# Appendix 4B
# Case Studies

**May 2015**

# 4B Case Studies

## Case Study 1

## Central Arizona Project Service Area Irrigation Districts' Agricultural Conservation Activities

Arizona

### *Overview*

Agricultural water users are among the most junior served by the Central Arizona Project (CAP). Since the 1980 Arizona Groundwater Management Act and subsequent authorizations such as the 2002 Agricultural Best Management Practices Program, irrigation districts and individual water users in the CAP service area have invested in a range of water conservation measures.

### *Description*

Within the CAP service area, Arizona's water management framework requires mandatory agricultural water conservation by all districts and limits the expansion of agricultural lands. This has resulted in a general decline in agricultural water use over the past 30 years. During this period, more than 150,000 acres were converted to high-efficiency, laser-level basins with efficiencies estimated near 85 percent, along with the adoption of other highly efficient technologies such as sprinkler and micro-irrigation practices. As a complement, conveyance improvements have reduced delivery losses from approximately 10 percent to near 3 percent in many areas.

### *Outcome*

Irrigation districts in the CAP service area have made significant investments, totaling over $750 million in water-efficient practices and infrastructure. This represents an average per acre of $3,700 (2013 dollars), of which roughly $2,700 was attributed to reducing losses through conveyance improvements. Similar investments have and continue to be adopted across agriculture served by the Colorado River. This case study serves to highlight the cost associated with implementing common efficiency enhancements and illustrates the types of measures that have been implemented by irrigators throughout the Basin.

**Agencies**

Central Arizona Project, Arizona Department of Water Resources

**Project Status**

Ongoing

**Key Program Elements**

Growers and districts are incentivized to improve water use efficiency

**Budget**

More than $750 million invested in agricultural efficiency improvements

**Water Savings**

Much of the agriculture in the CAP service area exceeds 80% water use efficiency

The Central Arizona Project delivers Colorado River water to users in the Phoenix area and beyond
*Source: Central Arizona Project*

### *Sources*


- Cullom, Chuck. 2014. "Case Study Example Central Arizona Project Irrigation Districts." Presentation to the Agricultural Conservation, Productivity, and Transfers Work Group. March 26.
- Evaluation of the Best Management Practices Agricultural Water Conservation Program: http://www.azwater.gov/azdwr/WaterManagement/AMAs/PinalAMA/documents/EvaloftheBMPReport.pdf

**Case Study 2**

# A Case Study in Efficiency – Agriculture and Water Use in the Yuma, Arizona Area

Yuma County Agricultural Water Coalition, Arizona

## *Overview*

Yuma area agricultural practices have changed considerably since the early 1900s. These changes came mainly as a result of food industry demand. Area growers adapted to consolidated production processes. Grower adaptation to food industry demand resulted in Yuma becoming the center for winter vegetable production in the U.S. Required efficiency and consistency improvements for quality, size, uniformity, and yield were met. Using more efficient infrastructure and irrigation practices, growers are producing higher-crop yields with less water.

**Entity**

Yuma County Agricultural Water Coalition

**Project Status**

Agricultural water use efficiency and productivity continue to be a priority in the area

**Key Program Elements**

- Infrastructure improvements
- Adoption of practices such as multi-cropping

**Budget**

Many efficiency and productivity enhancements have been made by individual growers in response to market demands

**Water Savings**

Since 1970, growers are irrigating 50% more crop acres with about 20% less water

## *Description*

Before 1975, agricultural production occurred largely on single cropped acreage. During the last 40 years, multi-crop production has increased almost 600 percent. Multi-cropping is the practice of growing multiple vegetable crops on the same land in the same season. Growers also multi-crop both vegetable and non-vegetable crops on the same land in the same year. Multi-cropping takes place on more than 80 percent of the cultivated acreage in the area.

The increase in multi-cropping reflects the emphasis on increasing yield (see Figure 4B-1). Vegetable production acreage expanded from 30,000 acres in 1970 to more than 130,000 acres in 2010. Vegetable production increased more than 400 percent in the same period.

The long growing season and infrastructure unique to the area make multi-cropping possible. Yuma area agriculture also developed the capability of growing, harvesting, cooling, storing, and shipping winter vegetables. Those winter vegetables (iceberg, leaf, romaine lettuce, broccoli, cauliflower, and spinach) along with cantaloupe and honeydew melons have the largest crop acreage footprint in the region, more than 80 percent.

The irrigated acreage increase occurred in conjunction with an overall reduction of on-farm water deliveries (see Figure 4B-2). In 1970, using more than 1 million acre-feet, growers produced 187,000 acres of crops. In 2010, growers produced 270,000 acres of crops on 150,000 acres of land using 880,000 acre-feet of water.

## *Outcome*

Infrastructure improvements and practices such as multi-cropping have notably enhanced Yuma area agricultural productivity. For example, the area ranks in the top 0.1 percent of counties in vegetable and melon sales nationally. Other rankings include the top 0.5 percent in sales of all crops and the top 1 percent in combined sales of crop and livestock products. Correspondingly, this high agriculture productivity has had a significant influence on local economic growth, both overall and for ancillary sectors. It is estimated that agriculture and related industries contribute to one in four area jobs. The combination of national prominence and local significance highlights the universal value of agriculture in highly productive areas such as Yuma County.

## *Sources*


- Wade Noble/Yuma County Agriculture Water Coalition, personal communication. October 31, 2014.
- Yuma County Agriculture Water Coalition. 2015. A Case Study in Efficiency – Agriculture and Water Use in the Yuma, Arizona Area. www.agwateryuma.com


