 20036

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The Aspen Institute is an educational and policy studies organization based in Washington, D.C. Its mission is to foster leadership based on enduring values and to provide a nonpartisan venue for dealing with critical issues. The Institute has campuses in Aspen, Colorado, and on the Wye River on Maryland's Eastern Shore. It also maintains offices in New York City and has an international network of partners.

The Aspen Institute **Energy and Environment Program** (EEP) provides nonpartisan leadership and a neutral venue for improving energy and environmental policy-making through values-based dialogue. The Program's core competency is convening professional, high-level, content-driven dialogues in the policy, science, finance, and business arenas with experts from government, business, academia, and nonprofit organizations. These dialogues are structured and moderated for discussion, exploration, and consensus building. www.aspeninstitute.org

The Nicholas Institute for Environmental Policy Solutions at Duke University improves environmental policymaking worldwide through objective, fact-based research to confront the climate crisis, clarify the economics of limiting carbon pollution, harness emerging environmental markets, put the value of nature's benefits on the balance sheet, develop adaptive water management approaches, and identify other strategies to attain community resilience. The Nicholas Institute is part of Duke University and its wider community of world-class scholars. This unique resource allows the Nicholas Institute's team of economists, scientists, lawyers, and policy experts not only to deliver timely, credible analyses to a wide variety of decision makers, but also to convene these decision makers to reach a shared understanding regarding this century's most pressing environmental problems. www.nicholasinstitute.duke.edu

The 2016 Aspen-Nicholas Water Forum was the fifth forum in which the Aspen Institute and the Nicholas Institute have partnered. The first, in 2005, on water, sanitation, and hygiene in the developing world, produced *A Silent Tsunami*, which made a material contribution in advancing priorities in U.S. foreign assistance for basic water services. The report ultimately helped spur passage of the Paul Simon Water for the Poor Act. In 2011, the two institutions again joined together to host a one-day forum to take stock of progress, documented in *A Silent Tsunami Revisited*. The success of these endeavors provided the impetus for additional forums focused on water concerns in the United States. www.aspeninstitute.org/programs/energy-and-environment-program/aspennicholaswaterforum

TABLE OF CONTENTS

PREFACE	v
EXECUTIVE SUMMARY	vii
KEY FINDINGS	x
INTRODUCTION	1
TODAY’S WATER FINANCING CHALLENGE	3
Where is Funding Needed?.....	3
Financing Options.....	5
A Historical Perspective: The Slow Shift.....	6
Governance: Roles and Responsibilities.....	7
Federal Government.....	9
Urban Systems.....	10
Rural & Agriculture Systems.....	12
Private Financing.....	13
Stepping into the Future	14
EXPANDING THE VIEW OF INFRASTRUCTURE	17
People.....	17
Policies & Processes.....	19
IS THERE A MARKET FOR WATER?	23
Markets are a Tool.....	25
What Do Markets Need?.....	25
Challenges to Water Trading in Western Markets.....	26
Federal and State Governments Have an Important Leadership Role	27

FROM PHILANTHROPIES TO CORPORATIONS	29
Who Decides Which Projects are Funded?	31
Leadership & Trust.....	32
INVESTING IN TECHNOLOGY.....	34
Barriers to Financing Water Technology	34
Creating a Market for Water Technology.....	35
WATER RISK.....	37
Water-Related Risks to Companies.....	37
Water Risk and Investors.....	38
CONCLUSION	40
APPENDIX I: FORUM AGENDA.....	42
APPENDIX II: FORUM PARTICIPANTS	46
APPENDIX III: BIBLIOGRAPHY	49
APPENDIX IV: ACRONYMS	52

PREFACE

The 21st century has brought a dramatic shift in expectations for how water and the economy will intersect. The past century and a half were marked by staggering expansion of conventional water infrastructure funded through the federal government from direct spending to tax exemption for municipal bonds. However, government funds have atrophied, creating a funding gap that has the potential to be filled by private and philanthropic capital. New approaches to finance water infrastructure are rapidly developing and these programs provide an opportunity to rethink water supply and demand infrastructure technologies. The rise of private investment also raises interest in alternative mechanisms for generating financial returns through the development of water markets.

To understand the opportunities and challenges that private financing presents in the water sector, the Aspen Institute's Energy and Environment Program and Duke University's Nicholas Institute for Environmental Policy Solutions focused this year's Water Forum on conservation finance and impact investing for U.S. water.

The annual Aspen-Nicholas Water Forum serves as a platform for addressing domestic water challenges in the 21st century. The 2016 forum focused on the shifting role of public and private financing for water infrastructure and the new universe of innovative financing solutions to create impacts in the water sector, including how impact investing can hold the multiple roles of bridging the ever growing funding gap for infrastructure, improve water use efficiencies, and protect water resources while at the same time making a financial profit.

This forum summary was written collaboratively by the Nicholas Institute for Environmental Policy Solutions at Duke University and the Aspen Institute. Although the authors have attempted to capture the ideas and sentiments expressed during the forum, not all views were unanimous nor were unanimity and consensus sought. Forum participants and sponsors are not responsible for its content.

We thank the following sponsors for their generous support of the forum: the Walton Family Foundation, Water Asset Management, S.D. Bechtel, JR. Foundation, Intel Corporation, National Renewable Energy Laboratory, TomKat Foundation, the Cynthia & George Mitchell Foundation, National Association of Water Companies, and Gallo Wines.

Looking ahead, the Aspen Institute and the Nicholas Institute will continue to collaborate to develop pathways for addressing the state of the U.S. water system. The plethora of challenges in the U.S. water sector today—from the drought in California to water quality problems in the Chesapeake Bay to groundwater depletion in the Ogallala aquifer—will continue to be addressed through the Aspen-Nicholas Water Forum in the years to come.

EXECUTIVE SUMMARY

In May 2016, the Aspen Institute Energy and Environment Program and the Nicholas Institute for Environmental Policy Solutions at Duke University hosted the Aspen-Nicholas Water Forum, a roundtable discussion to address ongoing challenges to our water systems. The participants—including thought leaders from the private sector, government, academia, and non-governmental organizations—represented expertise in industry, finance, government, academia, agriculture, food and technology companies, investors and entrepreneurs.

Water is essential to life, and significant cultural, economic, social and environmental values have been constructed by society around water. Despite this centrality of water in society, there is a surprising lack of investment in the systems that provide and sustain water resources. A central driver in this underinvestment is the shifting role of the levels of government responsibility in both management and in funding; that is, fiscal federalism. Ongoing—but not clearly communicated—devolvement of federal funding of water management to states and local governments has been occurring for three decades yet without a comparable and sufficient adoption of fiscal responsibility by these lower levels of government.

Given these changes, U.S. water is facing a growing financial crisis, with an estimated water infrastructure funding gap of \$84 billion by 2020. It is improbable that public funding will or can meet the growing financial need. However, the good news is that substantial private capital is available and innovative financing solutions are emerging in the water space. Values-based financing, like good governance, is needed to create value while fostering transparency. Developing and implementing strategies for sharing accurate data with stakeholders can add significant value to the water sector by enabling water managers to remain in compliance with regulations while monitoring and measuring organizational performance and impact. Yet because water is highly fragmented and not highly valued by the public, data on water accessibility and quality are often lacking, particularly in formats that allow investors to assess water-associated risk.

A second barrier to innovative private financing—a barrier which also prevents good governance—is the fragmented nature of water management. Small water utilities or agricultural businesses don't often have the revenue base to recover full costs, and so are unlikely to take financial risks. Additionally, the transaction costs between

water holders and investors for making innovative deals around new markets or business lines are high, incentivizing investors to focus on larger deals with similar transaction costs to cheaper projects. This decreases the financial access of small and medium size utilities and farms or irrigation districts in desperate need for financing of infrastructure. Bundling small utilities, farms, or irrigation districts farms can help to spread the cost among more rate payers while enabling access to private capital and reducing risk to investors. Regionalization of water utilities may be an important element of the future for sustaining sufficient access to capital for smaller water utilities.

A third barrier to private capital entering the water market is related to culture and communication around the value of water. Water is held as a right and that has been equated in the public's mind as "free." Going forward, the water sector must better communicate that, while water is a right, the infrastructure needed to deliver safe drinking water must be recovered at full cost. Education is required to change this cultural perception of access to water being free. Mistrust of private companies' profit motives must be overcome so that companies can have a positive impact on water resources while making a profit. (There is a particular mistrust of private funding for water utilities, and the public should be educated around the difference between private capital and private ownership; there are many successful investor-owned utilities globally.) Government should provide guardrails around investor-owned utility arrangement through regulations and policies, while also messaging the value of water to our livelihoods—an understanding that is required to earn public buy-in on water investment and governance.

The role of a water funding stream—whether government, private investors and corporations, non-governmental organizations (NGOs) or philanthropy—should be structured to balance risk tolerance with the desire to achieve a measureable impact. For instance, philanthropies seek to make a large impact towards the good of water resources and are more willing to absorb the risk of failure; similarly, NGO's are able to invest in smaller and riskier projects to prove their viability and increase deal-flow. These entities can guide the development of pilot projects that demonstrate how impact investing can benefit the water sector while generating financial profit. Once blueprints are established for structuring deals, the transaction costs and perceived risks will decrease, opening the water market to private and corporate capital. The environmental, social and economic impacts could theoretically grow as these deals are scaled from single one-off projects to basin-wide efforts to standard practices.

Government, on the other hand, can be a source of low-risk, long-term funding, providing an important role in subsidizing communities that cannot access private capital or those rare but large-scale infrastructure projects outside of private capital markets. Government may need to shift from financing and toward providing

governance structures that foster public-private partnerships and innovate private financing.

The gap between philanthropies and government is gradually being filled by private sector investors. While there is a long history of private capital sourcing municipal water systems (e.g., municipal bonds), the movement of private capital into other areas of water resources such as ecosystem restoration and large-scale irrigation, has been more recent. Innovative finance opportunities for the private sector are being identified by philanthropic foundations and new federal government initiatives, but there is a fundamental lack of deal-flow for the private sector; there are not enough opportunities in which to invest compared to the level of financial interest or the existing demand for investment.

The role of the government in providing leadership and regulation to enable new financing opportunities for water cannot be understated. Water is a local resource that is difficult to transfer between locations and it is heavily regulated. These factors make it difficult to establish viable, large scale water markets. The federal government and state governments could open up opportunities for water investment and water markets by developing interstate water trading, along with interstate water quality trading. Such markets often serve as the foundation for subsequent private sector investment. For water quality trading or ecosystem service markets, the federal government could also provide leadership on establishing metrics for assessing the value and success of trade agreements.

Important questions are being raised by the water community, and will continue to be explored in the coming year: What will the next generation of water infrastructure and financing look like? How do we integrate the legacy of old centralized infrastructure if we move towards decentralization? Do we want to build efficiently or with an eye towards resilience, by building redundancy into the system? Good governance and financing have the potential to shape the future of our water resources, and it is imperative that both the private sector and policymakers are fully engaged in developing this vision and rebuilding our water system for the next generation.

KEY FINDINGS

The challenges of financing water infrastructure in the coming decades require an alignment of forward-thinking governance, innovative private sector financing, and education of key stakeholders—including the public—around the value of water and the funding required to continue to provide high quality and sufficient water for the variety of society’s needs. This report summarizes the Aspen-Nicholas Water Forum discussions of May 2016, offering various approaches to financing water infrastructure.

1. Business as usual is not sustainable—we as a society are now paying for the “can-kicking” that has occurred while we debated responsibility for U.S. water resources.

Addressing the water issues of today will be difficult, expensive and take time. But business as usual will not work. A new vision for water management must be created outlining how innovative financing solutions and technologies can be implemented alongside aging 20th century infrastructure. Good governance can help to form that vision, set standards, and scale projects. However, as the federal government steps away from funding and new private capital (whether corporate investor or philanthropic) comes in, questions around oversight responsibility must be addressed.

Securing funding for capacity building can be challenging, compared with raising capital for pumps and pipes; however, it is essential that investments be made in leadership and capacity, as water management requires trust, education and strong relationships. Leadership on water must be cultivated to develop and implement the new vision for water management, and this must include innovative thinking and leadership from engineering and management to finance and revenue-generation.

2. The water issues we face as a nation continue to grow as the water community dithers and invests in one-off projects, rather than focusing on scaled solutions like regionalization and integration.

The process of making decisions in an atmosphere of complexity is challenging, even when governance structures are clearly demarcated. Government sets regulations and provides assistance in crises, but should also play a role in setting the vision for water management through legislation and enforcement. Policymakers have a responsibility

to pave the path forward for innovative financing solutions to address problems in the water sector, particularly the pressing issues surrounding urban water infrastructure.

Whether new infrastructure gets financed depends largely on how well the scale and economics of a project are matched. Large, centralized infrastructure cannot be funded privately if the scale of rate-payers in the system does not match the scale of the investment. This is particularly challenging for water utilities in small and mid-size communities without the rate base to finance upgrades to their system, or in small irrigation districts with limited revenue streams or diversification. Unless governments are willing and able to provide direct funding for small utilities or districts, financial regionalization of smaller systems may be an unavoidable future for creating sufficient economies of scale required to attract and sustain effective financing.

