USCID NEWSLETTER

**Fall 2018** | **USCID** | **Issue No. 126**

***The U.S. society for irrigation and drainage professionals***

**A Joint USCID/WRF Conference**

# USCID Holds 2018 Conference in Mesa

*by Brian Wahlin, Conference Co-Chair, WEST Consultants, Inc., Tempe, Arizona*

USCID's Annual Conference was held on October 16-19, 2018, in Mesa, Arizona, at the Sheraton Mesa Hotel at Wrigleyville West. The theme of the Conference was *Water Reuse and Non-Traditional Water Sources for Irrigated Agriculture*. This is an important and timely topic, as water scarcity is a critical issue in agriculture. In a world where agriculture must continue to compete for a water supply that is becoming more and more scarce, it is important now, more than ever, for agriculture water users to conserve water. One strategy to accomplish this is to look to non-traditional sources of water such as reused or reclaimed water. While reused or reclaimed water has great potential to alleviate some water scarcity issues, there are many issues and constraints that make using this water difficult.

The Cooperating Organization for this Conference was the Water Research Foundation (www.waterrf.org). WRF is the leading research organization advancing the science of all water to meet the evolving needs of its

*(continued on page 12)*

**2019 Conference**

November 4-8 — Reno, Nevada

Call for Papers Now Online!

# 2018 Scholarship and Awards

Three prestigious awards were presented during the recent USCID Conference in Arizona. **Julia Reese**, University of Idaho, received the USCID/Summers Engineering Scholarship.

The USCID Merriam Improved Irrigation Award went to **Thomas W. Gill**, Bureau of Reclamation. The USCID This year's Service to the Profession Award winner was **Jeffrey B. Bradley**, founder and president of WEST Consultants, Inc.

*(continued on page 16)*

# History of Wastewater Reuse in the U.S.

*by William F. Ritter, Ritter Engineering, Elkton, Maryland*

*Editor's note: This paper was presented during the USCID Arizona Conference.*

## Sewage Farms in the 1800s

Land application of wastewater in the U.S. began in the 19th century. By the late 19th century, it was considered the safest and best method for wastewater disposal. George Rafter of the U.S. Geological Survey did the first comprehensive reviews of wastewater treatment in the U.S. from 1894 to 1899 (Rafter and Bayer, 1894; Rafter, 1897 and Rafter, 1899). Sewage utilization was important in the West because every drop of water was needed for crop production, especially during the

*(continued on page 4)*

# President's Message

This Newsletter includes a summary of our Annual Conference held during October in Mesa, Arizona. This was an interesting Conference in that the Conference Theme was *Water Reuse and Non-Traditional Water Sources for Irrigated Agriculture*, which is a completely different topic for a USCID conference. I became interested in this topic several years ago when I noticed that the Water Research Foundation (WRF) was producing a publication on the state of the art in using recycled water for irrigated agriculture. I kept my eye on the status of this publication and patiently waited for it to be finalized and published. After a while, my patience wore out and I got tired of looking at the website that only said the paper's status was "in process." So, I asked a good friend of mine, Guy Carpenter from Carollo Engineers, if he knew the status of the paper. Guy immediately put me in touch with the great people at the WRF who gave me an update on the status of that paper. I then asked if WRF would be interested in hosting a joint conference on recycled water in irrigated agriculture. To my delight, WRF was quite interested in that idea and agreed to come on board.

It was a wonderful experience to work with the people at WRF and they worked tirelessly to help put this

*(continued on page 22)*

## Inside . . .

## USCID

2940 West 26th Avenue, #100A
Denver, CO 80211
**Telephone: 303-988-0925**

E-mail: stephens@uscid.org
Internet: www.uscid.org


The United States Committee on Irrigation and Drainage is a National Committee of the International Commission on Irrigation and Drainage.

## Mission Statement

*The Mission of USCID is to promote progressive and sustainable irrigation, drainage and flood control practices in support of food and fiber production and public safety, recognizing that sustainability embodies economic, social and environmental goals.*

## USCID Newsletter and Membership

The *USCID Newsletter* is published in Winter, Spring and Fall for USCID Members. News items and technical articles of interest to the irrigation community are invited. Membership information is available on the USCID website.