**FIGURE 4B-1**
Yuma County Crop Acreage

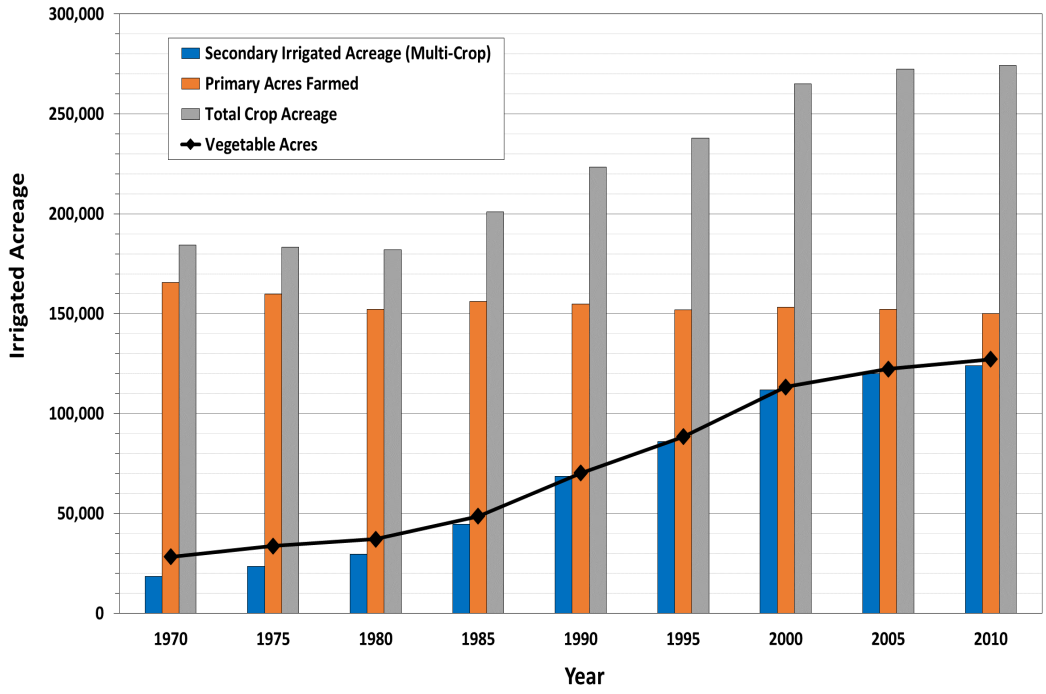
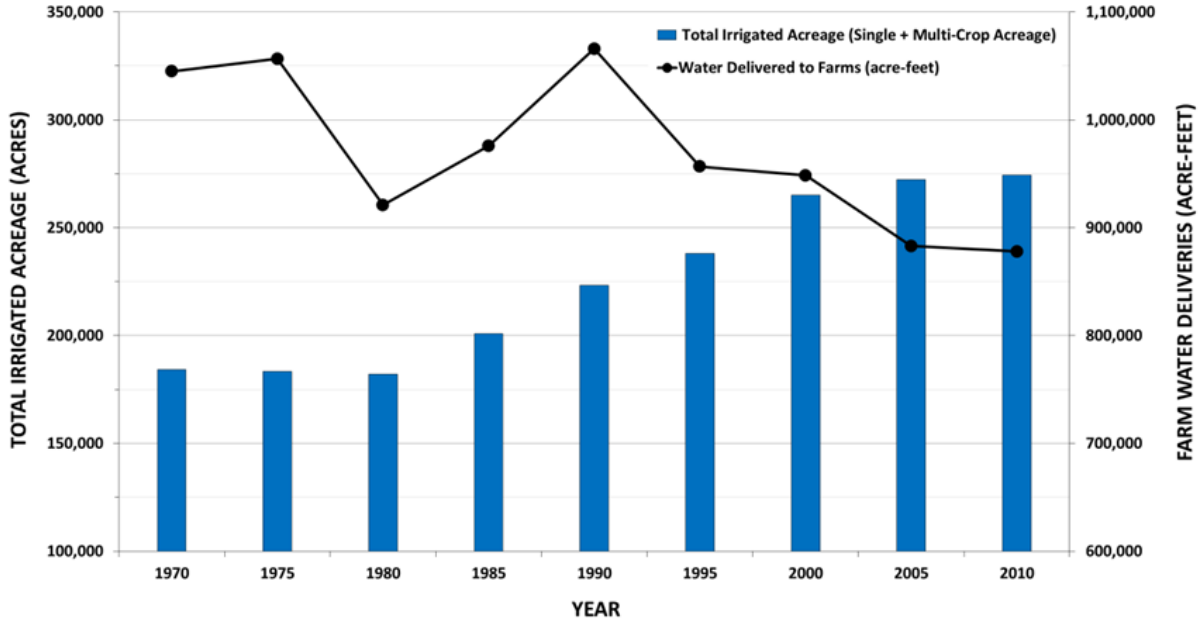



**FIGURE 4B-2**
Irrigated Acres Farmed in Yuma County and Water Deliveries (1970-2010)



## Case Study 3

# Imperial Irrigation District Quantification Settlement Agreement Conservation and Transfer Program

Imperial Irrigation District, California

### *Overview*

As part of the Quantification Settlement Agreement (QSA), the Imperial Irrigation District (IID) agreed to a 45- to 75-year conservation and transfer program. The program has been supported initially (2003 to 2017) by fallowing programs that transition over time (2008 to 2026) to efficiency-based conservation programs at full implementation. During the 15-year fallowing period, landowners and/or lessees voluntarily let their fields lie fallow to help IID meet water transfer obligations to a funding partner, Salton Sea mitigation delivery requirements, and as needed, Colorado River overrun paybacks. The fallowing programs were largely implemented to offset potential impacts to the Salton Sea resulting from conserved water that is transferred out of Imperial Valley to the San Diego County Water Authority (SDCWA), consistent with the refined Salton Sea Habitat Conservation Strategy, as defined in the Amended and Restated Addendum to the Final Environmental Impact Report for the IID Water Conservation and Transfer Project (September 2003).

In 2008, IID began implementing system conservation projects with a main canal seepage recovery system (see Case Study 5). At full implementation, system conservation improvements may exceed 100,000 acre-feet per year (AFY).

In 2013, IID initiated a voluntary on-farm conservation program to begin the process of converting from fallowing to efficiency-based conservation measures. The on-farm conservation program began at 20,000 AFY and ramps up until fully implemented, with a minimum conservation goal of 130,000 AFY.

### *Description*

Based on the quantity of conserved water attributed to each field, landowners/lessees are compensated for voluntarily fallowing fields they would have otherwise farmed.

**Agencies**

- Implementation (Transferor) – Imperial Irrigation District
- Funding (Transferees) – SDCWA and Coachella Valley Water District

**Project Status**

The fallowing program runs from 2003 through 2017 and then will be mostly replaced with efficiency based on-farm and system conservation programs. Full implementation of the 303,000 AFY of conservation and transfer program is scheduled in 2026.

**Key Program Elements**

- Land fallowing, without permanent change in water rights or retirement of agricultural lands
- System conservation projects implemented within the District's half-million irrigated acre service area
- On-farm conservation program funds field-level conservation measures implemented by growers
- Conserved water is transferred to the funding partner for 45 years without permanent change in water rights. Option for a 30-year renewal with mutual agreement

**Budget**

$136 million, 2003 to 2014 ($90.7 million paid to participants, plus $50 million community fund) for fallowing. Significantly increased budgets are anticipated in future years to fund efficiency-based conservation programs.

