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RESTORING A WORLD CLASS AQUIFER

A BRIEF HISTORY BEHIND MANAGED RECHARGE & CONJUNCTIVE MANAGEMENT FOR IDAHO'S EASTERN SNAKE PLAIN AQUIFER

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&
Wesley Hipke (Idaho Department of Water Resources)

Introduction

THE EASTERN SNAKE RIVER PLAIN AQUIFER

The Eastern Snake Plain Aquifer (ESPA) underlies the Eastern Snake Plain in the southeastern portion of Idaho and is one of the world's largest and most productive aquifers. The ESPA covers 10,800 square miles of semi-arid plains surrounded by mountains. A key feature of the area is the Snake River, entering from the ESPA's eastern boundary northeast of Idaho Falls, Idaho, and carving its way along the southern boundary of the aquifer (*see* Map, page 2). The aquifer and river have been critical to the economic development of the area and the transformation of the Eastern Snake Plain from semi-arid plains into the breadbasket of Idaho.

Some key statistics demonstrate the importance of water in this area:

- Approximately 2.1 million acres are irrigated across the ESPA (60% of the State's total irrigated acres)
- 50% of Idaho's power needs (IWRB, 2009) are in the area
- Over 70% of trout production in North America (NASS, 2018) occurs in the area
- Fourth largest milk producer in the United States (United Dairymen of Idaho, 2017) is located there
- The Magic Valley, was ranked as a top 12 US manufacturing community and ranked in the top third of the US for food processing (Industry Week Magazine, 2015).

In 2012, the area covered by the ESPA accounted for 33% of all goods and services produced in Idaho, some $14.9 billion dollars annually (*see* Division of Financial Management, 2012). Through a combination of farming, agriculture related business, food processing, dairies, aqua-culture facilities and other industries this area accounts for 21% of the **g**ross **d**omestic **p**roduct (GDP) of Idaho (IDEQ, 2005). The Snake River Basin also provides the water supply for 76% of Idaho's population (IWRB, 2012).

The ESPA and the Snake River are intricately linked. The majority of surface water in the area originates as snowfall from high elevation mountains surrounding the Eastern Snake Plain. Historically, the streams surrounding the Eastern Snake Plain and some areas of the Snake River naturally added water to the ESPA. The aquifer then returns a significant amount of water back to the Snake River through spring discharge. As the area was developed in the early 20th century, the aquifer was augmented with seepage from unlined canals and irrigated farm fields via incidental recharge. This resulted in an increase in aquifer water levels and spring flows to the Snake River (*see* Figure 2, page 3).

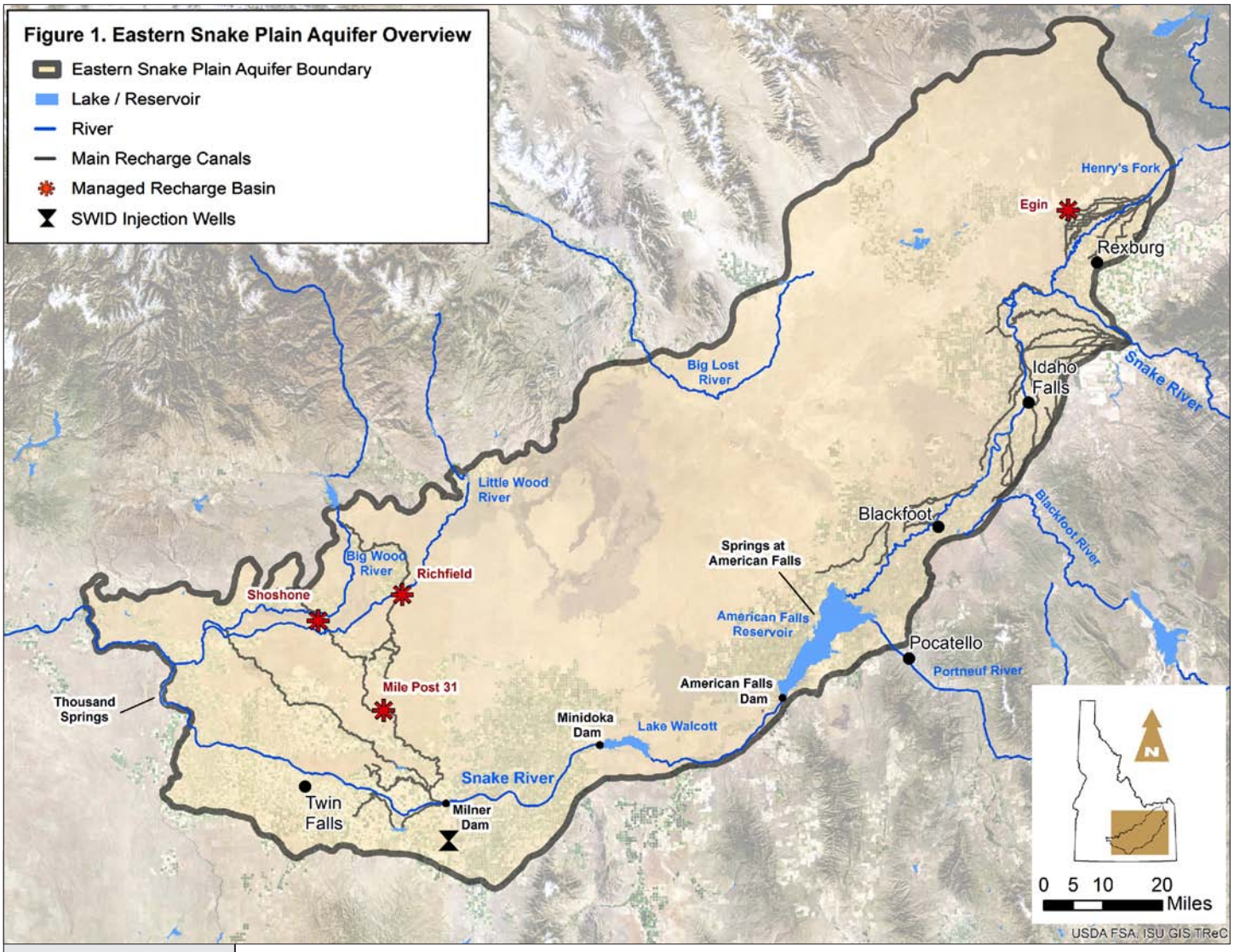

Figure 1. Overview map of the ESPA including recharge canals and basins. The map also illustrates the primary locations of returns flows from the ESPA to the Snake River at the Thousand Springs and American Falls Reservoir. Water Rights from the Snake River and ESPA are administered conjunctively. [*See* Rassier, ***TWR*** #10; Fereday, ***TWR*** #40]

Aquifer conditions started to change in the early to mid-1950's from increased demand on the aquifer as well as changes in irrigation practices that reduced recharge to the aquifer. The use of groundwater increased as a result of new pumping technology and economical energy prices. The early 1950's saw the development of turbine pumps making it feasible for many farmers previously using surface water to switch to groundwater. This also facilitated development of new irrigated land in areas previously unreachable by canals. During this time, improved irrigation and water delivery efficiency as well as the termination of winter canal flows resulted in a reduction in water recharged to the aquifer. Numerous canals delivering water from the Snake River were lined to reduce leakage and improve water delivery efficiency. Irrigation practices changed with the introduction of more water efficient sprinkler irrigation using center pivots rather than traditional flood irrigation techniques. A series of droughts also contributed to the increased use of groundwater and reduction in recharge from annual precipitation.

The combination of these factors resulted in a steady decline in the volume of water in the ESPA of approximately 200,000 acre-feet per year on average. The reduction in both the water table elevation and the volume of water within the ESPA had a direct impact on the flows at Thousand Springs near American Falls and return flow to the Snake River (Figure 2).

Reduced aquifer levels: affected senior surface water right holders who relied upon these discharges to serve fish hatcheries along the Snake River; adversely impacted supply irrigators across the Eastern Snake Plain; and impinged critical minimum stream flows on the Snake River downstream of the ESPA.

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Aquifer Recharge

Priority System

Conjunctive Use

Delivery "Calls"

Aquifer Management

Idaho Water Rights and the ESPA

Idaho water law is founded upon the Prior Appropriation Doctrine, which establishes water rights based upon diversion and beneficial use of the water. The Prior Appropriation Doctrine is also known as "first in time, first in right" because the priority date determines who gets water when there is not enough to go around. Water rights with a more senior, or older, priority date must be fulfilled completely before water users with a junior priority date receive their water rights. In times of drought and water shortages, junior water rights may be curtailed to ensure the senior water right is filled. This is fairly straightforward in surface water systems since diversions can be turned on or off, flow rates can be easily measured, and available water supply can be monitored. However, in groundwater systems, the influence of pumping activities on other groundwater water right holders can be very difficult to accurately determine and it is difficult to administer those water rights based on their priority date.

Even more challenging is the administration of water rights in systems within which the diversion and use of groundwater — or changes in groundwater recharge — affects the flow in a surface water source. In other words, if a groundwater and surface water source are hydraulically connected, diversion of water under a more junior groundwater right may have an impact on a more senior groundwater or surface water right. Under Idaho law, the Rules for Conjunctive Management (IDAPA 37.03.11) allow for administration of diversion and use of water under water rights from surface and groundwater sources together (conjunctively), as the same source. The ESPA and Snake River are managed conjunctively in order to address impacts to the senior water right holders and to ensure spring flows are sufficient to meet the water use demands on the Snake River downstream of the Eastern Snake Plain.

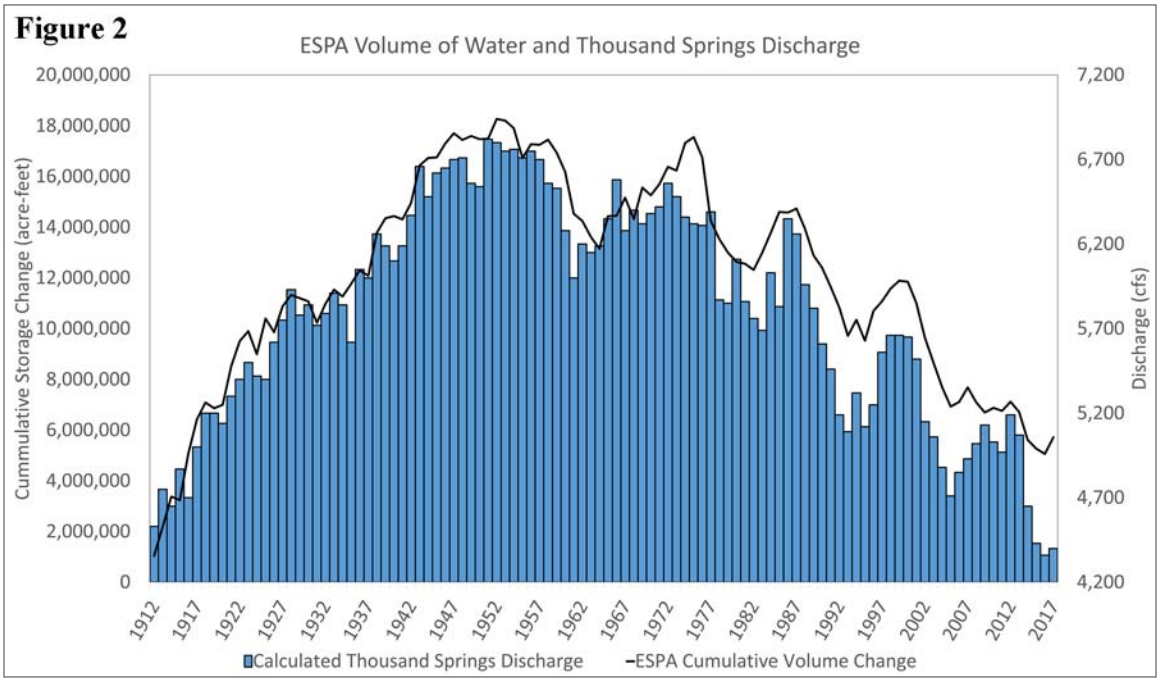


Figure 2. The calculated Thousands Springs discharge is shown as vertical bars and is calculated following Kjelstrom, 1995. Cumulative storage change in the ESPA is shown by the black line.

The combination of a declining aquifer levels and spring flows had the potential to significantly impact the state economy and resulted in decades of litigation and water delivery "calls" by senior users. Recognizing the hydraulic connection between the ESPA and the Snake River, and the need to identify a long-term solution to the problem, the State implemented measures to improve aquifer conditions and spring discharge to the river. The 1984 Swan Falls Settlement explicitly called for effective management of the ESPA and Snake River to ensure the minimum flows downstream of the ESPA at the Murphy gage could be met into the future. The need for conjunctive management of the ground and surface water resources was identified in the State Water Plan in 1986. Later, the Idaho Water Resource Board and Idaho Legislature adopted the Eastern Snake Plain Aquifer Comprehensive Management Plan (CAMP) in 2009 to "[s]ustain the economic viability and social and environmental health of the Eastern Snake Plain by adaptively managing the balance between water use and supplies" (IWRB, 2009).

The ESPA CAMP laid out an incremental plan to actively manage the aquifer to adjust the ESPA water budget by 600,000 acre-feet (AF) annually by the year 2030. This change was to be achieved through

Aquifer Recharge

implementation of measures designed to reduce demand on the aquifer and augment water supply. ESPA CAMP measures included:

- conversion of groundwater use to surface water for irrigation
- reduction of groundwater pumping by retiring existing water rights or farm ground
- weather modification (cloud seeding)
- groundwater pumping metering to better quantify withdrawals
- managed aquifer recharge

CAMP Plan Measures

Mitigation Settlement

In June 2015, an additional settlement was reached between the surface water users (Surface Water Coalition – SWC) and groundwater pumpers (Idaho Ground Water Appropriators – IGWA) on the ESPA to resolve the ongoing delivery calls and more adequately address the groundwater user's mitigation requirements to the senior water right holders. The SWC Settlement Agreement was supported by Governor Otter and the Idaho State Legislature as a significant effort to support a long-term approach to improve the health of the aquifer and management of the Snake River system for the benefit of the state.

The long-term objectives of the agreement were to stabilize aquifer levels and increase water supplies, and support additional measurement, compliance, and enforcement.

Key elements of the agreement included:

- Groundwater districts would reduce their consumptive use of water by 240,000 AF per year
- Measuring devices would be installed on all groundwater wells
- The settlement reaffirmed the importance of the IWRB's managed aquifer recharge program and recognized it would be instrumental in meeting the goals of the agreement.

Managed Recharge Pilot

ESPA Managed Recharge by IWRB

Managed aquifer recharge in the ESPA has been occurring since the early 1970s with the initiation of a pilot program by the IWRB at Egin Lakes, near Saint Anthony, Idaho (*see* Figure 1). The US Bureau of Reclamation (Reclamation) first considered recharge in the Henry's Fork River Basin in the early 1960s, but concluded that a large-scale recharge project would require an ongoing source of funding (USBR, 1962). IDWR designated the Lower Snake River Aquifer Recharge District (LSRARD) in July of 1978. LSRARD was created to develop recharge basins in the western portion of the ESPA along the Northside, Milner-Gooding, and Big Wood canal systems. The first site developed was the Shoshone recharge basin, which was first used in 1984 to recharge excess water from the Snake River and the Big and Little Wood River systems. The Shoshone site has since been used intermittently when water was available and is still used today.

State Program

After the adoption of the ESPA CAMP in 2009 and prior to execution of SWC Settlement Agreement in 2015, the IWRB developed a Managed Recharge Program for the State. The IWRB, through various one-time State funded allocations, operated the "pilot" phase of the recharge program from 2009 through 2014. During this phase, the IWRB developed partnerships with the canal companies and irrigation districts and focused on identification and survey of possible locations for the development of managed recharge sites. Managed recharge generally occurred during the "shoulders" of the irrigation season during late fall or early spring when water was not being delivered for irrigation purposes. Even though portions of the canals had been lined, there were still a vast number of unlined sections capable of infiltrating significant volumes of water when it was available. [*See* Anderson, Comeskey, & Tuthill, ***TWR*** #130]

"Shoulder" Seasons

Expansion & Funding

With the continued decline of the water table in the ESPA, the State and the water users recognized that it was necessary to significantly expand recharge operations and secure a long-term funding source to implement a "full-scale" managed recharge program. In 2015, the State legislature allocated approximately $5 million from the Cigarette Tax funding for aquifer stabilization projects state-wide with a focus on ESPA managed recharge (Idaho HB 547). After execution of the SWC Settlement Agreement, additional annual funding was secured for operation of the IWRB's Managed Recharge Program when the legislature authorized use of an additional $5 million from the State's General Fund. At that time, the Legislature also directed IWRB to expand the program to achieve an annual average of 250,000 AF of managed recharge to the ESPA by December 31, 2024 (Idaho Senate Concurrent Resolution 136, 2016).

Strategies

Since the "pilot" phase of the recharge program, the IWRB has initiated a number of strategies to expand the program. These include improved understanding of operations and optimization of water availability, increased season of recharge, and increased capacity to recharge.

Recharge Operations and Water Availability

Beneficial Use

To divert water for managed recharge in Idaho, a water right is required with the stated beneficial use of recharge. The IWRB has three water rights for recharge on the Snake River and one on the Big and Little Wood Rivers. The IWRB has recharge water rights on the Snake River in the amount of 1,200 **c**ubic **f**eet per **s**econd (cfs) with a 1980 priority date and 6,569 cfs with a 1998 priority date. The IWRB is in the process of developing water rights for an additional 7,503 cfs (1998 priority date) from the Snake River.