3. Money is not the issue; there is plenty of private capital available to meet the current water funding gap, but there are significant barriers to impactful and innovative financing.

There is a broad spectrum of capital available for water financing that vary on factors like risk tolerance and mission; the challenge is in matching this capital with appropriate projects. Innovative financing solutions are starting to emerge in the water space. Government finance and funding is shrinking, but there is considerable private finance interested and available for the broad range of opportunities associated with water. Philanthropic foundations and NGOs have stepped into the role of bridging investment opportunities with investors, but this has only recently developed. The single greatest limitation to private capital moving into water is the lack of deal flow.

For private capital to move into the gap left by government funding, there must be sufficient revenue to generate a competitive return on investment. To date, water has been under-valued in part because of the ubiquity of low-cost government capital subsidizing water infrastructure, and thus, water itself. This has lulled urban and suburban water users, along with rural irrigators into a fallacy of cheap water. If private capital is to play a role in the future of water in the U.S., there will need to be a society-wide acceptance of increased cost of water. If instead society demands subsidized, under-priced water, then government alone will play a finance and funding role.

4. Government regulation and public education can go hand in hand to gain public support for improved water management while supporting social equity.

Federal and state government need to play a strong role in the provision of equity to those in society who cannot afford to pay for the true cost of water delivery. Social equity must be taken into account when determining which water utilities and

projects receive financing. Large utilities with good ratings have access to various types of private capital at low interest rates, while smaller, struggling systems are not large enough or financially sound enough to attract private capital and may not qualify for any type of federal assistance. Infrastructure costs can be managed to increase affordability by securing long-term bonds that spread the cost over generations of payers, or across space by consolidating projects or utilities to spread the cost across a larger population.

Given that government is meant to reflect the values of society, and currently the public does not highly value water, public communications must be created that increase the public's understanding of the importance of water. Linking water to public health, as an important element of personal wellbeing, could be an effective way to increase the public's concern around the quality of water and willingness to support investment in vital infrastructure. The public should be informed of where their drinking water comes from, how much they use on a daily basis, and how that compares with others in the same watershed. Likewise, the public should understand the embedded cost of water in the food supply. And then the public should be made more aware of the costs of providing those water-related services. The data exists to communicate this information to customers, but it is rarely used for such purposes effectively.

5. Leadership is one of the prime movers for innovative finance projects in the water space.

Leadership is needed at all levels. The federal government has a leadership role that includes setting the vision for water in the U.S., setting boundaries for private-public partnerships, convening projects, and supporting innovative financing solutions. The federal government is stepping towards that role with the establishment of three new centers related to water financing:

1. The U.S. Department of Agriculture's Rural Infrastructure Opportunity Fund
2. The Environmental Protection Agency's Water Infrastructure and Resiliency Finance Center
3. The Department of Interior's Natural Resources Infrastructure Center

Leadership is also needed at the state and regional level to identify needed projects and to match funding sources to those projects. The state governments must also play their role to ensure sufficient funding and financing is reaching portions of society that have no other sources of finance.

INTRODUCTION

In May 2016, the Aspen Institute Energy and Environment Program and the Nicholas Institute for Environmental Policy Solutions at Duke University hosted the Aspen-Nicholas Water Forum, a roundtable discussion to address ongoing challenges to our water systems. The participants—including thought leaders from the private sector, government, academia, and non-governmental organizations—represented expertise in industry, finance, government, academia, agriculture, food and technology companies, investors and entrepreneurs. Sessions explored the growing opportunity for innovative water financing tools, and the need for supportive policies at the state and federal level to ensure that organizations—whether companies, utilities, states, or even the nation—are sustainable and resilient through crisis events.

The challenges of financing water infrastructure in the coming decades require an alignment of forward-thinking governance, innovative private sector financing, and education of key stakeholders—including the public—around the value of water and the funding required to continue to manage water, from providing drinking water to controlling floods. This report summarizes the Aspen-Nicholas Water Forum discussions of May 2016, offering various approaches financing water infrastructure.

TODAY'S WATER FINANCING CHALLENGE

Water management is entering the realm of “Big Data”—a phrase that is used to capture four broad information trends: volume (sheer quantity of data), velocity (speed at which data are being generated), variety (increasingly unstructured, unintentional data with little pre-defined structure), and veracity (questioning the trustworthiness of data as the world’s digital footprint grows). The challenge is to create value from data in a reasonable time frame and in a way that increases the sustainability of water resources.

The 21st century has brought a dramatic shift in expectations for how water and the economy will intersect. The past century and a half have been marked by a staggering expansion of conventional water infrastructure, including more than 80,000 dams for storage, 25,000 miles of levees for flood control and 35,000 water treatment plants. Most of this infrastructure was financed through conventional public funding, including municipal and local district debt combined with large-scale federal funding and financing.

In recent decades, federal and state funds for water infrastructure have contracted significantly, creating uncertainty in how needed water investments will be made in the future. Given this reality, new financing options that allow private capital to invest in water resources are being developed, including conservation financing (e.g., “green bonds” or impact investing), blended public-private capital, and philanthropy. The rise of private investment has also increased interest in alternative mechanisms for generating revenue like water quantity and quality trading along with ecosystem markets.

WHERE IS FUNDING NEEDED?

Water infrastructure funding is required for capital expenditures (CAPEX) and operations and maintenance (O&M), water resources management, service infrastructure (for water and wastewater), and ecosystem expenditures. Capital expenditures and operations and maintenance needs include water resource management; supply, treatment, and distribution of water; collection and treatment of wastewater; and management of storm and flood water. Capital expenditures serve to maintain, expand, and upgrade water systems through new construction and

facility replacement, while O&M funds pay for salaries, energy costs, materials and supplies, and other ongoing expenses.

Water resource management funding is needed to repair and manage levees along with reservoirs that control water flow paths and increase reliability of supply, whether for municipal supply or agriculture and irrigation. The average age of dams in the United States is 52 years, and many are beyond their expected design lives.

Over the next 20 years, maintaining and expanding our water service infrastructure will require \$1 trillion—more than twice the current level of investment by all levels of government.

The American Society of Civil Engineers (ASCE) estimates that repairing high hazard dams would cost \$21 billion. Most dams are privately owned and would necessitate private financing.

Water and wastewater service infrastructure are estimated to cumulatively cost local governments more than \$130 billion annually on construction, repairs, upgrades, equipment, and operation of water transport, treatment, distribution, and collection through public water and wastewater

systems. The United States has nearly 170,000 public water systems and 15,000 large wastewater treatment plants. ASCE estimates that the United States has more than one million miles of water mains and nearly as many miles of sewer mains with many nearing the end of their average life expectancy. Over the next 20 years, maintaining and expanding our water service infrastructure will require \$1 trillion—more than twice the current level of investment by all levels of government.

Stormwater and flood control expenditures aim to curb water pollution, eliminate combined sewage overflows (CSOs), and manage flood risks. Stormwater programs invest primarily in pollution prevention, such as street sweeping and illicit discharge detection and elimination. Cities have invested more than \$15-45 billion annually in new pipes, equipment, and treatment plants to eliminate CSOs. Local governments are struggling to fund existing services and comply with stormwater regulations. Local, state, and federal authorities share flood-control responsibilities, which have been described as woefully inadequate. For example, over the next five years, flood-risk management in San Diego alone will likely cost about \$250 million—five times more than the amount allocated.

Ecosystem expenditures have grown considerably with some spending driven by regulatory compliance, such as mitigation banking to offset impacts of development. The value of ecosystems for their services has also led to specific expenditures for sustaining those services. Perhaps the most well-known mechanism has been the purchase and preservation of lands for sustaining and improving the water quality of distant, downstream water supplies. One example is the preservation and restoration of lands in the Catskills for the water supply of New York City. There

is considerable interest in using these types of ecosystem services to provide lower costs for comparable water resources, whether reducing the costs of water treatment or reducing flood peaks. However, there is considerable scientific uncertainty as to whether the services sought are being produced, and whether those services are sufficiently measurable in comparison with their ‘grey’ infrastructure counterparts.

FINANCING OPTIONS

Financing ultimately comes from local, state, or federal government or from private sources like philanthropies, non-government organizations (NGOs), or private individuals and corporations. Each funding stream sits along a spectrum of risk tolerance and a balance between making a return on investment and achieving desired outcomes.

Public money seeks to make an impact for the public good, rather than being profit oriented. The government serves as a trusted entity of public money and has low tolerance for investing in projects with a high risk of failure. Public money for water can be obtained through a variety of mechanisms, including debt service through bonds (e.g. revenue bonds and general obligation bonds), grants, and state revolving loans that provide low cost financing. Revenue bonds are municipal bonds that finance projects and are secured through a specified revenue source, such as rate payers for water-related services. General obligation bonds are municipal bonds that are secured through stable streams of tax revenues (e.g. property tax).

Public money for water can be obtained through a variety of mechanisms, including debt service through bonds (e.g. revenue bonds and general obligation bonds), grants, and state revolving loans that provide

Federal financial assistance through loans and grants can be obtained through the Army Corps of Engineers (for projects to protect water resources and wetlands) and the Bureau of Reclamation (to secure water supplies, deliver water, generate hydro-electricity and ensure healthy watersheds). In addition, the Environmental Protection Agency (EPA) administers the \$17.3 billion Drinking Water State Revolving Fund (DWSRF) and the \$39 billion Clean Water State Revolving Fund (CWSRF) programs to provide grants, or no- or low-interest loans, to local communities to install, expand, repair, upgrade, or replace aging pipelines, storage and treatment facilities, and other similar infrastructure. The Farmers Home Administration, Department of Housing and Urban Development, U.S. Department of Agriculture (USDA), and Department of Commerce Economic Development Administration also fund infrastructure investments and operating expenses to improve health and welfare in rural, low- income, and economically distressed communities.

The private sector directly finances water projects with private capital, tax-increment financing and private ownership and operation of infrastructure. Private capital also seeks to make an impact in line with their values, but often with the added goal of achieving a monetary return on investment. There is a wide spectrum of private capital, with varied level of risk tolerance and interest in impact. Philanthropies are generally more willing to accept the risk of failure in terms of not obtaining a return on investment, but have a strong desire for impact. Similarly, NGO's tend to take measured risks with a strong value of achieving their desired impact. Private investors and companies have a lower tolerance of losing money in an investment.

A HISTORICAL PERSPECTIVE: THE SLOW SHIFT

Water infrastructure and financing in the United States have undergone dramatic shifts between government and private financing over the past two centuries. Until recently, these shifts have been abrupt and linked to a financial crisis (e.g., Great Depression) that resulted in a clear reorganization of governance and financing around water infrastructure. The ongoing shift has been a slow devolution of both governance and finance responsibility from the federal government to state and local governments, and most recently to private capital. The slow shift has led to confusion around who is responsible for delivering water-related services and what the future of water resources should look like moving forward.

The slow shift has led to confusion around who is responsible for delivering water and what the future of water resources should look like moving forward.

It could be argued that our current water infrastructure system is largely the product of a financial crisis. The Great Depression, coupled with the New Deal, pivoted almost all water finance to the federal government in the mid-20th century. The 16th Amendment authorized the federal government to collect income taxes, becoming the primary source of revenue, and providing the federal government with a source and scale of revenue it had previously lacked. During the Depression, local governments were unable to cover the cost of water infrastructure because local citizens were unable to pay their property tax. The New Deal enabled the federal government to collect income taxes nationally and redistribute funds to state and local governments to cover costs and reduce the risk of bankruptcy.

The federal government also had the capital to invest millions in large-scale infrastructure through establishment of multi-purpose dams and reservoirs, navigation channels, irrigation canals, and flood control infrastructure. The majority of these projects were built between 1930 and the early 1980's, and sustaining its operation will require significant capital to upgrade or replace. It has been estimated

that \$21 billion is needed just to replace dams at high risk of failing—many of which are privately owned. Yet unlike the era when much of this infrastructure was initially built, the federal government does not devote the financial resources to fund these projects.

During the New Deal era, the federal government also invested heavily in water and wastewater infrastructure through grants, particularly in small, rural water systems and districts. Decades later, the federal government continued to invest in water quality improvement by spending more than \$40 billion to help communities develop the infrastructure needed to control pollution following passage of the Clean Water Act in 1972. Until 1984, the federal government was the primary mechanism for meeting new regulatory standards established around water quality and protection of ecosystems and species through the Endangered Species Act. To that point, the federal government played a pivotal role in financing water infrastructure projects and setting the vision for water governance in the United States.

During and after the 1980s, federal spending on water infrastructure began to be reduced dramatically, or had to be met with local cost-share programs. Financing for water has steadily been devolved to state and local governments, returning to fiscal structures reminiscent of those in place prior to the Great Depression.