**Water Savings**

1,220,441 AF, 2003 to 2013, ramping up to 303,000 AFY post 2026 (not including All-American Canal Lining Project that conserves 67,700 AFY)

Fallowed field and dry lateral
*Source: Amy Loper*

For the on-farm conservation program, growers volunteer to implement field-level conservation measures they select, with conservation yields calculated from water delivery reductions determined from pre-established field and crop-specific baselines.

Additional system conservation projects are still being prioritized, but current planning efforts are focused on system automation, main canal concrete lining, reservoirs, and integrated information management systems.

The schedule of water transfers and mitigation water requirements is defined in the QSA and related agreements and, when combined with varying annual payback requirements, results in a mix of water conservation and fallowing target volumes each year.

The IID Board of Directors sets conservation payment rates each year. The price per AF paid to fallowing participants has been as low as $60 per AF and as high as $175 per AF (2014). The price per AF paid to on-farm conservation participants was set at $285 per AF in 2013 and 2014. When combined with system efficiency project costs and conservation targets, there can be significant annual variances in the program budget.

From December 2003 through June 2015, the total to be paid to fallowing participants is about $90.7 million.

Additionally, a $50 million community fund was set up and managed locally for mitigation of direct and indirect socioeconomic impacts caused by fallowing. The fund is used to compensate businesses and organizations, such as farm service providers, who have been negatively impacted by fallowing. Competitive funds are also distributed for job training services and programs that provide an economic stimulus in Imperial County.

### *Outcome*

Between December 2003 and June 2014, a total of 1,242,283 AF of Colorado River water was conserved as a result of fallowing.

Since the QSA's 2003 implementation, IID has generated 143,306 AF of efficiency-based conservation for transfer and payback purposes. A total of 125,213 AF resulted from system conservation measures and 18,093 AF from growers participating in IID-funded on-farm conservation programs.

### *Sources*

- Imperial Irrigation District Fallowing Program Status Report, October 2013: http://www.iid.com/Modules/ShowDocument.aspx?documentid=8383
- IID Fallowing Programs: http://www.iid.com/index.aspx?page=190
- Annual Implementation Report. 2009. Quantification Settlement Agreement, Imperial Irrigation District, Water Conservation and Transfer Project: http://www.iid.com/Modules/ShowDocument.aspx?documentid=4644
- 2010 Annual Water Report. Imperial Irrigation District: http://www.iid.com/Modules/ShowDocument.aspx?documentid=5057
- Revised Fourth Amendment to Agreement between Imperial Irrigation District and San Diego County Water Authority for Transfer of Conserved Water: http://www.iid.com/Modules/ShowDocument.aspx?documentid=886

## Case Study 4

# Imperial Irrigation District and Metropolitan Water District of Southern California Water Conservation Program

Imperial Irrigation District, California

### *Overview*

A 35-year water conservation agreement was signed in 1988 between the Imperial Irrigation District (IID) and the Metropolitan Water District of Southern California (MWD). Under the agreement, MWD pays for the costs of water conservation measures in exchange for conserved water. The 1988 IID-MWD agreement was amended in 2003 at the time of the Quantification Settlement Agreement (QSA) and extended to 2041 or through the QSA term, whichever is later.

### *Description*

Fifteen new projects were constructed between 1990 and 1998 and water conserved by two augmentation projects was made available beginning in 1990. Projects were primarily conveyance improvements and included lateral interceptors, reservoirs, concrete lining of main and lateral canals, non-leak gates, and system automation. Projects also included on-farm irrigation system improvements (tailwater return systems, irrigation evaluations, and pilot linear move and drip irrigation systems) and 12-hour delivery of irrigation water. The total capital cost was about $112.5 million, with indirect payments to IID of $23 million, and cumulative annual operation and maintenance (O&M) costs totaling $157.5 million through July 2014. MWD has paid all of the costs associated with the 15 projects and will continue to pay the annual costs until the agreement terminates. In return, MWD is allowed to divert the saved Colorado River water through the Colorado River Aqueduct or store it in Lake Mead.

A Program Coordinating Committee (PCC) facilitates cooperation and information exchange between IID and MWD related to the program's various financial, economic, administrative, and technical aspects.

A consultant group, called the Conservation Verification Consultants (CVC), prepared an annual report on the estimated amount of water conserved by the program for the Water Conservation Measurement Committee (WCMC) through 2006, which verified the amount of water conserved. IID now provides this information using procedures developed by the CVC and approved by the WCMC and the PCC.

**Agencies**

Implementation – Imperial Irrigation District
Funding – MWD

**Project Status**

Project construction complete. Associated water conservation and transfer is ongoing

**Key Program Elements**

- Conveyance system improvements
- On-farm irrigation system improvements
- Water conserved to be used by MWD and Coachella Valley Water District
- Conservation verification

**Budget**

$112.5 million capital, $23 million indirect, plus $157.5 million in cumulative annual O&M costs (through July 2014)

**Water Savings**

2,242,779 acre-feet (AF), 1990-2014; 105,000 acre-feet per year (AFY) through at least 2041

Canal lining
*Source: Bureau of Reclamation*

### *Outcome*

Annual water savings between 1998 and 2013 averaged 105,009 AFY and ranged between 101,940 and 109,460 AFY. Through 2013, 1,841,242 AF have been used by MWD, 159,381 AF have been stored in Lake Mead for MWD, and 137,156 AF have been used by the Coachella Valley Water District.

The program also resulted in greater water management flexibility for Imperial Valley farmers and opportunities for farmers to apply water more effectively. Distribution system and on-farm management improvements were related and often resulted in greater overall program improvements than would be expected than when considered individually.

### *Sources*

- MWD Plan for the Creation of Extraordinary Conservation Intentionally Created Surplus, Calendar Year 2015
- Imperial Irrigation District and Metropolitan Water District of Southern California Water Conservation Program Final Program Construction Report, IID Water Resources Unit, April 2000: http://www.iid.com/Modules/ShowDocument.aspx?documentid=4060
- IID, Water Conservation: http://www.iid.com/index.aspx?page=121
- IID & MWD Water Conservation Program: http://www.iid.com/index.aspx?page=201

## Case Study 5

# Imperial Irrigation District Seepage Recovery Program

Imperial Irrigation District, California

### *Overview*

Open drains were constructed along main canals some time ago to intercept canal seepage that was flowing to the Salton Sea and to reduce water tables on adjacent agricultural lands. The seepage recovery program includes the installation of pump stations, collection sumps, and appurtenant structures in the open drains to pump water back into the All-American, East Highline, and West Side Main Canals. The increased water returned to the main canals reduces Imperial Irrigation District's (IID) delivery needs at Imperial Dam and allows for transfer under the Quantification Settlement Agreement (QSA).