Availability

Timing of water availability for recharge on the Snake River is highly variable depending on where on the river the water is diverted. On the Big and Little Wood systems, the IWRB has a water right for 250 cfs

Aquifer Recharge

Storage

(1980 priority date) and applications for an additional 800 cfs on both rivers. The IWRB's water rights are generally only in priority, or authorized for diversion, 4 out of 10 years on the Big or Little Wood rivers due to shortages. However, during wet years, historically, large volumes of water can be available for recharge.

The water utilized for managed recharge for the ESPA is an opportunistic use of available natural flow in a highly regulated and complex river system. Reclamation operates the extensive reservoir system along the Snake River and controls when water is released and stored in reservoirs. The water stored in the reservoir system is vital to the agricultural industry throughout the ESPA and the IWRB maintains a policy to avoid impacting the filling and storing of water in the reservoir system. Therefore, water is only diverted for managed recharge if other water rights and administrative conditions have been met and the IWRB's natural flow water rights are in priority and available for use

Figure 3. The MP31 Recharge Site off of American Falls Reservoir District #2's Milner-Gooding Canal

Water availability above and below Minidoka Dam is dramatically different. Below Minidoka Dam, a minimum of 500 cfs is available after the irrigation season ends in the fall and before it starts in the spring. Water is typically available under the IWRB's water rights for 150 days out of the year (IWRB, 2016). Both the amount and period of availability vary depending on the snowpack in the mountains and flood control releases from the upstream reservoirs. The median flow available for recharge below Minidoka Dam is around 1,000 cfs but daily flows can range from 500 to 60,000 cfs (IWRB, 2016).

Above Minidoka Dam is a different story. Water availability for managed recharge is mostly controlled by Reclamation's unsubordinated water right for power generation at Minidoka Dam for 2,700 cfs (1909 and 1912 priority dates) and its storage water right on the American Falls Reservoir with a 1921 priority date. Historically, these administrative requirements have limited recharge opportunities in the Snake River upstream of American Falls fifty percent of the years. When water is available, it is typically limited to a 30-day period between April and June (IWRB, 2016). However, during particularly wet years there are usually significant volumes of water available for diversion to recharge. For example, in 2018 recharge above Minidoka was responsible for almost half of the recharge that occurred.

"Managed Recharge"

Figure 4. One of Southwest Irrigation District's injection wells

Increased Recharge Season and Recharge Capacity

A key principle of the recharge program is to divert and recharge water that would not have otherwise infiltrated into the aquifer. In Idaho, water that reaches the aquifer as a result of normal irrigation or other water delivery operational practices (e.g. seepage within a canal during the transport of irrigation water) is considered to be "incidental recharge." Water that is specifically delivered to enhance or recharge the aquifer is considered to be "managed recharge." Therefore, recharge water intended to increase volume in the ESPA by an annual average of 250,000 acre-ft per year must be supplied through managed recharge efforts. Seepage along a canal during the irrigation season does not count toward the recharge goal because this seepage would have occurred *regardless* of the managed recharge efforts. However, canal seepage occurring when the canal does not normally carry water will count as managed recharge.

The IWRB currently accomplishes managed recharge through existing unlined canals, off-canal spreading basins, and, on a limited basis, injection wells. As described above, managed recharge occurring in existing canals must be delivered during the non-irrigation season. However, water may be delivered to a spreading basin whenever the IWRB's water right is in priority and the connecting canal has the capacity to deliver water. In the ESPA, off-canal recharge sites are typically constructed in areas with pre-existing depressions that are used as infiltration ponds (*see* Figure 3). The primary limitations of the basins are the carrying capacity of the canals and infiltration capacity of the basin, which is a function of the hydraulic head, soil type, and underlying geology. Currently in the ESPA, only one irrigation district (Southwest Irrigation District) operates injection wells for managed recharge (Figure 4). The IWRB partners with this district to deliver managed recharge under the IWRB's water right when possible.

Aquifer Recharge

Leveraging

To increase the length of the recharge season, the IWRB executed long-term contracts with canal companies to recharge water under the IWRB's recharge water rights during the winter months (*see* Figure 5). Funding dedicated to the IWRB program has been used to increase the capacity of the off-canal sites and to complete infrastructure improvements to allow canals to operate and deliver managed recharge water during freezing conditions in the winter. A few of these projects include improvements to existing access roads, canals, hydroelectric plants, and telemetered flow structures so that recharge waters can safely flow during non-irrigation season and be accurately documented. The IWRB has also partnered with individual canals on a number of projects that benefit both parties. In these cases, the canal companies enter into a long-term commitment to deliver managed recharge water for the IWRB in exchange for improvements that benefit the canal system year-round. These partnerships have proven to be an efficient way to expand the recharge program while leveraging existing infrastructure. Since 2013, the IWRB has invested over $14 million dollars in investigations and infrastructure improvements to increase managed recharge capacity. It is estimated that over $40 million dollars will be spent by 2024 to reach full build-out of the program.

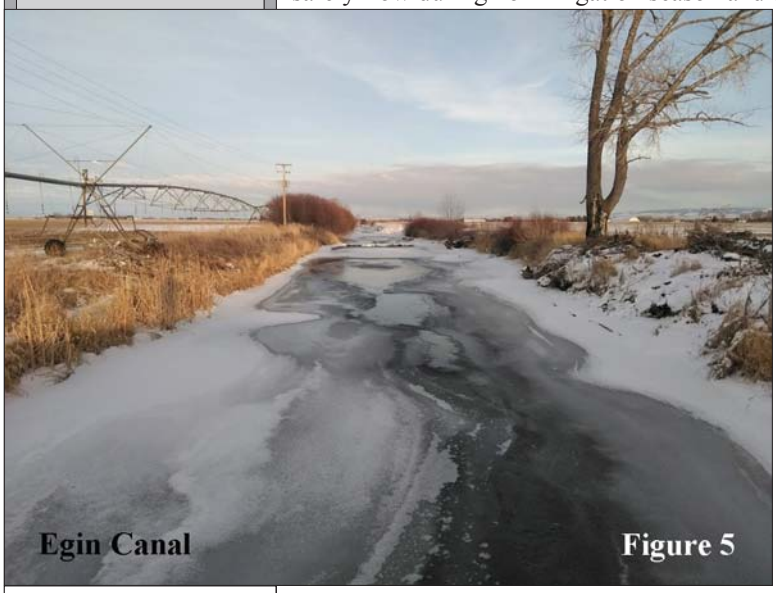


Figure 5. The Egin Canal, part of the Fremont-Madison Irrigation District, conducting managed recharge in eastern Idaho in March, 2018

Another significant program expense is the payment to canal partners to deliver recharge water. From 2013 through the spring of 2017, the IWRB spent over $3 million dollars in conveyance fees with an average conveyance cost of $7 per acre-foot. However, during the current 2017-2018 recharge season, conveyance costs are expected to be over $4 million dollars due to the significant amount of water that has been recharged to date.

Infrastructure

Since 2009, the IWRB has steadily increased available capacity to perform managed recharge. Between 2009 and 2012 the ESPA region experienced a period of wet years with a significant amount of water in the system. During these wet years, the IWRB conducted managed recharge during the "shoulders" of the irrigation season. In the 2011-2012 recharge season over 166,000 acre-feet (AF) was recharged. The period between 2012 and 2016 was a relatively dry period with limited volumes of water available for managed recharge. During this period, the MP31 recharge site was constructed, infrastructure improvements to conduct winter-time recharge were completed, and long-term conveyance agreements were put in place with canal partners below Minidoka Dam. The impact of this work is evident based on the volume of managed recharge during the 2014-2015 to 2015-2016 recharge seasons. The water available for recharge from the fall of 2012 through the spring of 2016 was similar, being relatively dry years. However, the volume of recharge increased by 45,000 to 64,000 AF of recharge after the full-scale recharge program started in 2014 (Figure 6). The principle difference between the 2014-2015 recharge season and the prior seasons was that it was the first time managed recharge was conducted throughout the winter.

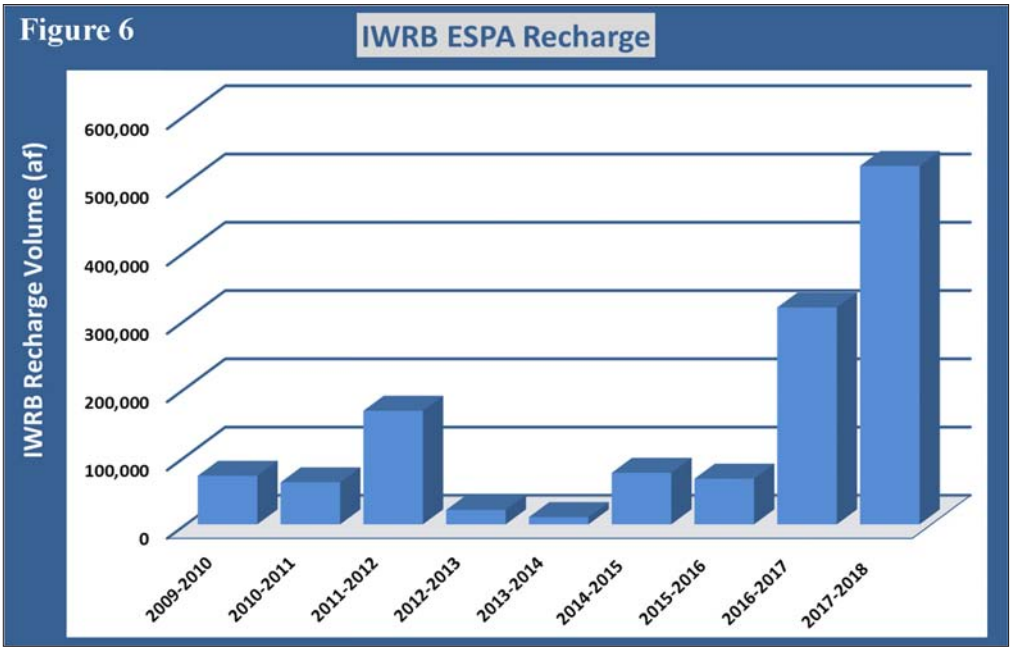


Figure 6. IWRB managed recharge volumes from 2009 through the spring of 2018. Managed recharge for the 2017-2018 recharge season is ongoing.

Aquifer Recharge

Recharge Capacity

Maximized Diversions

Monitoring Network

Aquifer Level

Dye Testing

Groundwater Quality

Water User Cooperation

Canal Systems

During the past two recharge seasons (2016-2017 and 2017-2018), there has been a tremendous volume of water available for managed recharge. Managed recharge was conducted for 250 days during the 2016-2017 recharge season and the IWRB has been able to perform managed recharged for over 298 days so far during the 2017-2018 season. Over the last two recharge seasons, over 317,000 and 545,000 AF respectively have been recharged by the IWRB. These volumes significantly surpass the previous managed recharge record of 166,000 AF (2011-2012).

Since 2014, when significant funding was appropriated for the program, IWRB has recharged over 975,000 AF of water with the majority occurring during the past two years. As new off-site recharge facilities have been constructed, IWRB's recharge potential has dramatically increased. The average rate of recharge for the 2014-2015 recharge season was 211 cfs. This has steadily increased to an average of over 1,000 cfs for the current recharge season. The increase in the average recharge rate is directly related to the infrastructure improvements the IWRB has funded and the partnerships that have been developed with all the entities that conduct managed recharge on behalf of the IWRB.

In order to reach the annual average goal of 250,000 AF it is critical that the IWRB maximize recharge during wet years, since the amount of water available for recharge during dry years is significantly less than the goal. This will also require development of enough recharge capacity to maximize diversion during high flow seasons and to provide system redundancy to accommodate canal maintenance schedules, and difficult weather conditions. Figure 7 (next page) shows recharge for the 2017/2018 season by the individual canal companies. The variability in the daily flows provides a snapshot into how quickly conditions can change.

ESPA Managed Recharge Monitoring Program: Quantify & Quality

The ESPA monitoring program is operated by the Idaho Department of Water Resources (IDWR). The program has support from other cooperating entities to evaluate the state of the ESPA, to quantify effects of aquifer stabilization efforts such as the IWRB's Managed Recharge Program, and to demand reduction of use by the groundwater users. To ensure that the long-term goals of aquifer stabilization are met, IDWR and cooperating entities have an extensive network of more than 460 wells throughout the ESPA. IDWR measures these well throughout the year and performs synoptic sampling of select wells in the spring and fall. Twice a year for the sampling, water level measurements are taken to determine the changes that occurred in the aquifer from year-to-year and season-to-season. This information is used to develop water level change maps of the aquifer. Of these wells, 20 sentinel wells were selected by the parties to the SWC Settlement Agreement. These wells are used to calculate a single, normalized groundwater index using the average of the March and/or April centered value in the 20 wells for that year. This groundwater index is used to assess the progress of the agreement in meeting established aquifer benchmarks. The aquifer benchmarks were defined to ensure the decreasing groundwater level trends are reversed, and groundwater levels are ultimately returned to the average from 1991-2001. Currently, after an extremely wet winter, the 2017 groundwater index has already exceeded the 2020 benchmark. [*See* Water Brief, ***TWR*** #172]

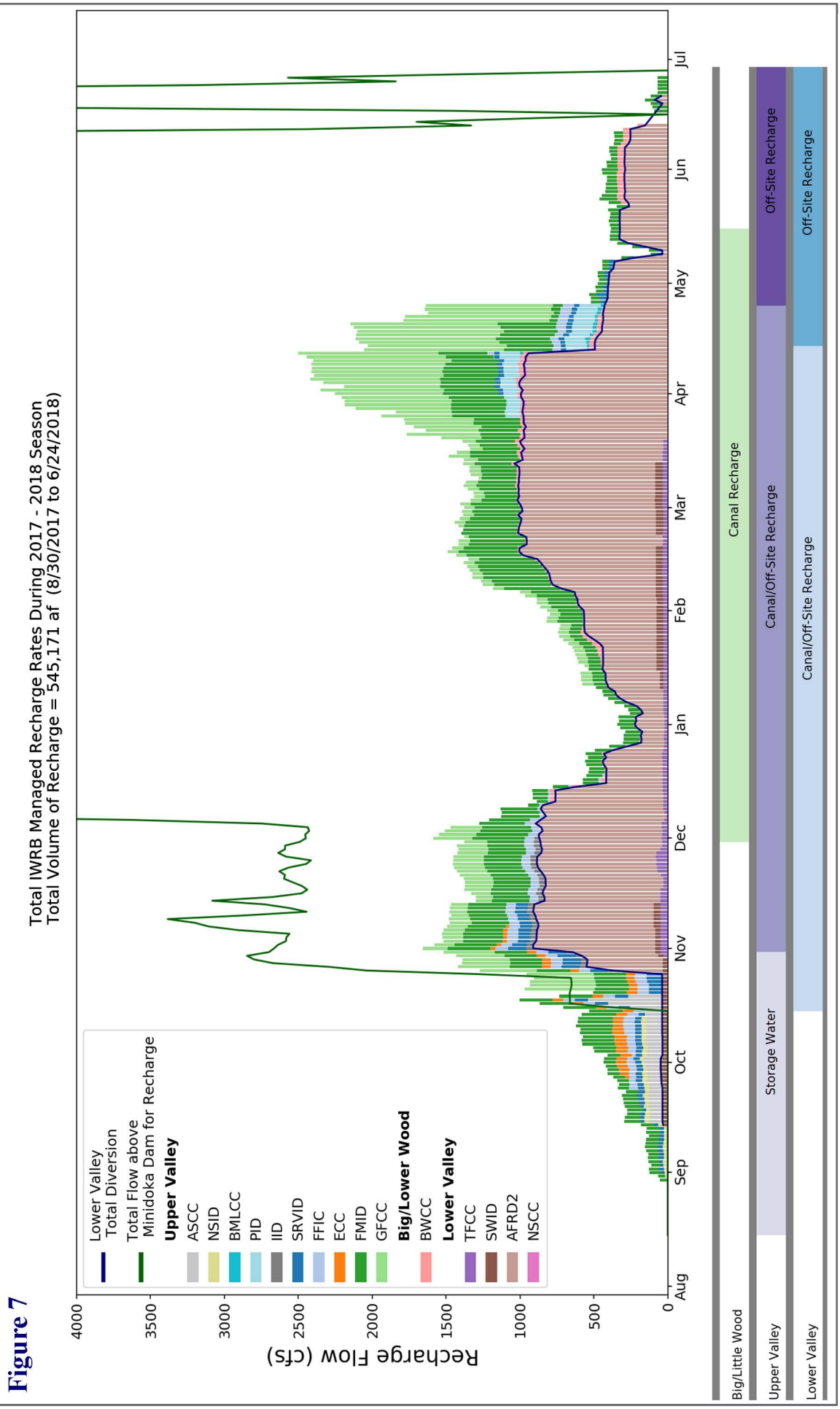
To monitor effects of the IWRB's managed recharge activities, the IWRB conducts site specific monitoring, including detailed surface flow measurements, groundwater level measurements, and dye testing of the various recharge sites and areas to assess aquifer response and long-term effectiveness of the program. In compliance with Idaho Department of Environmental Quality (IDEQ) requirements concerning the use of spreading basins for managed recharge, the IWRB manages groundwater quality monitoring programs (GWQMP) for the MP31, Shoshone, and Richfield recharge sites. The monitoring programs ensure waters infiltrating to the aquifer meet specified standards. These monitoring plans are designed to assess each individual basin's underlying geology, soil characteristics, and spatial location to proximal wells and spring discharges. Installation of local monitoring wells is included in the GWQMPs to allow ongoing testing and analysis of potential impacts of recharge water on the groundwater.