GOVERNANCE: ROLES AND RESPONSIBILITIES

The return to the local government funding models in place prior to the Great Depression reflects a lack of clear leadership and governance in the water sector as well as a shift away from a central role of the federal government in funding water resources. This raises questions around what the vision for water resources in the U.S. should be, and what type of governance would be needed to achieve that vision. Governance and financing go hand-in-hand to ensure an organization is achieving its values and is sustainable and resilient against crises.

Governance establishes the culture, policies, regulations and processes that form the structure under which an organization and its assets are managed. Good governance creates a system that clearly demarcates authority, responsibility and accountability over every process to ensure the organization is achieving its underlying values and goals. A robust governance system is an important tool for mitigating conflicts of interest between stakeholders, building trust and transparency that provides confidence and buy-in for the organization, as well as financial market stability and economic development.

Water governance is complex, to say the least. Water is essential to life and there are strong cultural, economic, social and environmental values around water. Water governance is extremely fragmented, with 51 U.S. federal agencies or bureaus

governing some aspect of water ranging from the quantity of water in streams and groundwater, to the quality of the water in lakes and rivers, to infrastructure projects managing water resources, to the flows that provide for healthy aquatic ecosystems. Overlaying federal governance are state governance structures that manage water resources. For example, California has 32 agencies responsible for managing water in the state, each with a different mandate and perspective on water. This fragmentation of responsibilities has led to poor transparency and “dithering” as public agencies struggle to advance their particular mission amongst the many others across federal, state, and local levels.

Money is not the issue; there is plenty of private money available to meet the funding gap ... but there are significant barriers to good and innovative financing.

This lack of clear leadership in water governance raises important questions. For example, who is responsible for the crisis in Flint, Michigan? Is it the local government, state government, or an individual decision maker? In the aftermath of the unfolding water quality crisis, there was a collective sense that it is a national responsibility and the federal government should provide

funding to pull Flint out of its current water crisis. Likewise, who is responsible for water in California, and should northern California help southern California with their water issues? Does the entire state of Iowa have a responsibility to help rural areas cover their water quality management costs, or should this fall to the farmers, or perhaps to the cities? These are all important questions of governance which have yet to be resolved.

The current lack of governance has contributed to poor communication with the public around the importance of water, which leads to under-education and undervaluing water. The federal government has added to the confusion through their continuous, but not clearly communicated, devolvement of responsibility and financing of water management to states and local governments. The water industry has a growing financial crisis, with an estimated funding gap of \$84 billion by 2020 for water infrastructure alone. It is unlikely public funding will or can meet the growing financial need, which has opened the door for private capital to fill in the gap.

Money is not the issue; there is plenty of private money available to meet the funding gap and innovative financing solutions are starting to emerge in the water space, but there are significant barriers to good and innovative financing. Good financing has a similar role as good governance in that the goal is to create value and foster transparency. Value is added by developing and implementing effective strategies to share data with stakeholders to enable decision-making to be based on accurate information. The combination of value and transparency enables management to remain compliant with regulations while monitoring and measuring the performance of the organization to ensure objectives are met. The data collected

enable organizations to undertake risk-based analytics to help with decision-making on current and future financial decisions. The following sections explore what the shifting role of governance and finance looks like in federal, urban, agriculture, and private groups.

FEDERAL GOVERNMENT

Water security is of growing interest to the federal government, given that water is an accelerating source of conflict overseas. Regions with threatened water resources are at high risk of food shortages, destabilization, and conflict, with direct impacts on international relationships. Domestically, water issues reach the federal government through multiple dimensions: through natural disasters (e.g., reconstruction after Hurricane Sandy), drinking water crises (e.g., Flint), crop insurance requirements for agriculture (e.g., California's current drought has cost the federal government \$30 billion), and climate change (increasing the risk of hurricanes and drought in the future).

The federal government needs to play a strong role in the provision of equity to those in society who cannot afford to pay

The multi-faceted nature of water has led to silos in government between management of water quantity, water quality, flood control, and agriculture to name a few; undermining the federal government's ability to provide effective and consistent governance. The future role of the federal government in the water space is unclear; currently the federal government is moving away from directly funding or financing water infrastructure, without providing clarity to state and local governments on its vision for the future. While the federal government may no longer be able to finance infrastructure or enforce regulations, it may still have an essential role to play in providing leadership and clarity for state and local governments, as well as setting a more clear stage of opportunities for private capital to invest in water.

Looking forward, the federal government could provide leadership by investing in information and data that would provide transparency and pave the way for greater private sector participation in water management. Investing in monitoring and data allows stakeholders to figure out the true condition of the system and design strategies that are more efficient and effective; essentially saving money on the back-end while freeing up money to invest in other things.

The federal government also has a role to play in investing in research and development (R&D) for more efficient technologies. Non-defense related federal spending in R&D has decreased from 0.62% of GDP in the late 1970s to less than 0.4%, of which a small percentage is dedicated to natural resources and the

environment. Investing in technology, particularly with regard to sensors and leaks, will help to prioritize infrastructure upgrades to save water and decrease the cost of treating water that is lost in the system prior to delivery. Advanced technology will make investments in infrastructure more cost-effective.

The federal government has the responsibility to change or pass regulations that create guardrails for the influx of private capital into traditionally owned public entities. The federal government has historically been entitled to provide equity to poor systems, linking entitlement to water and subsidies. The history of subsidizing water rates has led to a public sense of entitlement for cheap water, and because public utilities set rates through a political process, there is often resistance by the public to rate increases that would cover the full cost of water delivery. That link between entitlement to water and subsidies needs to be unbundled and made more transparent. The federal government needs to play a strong role in the provision of equity to those in society who cannot afford to pay for the true cost of water delivery.

URBAN SYSTEMS

Water infrastructure was initially developed and financed by private water companies. However, many of these systems failed due to mismatch between capital needs and the costs of establishing water systems. As private systems failed, the responsibility for those systems transferred over to local and state governments in the early 1800's. State governments financed infrastructure with loans and serviced debt through rate-payers; however, a financial crisis and recession in 1837 resulted in many states going bankrupt and unable to pay their water-related debt. Local government stepped in and took the role of financing water systems through municipal bonds that were serviced by property taxes and rate payers. Over time, some local governments began to create special districts to expand their tax base and provide services beyond municipal boundaries. The use of general obligation bonds and revenue bonds that began in the 19th century is the financial structure that is predominately used today.

Investors are good at running a business, but the government has an essential role to protect the public through a pen (writing policies and regulations) and a gun (enforcing regulations).

Urban systems enjoyed a huge influx of capital from the federal government through grants and loans for capital improvement projects. Since the 1980s, local revenue from service charges, taxes, and development and improvement fees provide the main source of funding. However, these rates often only cover the ongoing O&M and do not cover the full cost of services including capital expenditure (CAPEX).

There is a cultural acceptance that water should be very cheap. Public utilities often struggle to raise rates or create innovative financing structures to ensure adequate revenue streams because of public opposition. Education and communication are necessary to decouple the right to access water from the cost of delivering safe drinking water to the customer. Ratepayers are paying for the delivery system, not the water, and that payment should be at the full cost of delivery to ensure reliable and safe drinking water. Not paying the full cost for water delivery systems can lead to crisis situations such as the lead contamination of drinking water from old pipes in Flint, Michigan. Aging water and wastewater infrastructure is projected to require \$1 trillion over the next 20 years to bring these systems up-to-date. Rate payers covering the full cost of water delivery systems will stop the funding gap from growing, but the current gap will need to be covered through other financing mechanisms involving private capital.

Public-Private Partnerships (P3s) are one option that some utilities are taking to help cover the costs of upgrading and operating water and wastewater systems. Examples include Rialto, California, Bayonne, New Jersey and Middletown, Pennsylvania. P3s are agreements, typically a long-term contract, between local government utilities and the private sector by which the private sector provides a public asset or service, in which the private party bears significant risk and management responsibility and the return on investment is linked to performance. Not all P3s are the same and the success of these partnerships has varied depending on how the deal was structured.

Investor-owned utilities (IOUs) are utilities that are owned and managed by a private enterprise rather than a government agency. IOUs are more common in other parts of the world, yet make up a smaller portion of water supply and wastewater services in the U.S. Where they do exist, high quality government oversight remains an important aspect of their operation. These utilities tend to be more transparent because the investor is accountable for the success or failure of the utility. This means IOU managers think in worst case scenarios out 10 to 30 years in the future and account for risks. Currently, publically owned utilities, unless there is exquisite leadership, doesn't take into account the full spectrum of risk because, in the past, they have been able to rely on government bailouts.

Ongoing conversations reflecting on the crisis in Flint may change these risk assumptions and provide the impetus to bring accountability, long-term sustainability and risk into their business model. IOU's have the added benefit of decoupling rate structures from the political process, and have greater flexibility than publically owned utilities to increase rates, price by type of water use, or implement other innovative rate structures that match values and recover the full cost of water delivery. Investors are good at running a business, but the government has an essential role to protect the public through a pen (writing policies and regulations) and a gun (enforcing regulations).

METROPOLITAN DISTRICT OF SOUTHERN CALIFORNIA

As the West was being settled, it became apparent that there was not enough surface water to support large cities in Southern California. In the early 1900's, several conveyance systems and water infrastructure projects were developed to move surface water from Northern California to Southern California. These developments were financed through general obligation bonds, because the population at the time was insufficient to cover the costs. The population in Southern California has grown enough to cover the operating costs and now many California water projects are financed through revenue bonds, grants and state revolving loans. The growing demand for water has contributed to scarcity and the 1991 drought was a wake-up call for California to invest in water recycling and conservation efforts using state revolving loans, grants and state issued bonds. P3 agreements provided the revenue to construct an off-stream reservoir and a desalination plant outside San Diego that provides expensive, but reliable water. In the future, they are looking to invest in large scale direct potable reuse from wastewater plants through revenue bonds so that in 20-30 years little to no wastewater will run downstream. The major urban areas in Southern California have large populations that provide the rate base to cover the costs of these large projects. Smaller urban areas don't have the money to address these critical water infrastructure needs and the state of California is debating how to provide funding for small utilities.

RURAL & AGRICULTURAL SYSTEMS

Economies of scale determine access to capital. Large, urban systems with strong ratings and a low likelihood of bankruptcy can more easily access government and private funds. Small water systems present a unique problem to accessing capital. The smaller system has a smaller revenue base that is not capable of recovering the full cost of water delivery, while at the same time the projects requiring funding are too small to attract private investor capital. The only way to get reliable, safe, affordable water to these communities is by spreading the cost over a larger base.

This could mean that states and larger cities are responsible for covering the costs, but there is a lot of pushback on this notion because smaller communities may never pay back the borrowed funds. Cities and states are also in competition with one another for tax dollars, jobs, and water supply. Another option would be to consolidate these smaller systems into a regional utility. The United Kingdom underwent a process of water utility regionalization and in 2010 had 26 private, investor-owned water utilities serving 64 million compared to the 52,873 regulated community water systems in the United States serving 300 million.

If the United States does not shift to physical regionalization of smaller utilities, another option is for deals to bundle smaller utilities to reach a scale that attracts private capital. This would be a type of fiscal regionalization rather than a physical one. The transaction costs for deals in the water space are high so that the cost for a \$1 million project is equivalent to a \$5-10 million project. The deals put on the table must be attractive to private capital and single, small utilities are not often able to present a viable economic proposition to private capital. This makes such regionalization attractive, yet difficult, at least for the first pilot projects due to the high transaction costs.

Agricultural communities are tasked not only with acquiring water supply but also with meeting water quality regulations established by the federal government. Farms located within parts of 31 states have been tasked to improve water quality, particularly addressing nitrogen and phosphorus levels that cause hypoxia in the Gulf of Mexico.

State governments had originally waited for the federal government to provide funds to meet these new water quality requirements, yet the funding was never realized. Each state has since developed its own, separate strategy, although recognizing that these issues may be better addressed through a unified strategy driven by leadership from the federal government. States have difficulty securing funding for water quality problems within their own states, and so funding for water quality problems downstream of the state is difficult to identify. One solution being used by some states is the use of water quality markets that trade between non-point and point source pollution; so far these markets have been limited. While there has been some limited success, there has been very little success at the scale that would be necessary to address problems like the Chesapeake Bay or the Gulf of Mexico. National guidance on scaling markets beyond the state (to encompass river basins) is needed to make water markets more viable and secure.

National guidance on scaling water quality markets beyond the state (to encompass river basins) is needed to make water markets more viable and secure.

PRIVATE FINANCING

Private capital is viewed by many as the great opportunity to fill the water funding gap, but it could potentially offer more than dollars; private capital can also drive innovation. Federal dollars tend to be offered for low-risk projects that have been proven to work (i.e., little to no innovation), which means last-generation solutions are financed, but not the next generation solutions that are needed to solve this century's problems. The limitations to bringing private capital to the water sector are not finding the money. The money is there. The limitation is finding the right

deals that match the impact of a water project with the level of risk for a return on investment (ROI) that different types of private capital are willing to endure.