### *Description*

In total, 22 pumping stations were constructed at the lower ends of interceptor drains. These pump stations are operated to maintain drain water levels within 6 inches of historical levels to prevent interference with normal drainage and induction of additional seepage from the main canals.

The total capital cost was $7.29 million, and annual operation and maintenance (O&M) costs average about $500,000.

Intercepted seepage water pumped to the main canal is metered, and flow measurements are reported electronically to IID's Operations Center, where the information is subject to quality control procedures and stored in a relational database.

The Bureau of Reclamation verifies measurement accuracy and conducts semiannual visits to project facilities for verification of operability and data accuracy.

### *Outcome*

Total seepage recovery capacity is up to about 40,000 acre-feet per year (AFY).

This seepage recovery project was developed to conserve water for acquisition by Coachella Valley Water District under the QSA. However, because of the timing of construction, this project is ahead of the conserved water delivery schedule required by the Acquisition Agreement, and the project may produce conserved water in excess of the acquisition requirements. Any excess conserved water is available for use by IID for other purposes, including obligations associated with the Inadvertent Overrun and Payback Policy and creation of Intentionally Created Surplus, until the full conservation yield of this program is needed under the QSA.

**Agencies**

Imperial Irrigation District, Coachella Valley Water District, San Diego County Water Authority

**Project Status**

Pump stations completed in 2009. Associated water conservation continues today

**Key Program Elements**

- Conveyance improvements
- Acquisition of conserved water

**Budget**

$7.29 million capital cost, plus average $500,000 per year O&M

**Water Savings**

Up to 40,000 AFY

Seepage interception pump

*Used by permission of IID*

### *Sources*

- IID 2014 Plan for the Creation of Extraordinary Conservation Intentionally Created Surplus
- 2010 Annual Water Report, Imperial Irrigation District: http://www.iid.com/Modules/ShowDocument.aspx?documentid=5057
- Status Report: Main Canals Seepage Interception Project, April 15, 2008: http://www.iid.com/Modules/ShowDocument.aspx?documentid=4057

## Case Study 6

# Palo Verde Irrigation District and Metropolitan Water District of Southern California Forbearance and Fallowing Program

Palo Verde Irrigation District, California

### *Overview*

On January 1, 2005, the Palo Verde Irrigation District (PVID) and the Metropolitan Water District of Southern California (MWD) began a 35-year Forbearance and Fallowing Program with landowners within PVID. The key component of the program is land fallowing, where participants fallow land in exchange for payments. The volume of water that becomes available to MWD is governed by the federal Quantification Settlement Agreement (QSA), the 2003 Colorado River Water Delivery Agreement.[1] Under these agreements:

- MWD must reduce its consumptive use of Colorado River water by that volume of consumptive use by PVID and holders of Priority 2[2] that is greater than 420,000 acre-feet (AF) in a calendar year, or
- MWD may increase its consumptive use of Colorado River water by that volume of consumptive use by PVID and holders of Priority 2 that is less than 420,000 AF in a calendar year.

In both cases, each AF of reduced consumptive use by PVID is an additional AF that becomes available to MWD.

### *Description*

Program participation is voluntary but requires participating landowners to sign a 35-year participation contract. A one-time sign-up payment was paid to participants for enrolling in the program. Annual payments are also made to participants in years when their land is fallowed. Land taken out of production is rotated every 1 to 5 years and maintained in accordance with approved soil and water management plans.

Fallowing amounts vary year to year, depending on MWD's water needs. MWD sets a fallowing "call" annually. The program sets a minimum of 6,487 acres for fallowing in a given year (7 percent of the District's acreage in the Palo Verde Valley) to a maximum of 25,947 acres (28 percent of acreage).

**Agencies**

Palo Verde Irrigation District and Metropolitan Water District of Southern California

**Project Status**

The program commenced on January 1, 2005, and is termed to end on July 31, 2040

**Key Program Elements**

- Land fallowing, without permanent change in water rights or retirement of agricultural lands
- Forbearance of diversion of saved water by PVID

**Budget**

$82.8 million capital cost, $115.6 million in cumulative annual costs through 2014, plus variable future annual costs depending on acreage fallowed ($752/acre in 2014, or $8.61 million total, for a 50% fallowing call)

**Water Savings**

32,750 to 122,216 acre-feet per year (AFY)

View of fallowed field
*Source: Bureau of Reclamation*

Capital cost were $82.8 million, including $73.5 million for one-time payments to landowners upon enrollment, $3.3 million for program environmental documentation and implementation, and $6 million for local community improvement programs, which are discussed below. Through 2014, cumulative annual payments to landowners have totaled $112.2 million and $3.4 million to PVID for administrative costs.

[1] The parties to the Colorado River Water Delivery Agreement are the U.S., Imperial Irrigation District, Coachella Valley Water District, MWD, and the San Diego County Water Authority.

[2] The Yuma Project Reservation Division holds California's Priority 2.

Annual operating costs vary according to acreage fallowed. In 2014, payments to landowners are $752 per acre, totaling about $8.61 million to fallow at a 50 percent fallowing call. In addition, PVID program administrative costs are covered through an annual payment ($0.27 million in 2014), which includes funding for staff to verify that land is fallowed, calculate water savings, and document calculations of water saved.

A $6 million fund for local community improvement programs was established to mitigate third-party economic impacts. The fund is administered by a nonprofit public benefit corporation established by the community for this purpose. The fund has made available $5.27 million in loans to 16 local businesses and has provided more than $0.8 million in grants to various nonprofit entities serving the Blythe community.

### *Outcome*

Annually, water saved has varied from between 32,750 AFY and 122,216 AFY. Over the 35-year program, total water saved is estimated to be between 1.9 million AF and 3.7 million AF.