**USCID Newsletter ©2018** **ISSN: 1083-1320**


## USCID Advertising Rates

| | Professional Card | ¼ Page | ½ Page | Full Page | Inside Back Cover |
|---|---|---|---|---|---|
| Directory & Website | $75 | $125 | $225 | $400 | $450 |
| Newsletters, 3 issues | $150 | $250 | $450 | $800 | $900 |
| Directory, Website and Newsletters | $195 | $325 | $625 | $1,100 | $1,250 |

Corporate Members receive a free Professional Card or a 20 percent discount on ads.

Media specifications are available at www.uscid.org/idmedia.PDF.

## Sustaining Member

- Bureau of Reclamation

## Corporate Members

- Advanced Drainage Systems
- Aqua Systems 2000 Inc.
- AWBlair Engineering
- Davids Engineering, Inc.
- Eagle-Spec Sales Group
- GEI Consultants, Inc.
- Geosyntec Consultants, Inc.
- Imperial Irrigation District
- In--Situ Inc.
- International Water Screens
- Jacobs
- Land IQ
- MBK Engineers
- Provost & Pritchard Consulting Group
- Quantumflo, Incorporated
- Rubicon Water
- Sierra Controls, LLC
- SonTek
- Summers Engineering, Inc.

## Water District Members

- Glenn-Colusa Irrigation District
- Greenfields Irrigation District
- Henry Miller Reclamation District
- Lower Colorado River Authority
- Merced Irrigation District
- Middle Rio Grande Conservancy District
- Modesto Irrigation District
- Northern Colorado Water Conservancy District
- Oakdale Irrigation District
- Pershing County Water Conservation District
- South San Joaquin Irrigation District
- Stockton East Water District
- Turlock Irrigation District
- Uncompahgre Valley Water Users Association
- Upper Arkansas Water Conservancy District
- White River Irrigation District

## Institutional Members

- American Academy of Water Resources Engineers
- Colorado Water Institute
- Daugherty Water for Food Global Institute
- Irrigation Training & Research Center
- Land, IQ LLC
- Pueblo of Sandia

# ICID News and Activities

ICID·CIID

## ICID to Meet in Bali during 2019

The Indonesian National Committee of ICID will host the 3rd World Irrigation Forum (WIF3) and the 70th IEC Meeting of ICID, September 1-7, 2019, im Bali, Indonesia.

The week's activities will include ICID workbody meetings, social events, exhibition, and technical tours. A post-meeting study tour will also be offered.

### World Irrigation Forum

The triennial World Irrigation Forum brings together multiple types of stakeholders involved in irrigation, including policy makers, experts, research institutions, non-governmental organizations and farmers.

WIF3 will focus on the theme, ***Development for water, food and nutrition security in a competitive environment*** and will cover a wide range of topics under three sub-themes:

- Enabling policy environment for water, food and energy security
- Role of civil society and NGOs with focus on farmers and extension facilities
- Improving agricultural water productivity with focus on rural transformation.

A call for papers has been issued, and abstracts are due **February 1, 2019**. Visit www.icid.org for more information.

### Workshops

Two workshops will be organized by ICID workbodies during the week.

**International Workshop on Participatory Irrigation/ Drainage Management**. The deadline for abstracts is March 30. Information: http://www.icid.org/callforpap_pidm_bali.pdf.

**International Workshop on Innovation of Developing the Strategy for Impact Assessment of and Adapation to the Climate Change as the "New Normal."** Abstracts must be received by February 1. Information: https://bit.ly/2QIR71f.¤

## Nominations Sought

ICID is seeking nominations for individuals to serve on two working groups recently established by ICID: 1) Working Group on Irrigation and Drainage in the State under Socio-economic Transformation; and 2) Working Group on Non-Conventional Water Resources for Irrigation.

In addition, nominations are being sought for existing workbodies, and a proposed working group on Adaptive Flood Management. Contact USCID (stephens@uscid.org) if you are interested in serving.¤

## Wastewater Reuse (continued)

summer months. Sewage irrigation was more easily accomplished in the West than the Eastern U.S. because of the need for irrigation to grow crops.

In his 1899 report, Rafter (1899) briefly described all of the sewage treatment plants in operation or would begin operation in the next few years in the U.S. and Canada. The total number of plants was 143 for the U.S. and Canada. About 120 of these plants were constructed in the last 10 to 12 years. The plants included irrigation, intermittent filtration or chemical precipitation and filtration plants. Most of the plants were land treatment systems.

The first crop irrigation system in the U.S. was constructed in 1872 in Augusta, Maine, with a flow of 7,000 gpd at the State Insane asylum. It was used to irrigate hay and a vegetable garden. By the late 1880s, eight western cities and several eastern cities used land treatment. The first large scale land treatment system was built in 1881 in Pullman, Illinois. The population was about 11,000 and the average daily flow was 1.85 mgd. The system utilized spray irrigation and used less than 140 acres (Jewel and Seabrook,1979). Around the turn of the century the system failed.