Conclusion

Most Western States are faced with the challenge of managing existing water supplies along with the increasing or changing demands on the resource. Idaho is taking steps to actively address the current and future water supply needs on the Snake River Plain with a long-term adaptive management plan coupled with cooperation with the water users. The ESPA Managed Recharge Program in particular has highlighted the need for wide-ranging collaboration. The program would not have been possible or successful without the water users and the State working together to define and proactively address the problem. The Office of the Governor as well as the Idaho State Legislature have supported the program in the form of legislative direction as well as the commitment of a long-term funding source for the program which has been critical to the implementation of such a large-scale project. The partnership with canal owners to deliver recharge water through their canal systems and convey water to recharge basins has been a key component to the success and efficiency of the program. Communication between all the water users, State departments, and

Aquifer Recharge

Figure 7.
Daily recharge amounts by Canal Company for IWRB recharge for the 2017-2018 season up to 04/24/2018.
All values are provisional and subject to change.



Aquifer Recharge

Additional Capacity

Federal agencies involved with the ESPA and the Snake River have been significantly increased to ensure that available water is used effectively. Build-out of a comprehensive monitoring program at the regional and local level is also critical to evaluate progress and allow program managers to adapt and refine the program to meet the overarching goal to rebuild the aquifer to a sustainable level. The IWRB will continue to collaborate with canal companies and stakeholders to expand the State's managed recharge program to meet the goal of recharging an annual average of 250,000 AF. While the past two years have seen record breaking amounts of recharge, additional capacity is required to recharge excess water when it is available in order to compensate for other years when the water supply is more limited.

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Paul Thomas holds a Master's in Geology from University of Utah. Prior to joining the IWRRI team, he worked at Brown and Caldwell as a hydrogeologist supporting clients throughout the Pacific Northwest, both in the field and office along with a variety of internships and seasonal positions working throughout the Delaware River Valley, Patagonia, and Southwestern US.

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Augmenting Streamflow

Decreased Streamflow

Climate Variability

Incidental Recharge

AUGMENTING SUMMER STREAMFLOW

INNOVATIVE APPROACH IN THE TETON RIVER, IDAHO

by Kate Burchenal, Morgan Campbell, Lucy Hedley, Emily Honn, Tessa Reeder, and Gary Libecap
Bren School of Environmental Science & Management, University of California (Santa Barbara)

Introduction

Decreased late-summer streamflow is a pressing issue for many water-short river systems throughout the western United States. In the face of climate change and with increasing human pressure on natural river systems, it is paramount to develop creative solutions to address this problem. Our team at the Bren School of Environmental Science & Management (Bren Team) used the Teton River in southeastern Idaho as a case study and proving grounds to design one such solution. The Bren Team believes the community-based program detailed in this article can be replicated in similarly situated communities throughout the West.

The arid climate of the western United States drives a critical dependence on the natural storage and conveyance infrastructure provided by mountain snowpack and snowmelt-fed rivers (Figure 1). These rivers deliver essential water for: unique ecosystems; iconic species; agricultural economies; and vibrant urban centers. Consideration of the impacts of climate variability is especially important for water managers relying on snow-fed rivers. Changes in the depth of snowpack and the timing of snowmelt from year-to-year will only increase the stress already faced by agricultural users, urban populations, and ecosystems.

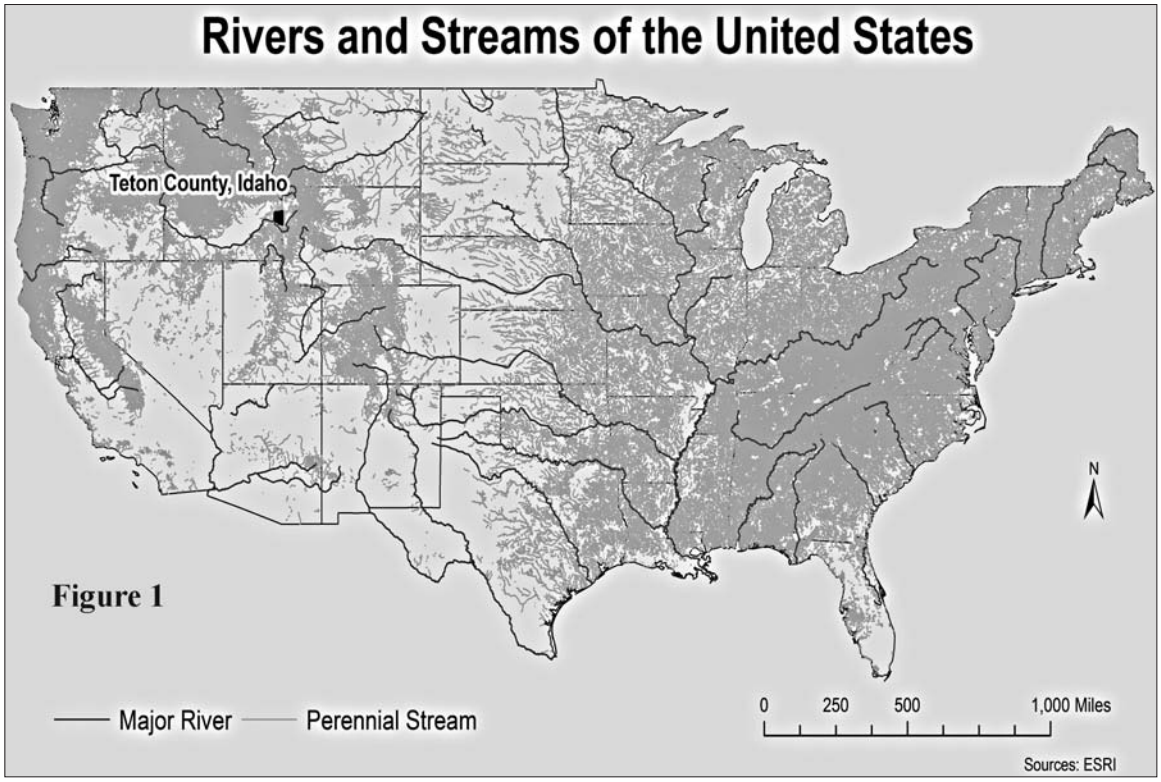


Figure 1. Map of the rivers and streams of the United States. Fewer natural rivers and streams flow in the western half of the country in comparison to the eastern half. Teton County, Idaho is highlighted in black.

LegacyWorks Group and Teton Water Users Association (TWUA) recognized that late-summer streamflow was a problem in the Idaho's Teton Valley. In partnership with these groups, the Bren Team explored incentivizing irrigation behavior changes to increase summer flows in the snowpack-fed Teton River for native fish and irrigation-dependent farmers. The Bren Team proposed that farmers take advantage of the existing irrigation infrastructure by diverting water when their water right first comes into priority, but before they begin irrigating. Doing so will augment incidental groundwater recharge. Recharged water will move through the shallow aquifer and then emerge in the wetlands and Teton River during the late summer when streamflow is low.

Augmenting Streamflow

Objectives & Questions

Goals

Teton River

Irrigation

Eco-Benefits

To assess the feasibility of this proposal, the Bren Team developed three key objectives:

- Model hydrologic conditions to determine the potential impact of incidental groundwater recharge on streamflow and stream temperatures in the Teton River
- Quantify the economic and environmental impacts of augmented flows, including the costs and benefits of conducting incidental recharge
- Design a framework for incentivizing recharge to augment late-season streamflow in the Teton River

Through these objectives, the Bren Team sought to answer two questions:

1) Will incidental groundwater recharge actually increase streamflow?
2) If so, what will be the impact on the economy and the environment?

The Bren Team found the answer to the first question to be "yes." The answer to the second question was also in the affirmative — provided certain conditions are met.

If there is a sufficient increase in streamflow, a recharge program has the potential to increase water availability for upstream farmers during dry summer months, lower water temperatures for fish habitat, and slow the shrinking critical wetland habitat in this portion of the Greater Yellowstone Ecosystem. A more consistent water supply during this critical time has the potential to decrease annual hydrologic variability, thereby benefitting both the agricultural economy and the important ecosystems in the Valley. The Bren Team is optimistic that our findings from Teton Valley can be replicated by other rural agricultural communities in the West and adapted to meet their specific needs.

Teton Valley Overview

BASIN CHARACTERISTICS

The Teton River Basin is in the southeastern corner of Idaho on the border with Wyoming (Figure 2). The basin lies on the western edge of Grand Teton National Park and just south of Yellowstone National Park. Most of the water in the Teton River Basin originates as seasonal snowmelt from the Teton Range and the Big Hole Range. Figure 2 highlights the seven major tributary streams that feed the Teton River through surface flow and contribute to the shallow aquifers beneath the valley floor through seepage. As the Teton River flows through Teton Valley it is flanked by agricultural land and wetlands. The wetlands, fed by the tributaries and local aquifer, provide key habitat for various migrating and wintering wildlife populations that use the neighboring national parks for summer habitat (*see* References below (1)). The Teton River and its tributaries also supply irrigation water for 120,000 acres of agricultural operations in the Valley (References (2)).

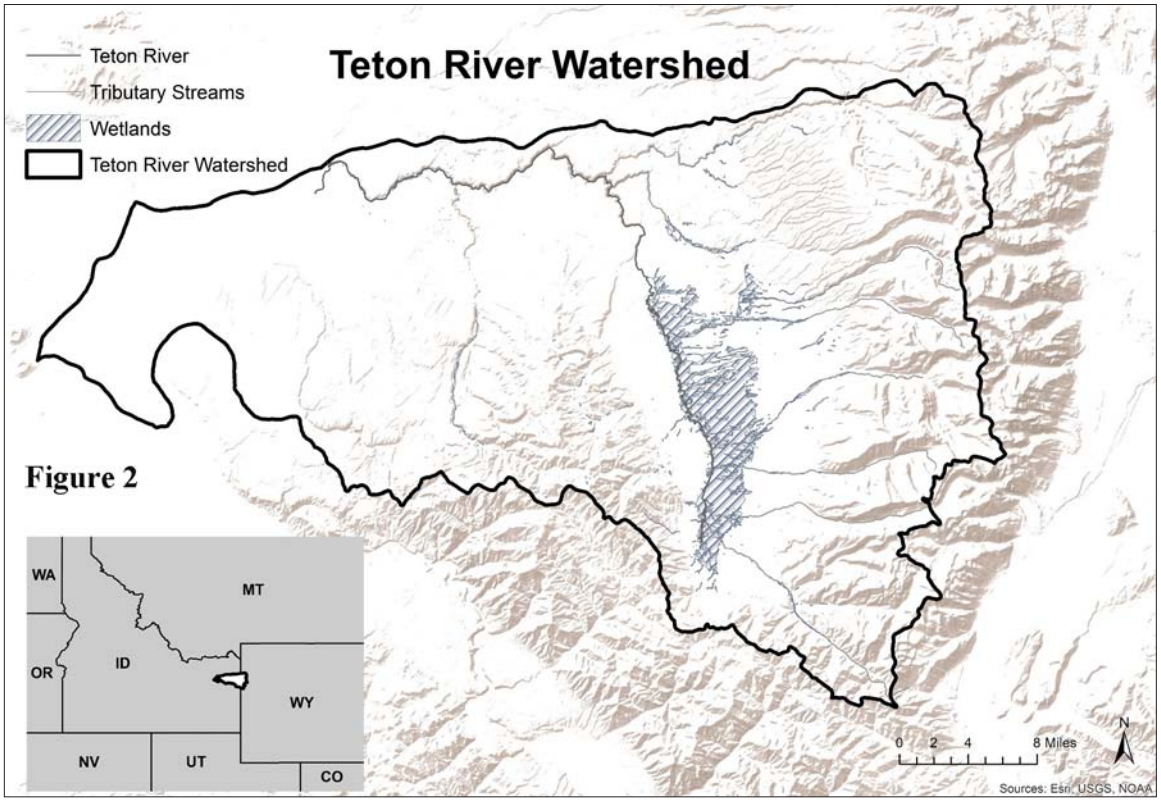


Figure 2: Map of the Teton River Watershed in Teton County, Idaho. Teton River Watershed boundary is highlighted by a thick black line. Tributary streams are marked by light grey lines and the Teton River is marked by the dark grey line. Wetland areas are delineated by crosshatching.

Augmenting Streamflow

Irrigation Curtailment

Storage Water

Ecosystem Impacts

Shallow Aquifer Storage

Managed Recharge

Approval Process

Incidental Recharge

Although snowmelt and streamflow vary greatly from year to year, peak streamflow typically occurs in late spring to early summer with lower flows expected in July and August as the snowpack diminishes. Late-season reductions in streamflow leave farmers particularly vulnerable because they rely on the river to supply critical irrigation water during the dry, summer months.

Similar to other western states, Idaho's surface water allocations are controlled by the Prior Appropriation Doctrine. Farmers who began using water first have the oldest priority dates and, therefore, received the most senior water rights. Water allocations are filled in order of priority dates. During the spring when there is plenty of water in the river, all users receive their full allocation of water. However, in July and August when streamflow levels are low, water is allocated based on seniority. The most senior users get their water first and the junior users have to curtail their water use. Reductions in irrigation water allocations negatively impact crop yields and profits, especially in Teton Valley where most farmers hold water rights junior to those downstream. Fear of these yield losses in most years forces farmers to buy expensive storage water from nearby reservoirs in order to make it through the dry season once their water use is curtailed, thus increasing their costs significantly.

Late-summer decreases in streamflow not only impact farmers but also adversely impact riverine and wetland ecosystems. Native fish need cold, clean water to survive and lower flows in the Teton River typically result in warmer water temperatures. The adjacent wetland ecosystems, which also rely on a consistent supply of water, are part of the Greater Yellowstone Ecosystem and support dozens of important wildlife species. Decreased water availability can dry out wetland habitat and cause significant harm to the species they support, as well as the ecosystem services they provide.

Using Groundwater Recharge to Increase Summer Streamflow

As described by Fereday et al., the purpose of groundwater recharge is not to "create new water in the hydrologic system. The issue is primarily one of timing — making water available when needed." (References (3)) The goal in Teton Valley is to do just that — utilize the natural storage function of the shallow aquifer to retain abundant, early-season water so that the delayed flow is released to the Teton River one-to-three months later when it is most needed.

Human-induced recharge can be achieved in a variety of ways, but generally falls into two categories: managed and incidental. Managed recharge refers to the engineered delivery of water to a recharge site for the explicit purpose of contributing water to the aquifer. Managed recharge often involves the use of injection wells, land application, or spreading basins, where excess surface water or reclaimed water is placed in a basin with high infiltration rates and allowed to percolate into the groundwater (References (4)). *See also* Mortimer & Tuthill, *TWR* #129 and Tuthill, Anderson & Comeskey, *TWR* #130.

It is possible to attain a water right for managed recharge or change the beneficial use of an existing water right to do managed recharge in Teton Valley. However, it isn't practical to rely on this option as an immediate solution due to the lengthy process involved to obtain approval (References (5)). Organizations such as TWUA are pursuing the opportunity for managed recharge, but it may take as long as a few decades to come to fruition (References (7)).

In the meantime, incidental recharge can be actively pursued as a strategy to augment groundwater without having to go through the arduous process of changing the beneficial use of a water right. Incidental recharge refers to the recharge of an aquifer as a secondary effect of human activity such as the seepage that occurs from irrigation, water storage, or conveyance. In Teton Valley, farmers divert water directly from tributaries into canals or pipes to transport to their fields. Unlined, earthen canals provide an important pathway for incidental recharge, as water seeps into the ground while being transported to fields. The excess water that is not "lost" to evaporation or runoff infiltrates into the shallow aquifer as recharge. Water stored in the shallow aquifer is slowly released to the Teton River one-to-three months later when streamflow is low and water temperatures are high (Figure 3).

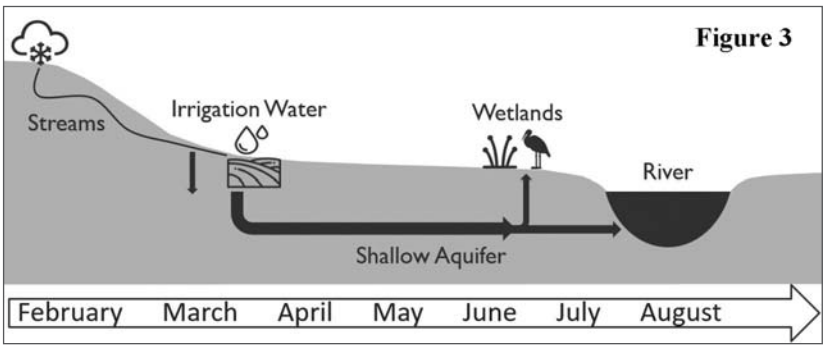


Figure 3. Conceptual model of incidental groundwater recharge in Teton Valley. Water diverted from tributary streams seeps into the ground via unlined canals. Water that is recharged into the shallow aquifer in the months of April and May will discharge into the Teton River in July and August.

Historically, most canals in the valley were unlined and highly permeable. However, in recent decades, lining canals and transitioning to more efficient irrigation has become more prevalent. This change has drastically reduced the amount of water that enters the shallow aquifer through incidental recharge and therefore reduces the delivery of late-season water to the Teton River. Water that once took months to

Augmenting Streamflow

Unlined Canals

Forfeiture

Hydrologic Components

Expected Changes

discharge into the Teton River now flows predominantly as surface flow from tributaries to the river in a matter of days. As a result, summer streamflow in recent years has been lower than it was in the past.