### *Sources*


- MWD Plan for the Creation of Extraordinary Conservation Intentionally Created Surplus, Calendar Year 2015
- Calendar Year 2013 Fallowed Land Verification Report. PVID/MWD Forbearance and Fallowing Program. PVID, MWD, Bureau of Reclamation. May 12, 2014
- Palo Verde Land Management, Crop Rotation and Water Supply Program…at a glance, MWD, June 2013: http://www.mwdh2o.com/mwdh2o/pages/news/at_a_glance/Palo-Verde-fact-Sheet.pdf
- Smith, MaryLou, and James Pritchett. 2010. Agricultural/Urban/Environmental Water Sharing: Innovative Strategies for the Colorado River Basin and the West, Colorado Water Institute Special Report Series No. 22. Colorado State University: http://cwi.colostate.edu/publications/sr/22.pdf

## Case Study 7

# Coachella Canal Lining Project

Coachella Valley Water District, California

### *Overview*

The Coachella Canal carries Colorado River water 123 miles northwest from the All-American Canal to more than 85,000 acres of highly productive agricultural land in the Coachella Valley. The Canal Lining Project was developed as a water conservation measure in response to Title II of Public Law 100-675. Implementation of the project resulted in the construction of 36.5 miles of concrete-lined canal directly adjacent to the original earthen canal. Additionally, the project included a variety of check structures, canal crossings, flow measurement structures, and environmental mitigation measures. The contract was awarded in September 2004, and water began to flow through the new lined canal in November 2006.

### *Description*

Capital costs totaled approximately $124 million, with 70 percent funded by the California Department of Water Resources (CDWR) and 30 percent funded by the San Diego County Water Authority (SDCWA).

Annual operating costs are shared among the Coachella Valley Water District (CVWD), SDCWA, and the San Luis Rey Indian Water Rights Settlement Parties. As part of the project agreement, a baseline was derived from historical average operation, maintenance, and repair costs. The project beneficiaries pay for all operation, maintenance, and repair costs above that baseline and also agreed to pay for monitoring, operation, maintenance, and repair of project environmental mitigation features.

CVWD was responsible for overall management of the project in collaboration with the Bureau of Reclamation and project funders. A number of consultants, designers, suppliers, contractors, and subcontractors were employed as part of the project. Additionally, a variety of federal, state, and tribal advisors provided input throughout the project. Implementation required considerable coordination through an agreed-upon project governance structure.

**Agencies**

Coachella Valley Water District, California Department of Water Resources, San Diego County Water Authority

**Project Status**

Completed 2007

**Key Program Elements**

- Conveyance improvements
- Allocation of conserved water

**Budget**

$124 million, funded 30% by SDCWA and 70% by CDWR

**Water Savings**

30,850 acre-feet per year

Water begins to flow through the new canal adjacent to the original earthen structure
*Source: Coachella Valley Water District*

### *Outcome*

Annually, water saved from the reduction of seepage and other losses is 30,850 acre-feet per year. Water savings from the canal lining are used to meet urban water demand in San Diego County, and on the Southern California coastal plain until a San Luis Rey Indian water rights settlement agreement has been executed and a stipulated judgment or other final disposition has been entered in pending proceedings in the U.S. District Court for the Southern District of California.

### *Sources*

- Coachella Canal Lining Project Construction Report.
- Canal Lining Projects: http://www.sdcwa.org/canal-lining-projects

## Case Study 8

# All-American Canal Lining Project

Imperial Irrigation District, California

### *Overview*

The All-American Canal was authorized as part of the 1928 Boulder Canyon Project Act to provide reliable delivery of Colorado River water to burgeoning agriculture in the Imperial and Coachella Valleys. Deliveries of Colorado River Water to the Imperial Valley travel approximately 80 miles from the mainstem to irrigate nearly 500,000 acres of agricultural lands. In the 1990s, estimates indicated that nearly 70,000 acre-feet of water would be conserved by reducing seepage in the middle reaches of the canal. Ultimately, the canal lining project became an important piece of the 2003 Quantification Settlement and related agreements, which provide a framework to meet California's water needs within its basic Colorado River apportionment. Construction began in June 2007 and was completed in 2009.

### *Description*

Construction costs totaled approximately $300 million, shared by the San Diego County Water Authority and the State of California. The Imperial Irrigation District provided project management and continued operation and maintenance of the canal. To allow continuous water deliveries to the Imperial Valley, the project constructed a new, concrete-lined canal in parallel with the original earthen structure. This required moving more than 20 million cubic yards of material in addition to the concrete-lining activities. A phased implementation brought new sections of the canal online as they were completed, providing the first water savings in 2008. The project also included the construction of a 1,200 acre-foot (AF) off-line storage facility for use by the Imperial Irrigation District. Recognizing an anticipated loss of wetlands dependent on canal seepage, the project included monitoring of species and habitats potentially impacted as well as the creation and enhancement of wetlands.

### *Outcome*

Hailed as a model of collaboration, the All-American Canal Lining Project has bolstered water supply reliability for communities in coastal Southern California. Annual water savings from seepage reduction total 67,700 AF. Water savings from the canal lining are used to meet urban water demand in San Diego County; and on the Southern California coastal plain until a San Luis Rey Indian water rights settlement agreement has been executed and a stipulated judgment or other final disposition has been entered in pending proceedings in the U.S. District Court for the Southern District of California.

**Agencies**

Imperial Irrigation District, State of California, San Diego County Water Authority, Bureau of Reclamation

**Project Status**

Completed in 2009

**Key Program Elements**

- Construction of 23 miles of lined canal to replace original earthen portion
- Environmental mitigation for wetlands impacts

**Budget**

Approximately $300 million shared by San Diego County Water Authority and the State of California

**Water Savings**

67,700 AF per year

All-American Canal lining in progress
*Used by permission of IID*

### *Sources*


- Imperial Irrigation District. 2008. Quantification Settlement Agreement Annual Implementation Report. http://www.iid.com/index.aspx?page=17

## Case Study 9

# Alternative Agricultural Water Transfer Methods Grants Program

Colorado

### *Overview*

In Colorado, agricultural-to-municipal water transfers have historically taken place through "buy-and-dry," in which irrigated farmland is either revegetated with native plants or converted to dryland farming.

To reduce the burden on agricultural economies and communities associated with buy-and-dry transfers, efforts have been made to identify alternative agricultural water transfer methods (ATMs). ATMs provide agricultural water for municipal and industrial (M&I) or environmental use on an as-needed basis while keeping farmlands irrigated and producing crops, avoiding traditional buy-and dry.

The Colorado Water Conservation Board (CWCB) implemented the ATM Grant Program to identify barriers to implement ATMs and to develop solutions to overcome barriers. Two rounds of grants occurred between 2009 and 2012.

**Agencies**

Colorado Water Conservation Board, numerous partner agencies as recipients of grants

**Project Status**

First round of grants completed; Second round of grants issued in 2011-2012

**Key Program Elements**

- Grant program
- Water transfers, without permanent change in water rights or retirement of agricultural lands

**Budget**

$3 million

**Water Savings**

Not specifically targeted

### *Description*

The first grants focused on interruptible supply agreements, rotational fallowing, water banks, reduced crop consumptive use, and purchase and lease-back.