In Los Angeles, sewage irrigation was originally carried out by a private company. Los Angeles first entered into a contract with the South Side Irrigation Company in 1883 and a second contract in 1895 for sewage flowing through the San Pedro street sewer for a total flow of 5.97 cfs. The South Side Irrigation Company applied sewage to about 2,200 acres of land devoted to vegetables for the Los Angles market. The estimated population in 1894 was 70,000. In the early 1890s Los Angeles constructed a new ocean outfall to the Pacific Ocean. Along the line, numerous valves were placed for sewage irrigation. In 1895 and 1896 approximately 1550 acres were irrigated along the outfall sewer (Rafter, 1899).

Rafter (1897) pointed out in his review:

- In order to utilize sewage to the greatest advantage, towns should construct intermittent sand filtration areas to treat the sewage when it is not used for agriculture. Farmers should only be required to take the sewage to meet crop water requirements.
- Sewage may be purified by irrigation during all seasons of the year at any place where the mean air temperature in the coldest month is not lower than 20 to 25 deg F.
- Almost any of the ordinary crops can be successfully cultivated on a sewage farm.
- The most efficient purification can be obtained by land application.
- On properly managed sewage farms the sewage is not prejudicial to health.

## Land Application from 1900-1972

The period from 1900 to 1920 was an ambivalent period for land treatment systems (Jewell and Seabrook, 1979). There was a shift to sewage disposal and it was thought other technologies were more desirable even though they were not as efficient as purifying wastewater as land application. New wastewater treatment processes were taking the place of land application. The activated sludge process was developed in 1914. New wastewater treatment plants were being constructed using trickling filters and activated sludge. The new philosophy in wastewater management was towards partially treating wastewater and discharging it to water bodies instead of applying it to land.

Hutchins (1939) reviewed sewage irrigation practices in the western states to see if it should be promoted. He reported 125 communities were using land application. From 1934 to 1937, 11 communities discontinued the use of sewage application to land due to poor soil characteristics, insufficient water volume to meet demand or insufficient land available. The most common treatment method of the 125 land treatment systems was the Imhoff tank, used alone or in conjunction with a filter. Pound and Crites (1973a) did a follow up study to the Hutchens survey. In 1973, 84 percent of the systems were still in operation. Most of the ones that ceased operation did so because of population growth and expansions around the land application sites.

There was pioneering work done in the 1960s at Pennsylvania State University starting in 1962 which was designated as the "Living Filter." Over the years it has become a model for the design and management of numerous land application systems.

Land treatment facilities continued to be built between 1920 and 1940 but at a slow rate. The food processing industry stated using land treatment systems in the 1940s and 1950s. In 1964 it was estimated there were about 2,200 land treatment systems in the U.S. California had the largest number of systems with 623 followed by Pennsylvania with 258 and Wisconsin with 178. The different categories are summarized in Tables 1 and 2 (Jewell and Seabrook, 1979).

There were several other estimates of land treatment systems published in the 1970s. Thomas (1973) summarized the number of systems from 1940 to 1972. Starting in 1940, a periodic inventory of municipal wastewater facilities included facilities applying wastewater to land. In 1940 there were 304 municipal land application systems serving 0.9 million population. By 1962, the number had increased to 408 and by 1972 to 571 systems that served a population of 6.6 million. Thomas (1973) pointed out that a comprehensive survey conducted in 1965 listed 947 municipal facilities using land application compared to 571 facilities listed in the 1972 Inventory of Municipal Waste Facilities. The method of determining application to the land for the municipal waste facilities inventory may have been responsible for the difference.

Numerical information on the discharge of industrial wastewater to the land is more difficult to obtain than information for municipal facilities. The 1965 survey summarized by Thomas (1973) listed approximately 1,300 industrial facilities that applied wastewater to the land for disposal. One or more of these industrial facilities were located in 44 states, and 20 states reported 10 or more industrial facilities applying wastewater to the land. It seems that industrial utilization of the land for wastewater disposal began a relatively rapid growth in the late 1940s. Food processing is one segment of industry that has made effective use of land application.