Fortunately, not all private capital is the same and financial returns are possible for water (see for reference Liquid Assets Highlight Box). On one end of the spectrum, philanthropic agencies tend to have a large desire to make an impact and are more willing to accept high risk. On the other end of the spectrum, private firms tend to have a lower risk and want to maximize ROI. There are deals to be made all along the spectrum. The problems are large and the solutions need to be large as well. Ways to scale solutions across regions and beyond localized one-off projects are needed. Once projects are proven and business lines are established, commercial capital needs to be drawn in to provide the dollars to invest in solutions that extend beyond local watersheds to river basins.

Culture is a large barrier to bringing private capital into the water sector. The fact that private capital often seeks a financial return is not a universally accepted motive. Deals between water and private capital need to incorporate economic, social and environmental values. However, the profit motive creates mistrust in the public towards water management solutions that involve a large footprint from private capital, such as P3s and IOUs. Education is needed to decouple the presumption that private capital means privately owned. Many P3s provide capital, essentially a more expensive loan, while leaving the utility or project in the hands of the public sector. There also needs to be education around water rights and payment for delivery services. It needs to be clear that payment is for the delivery of safe, reliable water and not for the right to use that water.

STEPPING INTO THE FUTURE

In the U.S., we are locked into a broader conversation on governance, whether government is necessary, and what its role should be. This conversation has grown with the retreat of the federal government and the implicit assumption that capital will flow into the open space and provide a solution. However, for that to work, government needs to define the contours along which private investment can flow into traditionally public domains. On the financing side, investment is locked into a similar problem as governance, with an old model continuing that has unrealistic expectations of investing in safe, high credit and high return deals. With the exception of old, heavily subsidized infrastructure and large cities with good ratings, that expectation is unrealistic in the current water infrastructure context.

There is enormous opportunity here to shape the future of water resources if governance and financing can move towards one another. Businesses always have a mission statement and it is imperative we define a vision for water resources in

LIQUID ASSETS REPORT FOR THE COLORADO RIVER BASIN

Water in the Colorado River Basin is governed by a series of complex laws and compacts that came into play during one of the wettest periods in the history of the basin. Government funded infrastructure was developed to deliver water based on these laws. Now, the basin is over-allocated and water demand is outstripping water supply. Climate change is likely to exacerbate the imbalance between supply and demand. There is a significant need for change in the institutions and management of water in the basin. There is a critical role for private capital in helping to meet these needs. Encourage Capital and Squire Patton Boggs were funded by the Walton Family Foundation to assess the potential for impact investment in the basin and develop viable business lines to match investors with water projects. They developed nine blueprints outlining the potential environmental impact and financial risk of investment:

								Environmental Impacts					
		Financial Return	Market Size	Liquidity	Deal Execution Risk	Public/Charitable Funding Interest	Policy Change Required	Watershed Health	Instream Flow	Groundwater Levels	Water Quality	Reduced Risk / Enviro Pressure	
		LOW	MEDIUM	LOW	MEDIUM	HIGH	LOW	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH
Watershed Enhancement	Forest Health Environmental Impact Bond	MEDIUM	HIGH	LOW	MEDIUM	HIGH	MEDIUM	HIGH	MEDIUM	HIGH	HIGH	HIGH	HIGH
	Riparian Restoration Environmental Impact Bond	MEDIUM	MEDIUM	LOW	HIGH	HIGH	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM
Agricultural Water Use	Sustainable Ranching	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	LOW	HIGH	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM
	Crop Conversion and Infrastructure Upgrades	HIGH	HIGH	HIGH	MEDIUM	MEDIUM	LOW	LOW	MEDIUM	LOW	LOW	MEDIUM	MEDIUM
	Commodity-Indexed Dry-Year Option	MEDIUM	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	LOW	MEDIUM	LOW	LOW	LOW	HIGH
Muni Water Infrastructure	System Loss Pay for Performance	MEDIUM	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	LOW	MEDIUM	LOW	LOW	MEDIUM	MEDIUM
	Green Bond with Sustainability Conditions	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH	LOW	MEDIUM	MEDIUM	HIGH	HIGH	MEDIUM	MEDIUM
Market Development	Next Generation Water Trust	MEDIUM	MEDIUM	LOW	MEDIUM	HIGH	MEDIUM	MEDIUM	LOW	LOW	MEDIUM	MEDIUM	MEDIUM
	Water Storage Trading	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH	LOW	LOW	MEDIUM	LOW	LOW	LOW	MEDIUM

the United States and build towards that vision, rather than rebuilding a system that no longer works. These are hard conversations, but they are conversations we must have. Who sets the vision for water resources –government and public policy or private entities that are financing water projects? What will the next generation of infrastructure and financing look like? How do we integrate the legacy of old infrastructure that is centralized if we choose to move towards decentralization? Will distributed systems meet the same fate of not having access to capital as small utilities and farms that are facing equity problems with not being large enough to cover their costs? Do we want to build efficiently or with an eye towards resiliency by building redundancy into the system? What is good water governance and who is responsible for setting the vision are questions that we must start asking and answering to move forward.

EXPANDING THE VIEW OF INFRASTRUCTURE

Infrastructure is more than pipes and pumps. It includes people, processes and policies along with green infrastructure which needs to be expanded and incorporated into water management. Current conditions of aging infrastructure, environmental needs, and climate change require a radically different paradigm of governance and financing for infrastructure.

PEOPLE

Leadership is one of the prime movers for innovative finance projects in the water space. Water utilities and infrastructure related projects tend to be led and organized by engineers. Engineers know water infrastructure, but they are not typically familiar with new, innovative financing mechanisms to pay for infrastructure and so they default to the old federal funding system.

That system is no longer in place, but the federal government has not done a good job communicating their intentions and what they will or will not fund in the future. It is important for the federal government to clearly define their role in funding water infrastructure. Necessity is the mother of invention, and as long as the hope for federal appropriations exists, then necessity and the drive for innovation are taken away. Rather than serve as a funder, the federal government has been moving into a relatively new role as a convener and identifier of innovative finance options through its establishing of three new centers to increase infrastructure investment through private sector collaboration:

1. **The U.S. Department of Agriculture's (USDA) Rural Infrastructure Opportunity Fund** aims to stimulate rural businesses and infrastructure projects. It has channeled nearly \$161 million in private capital to more than 20 water projects.
2. **The Environmental Protection Agency's (EPA) Water Infrastructure and Resiliency Finance Center** provides guidance on financing drinking water, wastewater, and water infrastructure. They also provide guidance on federal funding programs, procurement and partnership strategies, and decision-making support through regional finance forums, best-practice compendiums, peer-to-peer learning programs and P3 enhancement efforts.

- 3. The Department of Interior's (DOI) Natural Resources Infrastructure Center** facilitates private-sector investment in water exchange or transfer conservation projects in the western United States. This is done by developing new market-based financing approaches, such as mitigation banking initiatives, to increase investment in water infrastructure. They also support private investment and markets for species, habitat, and other natural resources in partnership with federal agencies.

Local and state water resource management agencies have similarly been identifying new roles to play. D.C. Water brought on a non-engineer to run the utility, resulting in a focus on communication and educational outreach around the value of water that has been instrumental in gaining public buy-in. They also hired a non-chartered financial analyst (CFA) to be the chief financial officer, who was able to develop innovative deals to finance large infrastructure projects (*see for reference D.C. Water Highlight Box*). Cities facing the loss of economic growth without input from private investors, such as Wichita, Kansas, can be benefited by local private interest, energized council members and a city manager to champion a P3 type agreement (*see for reference Progressive P3 Highlight Box*). The Colorado Water Conservation Board just finished their first strategic plan for the Colorado River Basin, due to a governor who saw that the bottom line for Colorado was water and used to having those hard conversations that previous governors avoided.

D.C. WATER

D.C. Water is a large urban utility needing to make large capital expenditures on stormwater infrastructure to meet federal environmental regulations. The D.C. Water system was constructed and financed by the federal government in the late 1800's. The design was a combined wastewater and stormwater system. When the federal government changed the environmental rules around stormwater with the passing of the Clean Water Act in 1972, it made their system out of compliance. The cost of compliance now sits on the backs of D.C. Water rate payers without any federal support. Their solution is to build a large tunnel with a life expectancy of 100 years at the cost of \$2.6 billion. Grey infrastructure was chosen because it has a known cost and a 100% guarantee to be effective in meeting regulations. Green infrastructure was explored but its success at meeting environmental regulations is unknown. Why would you take the risk of an unproven technology with unknown costs to address a federally mandated program where there are penalties if regulations are missed? Currently there are no incentives for a utility to take those risks.

Traditional financial models were going to finance the project as a 30 year debt while the asset was 100 years. D.C. Water became the first utility to issue a century bond. The century bond makes sense because it matches asset liability, provides inter-generational equity by spreading the cost over generations, diversifies the capital stack and current interest rates are low. The bond was targeted with pension fund and life insurance companies because they are looking for elongated assets. D.C. Water is looking at the potential for green bonds to generate incremental demand for debt, increase their portfolio and generate additional funds. Currently D.C. Water is negotiating for a 15 to 20 year loan to install green infrastructure with payments back to the investors linked on quantifiable performance metrics for reducing stormwater runoff. The greatest obstacle is on how to create collaborations and deals between public utilities and investors that create win-win scenarios. Often this requires having the right people in the right places. In D.C. these creative solutions came to bare because a non-engineer was the manager and a non-CFA was the CFO.

POLICIES & PROCESSES

Private capital is as good and useful to meet all of our objectives as the long-term cash structure put in place. Policies and processes go hand-in-hand to enable private capital to enter the market for public infrastructure at scale. New financing mechanisms inherently have a lot of transactional costs around structuring deals that have a measurable impact while providing a return on investment. These high transactional costs create natural barriers to smaller projects being funded. New governance structures are needed to aggregate systems and provide the rate base for large scale, private finance to become viable.

All of this is a general movement toward regionalization, which would be a significant step in addressing many of the financing challenges of small water systems. The new governance structures associated with regionalization might be to utilize a watershed approach, but there are not many governance bodies at the watershed scale. Legislation changes would be needed to enable a watershed approach to financing. An innovative approach has been the development of enhanced infrastructure financing districts (EIFD) in California (Enhanced Infrastructure Financing Districts). EIFD's are flexible and are formed at the scale of benefit for an infrastructure project to better match the costs and benefits of the underlying infrastructure. EIFD's had specific legislation put in place because they wanted publicity, debate, dialogue and buy-in to develop awareness and processes that would support their success.

ENHANCED INFRASTRUCTURE FINANCING DISTRICTS

The Santa Ana River Watershed is establishing new governance around the concept of “One Water One Watershed,” which is an innovative and integrative regional water management plan developed through collaborative partnerships. This unified governance structure is looking to break traditional silos of water quantity and quality and to manage water to maximize its benefit to society, the economy, and the environment. A unified financing strategy (to match the unified governance approach) was established in California in 2015 with the passing of legislation that put into place Enhanced Infrastructure Financing Districts (EIFD’s).

EIFD’s can be created within a city or county and used to finance the construction or rehabilitation of a wide variety of public infrastructure and private facilities, including water infrastructure. The size of the EIFD matches the scale of the problem and creates a revenue base equivalent to the infrastructure needs. The return is based on the assumption that property values will continue to rise, which is linked to the continued large scale economic activity occurring in the area.

It’s the chicken and the egg scenario. Economic activity grows where water resources are available, but water resources can only benefit where revenue streams are already available. The old paradigm did not have the money, authority or expertise to meet growing water-related problems. Renovation of governance and finance structures are needed to holistically manage water resources.

The path towards regionalization is an uphill battle. The hurdles are largely cultural, because in the process of regionalization, each individual entity has to relinquish some ownership and control over water infrastructure. Those incentives are not yet established, and will not form until those utilities and populations are no longer subsidized by government. Stepping aside from ethics, from a financial perspective, one of the best ways to address equity and inject funding into smaller, rural systems is by spreading the costs, which requires a wider customer base.

The USDA has taken a leading role in helping to finance rural and agricultural projects, as well as incentivizing investors to engage in rural water lending. The USDA is limited in its ability to finance systems with fewer than 10,000 people, leaving medium sized utilities without a reliable funding stream. For this reason, the USDA is considering how to transfer technologies and innovative solutions developed in larger utilities to smaller utilities. One approach the USDA is taking in this regard is fostering the formation of P3’s between rural communities and investors, and standing as a guarantor to de-risk these deals for private investors to make those opportunities more attractive.

As more infrastructure financing deals and business lines are successfully established, transactional costs can be expected to decrease. The outstanding question is what entity will come in to finance these deals. Can deals made for large, urban systems with resources be transferred to smaller, rural communities? For those deals to be successful, due diligence and a progressive procurement approach must be used when structuring a deal to take into account the full risk and potential return of investments (*see for reference Progressive P3 Highlight Box*). Managing that risk upfront should be part of any due diligence and should incorporate costs, transactions, avoided risks and costs, and savings from the project.