Grants in the second round were used to primarily fund projects addressing challenges to implementation identified during the first round of grants.

Each of the first two rounds of grants was $1.5 million, for a total of $3 million. There were six project groups in the first series of grants, with funding ranging from $70,000 to $477,500 per project. The second round of grants included 10 project groups, with funding ranging from $10,000 to $320,000 per project.

### *Outcome*

In the first round, four barriers to the implementation of ATMs in Colorado were identified: (1) potentially high transaction costs associated with water rights transfers, (2) water rights administration uncertainties and water rights accounting questions, (3) certainty of long-term supply and desire for water providers to have permanence of long-term supply, and (4) infrastructure needs and water quality issues.

In the second round, projects have ranged from research to conceptual implementation of ATMs.

This program has resulted in significant progress toward making ATMs a viable option for M&I providers and environmental uses. Several pilot projects have been initiated to examine how some of these projects could be implemented on a large scale. This program has resulted in successful partnerships between cities, farmers, land conservancies, funding partners, and environmentalists.

### *Recommendations*

The CWCB made three primary recommendations for the ATM program for the west slope of Colorado:

1. Advance the Colorado River Compact Water Banking study and its focus on rotational fallowing by integration using the results from the Aspinall Water Bank study and the Yampa ATM study.
2. Continue the Yampa ATM study to determine the acceptability by ranchers of an ATM and the concurrent benefits to fish habitat. These identified lands and associated water can also be used for the Compact Water Banking project and should be integrated.
3. Continue the study by Colorado State University and others on the suitability of pasture grass for rotational fallowing.

### *Sources*

- Alternative Agricultural Water Transfer Methods Grants, Colorado Water Conservation Board: http://cwcb.state.co.us/LoansGrants/alternative-agricultural-water-transfer-methods-grants/Pages/main.aspx

## Case Study 10

# Canal System Improvement Project

Orchard Mesa Irrigation District, Colorado

### *Overview*

The U.S. Fish and Wildlife Service identified the need for additional flows within a 15-mile reach of the Colorado River. The proposed project has been identified by the Upper Colorado River Endangered Fish Recovery Program as a source to provide additional flows along the 15-mile reach. These flows are expected to aid in recovery of four endangered fishes.

The project consists of improving and automating the Orchard Mesa Irrigation District (OMID) canal system. Saved water is then used to provide increased hydropower generation at the Grand Valley Power Plant, which will often result in the augmentation of stream flows within the 15-mile reach. In addition to increasing instream flows and power generation, current water shortages to municipal and industrial (M&I) providers and agricultural water users would be reduced.

### *Description*

Proposed improvements include the following:

- Constructing a new 80- to 100-acre-foot (AF) regulating reservoir
- Improving water level control using check structures and other improvements
- Installing a simple remote monitoring system and electronic flow meters (supervisory control and data acquisition system)
- Increasing pump capacity at existing B ¼ Rd pump
- Constructing interties to help balance flows in the irrigation system and upgrades to canal end spills by rerouting end spill on Canal No. 2 to Canal No. 1 and modifying operations of the lower portion of Canal No. 1
- Reducing canal and lateral seepage through lining and piping
- Improving operational procedures

Project budget is $16.5 million. Check structures were completed in 2014, and the regulating reservoir is planned to be complete in 2015.

**Agency**

Orchard Mesa Irrigation District

**Project Status**

The project is expected to be fully operational in 2016

**Key Program Elements**

- Conveyance improvements
- Improve instream environmental flows

**Budget**

$16.5 million

**Water Savings**

17,000 AFY

Orchard Mesa Pumping Plant
*Source: Bureau of Reclamation*

### *Outcome*

The project is expected to result in an average of 17,000 acre-feet per year (AFY) in water savings. Project savings result from reduced main canal and lateral spills, recovering spills from main canals in urban areas, and elimination of spills from the Mutual Mesa lateral. Total savings of about 17,000 AFY on average are expected even while improving the equitable distribution and reliability of water service. This water would be available to manage irrigation supplies more efficiently. If the water is not needed for irrigation, it would be used for hydropower generation and the resulting augmentation of low flows in the 15-mile reach of the Colorado River upstream of the confluence with the Gunnison River.

In addition to more efficiently managing irrigation water demands, the project reduces hydraulic pumping by 28,000 AFY, which results in a reduction in energy demand for pumping.

### *Sources*

- Orchard Mesa Irrigation District: http://www.irrigationprovidersgv.org/OMID.php
- Final Environmental Assessment, Orchard Mesa Irrigation District Canal System Improvement Project. U.S. Bureau of Reclamation, August 2013: http://www.usbr.gov/uc/envdocs/ea/OrchardMesa/final-EA.pdf

## Case Study 11

# Colorado River Water Bank Feasibility Study

Colorado

### *Overview*

Under the Colorado River Compact, the Upper Division States are obligated not to cause the flow of the Colorado River, at Lee Ferry, Arizona, be depleted below 75 million acre-feet per year (MAF) over any consecutive 10-year period. If the Upper Division States ever depleted the flow of the river at Lee Ferry causing it to fall below 75 MAF during a 10-year period, the Upper Division States may need to impose curtailments of certain water uses. One option being considered to avoid a Compact deficit and any related need to curtail water uses is a water bank. A study evaluating the feasibility of one particular water banking concept is in progress in Colorado. This study is examining whether a water bank could be used to prevent, delay, or reduce the negative effects of a Compact deficit. An effective water bank could help meet compact obligations, protect critical levels in Lake Powell, or allow continued water use in the event that curtailments would otherwise be needed to resolve a Compact deficit

### *Description*

The water bank would operate as follows. Voluntary agricultural participants in the water bank would be compensated to temporarily reduce their consumptive use through either deficit irrigation or split-season irrigation. The saved consumptive use would be available to a water bank. Post-Compact water users (of any type) would "subscribe" to the bank as a kind of insurance policy to offset or replace water use that would otherwise be curtailed by the Compact administration. Participating agricultural land may be part of the program temporarily or on a rotational basis. This approach may avoid permanent irrigation dry-up and minimize the economic and environmental impacts that can occur in surrounding communities and economies.

Financing for the feasibility study was provided by the Water Bank Work Group members (see list under Agency in text box above) and a $180,000 alternative agricultural water transfer method grant from the Colorado Water Conservation Board (see Case Study 9).