Proposal: Incidental Recharge to Increase Summer Flows

In order to increase summer streamflow, the Bren Team proposed that farmers take advantage of unlined canals to conduct early-season incidental groundwater recharge. Although farmers have the right to begin diverting surface water for irrigation on April 15th, the planting season typically begins in mid-May due to frost-risk and saturated fields. This leaves approximately one month in which farmers' rights are in priority, but not in use. Thus, the goal of this project is to augment late-summer flows by utilizing this extra month to run water through unlined canals, therefore increasing groundwater recharge. It is important to note that this will in no way jeopardize the farmers' water rights nor diminish the amount of water they have available for irrigation during the rest of the summer, as they are simply utilizing the full extent of their existing water right. Furthermore, it may actually serve to firm up their water rights against forfeiture since the farmers currently are not putting their water to beneficial use during the early part of the planting season (References (5)).

The Bren Team examined the hydrologic feasibility, as well as the ecological and economic impacts of using incidental groundwater recharge to augment streamflow in the late summer. Based on our findings, we developed a framework to incentivize farmers to participate in recharge efforts.

Is Incidental Groundwater Recharge Hydrologically Feasible?

In order to maximize the benefits of an incidental recharge program by providing augmented flows when they are needed most, it is crucial to understand the hydrologic system of Teton Valley. To better understand the impacts of incidental groundwater recharge on the Teton River the Bren Team:

- Quantified the impact of recharge on streamflow, using a water budget to predict how increased canal seepage contributes to Teton River streamflow
- Determined which recharge locations would best contribute to the goal of augmenting late-summer streamflow by developing a spatial site-suitability model
- Estimated the ecosystem benefits of recharge on fisheries by creating a model to assess the influence of increased streamflow on stream temperature

For each of these analyses, the Bren Team assessed the potential impact of recharge from running water through unlined canals and allowing it to seep into the shallow aquifer. To minimize adverse impacts to farmers, we did not assess the impact of recharge from flooding pasture land and land out of agricultural production, though the analytical model could easily be expanded to include these applications.

The Bren Team used the Teton Valley Groundwater-Surface Water Model, which is an analytical model written by Dr. Rob Van Kirk to evaluate the impacts of land use changes in Teton Valley (References (6)). We used it to model the expected changes in amount and timing of Teton River streamflow that would result from additional canal seepage. The results of the scenarios we ran show that recharge from canals does augment flows in the Teton River. Additionally, approximately 29% of the recharge volume discharges into the river in the late summer when it is needed most. Figure 4 indicates model output across different levels of farmer participation. Low participation represents two irrigation companies recharging through their canals, while high participation represents the entire Teton Valley recharging at the full capacity of their canals.

Figure 4

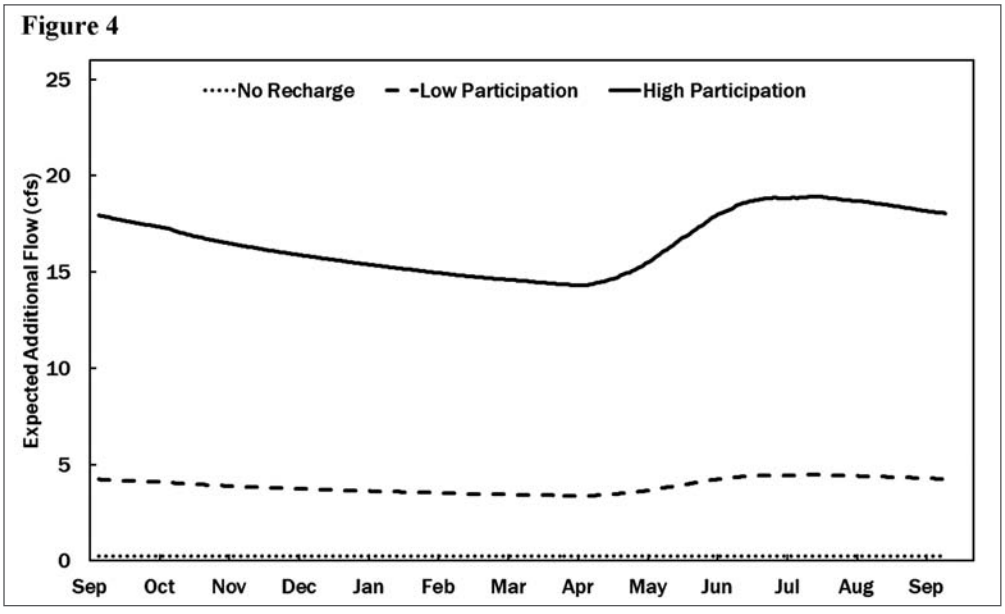


Figure 4. Modeled outputs of expected additional flows discharged into the Teton River. The dotted line indicates a no-recharge scenario where no additional flows, measured in **c**ubic **f**eet per **s**econd (cfs), discharge into the Teton River. The dashed line indicates the modeled results of low participation in the recharge program (the canal mileage owned by two irrigation companies). The solid black line displays the modeled results of high participation in the recharge program (all available canal mileage in Teton Valley).

Augmenting Streamflow

Expasion Need

Site Suitability

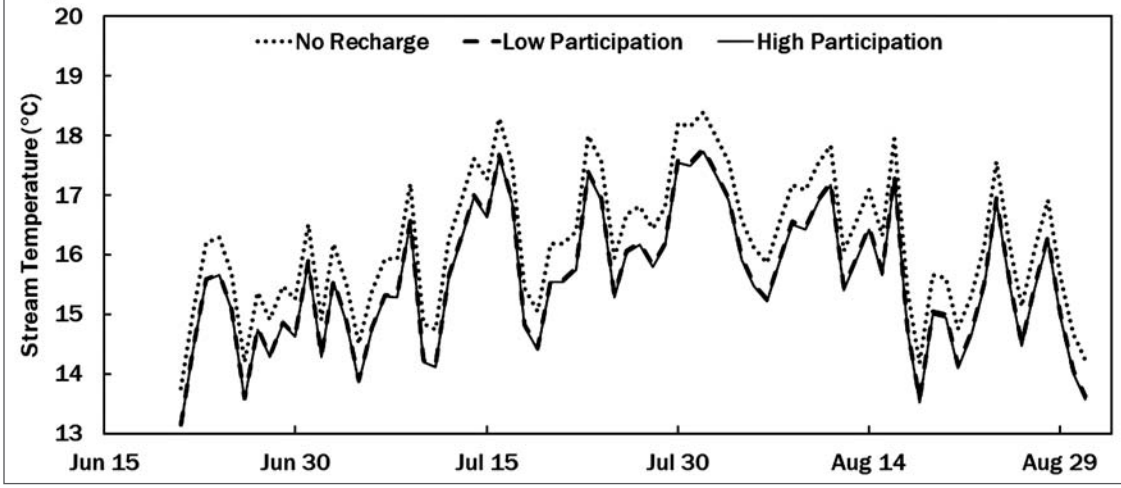
Temperature Impact

Through the different scenarios, the Bren Team determined that sufficient flow augmentation will be difficult to achieve solely using canals. More specifically, the feasible amount of such recharge will likely not delay the call for water. Thus, farmers will not benefit from recharge unless the amount of land area doing recharge is increased. Therefore, it will be critical to expand the area used for recharge to additional suitable areas such as pastureland and marginal land.

The site suitability model evaluated the site suitability based on the area's ability to provide both a sufficient quantity of recharge and the appropriate timing of discharge. The results of this analysis can inform not only which irrigation companies will be most beneficial to involve, but also which portions of a given property will yield the best results. The results of this evaluation are not meant to discourage participation in any way, but rather to gain a better understanding of recharge potential throughout the Valley.

Finally, the Bren Team developed a regression model to determine if the anticipated flow augmentation would alter water temperature and therefore benefit fish. We found that there was a significant negative correlation between streamflow and water temperature. Therefore, with higher flow in the river, one can expect lower water temperatures. We used our water temperature model to evaluate the impacts of changes in streamflow from incidental recharge on water temperature. The model predicts that the greatest decrease in temperature will occur at the end of August when streamflow is lowest, indicating that recharge could play a vital role in decreasing late-season summer temperatures, particularly in dry years.

Figure 5



Increased Flow Impact

Figure 5: Modeled output of the impact of increased flow volumes in the Teton River from incidental groundwater recharge on stream temperature. A baseline, no-recharge scenario, is marked by the dotted black line. The impacts of low and high participation are marked by dashed and solid lines, respectively. The impact of low and high participation is so similar in temperature reduction outcomes that it is difficult to discern the difference between the two lines on the graph.

Economic and Environmental Benefits

In order to garner support for an incidental groundwater recharge program in Teton Valley, the Bren Team needed to determine the economic and environmental impacts of incidental recharge. We evaluated the economic impacts by conducting a **c**ost-**b**enefit **a**nalysis (CBA) of the direct costs and benefits that farmers in the Valley would incur as a result of running water in their canals for one month prior to the irrigation season. To determine the ecosystem and recreation benefits, we evaluated the effects of decreased water temperature on riverine and wetland habitat. The benefit transfer method was then used to estimate the potential economic value of improved wetland habitat.

Cost-Benefit

Direct costs for Teton Valley farmers include canal maintenance and farmers' time to run early-season irrigation. The financial benefits to Teton Valley farmers come in the form of avoided costs to rent expensive water from a nearby reservoir to fulfill their late-season irrigation needs. As mentioned earlier, during July and August, junior water rights holders in Teton Valley must often stop diverting water from the tributaries and are forced to acquire water from alternative sources. Augmented surface flow in the Teton River could delay the date that senior water rights holders "call" for water, if sufficient recharge and therefore sufficient Teton River flow can be achieved. This would decrease the amount of time in the summer that Teton Valley farmers have to rent expensive storage water, benefitting them financially.

Delayed "Calls"

Augmenting Streamflow

Stored Water Cost

Agriculture Benefits

Fishery Impacts

Wetlands Habitat

Recharge Funding

Incentives Structure

Key Issue: Curtailment & Participation

Farmers currently pay an average of $6.00/**a**cre-**f**oot (AF) to rent stored water, which is significantly greater than the estimated price of $1.61/AF to $3.07/AF for conducting incidental recharge for a month. Thus, the farmers' current willingness to pay to rent stored water is higher than the cost of recharging. If recharge efforts can be expanded to result in sufficient flow augmentation to provide savings in stored water costs, the benefits of the program would be much greater than the cost per acre-foot of covering all costs of doing recharge. Therefore, there would be room to establish a price that takes this into consideration and provides extra incentive to participate in recharging.

The Bren Team chose not to include recreational and ecosystem benefits in the CBA. This was because we wanted to determine whether the actualized benefits to potential agricultural participants exceeded the costs of participation and, therefore, would encourage farmers to participate in the program. Due to the fact that farmers will likely not benefit from augmented river flow until there is sufficient farmer participation, we determined that recreation and ecosystem benefits will play an important role in increasing the benefit-to-cost ratio during the beginning stages of this program. These early benefits will also make the program more attractive to funders whose missions align with the goal of increasing streamflow to improve recreation and the environment in Teton Valley.

Predicting the exact changes in the fishery as a result of decreased stream temperatures was outside the scope of our study. However, we estimated the economic impact of an improved fishery by drawing on the current economic value of the local fishing industry. An improved fishery in terms of more fish and/or larger fish in the Teton River will likely increase the contribution to the local economy as a result of an increase in both the number of fishers and time that they spend fishing on the Teton River (References (8)). As a result, income from trip-related expenses will increase, benefiting the local economy. Using the results from a survey-based study on fishing-related expenditures in Teton County and, specifically on the Teton River, we know that the total spending on fishing-related expenses on the Teton River in 2003 was $688,068, not including fishing licenses and permit sales, which totaled $128,657 for all of Teton County (References (8)). Therefore, even with a modest 5% increase in angler days from 2003, associated spending in Teton Valley would likely increase by approximately $34,400.

While the incidental recharge program will not create any new wetland habitat, it will help to maintain the extent and vitality of existing wetlands, which total approximately 26,760 acres in Teton County (References (9)). This is especially important during dry years when wetlands typically dry out by July or August and cease to provide ecosystem services. Recharge could add to the value of wetlands by extending ecosystem services into July and August. Based on general values of conservation easements on wetlands in the Valley, the Bren Team estimated the value of ecosystem services to be about $1,500-$1,800 per acre of wetland. Based on this assumption, we estimated that recharge could increase the value of ecosystem services that wetlands in Teton Valley provide by as much as $2.79 million by keeping water in wetlands during July and August in dry years so that they can continue to provide valuable services.

Because the environmental benefits of recharge to ecosystem services and recreation are diffuse, it will be challenging to convince beneficiaries to contribute to funding recharge efforts. These beneficiaries include Teton Valley residents, local municipalities, as well as fishing and boating outfitters. Initially, we expect that non-profit organizations whose goals align with increasing instream flows will be willing to help fund recharge efforts since they will directly benefit from recharge. Moving forward, in order to avoid free-riding from the aforementioned beneficiaries, a structure will need to be implemented to account for these benefits and distribute the costs.

As noted, farmers will have direct incentive to participate in recharge efforts because they will receive the benefit of recharging and not having to buy water from a reservoir if and when participation expands sufficiently. Other beneficiaries, though, will need a structure in place to incentivize them to contribute to the program. Without such a structure, one could expect significant "free-riding." One option would be to implement a fee on municipalities and river outfitters. Because municipalities are reducing their costs for water-quality management and flood protection by maintaining wetland ecosystems, they should contribute to this service. River outfitters will also benefit from having more customers and, therefore, should also contribute by helping to provide funding to incentivize and implement recharge. Ultimately, such fees would be less than the costs of foregone ecosystem services and less than the increase in revenue to fishing outfitters. Thus, they will still receive an overall benefit.

There is great potential for an incidental groundwater recharge program in Teton Valley to provide ecosystem, recreational, and financial benefits. However, the full benefits will not be realized if incidental recharge does not augment streamflow in the Teton River enough to keep junior water rights in priority receiving water. Small amounts of increased flow may still provide some benefits to wetland and riverine ecosystems and those who use them, but farmers will only begin accruing financial benefits from augmented flow when there is enough additional water in the river to push back priority date curtailment.

Solution: A Community-Based Incidental Groundwater Recharge Program

The Bren Team found that conducting incidental recharge through unlined canals in Teton Valley is hydrologically feasible and, with enough participation, can be cost-effective and environmentally beneficial. However, despite the strong scientific and economic rationale for recharge, farmers are not

Augmenting Streamflow

currently undertaking this practice. From conversations with farmers, we found that they are not recharging because the benefits of incidental recharge are abstract and diffuse. Before farmers will be willing to invest in the costs of incidental recharge they will require physical evidence showing that incidental recharge increases late-season streamflow in the Teton River. If the benefits of recharge are evident, irrigation companies have said they would be willing to participate in a recharge program.

Water Markets

Water markets are becoming increasingly common as a method of resolving water allocation issues in the West. The Bren Team initially approached this problem with the intent of developing a market mechanism to incentivize incidental recharge in Teton Valley. However, because: 1) augmented flows are not fully specified or exclusive; 2) there is not a sufficient number of market participants; and 3) there is no way to exclude free riders — we have concluded that developing a traditional market is implausible.

Recommended Stages

Based on our research, our final recommendation is to implement a community-based resource management program implemented in three stages.

"Proof of Concept"

Stage 1: Pilot Project

LegacyWorks Group, in collaboration with the TWUA, began a two-year pilot project on April 15, 2018. The project is testing incidental recharge with two well-respected irrigation companies that have signed on as initial participants.

The purpose of the pilot is to provide "proof of concept" by demonstrating the ease and feasibility of: conducting incidental recharge; measuring the amount of recharge the participants are able to conduct before crop planting; and understanding the physical and financial challenges that farmers may face in conducting incidental recharge.

Non-Profits Project

Stage 2: Non-Profit Support

The short two-year duration of the pilot project will not provide enough time for the benefits of increased late-season streamflow in the Teton River to manifest. Therefore, the Bren Team recommends that LegacyWorks Group set up a structure that will allow local and national non-profit groups to provide supplemental funding to cover the costs of conducting incidental recharge for the following three years. Additionally, funding can be used to restore historic, unused canals, and identify marginal pastureland where recharge efforts can be expanded.

Only by conducting a significant amount of recharge beyond the capacity of the existing canal system will streamflow increase enough to incentivize farmers to voluntarily participate in the program. Benefits to the local fisheries and wetlands do not require the same critical mass of increased flows and will begin to accrue benefits earlier. Thus, a strong case has been made for engaging non-profits interested in funding projects that augment river streamflow and maintain valuable habitat for species of concern. Furthermore, funding incidental recharge will be financially attractive as it is less expensive than other flow-augmentation schemes (such as fallowing farmland or buying water rights).

Program Management

Stage 3: Community Support and Farmer Buy-In

After the completion of the two-year pilot and non-profit expansion stages, the Bren Team believes the financial benefits from augmented streamflow in the Teton River will be large enough that farmers will be willing to voluntarily conduct recharge in order to ensure their cost savings into the future. At this point, we envision that the farming community manages early-season recharge efforts via trusted and established irrigation districts and canal companies. We also recommend that LegacyWorks Group turn over management of the program to TWUA, a local governing body comprised of stakeholders in the valley, including representation from both farmers and non-profits. Because TWUA is a trusted local entity, they can also play a crucial role in assessing fees for other beneficiaries, such as the municipalities and fishing outfitters. While these fees would have to be implemented by a local government with authority over the beneficiaries, TWUA can provide the structure for distributing the funding appropriately and managing recharge efforts. Funding can be used to expand recharge efforts as well as to incentivize all irrigation districts to participate in recharge efforts.

Behavior Shift

Once farmers realize the benefits from Valley-wide, early-season incidental recharge and find that the costs for doing so are minimal, we believe they will continue this practice into the future. Thus, the main purpose of the proposed three-stage program is to create a behavioral shift in how farmers utilize their water rights.