PROGRESSIVE P3 PARTNERSHIP: WICHITA CITY, OREGON

Wichita City, OR has been in the process of forming a progressive P3 partnership that combines conventional and alternative financing. The city's water and wastewater treatment plants were constructed 65 years ago and are in need of \$1.6 billion to repair and upgrade the system. The proposal allowed bids from companies interested in loaning money and expertise. The city will maintain ownership over the water and infrastructure, but will provide annual payments to the selected company. The goal is to see if efficiencies can be gained in the system and to provide flexibility the utility would not have had if they issued revenue bonds instead.

The first phase lasts one year as companies evaluate Wichita's infrastructure and create a plan for repair. The proposal will assess existing operation and maintenance practice, the cost to repair, and the projected benefits that could accrue with changes in the current system. The proposal is taken to the City Council for approval. Once approved, the second phase includes a 10-year implementation agreement to put the plan in place. The cost to the city will be unknown until the company prioritizes repairs and if it is not advantageous to the city, the city is not obligated to continue the 10-year implementation phase. "We still needed to do a full assessment of the system regardless, and it kind of gives us an opportunity to look at our expertise and techniques and compare to what they're willing to offer from the private sector. I can't see any downside to at least taking it to that next level." (Mayor Jeff Longwell)

The progressive approach of procurement enables intensive due diligence and a life cycle assessment on the utility and to lay the risks side by side with the finances to see what savings could be made. It enables a deal to be structured that takes into account the full cost of the project, including monitoring and data analysis to accurately assess impacts and cost savings to the system.

The current financial situation creates an opportune environment for these types of deals. For the past 35 years, interest rates have decreased. Water infrastructure differs from long-term bonds by having significant up-front expenses but benefiting from rate payer revenues over the lifetime of the asset.

Unfortunately, lack of forward-leaning governance has led to a paralysis in decision-making. Will the water community cease its dithering in this opportune setting and adopt innovative financing structures? Can we learn from crises like Flint to catapult toward positive change? In California, drought spurred the creation of EIFD's, and the Colorado River drought led to the Interior spearheading an innovative Pilot System Conservation Program aimed at funding water-efficiency projects capable for reducing demands on the Colorado River. The water saved from these efforts will remain in the Colorado River system to increasing water levels at Lake Mead and Lake Powell. These actions are only the tip of the iceberg of needed change, and should be heralded as the beginning of new water management approaches. Yet in all of them, crisis was needed to instigate innovation. What is needed is a more visionary, crisis-free approaching to leading change.

IS THERE A MARKET FOR WATER?

The potential for market opportunities in water are increasing around four trading mechanisms: trading for 1) water rights, 2) water quality, 3) ecosystem services and 4) stormwater. The appropriation doctrine, which sets rules on how much water is allocated to a user, allows water rights markets and transfers to occur in the western United States. Each state manages water differently and each state has developed its own water markets that allow water to be transferred through voluntary agreements, resulting in a temporary or permanent change in the type, time, place, or right of water. Differences in state markets have made inter-state trades challenging.

Water quality trading came into existence with regulatory support following EPA's 2003 National Water Quality Trading Policy. Water quality markets have received attention in the eastern United States as a means to reduce the costs of achieving nutrient control to meet regulations set by EPA through the National Pollutant Discharge Elimination System (NPDES) which permits the maximum allowable amount of a pollutant that can be discharged at a point. If a given water body fails to meet water quality standards, an additional regulation of total maximum daily loads (TMDLs) is developed to set the maximum amount of a pollutant that can be discharged into a water body and still meet water quality standards.

Pollutants discharged into water bodies that fall under TMDLs can be derived from point sources (PSs), such as wastewater treatment plants, or from nonpoint sources (NPSs), such as agricultural and urban/stormwater runoff. One approach to PS-PS trading is a group compliance permit: within a watershed, PSs subject to NPDES permitting requirements are grouped and assigned individual source limits, the sum of which defines a cap for the NPDES permit holders. Individual NPDES limits are waived as long as the overall sum of discharges from the compliance group stays below the cap. Group participants are able to trade pollutant allowances with others in the group, thus creating market-like conditions.

A key constraint on water quality is that nonpoint sources, with the exception of large municipal stormwater systems, have been able to avoid regulation. That is, the federal government cannot require the reduction of nonpoint source pollution, although some states have independent statutory authority to regulate nonpoint sources. Even for those states that do have mandatory regulatory measures for nonpoint sources,

the discharge limits are not numeric. Instead, states require implementation of best management practices, which are considerably more challenging to enforce than end-of-pipe limits for PSs.

These differences in regulatory opportunities create the potential conditions for PS-NPS trading. PS management practices, such as retrofits to stormwater systems, typically cost more than NPS management practices, such as fencing to exclude livestock or riparian vegetative buffer strips along waterways. This cost difference creates an ideal format and economic incentives for trading. Farmers and landowners can implement relatively low-cost nutrient reduction strategies, such as stream buffers, creating the water quality benefits and credits, which can then be purchased by the PSs. One notable example of this approach is The Freshwater Trust's approach to managing stream temperature in Oregon: thermal loading from industrial water outfalls (i.e., a temperature point source) is offset by riparian tree-planting, which creates shade, thus reducing "nonpoint-source" thermal inputs.

Although the number of water quality trading schemes has increased substantially over the last two decades, nearly all active PS-PS trading programs have been characterized by low trading volumes and voluntary over-compliance. In a comprehensive summary of more than 70 proposed or active water quality trading programs in the United States, the National Center for Environmental Economics found that of 19 active trading programs, only 4 had experienced more than 3 trades.

There is, however, substantial interest in the PS-NPS markets, particularly markets targeting the Chesapeake Bay. The Chesapeake trading program will inevitably face challenges that have confronted all other water quality trading programs, most notably how to measure the actual benefits of trades. In all water quality trading programs, surrogate metrics are used to inventory trades. For instance, linear feet of planted trees are converted to pounds of removed nitrogen or avoided thermal loading. The veracity of these conversions underlies the programs' long-term potential to meet ecological goals.

Ecosystem service markets have predominantly taken the form of mitigation banking, which is the preservation, enhancement, restoration or creation of a wetland, stream or habitat conservation area which offsets the expected adverse impacts to similar nearby ecosystems due to development. The federal government created a market for mitigation banking under section 404 of the Clean Water Act, which regulates impacts to streams and wetlands. When a developer impacts a stream or wetland, they can purchase credits created by entrepreneurial mitigation bankers. This program has created a burgeoning of ecosystem investors, in which large private firms have provided the capital for mitigation bankers to restore streams and wetlands around the U.S., thus providing the necessary credits to permit development. There is hope that these markets will provide a foundation for other types of markets, including water quality trading markets and stormwater markets.

Stormwater markets are relatively new and often referred to as green infrastructure. Conventional stormwater infrastructure that pipes runoff directly to water treatment system is termed “gray infrastructure”. Green infrastructure is an attempt to mimic the natural water cycle by planting trees and restoring wetlands to slow down runoff and clean water prior to entering a stream. Philadelphia established a Green City, Clean Waters plan to transform approximately 1/3 of the impervious area into greened acres on which the first inch of rainfall from any given storm can be managed onsite. The Pennsylvania Water Department (PWD) offers a subsidy to private owners who invest in green infrastructure and the PWD is able to avoid the costs of expanding their current gray infrastructure. We are beginning to see significant private capital flowing into the green infrastructure of cities, which is then being used to comply with regulations under such stormwater markets.

MARKETS ARE A TOOL

Markets are often a useful tool for valuing and allocating resources, but they may not always be the right financing tool; regulations will continue to be a necessary stick, while markets are sought to be a carrot. There is growing excitement in the water community around the potential of water markets, whether in the form of water quantity (i.e. water rights), water quality, or ecosystem services, however they have not always been met with successes at the scales needed.

WHAT DO MARKETS NEED?

To create a water market, several foundational items must be established: the goal of the market; quantifiable metrics; transparency; and regulations that recalibrate the market to meet societal values (*see for reference Australia Highlight Box*). Market goals will vary between markets and over time, but in general, the Western U.S. markets are centered on reallocating water supply, while Eastern U.S. markets tend to be established for water quality trading with the goal of nutrient reduction, or ecosystem services such as wetlands. Regardless of the vision, each market needs metrics to be established to determine the success of a trade and the value of the overall market. The types of transactions that can take place under current conditions must be considered, and the value of those transactions to grow the market clearly demonstrated. Building a business case for water markets can help to clear the path for policy and legislative transformations to build markets that scale in the future.

Metrics are needed that are measurable, quantifiable, and transparent. In the case of water rights markets, this is relatively straightforward, as water diversion is transferred to another party, which can ensure that the water is used. However, in other types of markets, particularly water quality or ecosystems, metrics have proven quite difficult to establish for a market. Third party verification can be helpful in producing transparency by documenting outcomes and ensuring accountability between trades.

Establishing good data that are accessible is essential to lowering the transaction costs for trades.

While data can lower the overall transaction costs, data collection and analysis must be incorporated into the cost of a trade. Data can be used to provide clear communication and education between entities within the market, as well as to build a business case and buy-in around water markets by showing the return on investment. Currently, it is often difficult to demonstrate return on investment—both monetarily and environmentally—because data are either not being collected or are inaccessible to the public.

MODEL FOR MARKETS: AUSTRALIA

Markets are good at allocation problems. Australia is hailed as a model for establishing working water markets in a water scarce region. Prior to the decade long drought that hit Australia at the opening of the 21st century, they had been working on a vision to unbundle water rights and transition to a water-sharing system. The Australian government invested a significant amount of money to set up monitoring to assess how much water is in the country at any given time. Market shares are weighted based on the amount of water available for the year. They developed a centralized database that tracks water shares and transactions. The publically available data provides transparency and lowers transaction costs for trades to occur. Importantly, the Australian government bought water shares to ensure there is enough water in the streams for ecosystems. The market has all three components: it was built around a vision, established data and metrics, and provided regulation of the market with the governments buying up of shares for environmental protection and annual oversight and allocation of shares to different stakeholders based on water availability.

CHALLENGES TO WATER TRADING IN WESTERN MARKETS

Water markets in the U.S. have been largely ad-hoc and difficult. Aside from water being hard to transport, there are also legal doctrines and barriers, cultural barriers and educational barriers, to water transactions. Water is a resource that is local and heavily regulated, embedded within a legacy of historic water infrastructure and legal doctrines that discourage water transfers. Opportunities to move water across watersheds are dependent on pre-existing infrastructure, and often come with significant regulatory barriers. Water markets currently work well where substantial infrastructure and storage already exist, such as in Northern Colorado.

In those geographies, regulation—rather than infrastructure—is the barrier, as each transaction requires water court approval. Changes in legal doctrines are needed to lower transaction costs and provide incentives to trade water.

There are both legal and cultural barriers to water trading between agriculture and urban entities with water markets limiting water trades between different water uses. These barriers were set up to protect agriculture from getting bought out by urban communities; however, agriculture accounts for 70-80% of western water diversions, and there is only so much that urban conservation can achieve to reduce water use. It is often cheaper to conserve water in rural (i.e. agricultural) than urban environments and most of the focus of using markets for water conservation has been on leveraging this disparity in the cost per acre-foot between urban and agriculture. Yet, there is tremendous opportunity for agriculture if we tailor markets to pursue transactions that are designed to improve the sustainability and resilience of agricultural communities while conserving water. For example, markets could focus on transactions that lead to the conversion of existing farmland to less water intensive yet higher-value crops. Deals could also be structured to ensure that a critical mass of farmers convert, to ensure that adequate water supply is freed up for urban use in the basin while providing economic returns for farms.

There have also been innovative and successful water trading deals in recent years. For example, The Nature Conservancy's NatureVest project structured a deal around allowing an agricultural community to sell a portion of their water, with revenues reinvested into their farmland. Part of the trade involved establishing a long-term lease with the agricultural community for access to the water rights they sold. Structuring the deal to allow farmers to lease back water helped to alleviate the fear of losing access to water, and by extension livelihoods, in the future. These types of deals work when different interests are balanced, good relationships exist, trust is maintained and financial equity occurs.

FEDERAL AND STATE GOVERNMENTS HAVE AN IMPORTANT LEADERSHIP ROLE

The federal and state governments need to take a greater leadership role for water markets to become well-established and to scale. The federal government has a key role to facilitate trades between large stakeholders, particularly between states. State governments will also be key to facilitating and enabling trades, and to setting up institutions or water banks to facilitate water transfers. One of the most important roles for government, particularly the federal government, could be in the establishment of a centralized hub where the data are held and transparency could take place that would foster markets and lower transaction costs. Neither agriculture nor companies nor municipal utilities are eager to make their data accessible for fear

of losing potential economic opportunities, being hit with increasing regulations, or losing water that is not being used. Data transparency is critical to know what water rights are present, how much of that water right is being consumed, how much groundwater is being used or how much water is available in the system overall. Data and transparency cannot be a one-time snapshot, but must be continuously updated to provide real-time conditions. To establish a data hub for water markets would require a concerted effort of federal and state governments, along with market participants.