**Agency**

The Water Bank Group, which is composed of representatives of the Colorado River Water Conservation District, Colorado Water Conservation Board, Front Range Water Council, Southwestern Water Conservation District, and The Nature Conservancy

**Project Status**

Phase 1 is completed, and recommendations have been made for Phases 2 and 3

**Key Program Elements**

- Feasibility study
- Water transfers, without permanent change in water rights or retirement of agricultural lands

**Budget**

$180,000 for feasibility study

**Water Savings**

Up to 200,000 acre-feet per year (AFY) potentially feasible

View of sprinkler irrigation
*Source: CH2M HILL*

### *Outcome*

During Phase 1 of the feasibility study, the Work Group quantified post-Compact water rights and potential water supply available to the water bank from pre-Compact agricultural rights. The timing and frequency of potential curtailments was evaluated, and several scenarios were considered to evaluate possible supply use combinations.

Study results indicated the maximum potential consumptive use reduction from fallowing of all irrigated lands with pre-Compact water rights is about

940,800 AFY. Assuming split season irrigation of alfalfa and grass pasture and by varying the level of participation and the level of reduced irrigation, up to 200,000 AFY from the water bank could be used. Current post-Compact consumptive use in Colorado is on the order of 1.2 million AFY (350,000 AFY of municipal and industrial use). The water bank could, therefore, not fully compensate for all potential Colorado River curtailments but could ensure a significant portion of critical post-Compact uses. A 25 to 50 percent participation rate would be required to meet significant east and west slope uses, likely entailing deficit irrigation or fallowing on 130,000 to 260,000 acres on the west slope.

Phase 2 of the study assessed the feasibility of deficit irrigation and fallowing for eight representative irrigation systems on the west slope of Colorado, and evaluated methods for measuring water savings. Phase IIB is performing a more detailed assessment of how a water bank could operate within three of these systems. It is also looking at the agronomic impacts of reduced irrigation and means to quantify water savings on the farm. Phase 3 will examine regional economic and environmental considerations.

### *Sources*


- Colorado River Water Bank Feasibility Study, Phase 1. March 2012. Draft Report. Prepared for Colorado River Water Conservation District: http://www.crwcd.org/media/uploads/2012_Water_Bank_Phase1_Rept_draft.pdf

## Case Study 12

# Investigation of Drip Irrigation Consumptive Use

New Mexico Interstate Stream Commission, New Mexico

### *Overview*

The New Mexico Interstate Stream Commission (ISC) has funded conversion from flood irrigation to drip irrigation in some locations to promote water conservation. However, in these areas, an increasing rate of decline in groundwater levels has been observed.

### *Description*

To help quantify the broader effects of conversion to drip irrigation, the ISC commissioned a study to compare consumptive use on drip-irrigated fields with flood-irrigated fields.

### *Outcome*

Results of the study suggest that consumptive use on drip-irrigated fields is greater than consumptive use on flood-irrigated fields by 8 to 16 percent. Yield was also observed to be greater on the drip-irrigated fields, but the increase in yield was not quantified.

While quantification of consumptive use was the primary goal of the study, some broader implications were explored. Considering that drip irrigation has a higher irrigation efficiency than flood irrigation (that is, a higher percentage of the applied water is consumed by crops), the net effect of switching to drip irrigation from flood irrigation appears to be that less water is applied to the fields, more water is consumed by the crops, and there is a greater yield.

However, water rights in New Mexico are administered based on diversion rates, not consumption rates. So, rather than resulting in less water being diverted, conversion to drip irrigation on existing farms has resulted in farmers increasing the number of annual plantings, often doubling or tripling the number of plantings each year. This means increased consumptive use of water, while maintaining the same legally prescribed diversion rates.

In addition, previously fallowed land is being returned to production, increasing diversions and further increasing consumptive use of water.

**Agency**
New Mexico Interstate Stream Commission

**Project Status**
Completed

**Key Program Elements**
- Study
- On-farm efficiency improvements

**Budget**
~$60,000

**Water Savings**
Not applicable

While the conversion to drip irrigation has resulted in increased yields and multiple cropping, the net effect has been an increase in the consumptive use of water and an accelerated decline of groundwater levels in the area. It is unclear at this time whether the accelerated groundwater decline is due to increased withdrawals from the aquifer to irrigate previously fallowed land and/or reduced recharge to the aquifer from more efficient irrigation.

The recommended next steps of the study are to investigate the nature and timing of how return flows recharge the aquifer to better assess the Basin-wide water budget implications of converting to drip irrigation from flood irrigation.

### *Sources*


- Martinez, G., D. Jordan, A. Whittaker, and R. Allen. Remote-Sensing-Based Evaluation of Relative Consumptive Use Between Flood- and Drip-Irrigated Fields: http://nmawsa.org/ongoing-work/agricultural-water-use/impacts-of-drip-irrigation-abstract/view
- Remote-Sensing-Based Comparison of Water Consumption by Drip-Irrigated Versus Flood-Irrigated Fields. Deming, New Mexico. March 13, 2013. Final Report. Prepared for the New Mexico Interstate Stream Commission: http://nmawsa.org/ongoing-work/agricultural-water-use/comparison-of-water-consumption-by-drip-irrigated-versus-flood-irrigated-fields/view
- Jordan, D., G, Martinez, A. Whittaker, and R. Allen. Analysis of Relative Water Use Between Flood- and Drip-Irrigated Fields, Deming, New Mexico: http://nmawsa.org/meetings/01-14-2013-input-group-meeting/01-14-2013-intera-deming-et/view

## Case Study 13

# Ferron Project

Emery County, Utah

### *Overview*

The Ferron Project serves to reduce Colorado River salinity loading through improved agricultural infrastructure and practices. Increasing water conveyance and application efficiency reduces deep percolation, limiting salt mobilization. Secondary benefits, which include increased yields and an extended irrigation season, have also helped project participants.

### *Description*

The program consisted of the following:

- Two main pressurized 42-inch pipelines were installed to convey irrigation water stored in an existing reservoir.
- Six major laterals of pressurized pipe and three regulating ponds were constructed to deliver water to producers.
- About 175 miles of pipe were installed; pipes ranged in size from 2 to 42 inches.
- Approximately 10,000 acres of agricultural land was converted to use pressure sprinkler.

Funding for the Ferron Project came from the Bureau of Reclamation and the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program through the Colorado River Basin Salinity Control Program. Low interest loans from the Utah Board of Water Resources revolving loan funding program were used to meet cost-share requirements. The project cost is estimated to be approximately $20 million. Annual costs include annual loan repayments and maintenance.