Conclusion

Natural Infrastructure

Through this study, the Bren Team found that late-summer streamflow can be increased through natural infrastructure without requiring any new water supply. Diverting water into canals at the beginning of the irrigation season before planting increases incidental groundwater recharge. Using a hydrologic model, we were able to quantify the impact of this additional recharge and estimate the resulting additional streamflow in the river. We found that incidental recharge in the beginning of the season increases late-summer streamflow and decreases water temperature. With sufficient recharge, these hydrologic changes can benefit farmers by delaying the "call" for water by downstream senior water rights users, preventing them from having to buy expensive supplemental water from a reservoir. Fish and wetland habitat also benefit, which in turn benefits the local economy by providing valuable ecosystem services.

Hydrologic Timing

Augmenting Streamflow

Water Availability

Collaborative Approach

Creative Solution

In order to incentivize farmers to participate in early-season recharge efforts, though, there must be proof of concept. With funding from grants and non-profit organizations whose priority is to maintain instream flows, farmers could be paid to divert water early in the season for recharge. Once participation from farmers reaches a critical level, farmers will start benefiting from greater irrigation water availability. At this point, we believe that they will be willing to continue to participate in early-season recharge voluntarily. Thus, this program can help facilitate a behavioral shift by taking advantage of the natural hydrologic system to change the timing of when water enters the river, increasing streamflow and benefiting farmers and wildlife.

In the face of complex challenges, a cooperative, integrated approach to water management is crucial between agricultural users, urban users, environmental non-profit organizations, and local and state government institutions. This project recognizes a common cultural value between local farmers and environmental non-profit organizations and elevates their existing partnership. The success of such a project will prove that collaborative partnerships across sectors are not only feasible but can, in fact, generate greater community benefit.

A program like this can be replicated throughout the West as local stakeholders seek creative solutions to natural resource problems. By using existing infrastructure and avoiding costly, time-consuming legal changes to water rights, this three-phase program will be less expensive and faster to implement than many traditional managed recharge programs. It is best applied in regions where surface water provides the majority of supply and the most pressing problem is the variable timing of snowpack-fed streamflow. This project's model can be scaled up to meet the recharge goals of larger communities with a greater diversity of water needs and uses.

Backed by diligent economic and hydrologic research, the community-based resources management program proposed in this analysis provides the kind of innovative, partnership-based solution necessary to meet the water challenges of the 21st Century.

For Additional Information:

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The Bren Team's Full Report is available at: www.tetonrecharge.weebly.com

The Bren Team: Kate Burchenal, Morgan Campbell, Lucy Hedley, Emily Honn, & Tessa Reeder completed their Master's thesis together in partial fulfillment of the Master of Environmental Science and Management degree at the Bren School of Environmental Science & Management at University of California, Santa Barbara. With varied backgrounds in economics and the natural sciences, these individuals formed a powerful interdisciplinary team. The group is motivated by a shared interest in using innovative water stewardship solutions to protect watersheds in the West.

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Business of Water

THE BUSINESS OF WATER

WRRC CONFERENCE EXAMINES ON THE BUSINESS OF WATER

by Susanna Eden, Jacob Petersen-Perlman, & Victoria Hermosilla,
(Water Resources Research Center, University of Arizona)
& Jake Golden (Cherokee Nation of Oklahoma)

Introduction

The 2018 University of Arizona Water Resources Research Center's annual conference, *The Business of Water*, explored multiple issues at the intersection of business and water, including: public-private partnerships; water transactions; the interests of business in water stewardship; and the relationship of water and the environment to economic development. This conference brought together more than 350 people involved in the water world and featured experts from business, utilities, and government, philanthropic organizations, and non-profits operating in the state of Arizona and beyond. This article summarizes the issues discussed at the conference, with an examination of: the foundational value of water; partnerships that take advantage of complementary strengths; water transactions; and ethics and social responsibility.

Creative Collaboration

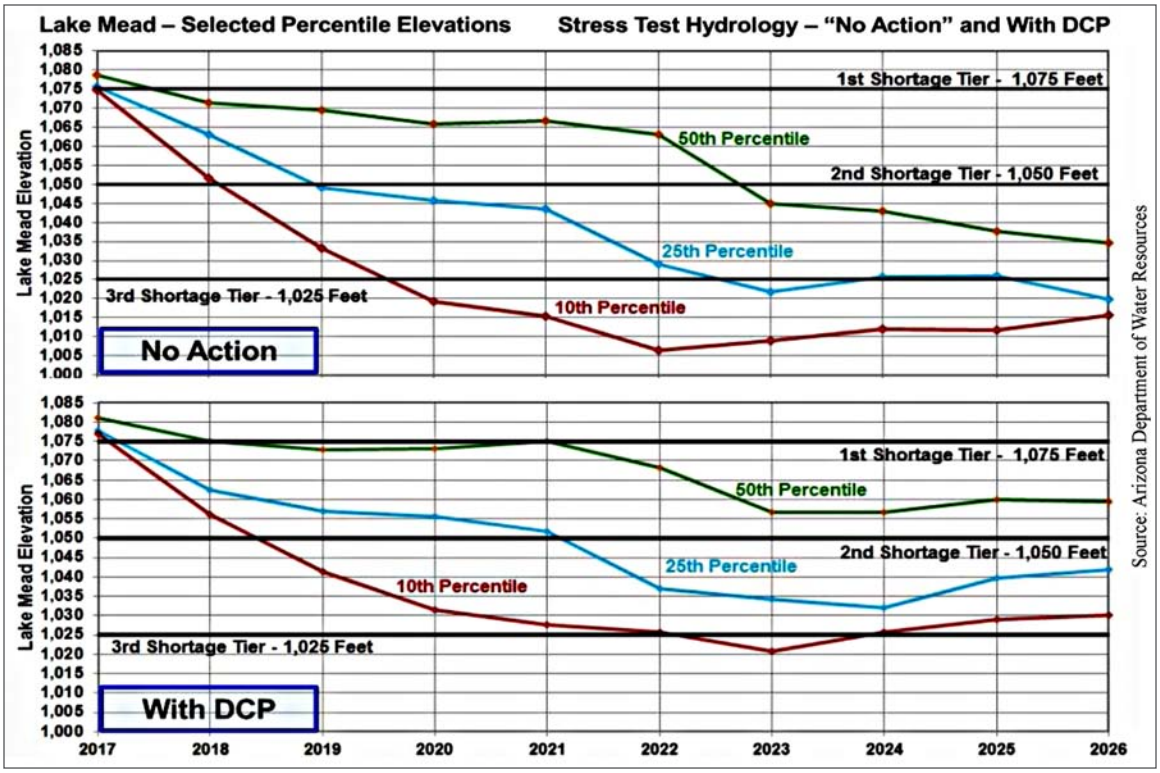
Collaboration Payoffs

Attendees heard from experts on a diverse range of subject matter and found many commonalities among presentations. Topics including the need for creative collaborations and responsible stewardship of financial and water resources provided recurring themes. Speakers emphasized that though collaborations may be difficult, the payoffs — including: increased water security; diverse water portfolios; robust sharing and trading relationships to flexibly adapt to system changes; and better understanding among all parties — are well worth the hard work. The lesson emerged clearly that in a world of limited resources, inclusive and innovative approaches to water management are imperative.

Drought Mitigation (Colorado River)

In the Colorado River Basin, for example, creativity and collaboration are essential to averting serious shortages. Tom Buschatzke, Director of the Arizona Department of Water Resources (ADWR), pointed out that the probability of a Colorado River shortage is close to 50 percent by 2020. Obviously, this is something that Arizona and the other basin states wish to avoid. The States and major water users have been negotiating drought mitigation strategies for several years with some successes. Buschatzke emphasized the importance of completing negotiations on a Drought Contingency Plan (DCP). He noted, however, that there have been delays in completing the DCP. Delay may mean that the opportunity for conserving Mexican water to Lake Mead is lost. Delay also has an impact on the decisions companies are making about doing business in Arizona; an impending water shortage discourages business investment. Arizona is partly responsible for the delay because the State has not been speaking with one voice. Buschatzke stressed the need for Arizona to find a unified voice. [See Buschatzke Interview, *TWR* #149].

Drought Contingency Plan (DCP)



Business of Water

Water Essential

Efficiency & Productivity

Infrastructure Valued

Supply Security

Leasing & Storage Credits

Water & Economics

Risks

Water-Based Recreation

The presentations and panels that preceded Buschatzke's remarks delved into how successful collaborations are structured and what has been learned from joint problem-solving experiences. Successes and challenges were examined and recommendations were offered. As a result, *The Business of Water* shifted the focus on water resources to reveal a new picture of a familiar scene.

The Foundational Value of Water

Water is fundamental to life. Farms, industry, recreation, and community could not exist without water. Statements regarding the foundational value of water set the tone for the day. University of Arizona College of Agriculture and Life Sciences Dean Shane Burgess observed, "Without water, there would be no business." University of Arizona President Robert C. Robbins expanded on this principle, noting that "water is a major opportunity and a major necessity."

Ian Lyle, Executive Vice President of the National Water Resources Association, noted water's foundational role in the national and global economy. Lyle said, "Agriculture relies on water. Ecosystems rely on water. Industry relies on water. The economy relies on water." The western United States needs a stable supply of water, not just for the West, but for the country and the world. Taking irrigated agriculture only, the US provides 20 percent of the world's food production in exports and the need for food will grow 70 percent by 2050. This need will have to be met by a combination of increased agricultural productivity and increased water use efficiency. Lyle reminded the audience that federal infrastructure investment was considered a value by the Founding Fathers, and the US Bureau of Reclamation (Reclamation), which constructed water projects throughout the West, was founded to make the West bloom.

The connection between water and the economy was expanded upon by the City of Phoenix's Nathan Wright (Program Manager, Community and Economic Development). Wright noted that the City often hears concerns about drought and Colorado River shortages from outsiders, who must be convinced that Phoenix has a secure water supply. The City of Phoenix has had a master water plan in place for over 40 years and its water, planning, and development departments work closely to align water strategies with economic action plans. Although they have attracted industries that are heavy water users, such as the semiconductor industry, they have considered the water supply in their industry recruitment; for example, advanced manufacturing cleans and recharges 50-90 percent of water used into the underlying aquifers.

Beyond supporting economic development, water supports other community values. Stephen Roe Lewis, Governor of the Gila River Indian Community (GRIC) in Arizona, discussed the importance of the secure allocation of water the Community receives because of the 2004 Water Settlement Act. This water is allowing them to restore their agricultural heritage and their cultural connection to the Gila River, in conjunction with building the economic strength to improve conditions for community members. The settlement includes funding for a water delivery system — the Pima-Maricopa Irrigation Project (PMIP), which is the largest in the country — for tribes. Under the GRIC water plan, PMIP will be built out in 2027-28. Until then, the Community is looking for fund-raising mechanisms, such as leasing water and marketing water storage credits, to help achieve their long-term goals. Establishing market mechanisms will allow them to supplement federal funding for their agricultural development, as well as meet other community needs. The GRIC's combination of economic and cultural aspirations is exemplified by Ramona Farms, which has been bringing back traditional crops — including tepary beans, wheat, and corn — and selling products to gourmet restaurants.

Corporations may have a different set of aspirations, but water still has major impacts. Ted Kowalski, Senior Program Officer for the Walton Family Foundation, discussed how businesses need clean, reliable water to succeed, and how environmental health goes hand-in-hand with economic health.

Todd Reeve, Chief Executive Officer of the Bonneville Environmental Foundation, also spoke about the link between high quality water supplies and economic health. Reeve noted that the value of water's many uses — such as for ecosystem services, power generation, and commercial goods — can be measured in monetary terms. "All businesses are affected by water," he said, "whether a small-sized business or a Fortune 500 company." Further, he pointed out that businesses were responding to increasing water-related risks, including: toxic algal blooms, which have affected tourism in Florida and commerce in the Great Lakes; wildfires, which endanger lives and property; and decreasing water supplies, which threaten future viability. Some businesses mitigate these risks as responsible members of the communities in which they operate. He stated that when corporations help the environment and contribute to improving the state's water quantity and quality, they are helping themselves at the same time. In Arizona, businesses assess water risks associated with locating to the state as a part of their risk assessment processes. Some companies with vested interests in Arizona have demonstrated leadership by supporting innovative projects employing new technologies and voluntary agreements that make the most of Arizona's limited water resources.

The economic life of small towns in rural Arizona may also depend on their water resources. Sustainable water-based recreation has been a boon to the town of Clarkdale, Arizona. Doug Von Gausig, Mayor of Clarkdale, spoke about collaborative efforts made by his town and other communities in

Business of Water

Eco-Tourism

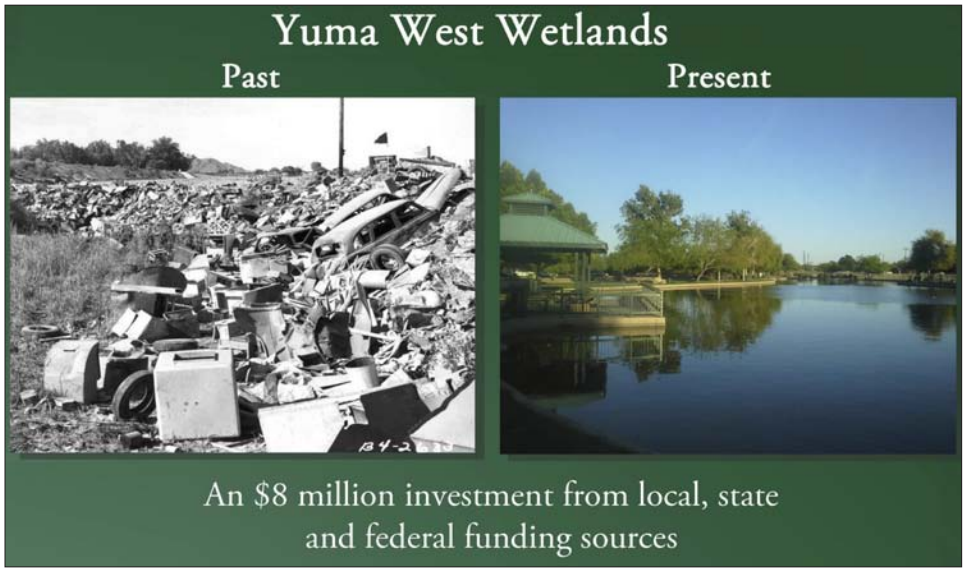
Riparian Restoration

Arizona's Verde Valley to bring recreational opportunities to the Verde River. In the past, the Verde River suffered from pollution coming from the smelters near Jerome, Arizona. Although this industrial activity made worthwhile contributions to the Arizona economy, it led to significant environmental damage, according to Von Gausig. By 1953, there was "no greenery of any kind" on the Verde River. Today, the Verde River supports a healthy ecosystem with stable flows and excellent water quality. The river attracts thousands of kayakers, hikers, birders, and eco-tourists every year. National Geographic now lists the Verde Valley as an ecotourism destination.

Three hundred miles southwest in Yuma, Arizona, riparian restoration revitalized a derelict section of the city. Charles Flynn, Director of the Yuma Crossing National Heritage Area, described how Yuma came up with a common plan for voluntary development of the Yuma Crossing Natural Heritage Area. The effort involved federal, state, and local funding, including $30 million in private investment. The project removed salt cedar and *Arundo donax* (giant reed) from over 400 acres and planted 250,000 cottonwood and willow trees. Benefits have included integrated commerce and recreational waterfront development and possible National Park status for the Yuma Crossing area.

Adapted from Charles Flynn's Presentation

Contrasted Conditions Before & After Public/Private Yuma Crossing Restoration Project



Colorado River Delta (Acquisitions)

River restoration can increase prosperity in affected areas, according to Yamilett Carillo, Director of the Colorado River Delta Water Trust and the "Restauremos El Colorado" program. The program's mission is to secure instream flows for the Colorado River via permanent and temporary water acquisitions and to help restore critical riparian and wetland habitats in the Colorado River Delta in Mexico. The program does this through a water trust which acquires permanent and temporary water rights on behalf of non-governmental organizations working in the Delta. Carillo said the Trust receives donations from both the United States and Mexico, utilities, and non-profits to work on restoration and conservation. Activities undertaken so far have demonstrated the positive impact on river communities through job creation and improved ecosystem health.

Getting Things Done

FINANCING, PUBLIC-PRIVATE PARTNERSHIPS AND OTHER COLLABORATIONS

Infrastructure Investment

One of the more robust topics of discussion throughout the conference was how collaboration among multiple partners is driving infrastructure investment and development. Infrastructure requires large capital investment. In years past, large water works projects were funded by the federal government. According to Ian Lyle, Reclamation has put forward a total of approximately $20 billion of capital investment money for projects like dams and canals. These Reclamation projects constructed in the past now return approximately $20 billion in economic benefits annually. While by this accounting Federal investment in water infrastructure is good policy, it is increasingly difficult to procure, given the on-going congressional stalemate in dealing with federal budget challenges. This retrenchment in federal funding has consequences for water and wastewater projects.

Retrenchment

"P3s"

Public-Private partnerships (P3s) make use of private sector capabilities to achieve public infrastructure goals for a return that satisfies private sector needs. Rod Smith, President of Stratecon, Inc., described the traditional view in which the private sector focused on short-term returns and profits, while the public sector was concerned with the long-term. According to Smith, the role of the private sector is fundamentally different today, incorporating longer-term goals in its decision-making processes while maintaining flexibility and creativity. They are able to take a lead role in developing projects because they do not have the political and institutional constraints of a public body.