Information from several sources show that the number of canneries disposing of wastewater by land application increased in the 1950s and 1960s and account for a major fraction of the 1,300 industrial facilities listed in the 1965 survey that also include the dairy industry and the meat packing industry. A combination of all food product industries accounted for 930 of the 1,300 industrial facilities listed in the survey. The seasonal operation of some facilities and the rural location of plants have contributed to the attractiveness of land application approaches.

Another report estimated there were about 3,400 land treatment systems (Table 3). It was estimated there were 1200 private individual systems. This report estimated that 10 to 20 percent of all treatment systems in the U.S. were land treatment systems (Jewell and Seabrook, 1979).

| Type of Wastewater | Number of Systems |
|---|---|
| Domestic | 914 |
| Food Products | 846 |
| Petroleum | 179 |
| Miscellaneous | 255 |

Table 1. Land Treatment Systems Reported in 1964.

| Method or Place Applied | Number of Systems |
|---|---|
| Surface Irrigation | 546 |
| Sprinkler Irrigation | 367 |
| Subsurface | 702 |
| Miscellaneous | 417 |

Table 2. Method of Application of Wastewater

| Type of Facility | Number of Systems |
|---|---|
| Publicly Owned Facilities Financed by EPA PL84-660 | 66 |
| Publicly Owned Facilities Financed by EPA PL92-500 | 300 |
| Publicly Owned Facilities Financed by FHA PL89-240 | 1600 |
| Private Systems for Privately owned Housing | 50 |
| Private Industrial Systems | 1200 |

Table 3. A 1976 Estimate of Land Application Systems (Jewell and Seabrook, 1979).

## Land Application from 1972 to 2018

From the 1950s to the early 1970s a strong emphasis was placed on stream assimilation for wastewater discharges. During this period, the main focus of wastewater treatment was to only prescribe the required partial treatment, so streams based upon their assimilation capacity could still meet water quality standards when wastewater was discharged to them.

Eutrophication became a problem in the 1960s. The emphasis on phosphorus resulted in state laws banning or severely limiting the content of phosphorus in detergents. The issue set the stage for the passage of PL92-500 (later known as the Clean Water Act) which made major changes to the 1956 Federal Water Pollution Control Act. (Jewell and Seabrook, 1979).

The goal of PL92-500 was to eliminate wastewater discharges, but it was to be accomplished with the best practical and economically feasible technology. During the first four years following the passage of PL92-500 more than 2,000 new wastewater facilities were built, but only 10 percent of these were land treatment. One of the problems when PL92-500 was passed in 1972 was environmental engineers has very little experience or training in land treatment systems, With no training in land treatment systems, they would consider other wastewater treatment processes. In 1974, EPA issued a special memorandum to the regions to avoid approving any new installation until the land treatment option had been sufficiently evaluated. In 1977, EPA issued a new policy that required land treatment processes to be evaluated for all projects (Jewell and Seabrook, 1979). With the EPA new policy and the passage of the PL92-500 there was a renewed interest in land treatment. It was considered innovative technology and eligible for 85 percent Federal funding.

During the early 1970s there was a lack of knowledge in state regulatory agencies and engineering profession on land treatment processes. This placed an emphasis on outreach and technology transfer. There were a number of EPA reports in the 1970s on land treatment (Pound and Crites, 1973a; Pound and Crites,1973b; Sullivan et al., 1973; EPA, 1976; Crites and Uiga, 1977 and Jewell and Seaward, 1979). A number of conferences and workshops were held in the 1970's (Sopper and Kardos, 1974 and Loehr, 1977). EPA contracted with Cornell University in 1975 to develop an educational course on land treatment that was released to the public in 1978 (Jewell and Seabrook, 1979). EPA issued the first design manual on land treatment in 1977 (EPA, 1977). It was revised in 1981 (EPA,1981) and another revised version was released by EPA in 2006 (EPA, 2006).

Overcash and Pal (1979) published the first textbook on land treatment systems in 1979. It was entitled "Design of Land Treatment Systems for Industrial Wastes: Theory and Practice." Reid and Crites (1984) published the *Handbook of Land Treatment Systems for Industrial and Municipal Wastes* in 1984. A revised edition of the 1984 book was published in 2000 (Crites et al., 2000). The agricultural engineering departments at Clemson, University of Minnesota and University of Delaware developed courses in land application in the 1970s and 1980s. The course at the University of Delaware was taught mostly every other year from 1978 to 2013. Starting in 1984 the *Handbook of Land Treatment Systems for Industrial and Municipal Waste*s was used as the textbook for the course. In 2000, the course was revised to include other topics besides land treatment and the title of the course was changed to *Natural Wastewater Treatment Systems*. The book *Small and Decentralized Wastewater Management Systems*, by Crites and Tchobanoglous (1998) was used as the textbook. The course at the University of Minnesota has been discontinued but the course at Clemson is still listed.