The Ferron Canal and Reservoir Company formed a construction division and installed the project, reducing cost and increasing local "ownership." One hundred percent of the watershed producers participated in the project.

**Agency**

Ferron Canal & Reservoir Co., San Rafael Soil Conservation District, Bureau of Reclamation, Natural Resources Conservation Service, Utah Board of Water Resources, Ferron City, Clawson Town, Emery County, Colorado River Basin Salinity Control Forum, Utah State University Extension Service, and the Utah Department of Agriculture and Food

**Project Status**

Completed 2006

**Key Program Elements**

- Salinity control (primary)
- Conveyance improvements
- On-farm efficiency improvements

**Budget**

$20 million, plus additional annual loan repayments and maintenance

**Water Savings**

Not quantified; water savings was not a goal, but there are anecdotal reports of savings

Salinity challenges faced by landowners in Utah.
*Photo courtesy of U.S. Department of Agriculture Natural Resources Conservation Service*

### *Outcome*

The project reduces Colorado River salt loading by an estimated 40,000 tons per year. Additional benefits cited include water quality improvements, productivity increases, and community safety through removal of open ditches.

Water savings were not a goal and they were not quantified. However, anecdotal accounts tell of greater water availability between the local community and agriculture.

More efficient conveyance and application of water has allowed the irrigation season to be extended into the

fall. This extension results in a third crop for producers. Productivity increases were also noted due to increased cropable land per acre through the elimination of furrows. The net productivity increase is estimated to be an additional 2 to 3 tons per acre of hay or 30 percent with an additional improvement in crop quality.

NRCS expertise and outreach were used to address concerns related to program cost and sprinkler applicability to area crops. Example implementation in other agricultural communities with experience implementing these improvements was used.

### *Sources*

- Eric Klotz/Utah Division of Water Resources, personal communication. March 25, 2014.

## Case Study 14

# Revolving Construction Loan Program

Utah

### *Overview*

Section 73-10-1(7) of the Utah Code provides revolving funds to give technical and financial assistance to water users to achieve the highest beneficial use of water resources within the state. This financial assistance is provided by the Utah Board of Water Resources through three revolving loan funds: (1) the Revolving Construction Fund, (2) the Cities Water Loan Fund, and (3) the Conservation and Development Fund.

Funding is available for projects that conserve, protect, or more efficiently use present water supplies, develop new water, or provide flood control.

### *Description*

Under the direction of the Board, the funding programs are administered through the Division of Water Resources (DWRe). The Board and DWRe plan for full use of water and power resources of the state. In the past 67 years, the Board and DWRe have been involved in the planning, design, construction, and financing of 1,406 water projects.

Since 1947, the Utah State Legislature has appropriated approximately $339 million for water development. The Board requires that the revolving loans be repaid, making funds available for subsequent loans. Using revolving funds, the Board has provided more than $743 million to water projects.

### *Outcome*

The agricultural-based water development projects funded by the Board in both the Upper Colorado River and Lower Colorado River Basins have resulted in improved farmland efficiencies, increased farmland productivity and yields, improved water quality, and improved water conservation. The conserved water and improved efficiencies have resulted in an extended irrigation season and, therefore, increased yields. Water savings due to these projects has not been quantified.

**Agency**

Utah Board of Water Resources

**Project Status**

Ongoing, since 1947

**Key Program Elements**

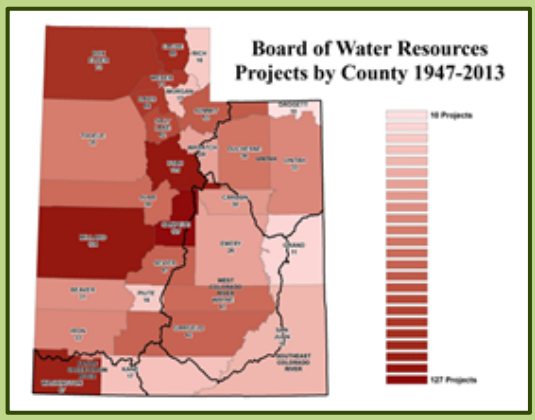
- Revolving loan fund supports various water conservation projects

**Budget**

$339 million appropriated; $743 million loans issued since 1947

**Water Savings**

Not quantified




### *Sources*

- Eric Klotz/Utah Division of Water Resources, personal communication. March 25, 2014.

## Case Study 15

# West Fork of Battle Creek Reservoir

Carbon County, Wyoming

### *Overview*

The Savery-Little Snake River Water Conservancy District desires to construct a new reservoir on the West Fork of Battle Creek in Carbon County, Wyoming, to provide a firm supply to agricultural producers within the District. The proposed reservoir will be filled with flows from Lost and Haggerty Creeks.

West Fork Battle Creek Reservoir will serve primarily as a supplemental irrigation supply, as well as provide environmental, recreational, and fishery benefits. The reservoir will have a total capacity of approximately 8,000 acre-feet, a portion of which will be used as a minimum pool for flat-water recreation.

### *Description*

A total of $7 million has been budgeted for a study that will include preparation of final designs and initiation of the permitting process for the reservoir. The Wyoming Water Development Commission's consultant is currently collecting water quality data for modeling of the proposed reservoir and downstream waterways. The consultant is also updating hydrology and exploring land acquisition opportunities with affected landowners, such as the U.S. Forest Service. Pending these efforts, final design, permitting, and related activities are anticipated to proceed.

### *Outcome*

Current estimates of unmet demand (shortage) in the District are in the range of 5,000 acre-feet. With construction of the proposed West Fork Battle Creek Dam and Reservoir, the District will be able to better serve its members and address these shortages. The project will also provide storage water to areas that currently are not served by other District storage.

The project also includes measures that will abate copper concentrations, which currently exceed maximum contaminant levels in the drainage. The resulting improvement in water quality will encourage establishment of additional native fish habitat. Further, the dam will provide a barrier to non-native species that traditionally out-compete the native Colorado River cutthroat trout.

**Agencies**

Savery-Little Snake River Water Conservancy District, Wyoming Water Development Commission

**Project Status**

Proposed

**Key Program Elements**

- Storage improvements
- Ecological and recreational benefits

**Budget**

$7 million for design; construction to be determined

**Water Savings**

Storage and re-timing of runoff to meet unmet agricultural demands on the order of 5,000 acre-feet per year

### *Sources*

- Dan Keppen and Pat O'Toole/Family Farm Alliance, personal communication. June 17, 2014.
- Wyoming Water Development Office Water News: http://wwdc.state.wy.us/newsletter/2013-1.pdf