Longer-Term Goals

Business of Water

Funding Gap

Desalination Project

Supply Diversification

Public/Private Structure

"Speed of Business"

Partnership Needs

Chris Higgins of Goldman Sachs spoke about how the private sector can help with investments in infrastructure projects. Highlighting the extent of the problem, he cited a recent assessment that found a 70 percent funding gap for water and wastewater projects. He noted that many cities and towns lack sufficient capital or the ability to quickly raise it through a tax or fee on residents. In addition, some cities and towns may be reluctant or unable to issue bonds on expensive construction projects. The private sector can make significant capital investments to help municipalities and local entities address these problems.

The first example of a successful P3 process presented at the conference was the Carlsbad Desalination Project. In Higgins's description, San Diego needed to diversify its water portfolio in the 1990s, but the water utility did not want to associate itself with the high financial risk of funding a desalination project. The Carlsbad P3 agreement put the construction and operations risk of the project on private investors. The San Diego County Water Authority (SDCWA) did not want to risk their AAA bond rating, so debt was issued on the private partner, Poseidon, with its BBB rating, resulting in a higher interest rate. The plant required a $900 million investment, and began producing water for a cost of $2,100 - $2,500 per acre-foot. The SDCWA was willing to pay for this to protect the ratepayers from risk. Investors were willing to take on the construction risk for secure returns once the plant was constructed and brought on line.

As a second example, Mike Irlbeck, Director of Business Development for EPCOR Water, spoke about how San Antonio diversified their water portfolio by importing water through a 140-mile pipeline from Burleson County. Irlbeck said that a great deal of interest exists in the private sector to find safe, low-return investments, particularly in the water sector. The City of San Antonio, like many municipalities, wanted to avoid the financial risks associated with carrying out a large, expensive project, whereas the private sector could be nimbler and more creative in dealing with political and institutional challenges. Similar to the Carlsbad P3, the Vista Ridge Project employed a partnership agreement structured such that the private sector handled managing the risk, acquiring permits, and doing the engineering. They were also responsible for securing the supply, while the public sector was responsible for repaying the costs. The project resulted in delivery of 50,000 acre-feet of water to San Antonio from 18 production wells. The total investment was over $900 million to be repaid by the city over 30 years. After 30 years, ownership of the facilities will be transferred to the city. This arrangement suited the capabilities and needs of both the public and private sector partners.

As a preface to his P3 examples, John H. Moffatt, Economic Development Director of Pima County, Arizona, talked about how the P3 process speeds up project development and completion. He noted that private-sector partners are accustomed to performance-based work because many repayment contracts are performance- or results-focused. According to Moffatt, private-sector partners understand if they don't provide a quality asset, they are unlikely to get paid for it. In the example of the award-winning Agua Nueva Water Reclamation Project, "working at the speed of business" allowed the project to come in under budget and eight months early.

Agua Nueva Water Reclamation Facility / Built through a P3 process by Pima County and private partners

All three P3 examples illustrate that the partnership needs to work for all partners involved. Private-sector partners need to feel secure about the return on their investments, and public-sector partners need to feel that the infrastructure will function well over the long-term. While private-sector partners need a return that balances their risk/reward function, public-sector partners need an asset that functions to effectively achieve its public purpose.

Business of Water

Incentive Payments

Sustainability Goals

Another kind of partnership between cities and the private sector involves how cities attract new businesses. Cities that understand the importance of water sustainability, like Tucson, Arizona, are including requirements for water conservation in their business incentive programs. Timothy Thomure, Director, Tucson Water of Tucson, Arizona, discussed the city's Water Infrastructure Initiative (WII). The WII aims to support development in targeted areas of the community that currently lack water infrastructure. The program conditions the receipt of incentive payments on meeting sustainability criteria. WII Projects must meet three of the following six sustainability goals:

- Sustainable building practices (LEED Silver or higher)
- Minimize potable outdoor water use (After a three-year establishment period, outdoor water use must be 100 percent harvested rainwater or 100 percent sustainable reuse)
- Minimize potable indoor water use
- Increase the urban tree canopy by planting native and/or desert-adapted trees for 25 percent of all non-roof areas over a 10-year establishment period
- Provide alternative transportation incentives that are available to 100 percent of employees and exceed typical standards
- Support a sustainable workforce, where 50 percent of the workforce is employed in green jobs and includes military veterans or those re-entering the workforce after incarceration

In exchange for businesses locating in a WII area, Tucson will offer up to $2 million per project.

Building Relationships

As Todd Reeve, Bonneville Environmental Foundation, observed, many partnerships are the result of building relationships where interests intersect. Taylor Hawes of the Nature Conservancy spoke about building relationships among many partners with the common goals of sustainability and viability of a water resource and the natural and human communities that depend on it. In these circumstances the partners see their relationship as "stepping into battle" along side each other instead of battling against one another. Multiple partners can bring a variety of skillsets to the process of getting things done. Reeve added that there are many solvable challenges that philanthropic organizations can tackle and are already tackling. Several businesses are funding non-profit projects, as well as taking part in volunteer work along riparian areas, or retrofitting their businesses to include more environmentally friendly features.

Von Gausig, who is also Executive Director of the Verde Institute, spoke about his push to improve the culture of neighborliness along the Verde River. Through increased public engagement and the flexibility of local leaders, the Verde River has not only increased its visibility as an eco-tourism destination, but also increased interest from more partners who want to engage in the community in more ways.

Transactions

CHALLENGES AND NEW APPROACHES

Moving Water

Session moderator David Wegner, Senior Scientific Consultant at Jacobs Engineering, defined "water transactions" succinctly as "how we move water." He also noted that the process can be either peaceful or contentious. Normally, water transactions involve an exchange between willing participants in which one party has water and another needs water, but this simplicity hides a multitude of challenges.

Shaky Status Quo

According to Peter Culp, Partner in Culp & Kelly, LLP, "Everybody loves to hate water transactions" because moving water rights from one place to another has been seen as a zero-sum game. Culp went on to explain that in the West, the legal doctrines of prior appropriation (first in time, first in right) and appurtenancy (right being tied to the land), combined with the history of water development, means that water rights are frequently attached to outdated locations. These locations tend to be where people were farming, building, or living in the past, not necessarily where economic pressures are driving economic activity today. The "no harm" or "no injury" rule (other rights holders on the same river may not be harmed by a transaction), anti-speculation provisions, and "use it or lose it" incentives are all part of the Prior Appropriation Doctrine and are barriers to moving water. Rules also prevent water saved through conservation from being put to other uses. In addition, physically moving water is expensive, so transactions tend to take place where infrastructure already exists; that is, locally. Furthermore, moving water from one place to another may threaten the viability and future development of communities on the losing end of a water deal. Intense concern about what happens if water is moved away leads to a defensive reaction: "They are coming for our water!" Culp also stated that most riparian areas in the West have been damaged in some way or eliminated, and moving water can make these compromised areas better or worse.

Barriers

Inertia Impacts Value

All of this tends to keep water where it is, which leads to disparities in the value of water use according to Culp. Water gets stuck in relatively low value uses, while higher value uses are limited by a lack of water. Water used in one place to produce crops may cost $100, while 50 miles away the same quantity of water applied to residential, commercial, or industrial uses may cost $1,000, $10,000, or upwards of a million dollars to produce semi-conductors.

Business of Water

"Green Infrastructure"

Crop Switching

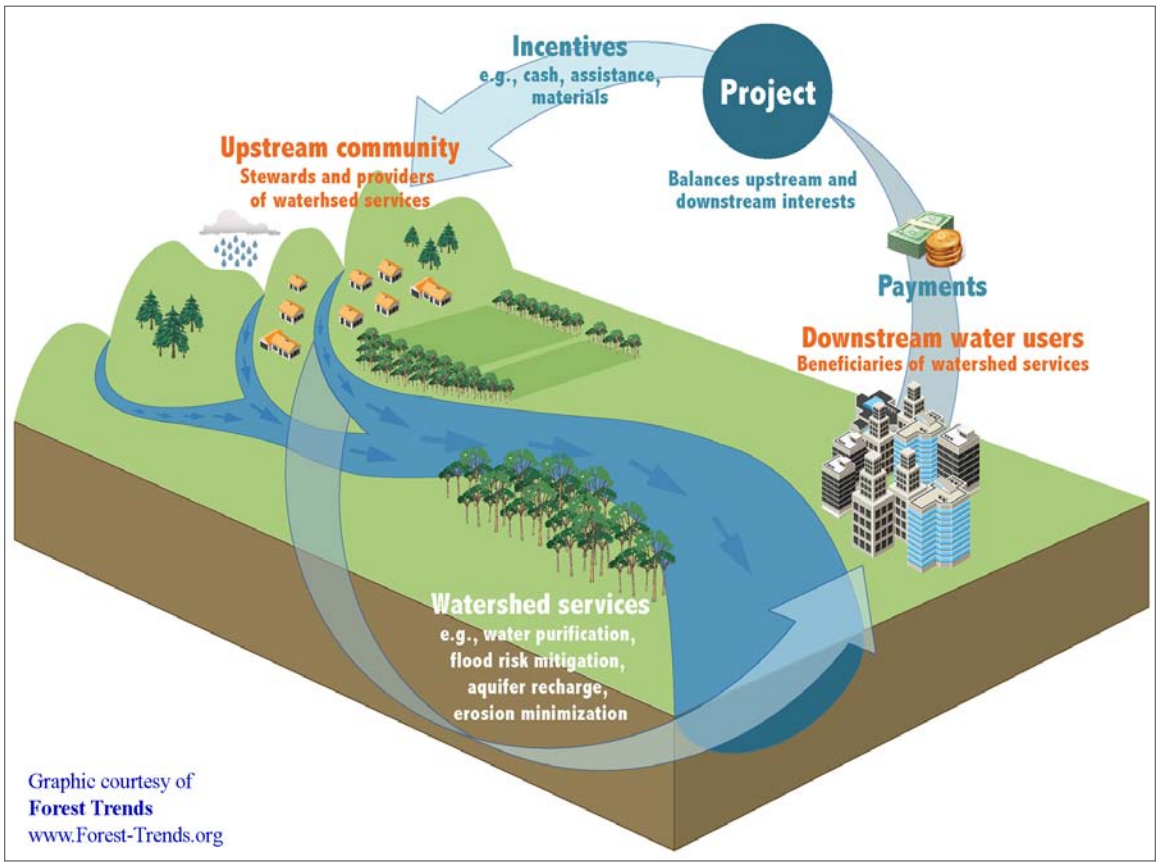
Voluntary Reductions

Incentives & Payments

Tribal Water Transactions

In addition, federal reserved water rights (rights reserved for federal purposes) are linked with the historic treatment of Native Americans. Realization of federally reserved Indian water rights has become a priority. Culp expressed his belief that although change is very hard, it is also inevitable. The pressure of growing scarcity and growing uncertainty will override barriers. There are also many new kinds of transactions that go far beyond the zero-sum game model.

Culp's vision for the future of water transactions involves improvements by cities to protect existing water sources and looking at ways to use "green infrastructure" to make the most of local rainwater. Transactions will look more like investments than trades. Improved efficiency can open opportunities for sharing water supplies and costs. One strategy encourages agricultural crop-switching by developing processing and distribution infrastructure and setting up new markets for low water use, high-yield crops — an example could be investing in a malting facility to encourage the switch from forage to barley. Solutions are flexible and do not result in permanent transfer of water away from the land. In many cases, water savings can be produced much more cheaply than simply paying growers to shut down. The Pilot System Conservation Program for the Colorado River put together a fund with contributions from some of the major water agencies in the basin to compensate water users for voluntary reductions in water use. The program's goal is to reduce water use and increase water storage in Colorado River reservoirs. Reactions have been generally positive, with many water users seeming to be amenable to voluntary compensation reduction. In Culp's opinion, these mechanisms are worth thinking about.



New approaches to water transactions will undoubtedly involve Native American tribes. Gila River Indian Community (GRIC) Governor Lewis emphasized that tribes will play a major role, not just as participants, but also as guides to development. Tribes bring a unique perspective that can influence state-wide and basin-wide planning. Most tribes would rather use all their water on their land according to their needs and values, but in the short term, some tribal water can be turned into funding for essential infrastructure, other tribal government purposes, or an important public purpose, such as protecting storage in Lake Mead.

Lewis laid out three categories of water transaction:

1) Acquisition: acquiring water rights through sale or lease
2) Forbearance: being paid not to use rights
3) Exchange: swapping water from one source for water from another

Exchanges may occur with or without payment. The GRIC's water marketing includes all three categories.

Business of Water

Tribal Marketing

Lewis explained that while tribes cannot sell their reserved water rights, they can enter into leases provided that their congressionally approved water settlements allow it. Tribes without the right to lease water are limited to on-reservation marketing or may be able to enter into forbearance agreements. More recent settlements have more flexibility; they include tradeoffs to market water to generate revenues. Future costs associated with the delivery of their Central Arizona Project (CAP) water motivated the GRIC to begin actively looking at innovative ways to market the community's water. As Lewis said, "Currently, we cannot use all of our waters on our lands. By marketing our water, we can generate revenue and address rising costs."

GRIC Governor Stephen Roe Lewis

The GRIC's experience with water marketing can be divided into two main periods, defined by Lewis as before and after water settlements were enacted. Before reaching settlement, non-Indians often needed tribes to lease back their rights and Non-Indian negotiators applied a kind of political extortion that all tribes have to confront when seeking a settlement. Post-enactment, the GRIC continues to market their water, but with much more flexibility and creativity.

Lewis maintained that most tribes do not like long-term leases (e.g., 100 years) because the ability to use leased water is lost for multiple generations. There can be advantages over short-term leases, however, as short-term leases have high transaction costs due to the need for multiple federal approvals.

Alternatives to leasing include the sale of **l**ong-**t**erm **s**torage **c**redits (LTSCs) generated under rules set forth in Arizona's Groundwater Management Code. Lewis recounted GRIC experiences with LTSCs. "Before the Community had its water settlement, we didn't see eye-to-eye with Salt River Project (SRP). After settlement, the Community decided to go into marketing aggressively. We needed a partner and saw commonalities with SRP. Together we formed the Gila River Water Storage LLC, which stores water off the reservation now but will store more on the reservation. …We've created in this process almost 1.5 million credits since 2010 and have sold over 200,000 of those credits." Lewis characterized their new relationship as a great partnership. [See *Gila Water Storage*, McJunkin, *TWR* #130].

Exchanges are another option described by Lewis. The GRIC sold credits to users who could not recover them because of poor groundwater quality. To solve this problem, the GRIC entered into a separate agreement in which the credits are recovered on GRIC lands for their use, and in return they deliver an equal amount of water to the credit purchasers. This helps to reduce costs for both parties.

Settlement Flexibilities

Lewis remarked that water marketing in Arizona is in nascent state. Costs to acquire water will rise and financing will be a challenge. Arizona needs flexibility to move water around the state. Governor Lewis suggested that his father, the groundbreaking water attorney Rod Lewis, would say that — given the opportunity and flexibility provided by water settlements — tribes can be sophisticated, equal partners and have the opportunity to build systems to address these issues.

The City of Phoenix has also engaged in several water transactions in the past few years and Cynthia Campbell, Water Resources Management Advisor for the City, enumerated the lessons learned and provided examples of the City's creative approach.

Water-for-Water Transaction

The first lesson is that a water transaction is not necessarily money for water. The City's transactions have facilitated the management of water to be available when and where it is needed. A good example described by Campbell is the exchange between Phoenix and Tucson that moves water through time by storing water in Tucson recharge projects. Phoenix entrusts some water to Tucson to be put in the ground with the goal of future water use in Phoenix. When the water is needed in the future, such as when there might be a shortage, Phoenix pumps the water through Tucson's recharge recovery wells and Tucson uses it. At the same time, Tucson accepts delivery of part of their Central Arizona Project (CAP) water through a diversion that directs the water to Phoenix and Phoenix uses that water, in a water-for-water transaction. Metropolitan Water District, a Tucson-area water provider with available recharge capacity, has a very similar agreement with Phoenix.

Water Exchange

In a second example, the City of Avondale, which is located in the southwestern part of the Phoenix metropolitan area, entered into a water exchange with City of Phoenix. Avondale relies on wells and wanted to make use of its CAP water to preserve the aquifer, but lacked the infrastructure to transport the water from the CAP canal. The City is too far from the canal to feasibly construct its own diversion canal. Phoenix, however, could take the CAP water for them, treat it, and send it right to their border using existing infrastructure. Avondale only needed to build the facilities to take the water from their border to their distribution system. This arrangement provides backup in case of a well outage, expands Avondale's portfolio of water resources, and gives them access to actual wet water.

Storage Credits

Phoenix created a number of long-term storage credits, which entitle them to recover a fixed amount of water from recovery wells. These credits were created through aquifer recharge in underground storage

Business of Water

projects within the SRP district. The City has projected that it does not have enough recovery capacity in existing wells. Through an agreement worked out recently, SRP is guaranteeing recovery capacity for Phoenix. As Campbell said, "Water efficiency, sustainability, and moving water through time; those are critically important issues for us."

Collaboration for Conservation

Another lesson Campbell shared is that collaboration is the key to shaping transactions that create efficiencies to deal with the effects of climate change, drought, and aridification. Phoenix participated with several other parties, including the Walton Family Foundation, in an agreement with the GRIC to compensate the Community for leaving 45,000 acre-feet of water in Lake Mead. Arizona and its neighbors in the Colorado River Basin are working to maintain the water level in Lake Mead through system conservation in order to prevent a shortage declaration by the US Bureau of Reclamation, which would trigger reductions in water allocations. The GRIC system conservation effort brought Phoenix no water, but the City of Phoenix is involved with funding because they believe the goal is worthwhile.