The federal government could also assist in setting standards and metrics for trading, particularly in ecosystem markets, which are already highly regulated by the federal government. Currently, the majority of these trades are through municipalities paying upstream land-owners to conserve land or use best management practices to improve the water quality and health of the stream. As of 2014, there were 100 active programs directly investing in ecosystem services for water via source water protection, stormwater trading and water quality trading programs.

One of the barriers in setting up these types of market mechanisms is that it is unclear the value of an ecosystem service. How many pounds of nitrogen are reduced by water quality trading? How do we define these outcome-based metrics? Once defined, the government or a 3rd party needs to regulate the transactions to ensure that financial paybacks match the environmental benefits. There needs to be regulation that ensures monitoring is budgeted into the transaction and returns on investment don't occur until benefits are measured. Standards and metrics (rather than one-off trades that monitor and set different standards for success) would streamline models for trades and lower transaction costs. Third party verification of these transactions can also help to build trust in markets.

Governance – perhaps through the federal government - and leadership are also needed to set the vision for a market. For example, what standards should be set in place for water quality and measuring outcomes? What is the optimal mix of gray and green infrastructure to maximize outcomes in terms of the benefits we want? How do we put that together with different financing options? Blueprints for structuring these deals are needed. Federal governance is especially needed for water quality, where the cost of pollution is moved downstream and away from the upstream users. The government needs to help the upstream and downstream users reach equilibrium, especially when the scale of the problem expands beyond a single state, such as the chronic problem of hypoxia in the Gulf of Mexico.

Markets are a tool that could be expanded in the U.S. Building successful markets at scale will require good governance and leadership, development of business cases, education and trust building, as well as investment in tools to transform data into meaningful metrics that are available to all stakeholders.

FROM PHILANTHROPIES TO CORPORATIONS

Sources of private and public capital vary on their financial risk tolerance and the focus on making impacts in the environment and society. Blending social and environmental returns with financial returns, broadly defined as “impact investing,” is considered a promising paradigm-shifting strategy to bridge funding gaps and attract private capital. Impact investing is defined by the Global Impact Investing Network as “investments made into companies, organizations, and funds with the intention to generate social and environmental impact alongside a financial return.” Finding projects that match the risk tolerance for different funding mechanisms can be challenging.

Philanthropic foundations are well-suited to impact investing as mission-oriented investors whose unique institutional role is to fund social or environmental change. Philanthropies have the capacity to provide significant startup capital to determine what types of innovative financing deals can create environmental impacts and returns on investment (*see for reference Philanthropy Highlight Box*). The goal is to bring in more private capital from traditional markets by investing in proof-of-concept projects that demonstrate viability, scalability and a return on investment to attract corporate financing. However, in 2015, the Center for Effective Philanthropy found that 41% of respondents reported impact investments and the majority do not intend to engage in impact investing in the future. The challenges were a shortage of projects that meet risk-return expectations, a wide range of risk-return expectations and a lack of standardized measurement impact. Indeed, one of the most critical limitations to impact investing generally is the lack of deal flow; there are simply too few projects to invest in.

PHILANTHROPY: THE WALTON FAMILY FOUNDATION

Philanthropy is at the intersection of private capital and the public –the taking of private capital and investing in public needs. The Walton Family Foundation invests in freshwater conservation and sustaining healthy and resilient communities for both nature and people. They are seeking a way to preserve the environment health of the rivers that benefit the communities and businesses dependent on them. Currently the Walton Family Foundation is convening stakeholders together in the Colorado River Basin to foster trust and build relationships. Their recent report “Liquid Assets” serves as educational outreach on different innovative financing strategies that were deemed viable options in the Colorado River Basin. As a philanthropic foundation, they are able to take risks and explore opportunities that aren’t possible for a more risk-adverse government or private capital. They are able to invest in riskier ventures and share the outcomes from both: look at the successes that can be replicated and scaled and learn from failures.

Traditional private capital focuses on a return on investment; however, companies are becoming more cognizant that their ability to make a profit is linked to the availability and quality of the water they rely on. While corporations traditionally invested in low-risk ventures, they are expanding to focus on impact, with the trade-off of not just maximizing profit. Private companies have access to a large amount of capital that can be brought into impact investing as philanthropy and NGO’s succeed in creating deals that are win-win.

Having philanthropies and NGO’s demonstrate how various deals work, in terms of both reaching desired environmental impact and a return on investment, is critical for securing future public funding. The government also has a role to play in protecting the public benefit and services that the environment provides, as well as through its services that can generate revenue streams. Government can provide leadership (*see for reference Cross Sectoral Highlight Box*) and develop a regulatory framework that drives markets and opportunities for impact investing. Government can also help solidify business lines by developing standardized metrics for success.

CROSS SECTORAL: COLORADO WATER CONSERVATION BOARD

The Colorado Water Conservation Board (CWCB) represents each major water basin in Colorado, Denver and state agencies in a joint effort to use water wisely and sustainably. They are involved with almost every water project in the state and have become a lender of choice. Colorado is the headwaters for other states leading to developed joint projects.

An interesting example is CWCB's Rio Grande project in partnership with NGO's and agriculture, environment and recreation stakeholders to assess the consumptive and non-consumptive needs of the basin stakeholders. The project's goal is to bring the Rio Grande into compliance with the Rio Grande Compact to the benefit of all stakeholders. The partners have established a cloud seeding program that produces 5-15% more precipitation from each storm system. Lower basin states have been paying into the program to help ensure more water will be delivered downstream.

Water data are critical to the ability of these projects to bring in new financing options with private capital. The private sector is often able to execute on projects more efficiently and faster than traditional financing through the public sector. Water data are plentiful but not always accessible, and are well behind where data in other fields like energy are today, in terms of usability. The first strategic water plan in Colorado established measurable goals that require data to determine success.

WHO DECIDES WHICH PROJECTS ARE FUNDED?

Who will become the arbiter of funding for water projects is a question of ongoing debate. As philanthropic and corporate capital enter the water investment space, the traditional role of the government in determining which water projects are funded based on protecting the environment and the public's interests is increasingly challenged. As private capital seeks projects with high returns and foundations look for projects that align with their own missions, to what extent can and should the responsibility for guiding water funding be transferred to the private sector?

Public-private partnerships will similarly raise challenges of compromising on multiple parties' missions, as philanthropies and NGO's may need to compromise their missions to ensure a return on investment that meets the needs of private individuals and companies with access to capital. Are win-win's good or does

everyone lose in these deals? Is this a conflict or a collaboration of objectives? Is it the responsibility of government to restore a watershed? Where are private-public partnerships appropriate, and not? These questions are important philosophical points for the water community to tackle.

It is important to distinguish where private-public partnerships are appropriate and where they are not appropriate. There is little value proposition for investors when a utility can go to the government for direct funding and sustain lower rates for users, thus undermining the real long-term need for private capital. These are risk areas for impact investment, and various types of financing must be evaluated for their suitability in addressing these risks. The sequencing of foundation dollars with government funding and impact investing capital will allow new levels of financing that can meet the scale of water-related problems.

LEADERSHIP & TRUST

Impact investing and public-private partnerships require both trust and relationships. Leadership and a dedicated staff that can facilitate innovative financing mechanisms are needed to build momentum and show repeated success stories that encourage more investors to enter the arena.

For example, the Colorado Water Conservation Board (CWCB) is a well-known and trusted entity within the Colorado River Basin that is involved with most water deals and has partnerships with stakeholders across state lines. The board sets goals and strategies for the basin and defines measurable metrics of success. They have been able to establish leadership and governance within the basin that has led to access to finance. In the same region as the CWCB, The Nature Conservancy's (TNC) NatureVest is successful and able to bring stakeholders to the table because of the relationships and trust built through TNC's previous and ongoing work with these stakeholders in Colorado. Oftentimes investors are seeking to have a positive environmental impact, yet there can be a level of mistrust because of the private sector's profit motive. Trusted, third party negotiators may initially be required to make public-private partnerships more attractive and to ensure goals are being met based on established metrics. Collaborations involving government groups and NGOs, like CWCB and TNC/NatureVest, are likely the critical bridging element needed to get impact investing off the ground.

Leadership is required to develop a strategic vision that moves beyond one-off projects to regional projects. Leadership is something that must be cultivated. One innovative program in California is working to cultivate leadership in the water sector through their program Water Education for Latino Leaders (WELL). WELL

strives to provide a forum for state and local Latino elected officials that provides baseline knowledge about California's water system to ensure effective participation in long-term water policy forums that will result in equitable and sustainable actions to ensure both an economy that works and an environment that is protected." This type of program is necessary in part because, as difficult as it is to finance water infrastructure, it is easier to find money to build pipes and pumps than to find money for building capacity and leadership.

INVESTING IN TECHNOLOGY

Water technology is where electricity and clean energy were about 7 years ago in terms of how to scale up the market. In energy, once market innovators began to creep into the regulatory system of investor-owned utilities, they recognized that technology was ahead of the policy and the market. However, investment in water-related technology is often limited in comparison to investments in energy because investors cannot see a market for water technology. Part of the reason is because water is so under-valued. Additionally, the water market is difficult because of fragmentation; to make a profit, technology would need to be adopted by a large number of independent water utilities with different needs and capacities to purchase technology. Uncertainty in a market being present creates a preventative feedback loop, because the limited market precludes substantial interest from broad venture capital in high-risk technologies for water. Yet, water technology has the potential to help solve the water problem, so how can we match financing mechanisms to the development of new water technologies?

BARRIERS TO FINANCING WATER TECHNOLOGY

Barriers to financing water technology include: lack of a viable market, fragmentation of the water market, water is under-valued, a culture of avoiding risk, and current regulations.

Fragmentation of the water market is linked to the reality that water is local and therefore utilities are local and solutions are local. Fragmentation of the water market means that innovation and new technologies are not readily scalable because there are so many utilities and entities that would have to agree to buy into a technology in order to create a viable market. Consolidation of utilities or agreements between 100 plus utilities to invest in a new technology could, however, start to create a market. This may be another benefit of utility regionalization. Indeed, this is one of the effects of private water companies, which operate several, or even many water utilities. Private companies often invest internally in their own technological solutions, which can then be used across the utilities that they manage.

Another reason for the lack of investment in water technology is that water is under-valued and too cheap. There is the broad perception that there is little to no profit

to be made because the underlying resource or commodity is fundamentally undervalued. If water were priced appropriately, which is likely much higher than it is now, then technological innovation would likely arise to use water more efficiently.

There needs to be regulatory innovation to help create a market for water technologies. Currently, a new water technology is only vetted and approved once it has performed well at several locations for several years; say, 3 locations for 3 years. Investing in technology then becomes a significant risk because venture capital is wary to spend money that takes 3 years to know if the venture will succeed. This is a significant amount of regulatory risk for venture capital to take on, particularly when other investment opportunities have substantially less regulatory risk. From the regulator's perspective, there is limited to no incentive to adoption of new, untested technology as there are resulting public health consequences to new technology failure. Bringing new technologies to market then faces an environment of intense scrutiny and high-risk ramifications of failure. It becomes increasingly easier to fund water technology the farther removed you are from treating drinking water. For example, investments in new water quality sensors and technology are growing rapidly because there is lower direct risk of failure.

For technology to be adopted, or for investors to look seriously at technological development, the reality of why technologies are purchased must be faced. Quite simply, people buy technologies or invest in the development of technologies because they (1) are required to do so via regulations or (2) it dramatically reduces the cost of doing business as usual. So long as regulations remain static, there is limited incentive for developing new technologies.

CREATING A MARKET FOR WATER TECHNOLOGY

Public outreach is essential to get buy-in and a voice pushing for change in the culture around water data and technology. People will invest in what they care about. The marketing around why water is important and valuable has been poorly framed. Climate change was messaged as creating warmer temperatures, which in the end was not effective at gaining attention or concern. Instead, more attention was paid to climate change when it was contextualized in terms of more extreme floods and droughts. That is, the effects of change are important for communicating the importance of the change, and thus the need for investment. The link between drought, water and economic development can be powerful to drive private investment in water technology and data.

How can we finance water technologies? Philanthropies are involved in directly funding technology development or indirect strategies to match financing to new technologies. Some foundations don't invest directly into the companies but will buy their products and push them into communities through NGOs and watch to

see how the technology performs. Another option may be to de-risk new technology ventures by characterizing risk and providing insurance on trying new technologies to protect against failure. Many utilities are already under-funded and under-staffed without the resources to readily incorporate innovation into the business model and projects have already been planned out for the next 10 years. Most utilities are not particularly flexible or well situated to take on risk from new technologies, but companies or private individuals may be able to assume more of that risk. It is most likely that large utilities, and private water companies, will be the first-adopters of water technology, and thus serve as a de-risking test bed.