Loss of Control Fear

Campbell also learned that the idea of water transactions is scary to people. They fear loss of control and this fear makes them suspicious of transactions. "We need to find a way to allay fears about what water transactions mean," she said.

Exchange Platform

Campbell's final lesson was that transactions are wickedly complex to construct, even if the deal is simple. They often take an inefficient amount of time because of the need to assemble the rules involved in the transaction, appropriate partners, available water supplies, and infrastructure. She concluded that some type of technological tool is needed that can simplify the process. Such a tool would allow potential partners to connect with each other. Past transactions have relied too much on chance and knowing the right people. With an exchange platform, however, the right match can be found.

Ethics & Social Responsibility

Because of water's role at the foundation of human and environmental well-being, business activities relating to the use and management of water are subject to moral and ethical scrutiny. Conference speakers generally concurred that the business of water should take place within a framework that considers its ethical ramifications through space and time.

National Policy?

David Wegner faulted the US government for a failure to provide a unifying policy framework to guide state and local actions. Without a national water policy in the United States, varied legal frameworks and interpretations produce conflicts among states, and between states and the federal government. Litigation replaces what could be otherwise be a common sense approach to solving water problems. It is fair to infer that this approach elevates what is legal above what is just.

Legal v. Just

Richard Morrison of Morrison Enterprises spoke directly to the issue of ethics in water management. Behaving ethically goes beyond obeying laws to considerations of virtue. These can provide ethical benchmarks to test against what is or what may become legal. While complying with the law is necessary, the law is incomplete. Morrison suggested that thinking about public virtue within the context of water policy can provide a basis for defining ethical considerations and boundaries. One element of public virtue is the notion that "I want the same for you as I want for me." Virtue limits personal desires in favor of the needs and desires of others. This attitude can support policies that encourage sustainability and economic justice.

Public Virtue

Principles of economic justice include:

- equal respect for all involved
- special concern for the poor and the disadvantaged
- responding to basic human needs
- human freedom
- contributing to the community
- fulfilling obligations to future generations

Economic Justice Principles

These principles also provide a foundation for sustainability and planning for the long-term. Morrison warned, however, that the principles may conflict and require balancing. For example, maximizing the economic benefits from water transactions to meet the needs of people alive today may limit resources and opportunity for future generations. This can happen when water is moved for the sake of putting it to a higher valued use, thus constraining the future for people located where the water originated. He added that moving water to achieve greater efficiency in use also ignores the intrinsic value of water to a place. Moving water not only may result in a loss of habitat and ecosystem-based economic benefits, but also affect personal identities, often tied to a place. He used the example of rural Arizona, where generations have relied on local water resources to maintain their way of life.

Balancing v. Maximizing

Morrison concluded that ultimately the ethical choice, when developing policies and managing water resources, is to do no harm. This entails looking beyond win-win solutions to see the potential effects on any party that is affected by the action.

Business of Water

Cultural Values

Community Values

Moral Compass

Creating Solutions

Morrison's ideas were influenced by the widespread belief in many tribal communities that planning must include consideration of the next seven generations. GRIC Governor Lewis described the GRIC's plans to manage their water sustainably and to honor tribal traditions while participating in 21st Century water policy-making. In water planning it is important to note the cultural significance water holds for many people; water is intrinsically linked with spirituality and cultural values. Community leaders are working toward their long-term goal of restoring portions of the Gila River. To do this work, they are relying on experts while adhering to their traditions and values. "In two years, riparian wetlands have had animals come back, flora and fauna come back, you can actually see the original flow of the Gila River — it's been an emotional process for reconnecting to our Gila River — our namesake. This has been an amazing time for us," said Lewis.

This focus on community values also drove Tucson's WII program, described above, which according to Tucson Water Director Thomure, was designed to have the following outcomes: build the economy with socially and environmentally responsible businesses; build the right infrastructure at the right time and location; and build partnerships with the private sector to meet common goals.

On a broader scale, Colorado River system conservation was characterized as a moral issue. According to Lewis, the drought is not going away, and GRIC can lightly pat themselves on the back for making an important contribution to responsible water management statewide. They made water available through forbearance for system conservation in Lake Mead. Although they received some payment, it was much less than sale the credits would bring. "We've had water taken away from us. We don't want water to be taken from [others]," said Lewis. "We want to be a moral compass for water conservation," he said. "We want to make sure that we lead the way."

Further on the issue of Colorado River system conservation, ADWR Director Buschatzke's presentation reinforced the social and moral responsibility of all the Colorado Basin states to work together to prevent the system from suffering catastrophic failure. His vision for the future included: demonstration of our values; nurturing of existing and upcoming partnerships; the use of transactions to reach common goals; and a firm stance on the ethics with which we want to define who we are for the future.

Overall, Kevin Moran of the Environmental Defense Fund summed it up best by saying that when considering water policies and decisions, it is important who we choose to be and the creativity we bring along in creating solutions to our water challenges.

A Final Word

The WRRC Annual Conferences attract a broad cross-section of water professionals, academics, advocates, and the interested public. The WRRC aims to provide a forum for multiple perspectives to be heard on important water resources topics. *The Business of Water* focused on issues that are often peripheral to other major water conferences. Speakers were frank about the advantages to water management of incorporating the motivations and potential contributions of business and business approaches. They also made a strong case for framing the business of water within an ethical system that reflects the values of sustainability and justice. In the tradition of WRRC conferences, the 2018 conference provided an opportunity for learning and some food for thought in support of informed water resources discussions and decision-making.

For Additional Information:

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WRRC *The Business of Water* conference agenda website (some presentations available): https://wrrc.arizona.edu/conference-2018-agenda

Susanna Eden is Assistant Director at the Water Resources Research Center, University of Arizona. She holds a PhD in Water Resources Administration from the University of Arizona and has been engaged with water resources research and outreach for 30 years. Her research centers on policy and decision-making in water management, stakeholder engagement, and the use of scientific information. She also writes for and edits the WRRC's quarterly newsletter, *Arizona Water Resource*, and the annual *Arroyo* publication.

Jacob Petersen-Perlman is a Research Analyst at the Water Resources Research Center, where he has focused on international water cooperation issues and issues of groundwater governance and management. He previously served as a post-doctoral scholar through the Ken Alberman Fellowship in Water, Society, and Geopolitics at Hebrew University of Jerusalem, Israel. He earned his PhD in Geography at Oregon State University, his MS in Geography at the University of Montana, and his BS in Meteorology at Iowa State University.

Victoria Hermosilla is currently working as an intern at the WRRC while completing her Master's degree in Hydrology at the University of Arizona. Before returning to graduate school, she worked for four years in Southern Arizona as a field hydrologist, assisting mines with groundwater contamination challenges. She also volunteers with a non-profit organization, helping to install passive and active rainwater harvesting features. Her Bachelor's degree is in Hydrogeology from Northern Arizona University.

Jake Golden, Cherokee Nation of Oklahoma, is a recent graduate from the University of Arizona with an MS in Water, Society, & Policy. Prior to graduation, he held positions at the City of Phoenix and the UA WRRC. His BA is in International Relations and History from the University of Arkansas. Throughout his academic career, he has focused on conflict resolution and tribal water resource management issues.

WATER BRIEFS

FLORIDA V. GEORGIA FL/GA

REMAND TO SPECIAL MASTER

On June 27, the U.S. Supreme Court (Supreme Court) issued a 5-4 decision by Justice Breyer remanding the case back to the Special Master appointed by the Supreme Court "for further findings and such further proceedings as the Master believes helpful." *Florida v. Georgia*, No. 142, Orig. (6/27/2018) (*Slip Op*. at 1). After a month long trial, Special Master Ralph Lancaster, Jr. submitted a 70-page Report to the Supreme Court in February 2017, recommending that Florida's request for an equitable apportionment of the waters of the ACF Basin be denied. *See* Water Briefs, *TWR* #157. The ACF Basin is comprised of the Apalachicola River, Chattahoochee River and the Flint River. The Supreme Court ruled in the June 27th decision, however, that Florida had made a legally sufficient showing as to the possibility of fashioning an effective remedial decree.

This case concerns the proper apportionment of water of an interstate river basin between Florida and Georgia. Florida, a downstream State, brought this lawsuit against Georgia, an upstream State, claiming that Georgia's actions denied it an equitable share of basin waters. The Supreme Court ruled that the dispute lies within the Supreme Court's original jurisdiction, and appointed a Special Master to take evidence and make recommendations. The Special Master's report recommended that the Supreme Court deny Florida's request for relief based on Florida's failure to prove "by clear and convincing evidence that its injury can be redressed by an order equitably apportioning the waters of the Basin." Report of Special Master 3. Florida filed exceptions to the Special Master's Report, resulting in the Supreme Court's decision. The review, as noted below, was limited to a threshold issue.

> We reserve judgment as to the ultimate disposition of this case, addressing here only the narrow "threshold" question the Master addressed below — namely, whether Florida has shown that its "injur[ies can] effectively be redressed by limiting Georgia's consumptive use of water from the Basin without a decree binding the Corps." Report 30–31. This dispositive threshold question leads us, in turn, to focus upon five subsidiary questions:
>
> First, has Florida suffered harm as a result of decreased water flow into the Apalachicola River? (The Special Master assumed "yes.") Second, has Florida shown that Georgia, contrary to equitable principles, has taken too much water from the Flint River (the eastern branch of the Y-shaped river system)? (Again, the Special Master assumed "yes.") Third, if so, has Georgia's inequitable use of Basin waters injured Florida? (The Special Master assumed "yes.") Fourth, if so, would an equity-based cap on Georgia's use of the Flint River lead to a significant increase in streamflow from the Flint River into Florida's Apalachicola River (the stem of the Y)? (This is the basic question before us.) Fifth, if so, would the amount of extra water that reaches the Apalachicola River significantly redress the economic and ecological harm that Florida has suffered? (This question is mostly for remand.)

Slip Op. at 19-20.

The Supreme Court's 37-page opinion delves into several aspects of interstate water disputes, including the burden of proof, the appropriate standard for an equitable decree, equitable principles, and remedy related matters (injury), among others. The Supreme Court also addressed "equitable apportionment" itself. "Where, as here, the Court is asked to resolve an interstate water dispute raising questions beyond the interpretation of specific language of an interstate compact, the doctrine of equitable apportionment governs our inquiry." (citations omitted) *Slip Op*. at 10.

The 37-page opinion by Justice Breyer, along with Justice Thomas' 37-page dissent, provide another view into the current court's outlook on water issues. Ultimately, the Supreme Court found in Florida's favor on the threshold question but ruled that further findings by the Special Master are needed on evidentiary issues. An important finding regarding equitable apportionment was stated near the end of the opinion. "We repeat, however, that Florida will be entitled to a decree only if it is shown that 'the benefits of the [apportionment] substantially outweigh the harm that might result.' *Colorado I*, 459 U. S., at 187." *Slip Op.* at 36.

Finally, Justice Breyer provided some caveats to guide the Special Master as he once again addresses evidentiary questions.

> Consistent with the principles that guide our inquiry in this context, answers need not be "mathematically precise or based on definite present and future conditions." *Id*., at 1026. Approximation and reasonable estimates may prove "necessary to protect the equitable rights of a State." *Ibid*. And the answers may change over time. Cf. *New Jersey v. New York*, 347 U. S. 995, 996–1005 (1954); *New Jersey v. New York*, 283 U. S., at 344–346. Flexibility and approximation are often the keys to success in our efforts to resolve water disputes between sovereign States that neither Congress "nor the legislature of either State" has been able to resolve. *Virginia v. West Virginia*, 220 U. S., at 27.

Slip Op. at 37.

For info: Opinion available at: www.scotusblog.com/case-files/cases/florida-v-georgia-2/

WATER BRIEFS

CULVERT CASE WA

9th circuit upheld

The US Supreme Court (Supreme Court) issued a 4-4 decision on the "Culvert Case" on June 11th. With Justice Kennedy not voting (he recused himself due to his participation in the case some 30 years ago), the deadlock means that the lower court decision remains in effect. The Supreme Court announced its 4-4 decision, but issued no opinion in the case. *Washington v. United States*, 584 U. S. ____ (2018). In 2013, Federal District Court Judge Ricardo Martinez issued his ruling in the case — which was upheld by the 9th Circuit and now affirmed by the Supreme Court — that Native American Tribes not only have a treaty right to fish for salmon, but also that the right includes having fish available for harvest. In this case, the treaty right compels the State of Washington to restore habitat by replacing hundreds of culverts that block salmon's access to spawning streams. The 9th Circuit found that the State's culverts violated — and continue to violate — the Tribes' treaty rights under what are known as the "Steven Treaties." It has been estimated that fixing and replacing the State's culverts will cost $2 billion; Judge Martinez' order gave the State 17 years to fix the highest priority blocking culverts. For additional information and background, see Moon, *TWR* #110 and #149; Water Briefs, *TWR* #160; and Mecham, *TWR* #154.

Washington's Attorney General Bob Ferguson issued a press release on June 11th that reiterated some of the arguments of the State. According to Ferguson, the ruling forces the state to pay 100% of the cost of replacing barrier culverts, even though the federal government provided the design for those culverts, and regardless of whether other barrier culverts block salmon from getting to the state culverts. "It is unfortunate that Washington state taxpayers will be shouldering all the responsibility for the federal government's faulty culvert design. The Legislature has a big responsibility in front of it to ensure the state meets its obligation under the court's ruling. It's also time for others to step up in order to make this a positive, meaningful ruling for salmon. Salmon cannot reach many state culverts because they are blocked by culverts owned by others. For example, King County alone owns several thousand more culverts than are contained in the entire state highway system. The federal government owns even more than that in Washington state. These culverts will continue to block salmon from reaching the state's culverts, regardless of the condition of the state's culverts, unless those owners begin the work the state started in 1990 to replace barriers to fish."

Ferguson did go on to address what lies ahead for the parties in his press release. "I look forward to working with tribal governments to advocate for the funding necessary to comply with this court order, and to ensure other culvert owners do their part to remove barriers to salmon passage."

Tribal officials meanwhile hailed the decision. "There is a choice to be made now that the Supreme Court has made clear that the treaties promised tribes there would always be salmon to harvest, and that the state has a duty to protect those fish and their habitat. One thing is certain: We will never stop fighting to protect and restore salmon habitat because that is the key to recovery," stated Lorraine Loomis, chair of the Northwest Indian Fisheries Commission (NWIFC), in her monthly column *Being Frank*. Loomis also said that the "ruling will open hundreds of miles of high quality salmon habitat that will produce hundreds of thousands more salmon annually for harvest by everyone." While noting the "state's shameful history of denying tribal treaty-reserved fishing rights" Loomis went on to urge that the parties choose a "path of cooperation" as advocated previously by the Commission's late chairman, Billy Frank, Jr.: "We can all win if we work together," she said.

The ramifications of the ruling are undoubtedly important. *The Water Report* will be publishing a major article discussing the case and its significance in our next issue.

For info: NWIFC website: https://nwifc.org/; Washington AG's office at: www.atg.wa.gov

WATER ACQUISITION OR/CA

klamath wildlife refuges

On June 22, the US Bureau of Reclamation (Reclamation) released a draft Environmental Assessment (EA) to disclose potential environmental effects and solicit public comment associated with a proposed water acquisition for National Wildlife Refuges within the Klamath Basin Refuge Complex. The Klamath Basin, similar to much of California and Oregon, had a prolonged dry winter. As of June 1, no snowpack remains in the upper basin, and the governors of California and Oregon have both declared a drought in the region. Drought conditions have limited the availability of water for the refuges in 2018. The constraints on water will reduce habitat and food sources for migratory birds in the Pacific Flyway as well as other wildlife.

Under the proposal, Reclamation could acquire up to 50,000 acre-feet of surface water supply from Klamath Project contractors for the benefit of migratory waterfowl and wetland-dependent wildlife in the refuges during the current drought year. The draft EA was prepared in accordance with the National Environmental Policy Act and is available at: www.usbr.gov/mp/nepa/nepa_base.php?location=kbao.

For info: Kirk Young at byoung@usbr.gov

STORMWATER CAPTURE CA

policies & funding

The Pacific Institute released *Stormwater Capture in California: Innovative Policies and Funding Opportunities* on June 28th following its review of stormwater programs across the country. The report provides insight on the potential of using stormwater as a local water supply. It includes recommendations on expanding stormwater capture in California.

Traditionally managed to mitigate flooding and protect water quality, stormwater has gained recent attention as a valuable local water supply option in water-stressed areas. As climate change increases the risk of both floods and droughts in California, urban stormwater capture also offers a significant opportunity to enhance community resilience. Stormwater

capture, especially when done with green infrastructure, can improve air quality, provide habitat, and reduce energy use, among other benefits.

This report from the Pacific Institute presents a summary of regulations, laws, and statewide initiatives that create the legal framework for stormwater management in California. The Report explores effective programs and initiatives in California communities and in other states, and concludes with a set of recommendations to overcome obstacles and expand stormwater capture in California.

Recommendations for supporting stormwater capture in California include: expanding state funding and reducing barriers for local funding of stormwater management (including how to improve the usefulness and uptake of the Clean Water and Drinking Water State Revolving Funds); developing dedicated, local funding sources for stormwater management (including basing stormwater fees on impervious area); and adopting policies, such as regulatory approaches or explicit local water policy goals, that drive innovative and sustainable approaches for water supply.

For info: Report available at http://pacinst.org/news/stormwater-capture-in-california/

AQUIFER RECHARGE CA

RECHARGE NET METERING

On July 3, the Center for Law, Energy + the Environment (CLEE) at the University of California - Berkeley released an "Issue Brief" on innovative incentives for groundwater recharge. Increasing recharge of aquifers will be a crucial component for achieving groundwater sustainability, which depends on balancing aquifer inflows and outflows. Extraction (pumping of groundwater) and recharge (inflow of water to an aquifer from the land surface and streams) are central components of this water balance.

Managed Aquifer Recharge (MAR) is a set of techniques used to improve groundwater conditions by routing surface water into aquifers. MAR based on the distributed collection of stormwater ("distributed MAR") can be accomplished at an intermediate scale, generating hundreds to thousands of acre-feet/year of infiltration benefit. A key challenge is creating incentives that will motivate landowners, tenants, and other stakeholders to participate. Distributed MAR projects can be funded by a limited number of private participants, but public benefits may accrue more broadly. Developing and implementing policies to encourage the creation and operation of distributed MAR systems is a challenge at the frontier of groundwater management.

Recharge Net Metering (ReNeM) is a strategy that incentivizes MAR by offsetting costs incurred by landowners for operation and maintenance of water collection and infiltration systems that are placed on their land. ReNeM participants benefit directly through the rebate program; they also benefit indirectly (along with other resource users and regional aquatic systems) because MAR helps to improve and sustain the supply and quality of groundwater.

ReNeM is derived from a renewable energy incentive known as Net Energy Metering (NEM), a popular model that encourages adoption of rooftop solar panels. NEM rewards customers for their onsite generation of electricity, by charging them when they draw power from the grid (such as during evening activity), and giving them a credit on their electricity bill when power flows to the grid (when generating excess power). In a similar way, ReNeM rebates link water use to generation of supply for other purposes. In ReNeM, participants infiltrate excess surface water; are rewarded on the basis of quantity of water infiltrated each year; infiltration generates a rebate on pumping or other use fees; no right to withdraw infiltration water is implied; and benefits accrue to the entire basin.

CLEE's Issue Brief presents a concise conceptual description of ReNeM, as well as a brief account of its first implementation as a pilot program in the Pajaro Valley of California.

For info: Mike Kiparsky, 510/ 643-6044, kiparsky@berkeley.edu or www.law.berkeley.edu/research/clee/research/wheeler/renem/

COLORADO RIVER AZ/CA/NV

CONSUMPTIVE USE REPORT 2017

Reclamation recently released the *Colorado River Accounting and Water Use Report: Arizona, California, and Nevada - Calendar Year 2017* (dated May 2018). The Colorado River is the principal source of water for irrigation and domestic use in Arizona, southern California, and southern Nevada. The Consolidated Decree of the U.S. Supreme Court in *Arizona v. California* (547 U.S. 150 (2006)) requires the Secretary of the Interior to provide detailed and accurate records of diversions, return flows, and consumptive use of water diverted from the mainstream of the Colorado River below Lee Ferry (lower Colorado River). Copies of the 2017 and previous years' reports may be found on Reclamation's website listed below.

The "Water Accounting Report" tabulates measured diversions, measured returns, and consumptive use of each user taking water from the lower Colorado River. For 2017, the three states consumptive use total was 6,779,443 acre-feet. The states have instituted various conservation measures to try to keep Lake Mead from dropping to levels that would cause "shortage" conditions to be implemented for the Colorado River. Under the 2007 Interim Guidelines, if the Lake Mead elevation drops below 1,075 feet, the Secretary of the Interior automatically implements the shortage guidelines and reduces the allocation of Colorado River water to Arizona and Nevada (see Interim Guidelines at: www.usbr.gov/lc/region/programs/strategies/RecordofDecision.pdf).

For info: Reclamation website: www.usbr.gov/lc/region/g4000/wtracct.html

WATERSENSE REPORT US

ACCOMPLISHMENTS 2017

WaterSense is out with its annual accomplishments report: *WaterSense Accomplishments 2017: Let's Keep Saving Water!* The 2017 list includes new specifications for home irrigation sprinklers, and a pilot program to fix water leaks in Fort Worth, Texas. WaterSense is a program sponsored by EPA.

WATER BRIEFS

WaterSense officially launched June 12, 2006. Through the end of 2017, WaterSense has helped Americans save a cumulative 2.7 trillion gallons of water and more than $63.8 billion in water and energy bills. Additionally, the use of WaterSense labeled products saved 367 billion kilowatt-hours of electricity.
For info: WaterSense website:www.epa.gov/watersense

WATER USE IN THE US US

USGS REPORT

On June 19, the US Geological Survey (USGS) posted its report *Estimated Use of Water in the United States in 2015*. The report is available in full on the website listed below.

Water use in the United States in 2015 was estimated to be about 322 **b**illion **gal**lons per **d**ay (Bgal/d), which was 9% less than in 2010. The 2015 estimates put total withdrawals at the lowest level since before 1970, following the same overall trend of decreasing total withdrawals observed from 2005 to 2010. Freshwater withdrawals were 281 Bgal/d, or 87% of total withdrawals, and saline-water withdrawals were 41.0 Bgal/d, or 13% of total withdrawals. Fresh surface-water withdrawals (198 Bgal/d) were 14% less than in 2010, and fresh groundwater withdrawals (82.3 Bgal/day) were about 8% greater than in 2010. Saline surface-water withdrawals were 38.6 Bgal/d, or 14% less than in 2010. Total saline groundwater withdrawals in 2015 were 2.34 Bgal/d, mostly for mining use.

Thermoelectric power and irrigation remained the two largest uses of water in 2015, and total withdrawals decreased for thermoelectric power but increased for irrigation. Withdrawals in 2015 for thermoelectric power were 18% less and withdrawals for irrigation were 2% greater than in 2010. Similarly, other uses showed reductions compared to 2010, specifically public supply (-7%), self-supplied domestic (-8%), self-supplied industrial (-9%), and aquaculture (-16%). In addition to irrigation (2%), mining (1%) reported larger withdrawals in 2015 than in 2010. Livestock withdrawals remained essentially the same in 2015 compared to 2010 (0% change). Thermoelectric power, irrigation, and public-supply withdrawals accounted for 90% of total withdrawals in 2015.

Irrigation withdrawals were 118 Bgal/d in 2015, an increase of 2% from 2010 (116 Bgal/d), but were approximately equal to withdrawals estimated in the 1960s. Irrigation withdrawals, all freshwater, accounted for 42% of total freshwater withdrawals for all uses and 64% of total freshwater withdrawals for all uses excluding thermoelectric power. Surface-water withdrawals (60.9 Bgal/d) accounted for 52% of the total irrigation withdrawals, or about 8% less than in 2010. Groundwater withdrawals for irrigation were 57.2 Bgal/d in 2015, about 16% more than in 2010. About 63,500 thousand acres (or 63.5 million acres) were irrigated in 2015, an increase from 2010 of about 1,130 thousand acres (2%). The number of acres irrigated using sprinkler and microirrigation systems accounted for 63% of the total irrigated lands in 2015. Total consumptive use for irrigation was 73.2 Bgal/d in 2015 or 62% of total use (withdrawals and reclaimed wastewater).

In 2015, more than 50% of the total withdrawals in the US were accounted for by 12 States (California, Texas, Idaho, Florida, Arkansas, New York, Illinois, Colorado, North Carolina, Michigan, Montana, and Nebraska). Californa accounted for almost 9% of the total withdrawals and 9% of freshwater withdrawals in the US, predominantly for irrigation. Texas accounted for almost 7% of total withdrawals, predominantly for thermoelectric power, irrigation, and public supply. Florida accounted for 23% of the total saline-water withdrawals in the US, mostly from surface-water sources for thermoelectric power. Texas and California accounted for 59% of the total saline groundwater withdrawals in the US, mostly for mining.
For info: Full Report at: https://pubs.er.usgs.gov/publication/cir1441; Addt'l info: https:water.usgs.gov/watuse/

MANITOBA SETTLEMENT US/CANADA

WATER TREATMENT PLANT

On June 27, US Reclamation and the Government of the Province of Manitoba announced they had reached a settlement ending Manitoba's appeal of the US District Court's August 2017 decision granting summary judgment in favor of Reclamation relating to the Northwest Area Water Supply Project (NAWS).

On June 22, the US Department of Justice, the Province of Manitoba and the State of North Dakota filed a Joint Motion for Voluntary Dismissal with the U.S. Court of Appeals for the District of Columbia Circuit. The parties have resolved their dispute through a Memorandum of Understanding (MOU) pertaining to Manitoba's participation in the development of the Adaptive Management Plan for the operation, maintenance and replacement of the NAWS Biota water treatment plant. The settlement resolves Manitoba's appeal. In the NAWS Record of Decision issued in August 2016, Reclamation committed to establishing an adaptive management team to assist in the development of the adaptive management plan. Reclamation reiterated this commitment in the settlement agreement with Manitoba.

Other federal, state and local entities with relevant expertise will also be invited to participate on the adaptive management team. No schedule for the adaptive management team/adaptive management plan development is available at this time. Design and construction of the NAWS Project features is proceeding. Currently, construction of upgrades at the Minot water treatment plant are underway and design work is proceeding for the biota water treatment plant.
For info: Alicia Waters, Reclamation, 701/ 221-1206 or awaters@usbr.gov

CALENDAR

July 16-20 MT
Water Law in Indian Country - Summer Program, Missoula. University of Montana School of Law; 9 am - 12 pm each day. Blewett School of Law 11th Annual Summer American Indian & Indigenous Law Program. For info: umt.edu/indianlaw

July 17-18 NM
AGWT Groundwater Conference: States' Rights & the Control of Groundwater, Albuquerque. State BAR of New Mexico, 5121 Masthead NE. Presented by American Ground Water Trust. For info: https://agwt.org/events

July 18 WEB
Managing Groundwater Storage Webinar, WEB. Free Webinar: Registration Required; 1-2 pm EDT. Presented by the American Geosciences Institute. For info: www.americangeosciences.org/policy-critical-issues/webinars/managing-groundwater-storage

July 19-20 WA
Tribal Water in the Pacific Northwest Conference, Seattle. Crowne Plaza Hotel. For info: Law Seminars Int'l, 206/ 567-4490 or www.lawseminars.com

July 19-21 BC
64th Annual Rocky Mountain Mineral Law Institute, Victoria. Victoria Conference Centre. For info: www.rmmlf.org/

July 20 OR
Agriculture Law Seminar, Bend. The Oxford Hotel, 10 NW Minnesota Avenue. For info: The Seminar Group, 800/ 574-4852, info@theseminargroup.net or www.theseminargroup.net

July 22-24 AZ
Arizona WateReuse Symposium, Flagstaff. Little America Hotel. Presented by WateReuse. For info: https://watereuse.org/event/az-water-reuse-symposium/?instance_id=323

July 26-27 CA
Sustainable Groundwater Planning in California: Important Practical Legal, Technical, Business & Regulatory Information for Preparing GSPs, Sacramento. Holiday Inn Downtown Sacramento. For info: Law Seminars Int'l, 206/ 567-4490 or www.lawseminars.com

July 26-27 CO
Long Term Capital & Financial Planning for Municipal/Public Water and Wastewater Utilities, Denver. EUCI Office Building Conference Center. For info: www.euci.com/conferences

August 1-3 OR
2018 Western States Water Council Summer (187th) Meeting, Newport. Best Western Agate Beach Inn. For info: www.westernstateswater.org/upcoming-meetings

August 1-3 UT
Western Water Seminar, Park City. Park City Resort. Presented by National Water Resources Assoc. For info: NWRA, www.nwra.org/upcoming-conferences-workshops.html

August 2-3 AZ
Arizona Water Law 26th Annual Conference: Reforms, Initiatives & In-Depth Legal Analysis, Scottsdale. Hilton Scottsdale Resort. For info: CLE Int'l, 800/ 873-7130, live@cle.com or www.cle.com

August 6-7 DC
Transformative Issues Symposium on Infrastructure Affordability, Washington. Washington Court Hotel. Presented by American Water Works Assoc.. For info: www.awwa.org/conferences-education/conferences.aspx

August 8 CA
Maximizing America's Alluvial Aquifers Conference, Healdsburg. Westside Water Education Facility, 9703 Wohler Road. Presented by American Ground Water Trust. For info: https://agwt.org/events

August 8 NM & WEB
New Directions in Hydrology & Water Law Seminar: Intensive Look at Broadening Areas Where Scientific Proof is Required in Water Disputes, Santa Fe. Hilton of Santa Fe Historic Plaza Hotel. For info: Law Seminars Int'l, 206/ 567-4490 or www.lawseminars.com

August 9 OR
Portland Harbor Superfund Site Cruise (Field Trip), Portland. Crystal Dolphin, 2:45 pm - 5 pm. Presented by OSB Environmental & Natural Resources Section: Sales end July 25th. For info: Caylin Barter, caylin.barter@jordanramis.com

August 9-10 NM & WEB
Natural Resource Damages Seminar, Santa Fe. Hilton of Santa Fe Historic Plaza Hotel. For info: Law Seminars Int'l, 206/ 567-4490 or www.lawseminars.com

August 12-15 CO
StormCon Denver (2018): The Surface Water Quality Conference & Expo, Denver. Hyatt Regency Denver at Colorado Convention Center. For info: https://www.stormcon.com/

August 12-15 TN
International Low Impact Development Conference, Nashville. JW Marriott Hotel. Presented by American Society of Civil Engineers. For info: www.lidconference.org

August 16-17 WA & WEB
Water Law in Central Washington Seminar & Live Webcast, Ellensburg. Red Lion Hotel & Conference Center. For info: The Seminar Group, 800/ 574-4852, info@theseminargroup.net or www.theseminargroup.net

August 16-17 WA & WEB
Clean Water & Stormwater Seminar, Seattle. Courtyard by Marriott Seattle Downtown/Pioneer Square. For info: Law Seminars Int'l, 206/ 567-4490 or www.lawseminars.com

August 20-23 OR
Oregon Association of Water Utilities Summer Conference, Seaside. Seaside Convention Center. For info: https://oawu.net/

August 28-29 DC
Water Finance Conference, Washington. The Washington Court Hotel. Presented by the National Association of Clean Water Agencies. For info: http://waterfinanceconference.com/

September 4-6 Mexico
Aquatech Mexico 2018, Mexico City. Mexico Room, WTC Mexico City, Montecita 38, Napoles. For info: www.aquatechtrade.com/en/mexico/

September 9-12 TX
33rd Annual WateReuse Symposium, Austin. JW Marriott Hotel. Presented by WateReuse. For info: https://watereuse.org/news-events/conferences/

September 12-13 IL
US Power Plant Water Treatment Conference, Chicago. For info: www.lmnpower.com/power-water-treatment-conference

September 13-14 TX
Texas Desal Conference, Austin. Sheraton Austin at the Capitol. For info: www.texasdesal.com/events/2018-conference

September 17-19 TX
WaterPro Conference, Fort Worth. Fort Worth Convention Center. Annual Conference of the National Rural Water Assoc. on Water & Wastewater Utility Systems. For info: www.waterproconference.org

September 20 WA
Northwest Remediation Conference, Tacoma. Greater Tacoma Convention Center. Remediating Brownfields, Sediments & More. For info: www.nwremediation.com

September 20-21 NM
New Mexico Water Law 26th Annual Conference: The Latest Updates from All Points of View, Santa Fe. Eldorado Hotel & Spa. For info: CLE Int'l, 800/ 873-7130, live@cle.com or www.cle.com

September 24 WA
CERCLA + MTCA: Advanced Sediments Conference, Seattle. Washington State Convention Center. For info: Holly Duncan, Environmental Law Education Center, 503/ 282-5220, info@elecenter.com or www.elecenter.com

The Water Report
Water Rights, Water Quality & Water Solutions in the West
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CALENDAR

(continued from previous page)

September 24-25 FL
Managing Florida's Aquifers: Annual Conference, Orlando. Florida Hotel & Conference Center, 1500 Sand Lake Road. Presented by American Ground Water Trust. For info: https://agwt.org/events

September 25-27 CA
First Annual Western Groundwater Congress - Technical Conference on Western Groundwater Quality & Groundwater Resources, Sacramento. DoubleTree by Hilton. Presented by Groundwater Resources Assoc. of California. For info: www.grac.org/events/151/

September 26-29 FL
Association of Water Technologies (AWT) Annual Convention & Exposition, Orlando. Omni Orlando Resort. For info: www.awt.org/annualconvention18/

September 29-Oct. 3 LA
WEFTEC 2018: The Water Quality Event & Exhibition, New Orleans. Morial Convention Ctr. Presented by Water Education Foundation. For info: www.weftec.org/future-weftec-schedule/

October 3-5 NV
11th Annual Water Smart Innovations Conference & Expo, Las Vegas. South Point Hotel and Conference Center. For info: WaterSmartInnovations.com

October 11-12 MT & WEB
Montana Water Law Conference - 18th Annual, Helena. Great Northern Hotel. For info: The Seminar Group, 800/ 574-4852, info@theseminargroup.net or www.theseminargroup.net

October 11-12 AZ
Tribal Water Law Conference, Scottsdale. WE-Ko-Pa Resort & Conference Center. For info: CLE Int'l, 800/ 873-7130, live@cle.com or www.cle.com

October 14-17 CA
Association of Metropolitan Water Agencies Executive Management Conference, San Francisco. TBA. Sharing Ideas and Building Relationships Among Top Drinking Water Utility Executives. For info: www.amwa.net/event/2018-executive-management-conference

October 15-17 CA
Connecting the Drops From Summit to Sea: CASQA 2018 14th Annual Conference, Riverside. Riverside Convention Center. Presented by California Stormwater Quality Ass'n. For info: www.casqa.org/events/annual-conference