Another option may be public funding through federally sponsored State Revolving Funds (SRF), which are capitalized with annual federal appropriations, state contributions and retained earnings. SRF's are authorized to provide financial assistance in the form of loans, the purchase of local debt obligations or guarantees for projects that meet eligibility requirements under the Clean Water and Safe Drinking Water Acts. Most states have accumulated strong and stable cash balances that could support alternative finance strategies without jeopardizing the use of program equity for meeting timely financial assistance obligations. Investments in predevelopment could be secured by dedicated revenues, to the extent available or anticipated project funding, including SRF financial assistance. SRFs could potentially allocate some portion of their cash reserves to higher risk investments without risking liquidity shortfalls. Importantly, SRFs may consider using this greater investment ability toward water technology. Investing in new water technologies that have the potential to reduce long-term infrastructure operating costs would be amenable to SRF mission. This type of innovative use of existing government finance authority is the type of approach that will be needed to break the logjam of water technology investment.

WATER RISK

The convergence of population growth, urbanization, and climate change is creating water-related risks, and investors are increasingly aware of these trends. A growing number of investors are filing shareholder resolutions asking for water-related disclosure from companies in a broad range of sectors. In addition to pressuring companies to improve disclosure, a number of prominent banks and institutional investors have begun not only to assess water-related risk in their portfolios, but also to directly engage high-risk companies on how they manage for water issues.

WATER-RELATED RISKS TO COMPANIES

Businesses rely on water to produce goods and services. By translating global water trends into a risk framework, businesses and investors can understand their own water challenges. Companies face three principal water-related risks, broadly speaking:

- **Physical risks.** Water scarcity directly affects business activities, raw material supply, intermediate supply chain, and product use. Declines or disruptions in water supply can undermine industrial and manufacturing operations, which need water for production, irrigation, material processing, cooling, and washing and cleaning.
- **Reputational risks.** Reputational risks increase as people become aware of their rights to access water and as they consider the ecological impacts of water withdrawal and discharge. Increasing competition for water among economic, social and environmental interests has a large potential for damaging the reputation and even growth prospects of companies.
- **Regulatory risks.** Physical and reputational pressures affecting water availability and wastewater discharge can result in increasingly stringent water policies. These changes will increase water prices and can lead to political and economic instability.

These three risks are often simultaneously present. For instance, water scarcity (physical) may lead to the revocation of water licenses (regulatory) or damage to

a firm's image and brand (reputational). These risks may affect different points along the value chain from suppliers to production facilities to product users. Most industry sectors, from mining and electronics to apparel manufacturing, have found the largest portion of their water footprint to be in the production of raw materials. Companies typically fail to assess water-related risks in this segment of their value chains because it is often far upstream from direct operations. Mitigating water-related business risks will require action by both investors and companies.

WATER RISK AND INVESTORS

Currently, water risk is not well captured by companies to meet the growing interest by investors who are wondering how their portfolio is impacted by water risk. Part of the problem is that most companies are not fully aware of their own water risk, particularly the further up on the supply chain you go from actual production.

Another piece of the challenge is that companies are often unable to convey water risk in a meaningful way to investors. And investors are starting to ask for this risk as they witness the Tennessee Valley Authority (TVA) shut down nuclear power plants because water temperatures were too warm, or beverage companies not being able to locate a facility because of public outcry and fear that they will take all the water, or mining companies not able to expand operations because of water shortages.

Water risk is clearly present, yet neither investors nor companies have developed ready ways to monitor or measure water risk in meaningful ways. There are a number of platforms that are looking at the exposure to risks from a geographic standpoint, but risk is a function of exposure, resilience, and vulnerability. We can access the exposure of a company to water supply and water reliability, but we don't know how resilient or vulnerable a company is to a water shortage. An underlying question is whether or not we are developing appropriate tools to manage water risk?

The resounding answer is “no.” It is possible to evaluate water sources, trends in demand within the basin, geopolitical issues, etc. but there is no clear path forward on how to take all of those variables and quantify risk. Private companies have to engage with due diligence before purchasing land for operations and this may require drilling wells and surveying upstream stakeholders to understand how they are managing their land and water resources. All of this work needs to be done because the data does not exist publically that automate or analyze the disparate elements of water risk. The mission critical data related to water for investors has not been identified for each sector and the public data that are available are often of poor quality and difficult to find. The bottom line is that the tools and data do not readily exist to evaluate water risk, making it an expensive and challenging activity for companies and investors.

Rating agencies are also struggling to quantify risk and develop meaningful metrics. The utilities with good data often have good ratings and data are missing for those utilities in the middle ground or failing. Fitch Ratings and Standard & Poor have released a number of special reports around water to help investors gain a broad view of trends that are likely to shape credit health. They have also changed some of their ratings based on environmental and climate risk factors that have led to some companies being downgraded. For example, one oil and gas company was downgraded because the majority of their operations were located in the Gulf of Mexico where the risk of hurricanes is increasing with climate change. Depending on the company size, water is often a small component of the overall rating and can be masked by the other components, such as asset adequacy, used to assess the health of a company.

In the energy sector, regulations with the Clean Air Act drove risk disclosure of businesses; however, the Clean Water Act has not had that sort of impact. A regulatory approach that doesn't create additional burden, but might trigger water risk disclosure may be warranted. A company's water risk disclosure is needed to be able to assess their vulnerability and resiliency to water risks. Many companies are assessing their exposure, vulnerability and resiliency to water risk, but they are not reporting that risk in a way that investors understand. Private companies have plenty of data, but investors are in a data poor environment.

CONCLUSION

The U.S. faces an unusual alignment of trends: aging infrastructure, climate change, and growing population increase the demand for investment in water; shifts in funding priorities decrease the funding for water coming from the federal government; and private sector finance has grown tremendously and has an appetite for water investment. The convergence of these trends creates enormous opportunities for alternative finance and novel investment models to meet growing water sector demand with private sector investment, or with alternative public sector funding models. However, there are a number of barriers that constrain this potential ranging from governance, to cultural, to the technological.

To date there has been interest around water investment, but a very small number of actual deals done. Each one of these have been ‘bespoke’ deals, with significant amounts of time and resources put into structuring the deal. While some of these have been large, such as DC Water’s stormwater investment, many have been small. Yet they are likely a precursor of what is to come, and those firms, governments, and groups that are developing the expertise in structuring these deals and connecting finance to opportunities will be well-positioned as the coming decades inevitably create rapidly increasing demand for such deals.

The greatest challenge to be confronted will be the effect of this shift in finance on smaller systems and those with constrained revenue opportunities. These are typically rural, or urban areas with declining populations and aging infrastructure, such as Flint, Michigan. The same is true of smaller irrigation systems, which face similar challenges. It is imperative that governments and NGOs keep these types of systems in mind when they use their ever-declining public funding, and allow private sector capital to flow to those systems which can generate revenue at the scale needed for private finance.

The development of finance and investment centers by the federal government are positive indications of the government coming to grips with the forthcoming reality. Likewise, the rapid growth in private investment firms focused solely on water and environment indicate a growing capacity around this critical challenge. But much more is needed, and more conversations are needed to move ideas to deal-

flow. Forums such as the Aspen-Nicholas Water Forum are an important piece of the process that provide space for diverse and visionary thinkers to collaborate and pave the way toward a transformed, world-class U.S. water system. Government at all levels, along with water utilities, irrigation districts, corporations, and major water users, must focus their attention and resources on appropriately funding and financing the nation's water.

APPENDIX I: FORUM AGENDA

THE ASPEN-NICHOLAS WATER FORUM

CONSERVATION FINANCE AND IMPACT INVESTING FOR U.S. WATER

May 18 – 21, 2016
The Aspen Meadows Resort
Aspen, Colorado

THURSDAY, MAY 19

Session One: Funding and Financing Water: Past, Present, Future

The sources of capital investment in water resources—from dams to advanced metering systems—have varied across time and place. While the federal government and states were a stable source of funding for water projects traditionally, their role has dramatically weakened over the past 30 years, while federal regulations have grown, leading to infrastructure that is aging and ecosystems that are degraded. This session will lay out the current landscape of water funding and finance, from cities looking at rural-urban water management to the potential of private sector investment.

Moderator: Martin Doyle, Nicholas Institute for Environmental Policy Solutions, Duke University

Discussants:

The State of Cities

Gary Breaux, Metropolitan Water District of Southern California

The State of States

Bill Northey, Iowa Department of Agriculture and Land Stewardship

The State of the Union

Ali Zaidi, Office of Management and Budget

The State of Investing

Margaret Bowman, Bowman Environmental Consulting

Session Two: Where's the Money for Infrastructure?

Cities and states are faced with enormous challenges in financing new demands for water infrastructure, from basic water delivery to stormwater treatment. Although large cities have developed financial tools to facilitate enormous expenditures, small and rural cities have limited ability to tap such private finance. The aftermath of the Flint, MI crisis shows the financial challenges of aging infrastructure, and the complexities of how to pay for rehabilitation. How have urban areas adapted to the changing need for capital in our cities? Which federal government programs might be best suited to link these utilities with private capital, and what do novel financial instruments like “green bonds” offer?

Moderator: David Monsma, The Aspen Institute

Discussants:

Financing Urban Water

Perspective from Asset Managers

Infrastructure Finance Districts

Financing Rural Water Infrastructure

Mark Kim, DC Water

Megan Matson, Table Rock Capital

Celeste Cantu, Santa Ana

Watershed Project Authority

Daniel Rourke, USDA

Session Three: Markets for Water Rights, Water Quality, and Ecosystem Services

This session will focus on how various water-related markets work in both the Western and Eastern U.S., the scale of trading that has occurred, and what types of opportunities exist in these markets. Participants will explore limitations, including what elements are missing for facilitating markets, and what markets may not be sufficiently tapped. Are current monitoring programs sufficient, and are ecosystems receiving sufficient allocations? Are there small adjustments that could help, or are more fundamental reforms necessary? How can concerns about the ag-urban intersection be addressed?

Moderator: Margaret Bowman, Bowman Environmental Consulting

Discussants:

Water Rights Trading

Urban-Rural Water Quality

Ecosystem Service Markets

Natural Infrastructure

Peter Culp, Squire Patton Boggs

William Stowe, Des Moines Water Works

Jan Cassin, Forest Trends

Todd Gartner, WRI

FRIDAY, MAY 20

Session Four: A Capital Conflux – New Roles for Philanthropy, NGOs and Corporations

This session will explore the changing role of non-traditional water financing institutions, as philanthropies increasingly play the role of investors and the private sector takes on a mixed mission of “Conscious Capitalism.” New projects are combining public and private capital with philanthropies to better spread risk, and NGOs and government agencies are shifting to verify environmental returns on investment. This session will explore recent examples, including barriers to the realization of such programs. How can distinct groups sustain their missions while facilitating the flow of private capital towards new types of projects? What might an ideal set of metrics be, and what overseeing body would verify such projects?

Moderator: Amy Pickle, Nicholas Institute for Environmental Policy Solutions, Duke University

Discussants:

NGOs as Investors

Corporate Investment

Impacts of Cross-Sector Partnerships

Philanthropic Investment Strategies

Taryn Goodman, NatureVest

Debora Fillis Ryba, Nestle Waters

James Eklund, Colorado Water Conservation Board

Ted Kowalski, Walton Family Foundation

Session Five: Impact Investing in Technology?

In comparison to technological changes that occur in energy, water technology is often slow to materialize. At the same time, the availability of funding for basic science and technology from the federal government has been stagnant or declining, although there is recent interest by federal agencies in re-investing in water technology. For the private sector, barriers to investing exist in water technology, and impact investors rarely focus on technology as a key element of water conservation, despite the transformative potential of technology. These trends raise significant questions about the availability of R&D funding for water technology, along with how limited funding and finance might be used most effectively. Should we think of water technology breakthroughs as the realm of a “moonshot” led by government, or like Silicon Valley led by the private sector?

Moderator: David Monsma, The Aspen Institute

Discussants:

Barriers to Water Tech Investing
Data/Information Sector
Private Sector R&D
Federal Investment in Innovation

Scott Mosely, The Water Council
Joya Banerjee, Bechtel Foundation
Matt Diserio, Water Asset Management
Jeffrey Lape, Office of Water, EPA

Session Six: Evaluating Water Risk & Investment Impact

Substantial water-risk is embedded in almost any commodity—from cotton to microchips—and more obviously in direct water investments like municipal bonds. A long-standing question is whether investors have the information and data to evaluate water-related risk. An emerging comparable question is whether Impact Investors are likewise able to measure environmental returns along with economic returns. Should funds focused on driving water conservation be expected to provide metrics of their impact? Are investors sufficiently interested to use this information to inform their investing decisions, whether to avoid risk or to drive impact?

Moderator: Martin Doyle, Nicholas Institute for Environmental Policy Solutions, Duke University

Discussants:

Water Risk and Return

Sharlene Leurig, Texas Environmental Flows Initiative

Assessing Risk and Return in Ag Rating Water Risk

Ryan Barr, E&J Gallo Winery

The Impact of Impact Investing

Trevor D'Olier-Lees, Standard & Poor's
Mary Kelly, Parula LLC.

SATURDAY, MAY 30

Opportunities on the Horizon & Key Takeaways

This final session will reflect on the forum discussions, and identify potential alternative futures for different sectors. What critical interventions could pivot water investing and finance in one direction or another? Looking forward strategically, participants will discuss how to further advance the application of increasing amounts of data to sustainable water management, as well as potential topics that the Water Forum can explore in the future.

Moderator: David Monsma, The Aspen Institute and **Martin Doyle**, Nicholas Institute for Environmental Policy Solutions, Duke University

APPENDIX II: FORUM PARTICIPANTS

- Jerad Bales**, Chief Scientist, Hydrology, US Geological Survey
- Joya Banerjee**, Senior Program Officer, Environment Program, S.D. Bechtel, Jr. Foundation, Stephen Bechtel Fund
- Ryan Barr**, Director, E&J Gallo Winery
- David Beckman**, President, Pisces Foundation
- Jason Blau**, Strategy Lead, Water Funder Initiative
- John Bohn**, Chairman, Water Asset Management, LLC
- Margaret Bowman**, Principal, Bowman Environmental Consulting, LLC
- Alan Boyce**, Executive Chairman, Materra Farming Company
- Gary Breaux**, Assistant General Manager and Chief Financial Officer, Metropolitan Water District of Southern California
- Celeste Cantú**, General Manager, Santa Ana Watershed Project Authority
- Jan Cassin**, Water Initiative Director, Forest Trends
- Peter Culp**, Partner, Squire Patton Boggs (US), LLP
- Jennifer Daw**, Technical Project Leader, National Renewable Energy Laboratory
- Michael Deane**, Executive Director, National Association of Water Companies
- Disque Deane, Jr.**, Co-Founder and Chief Investment Officer, Water Asset Management, LLC; President, Water Property Investor, LP
- Matthew Diserio**, President and Co-Founder, Water Asset Management, LLC
- Trevor D'Olier-Lees**, Senior Director, Standard & Poor's
- Martin Doyle**, Director, Water Policy Program, Nicholas Institute for Environmental Policy Solutions, Duke University
- James Eklund**, Director, Colorado Water Conservation Board
- Nivin Elgohary**, Senior Vice President, Electric Distribution, Water and Community Facilities, CoBank
- Kevin Fay**, Executive Director, The Alliance for Responsible Atmospheric Policy
- Derek Gardels**, Project Engineer, HDR
- Todd Gartner**, Senior Associate, Natural Infrastructure for Water, World Resources Institute

James Gebhardt, Director, Water Infrastructure and Resiliency Finance Center, US Environmental Protection Agency

Taryn Goodman, Director, Investment Partnerships, NatureVest/The Nature Conservancy

Jonathan Grant, Research Manager, WaterTAP

Stephen Harper, Global Director, Environment, Energy and Sustainability Policy, Intel Corporation

Crispin Hollings, Director, Financial Planning, San Francisco Public Utilities Commission

Mary Kelly, Principal, Parula, LLC

Mark Kim, Chief Financial Officer, DC Water

Katherine King, Project Manager, Redstone Strategy Group

Jeff Klein, Executive Director, Natural Resource Investment Center, Department of the Interior

Ted Kowalski, Senior Program Officer, Environment, Colorado River Initiative, Walton Family Foundation

Jeffrey Lape, Deputy Director, Science and Technology, US Environmental Protection Agency

Sharlene Leurig, Project Director, Texas Environmental Flows Initiative, Meadows Center for Water and the Environment

April Long, Stormwater Manager, City of Aspen

Megan Matson, Partner, Table Rock Capital

Matt McKenna, Advisor, Office of the Secretary, US Department of Agriculture

David Monsma, Executive Director, Energy and Environment Program, The Aspen Institute

April Montgomery, Program Director, Telluride Foundation

Scott Mosley, Director, Investment Strategies, The Water Council

Bill Northey, Secretary of Agriculture, Iowa Department of Agriculture and Land Stewardship

Amy Pickle, Director, State Policy Program, Nicholas Institute for Environmental Policy Solutions, Duke University

Felipe Pinto, Market Manager, Americas, Dow Water & Process Solutions

Jonathan Radtke, Water Sustainability Director, Coca-Cola North America

Sarah Richards, Water Program Officer, Cynthia and George Mitchell Foundation

Terese Richmond, Partner, Van Ness Feldman

Daniel Rourke, Senior Policy Advisor, US Department of Agriculture

Debora Fillis Ryba, Senior Sustainability Manager, Nestle Waters North America

John Sabo, Director, Future H2O; Senior Sustainability Scientist, Global Institute of Sustainability, Arizona State University

William Sarni, Director and Practice Leader, Enterprise Water Strategy, Deloitte Consulting, LLP

Jane Silfen, Vice President, Encourage Capital

Jeremy Sokulsky, Chief Executive Officer, Environmental Incentives

William Stowe, Chief Executive Officer and General Manager, Des Moines Water Works

Martha Symko-Davies, Laboratory Program Manager for Partnerships and Users, Energy Systems Integration, National Renewable Energy Laboratory

Jumana Vasi, Program Officer, Environment Program, C. S. Mott Foundation

Nancy White, Program Advisor, Water, TomKat Foundation

Roger Wolf, Director, Environmental Programs, Iowa Soybean Association

Karen Yacos, Director, Water Infrastructure, Ceres

Ali Zaidi, Associate Director, Natural Resources, Energy and Science, Office of Management and Budget, Executive Office of the President

FORUM STAFF

Nicole Alexiev, Deputy Director, Energy & Environment Program

Nicole Buckley, Assistant Director, Environment & Development, Energy and Environment Program

Avonique “Nikki” DeVignes, Senior Program Coordinator, Energy and Environment Program

Anna Giorgi, Program Coordinator, Energy and Environment Program

Lauren Patterson, Policy Associate, Water Policy Program, Nicholas Institute for Environmental Policy Solutions, Duke University

APPENDIX III: BIBLIOGRAPHY

- Ajami, N.K., B.H. Thomson Jr., and D.G. Victor. 2014. *The Path to Water Innovation*. Report by The Hamilton Project and Stanford Woods Institute for the Environment. 42 pp.
- American Society of Civil Engineers (ASCE). 2013. *2013 Report Card for America's Infrastructure*.
- Aspen-Nicholas Water Forum. 2015. *Data Intelligence for 21st Century Water Management*. A Report from the 2015 Aspen-Nicholas Water Forum. 50 pp.
- Barton, B., A. Berkley, D. Hampton, and W. Lynn. 2011. *The Ceres Aqua Gauge: A Framework for 21st Century Water Risk Management*. A Ceres Report. 60 pp.
- Bell, C. and Taylor, J. 2008. *Western Laws and Policies for a Sustainable Future: A Western States Perspective*. Western States Water Council, 67.
- Bovino, B.A. 2012. *Every Drop Counts: Is Water the Most Valuable Liquid Asset?* *CreditWeek: The Global Authority on Credit Quality*. Standard & Poor's Rating Services: 13-15.
- Branosky, E., C. Jones, and M. Selman. 2011. *Comparison Tables of State Nutrient Trading Programs in the Chesapeake Bay Watershed*. World Resources Institute: 15 pp.
- Breckinridge Capital Advisors. 2014. *Findings from Conversations with Water Systems: How Serious is the Drought Risk in the Arid Southwestern United States?* 14 pp.
- Brown, C. 2013. *Water Transfer in the West*. *The Water Report* 107.
- California Council on Science and Technology. 2014. *Achieving a Sustainable California Water Future Through Innovations in Science and Technology*.
- Center for Effective Philanthropy. 2015. *Investing and Social Impact: Practices of Private Foundations*.
- Cimons, M. 2014. *NSF Innovation Corps awardees founded the company Mammoth Trading to provide a neutral, centralized resource*.
- Culp, P.W., R. Glennon, and G. Libecap. 2014. *Shopping for Water: How the Market Can Mitigate Water Shortages in the American West*. Report by The Hamilton Project and Stanford Woods Institute for the Environment. 38 pp.
- EKO Asset Management Partners and The Nature Conservancy. 2014. *Investing in Conservation: A Landscape Assessment of an Emerging Market*.
- EPA. 2010. *Chesapeake Bay TMDL Executive Summary*. 14 pp.
- Garrick, D.E. 2015. *Water Allocation in Rivers Under Pressure*. Cheltenham, UK: Edward Elgar Publishing, Inc.

- Hughes, J.A. and S. Leurig. 2013. Assessing Water System Revenue Risk: Consideration for Market Analysts. Ceres Report with the University of North Carolina's Environmental Finance Center. 23 pp.
- Hughes, J.A., M. Tiger, S. Eskaf, S.I. Berahzer, S. Royster, C. Boyle, D. Batten, P. Brandt, and C. Noyes. 2014. Defining a Resilient Business Model for Water Utilities. Report for the Water Research Foundation and EPA. 229 pp.
- JPMorgan. 2008. Watching Water: A guide to evaluating corporate risks in a thirsty world. *Global Equity Research*. 58 pp.
- Kuwayama, Y. 2014. Groundwater Markets: Managing a Critical, Hidden Resource. *Resources for the Future* 186: 20-24
- Lazarova, I. 2016. The Wild West of Green Bonds. *Clean Energy Finance Forum*, Yale Center for Business and the Environment.
- Leurig, S. 2012. Water Ripples: Expanding Risks for U.S. Water Providers. A Ceres Report. 17 pp.
- Leurig, S. 2013. Disclosure Framework for Water & Sewer Enterprises. A Ceres Report. 15 pp.
- Morrison, J., M. Morikawa, M. Murphey, and P. Schulte. 2009. Water Scarcity & Climate Change: Growing Risks for Business and Investors. Ceres Report commissioned from the Pacific Institute. 50 pp. Retrieved from: <http://www.ceres.org/resources/reports/water-scarcity-climate-change-risks-for-investors-2009>
- National Center for Environmental Economics (NCEE). (2005). Water Quality Trading in the United States. NCEE Working Paper #05-07.
- National Resource Council (NRC). 2008. Urban Stormwater Management in the United States. A Report of the National Research Council. 513 pp.
- National Water Commission (NWC). 1973. Water Policies for the Future: Final Report to the President and to the Congress of the United States by the National Water Commission. Washington, DC: National Water Commission.
- Owen, D.L. 2015. Water Investment: balancing risks and opportunities. *Global Water Intelligence* 16 (10): 7.
- Reig, P., T. Shiao, and F. Gassert 2013. Aqueduct Water Risk Framework. World Resources Institute Working Paper: 15 pp.
- Smith, J.E. 2016. Urbanization, Financial Backlog Hurt Flood Control. *Emergency Management*
- USDA. 2016. Water Quality Trading Programs. Chesapeake Bay.
- Votteler, T.H. 2002. Raiders of the Lost Aquifer ? Or, the Beginning of the End to Fifty Years of Conflict Over the Texas Edwards Aquifer. *Tulane Environmental Law Journal*. 15: 257-335.
- Van Houtven, G., R. Loomis, J. Baker, R. Beach, and S. Casey. 2012. Nutrient Credit Trading for the Chesapeake, An Economic Study. Report Prepared by RTI International for the Chesapeake Bay Commission. 56 pp.
- Western Waters Governors' Association (WWGA). 2012. Water Transfers in the West: Projects, Trends, and Leading Practices in Voluntary Water Trading. Denver, CO. 146 pp.

Western States Water Council (WSWC). 2011. Resolution of the Western Water Council Regarding Preemption of State Law in Federal Legislation. Position No. 331.

Willamette Partnership. 2015. Building a Water Quality Trading Program: Options and Considerations. Report by Willamette Partnership and Water Resources Institute. 207 pp.

Young, M. 2015. Unbundling Water Rights: A Blueprint for Development of Robust Water Allocation Systems in the Western United States. NI R 15-01. Durham, NC: Duke University. 50 pp.

APPENDIX IV: ACRONYMS

ASCE	American Society of Civil Engineers
CAPEX	Capital Expenditure
CFA	Chartered Financial Analyst
CSOs	Combined Sewage Overflows
CWCB	Colorado Water Conservation Board
CWSRF	Clean Water State Revolving Fund
DOI	Department of Interior
DWSRF	Drinking Water State Revolving Fund
EIFD	Enhanced Infrastructure Financing Districts
EPA	Environmental Protection Agency
IOUs	Investor-Owned Utilities
NGOs	Non-governmental Organizations
NPs	Nonpoint Sources
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
P3s	Public-Private Partnerships
PSs	Point Sources
PWD	Pennsylvania Water Department
R&D	Research and Development
ROI	Return on Investment
SRF	State Revolving Funds
TMDLs	Total Maximum Daily Totals
TNC	The Nature Conservancy
TVA	Tennessee Valley Authority
USDA	U.S. Department of Agriculture
WELL	Water Education for Latino Leaders