There has not been a national conference or symposium entirely devoted to land treatment systems in the past 25 years. There are national conferences where papers on land treatment systems have been presented. The WateReuse Association has held an annual conference on water reuse since

1985. The American Society of Agricultural and Biological Engineers (ASABE) holds an annual conference where there have been sessions on land application. ASABE held four international conferences from 1990 to 2003 on animal agriculture and food processing waste management The National Poultry Waste Management Symposium has been held every other year since the late 1980s. Papers on waste management in the poultry processing industry are presented each year. Many poultry processing plants use land application systems for their wastewater treatment.

## Wastewater Reuse Guidelines and Regulations

Hutchins (1939) reported that in California a permit from the State Department of Public Health must be obtained for sewage irrigation. The regulations prohibited the use of untreated sewage that contain human wastes for irrigating growing crops. Partial treated and undisinfected effluents could not be used on vegetables or low-growing fruits, but could be used on nursery stock, cotton, and such field crops as hay, grain, rice, alfalfa, sugarbeets, fodder corn, cow beets, and fodder carrots. Arizona also required a permit from the Department of Health for sewage irrigation.

For other states Hutchins (1939) reported the following:

- Kansas did not have any regulations for sewage irrigation, but preferred sewage effluent be chlorinated if used for crop irrigation.
- Oregon did not approve of using sewage on fruit and vegetables.
- New Mexico did not have regulations, but it was believed that treated sewage should not be used to irrigate vegetables.
- Utah had no regulations governing sewage irrigation.
- Montana did not allow the sale of vegetables irrigated with sewage.
- Texas Department of Health had only advisory capacity on sewage irrigation but was against using sewage on fruits and vegetables.

Sullivan et al. (1973) mailed a survey to the State Health Departments and the State Water Pollution Control Agencies asking questions on land application of wastewater. The survey of State Health Departments addressed the question of the safety of wastewater effluent applied to land. The Water Pollution Control Agencies' survey was a broader based environmental survey related to guidelines for design, construction and operation of land application systems. Only 30 State Health Departments and 27 State Water Pollution Control Agencies answered the survey. Only five states Texas, Colorado, New Mexico, Arizona and Arkansas had regulations for land application. Only four of the states Texas, New Mexico, Arizona and Arkansas stated what crops could be used for land application systems.

The first EPA Guidelines for Wastewater Reuse was developed in 1980 as a research report (EPA, 1980a). The guidelines were updated in 1992 to support both project planners and state regulatory officials for developing regulatory requirements for wastewater reuse and were seeking EPA's guidance in developing the regulations (EPA, 1992). The guidelines were updated again in 2004 (EPA, 2004) and 2012 (EPA, 2012).

The primary purpose of the 2004 and 2012 updates was to summarize wastewater reuse guidelines and regulations with supporting research and information. Twenty-three of the states have regulations for agricultural wastewater reuse and ten have guidelines (EPA, 2012). The use of reclaimed water for irrigation is prohibited in some states. Some states allow irrigation on food crops with wastewater if the crop is processed and not eaten raw. Florida, Nevada and Virginia require that reclaimed irrigation water does not come in contact with the crop to be eaten. In Florida drip irrigation, ridge and furrow and subsurface irrigation can be used on any type of crop. California does not stipulate the irrigation water cannot come in contact with the food crop but have more stringent standards that are at or near potable water quality. Depending upon the type of crop or type of irrigation, the states' treatment requirements for food crops range from secondary treatment plus disinfection to oxidation, coagulation, filtration and higher level of disinfection.

Wastewater reuse for non-food crops or for food crops intended for food that will be commercially processed have less stringent treatment and water quality requirements. Most states require secondary treatment and disinfection. In most cases where milking animals would graze on fodder crops irrigated with wastewater, there are additional waiting periods for grazing and a higher level of disinfection is required if a waiting period is not adhered to.

## Case Histories

### Lubbock, Texas

Lubbock has one of the oldest land application sites that is still operating today. The site was started in 1925 when an average daily flow of 1.0 mgd was applied to 200 acres on a site operated by a farmer growing mostly cotton and some grasses. The average annual application was 5.6 ft. Over the years, the flow gradually increased and more land was added to the site. By 1955 they were applying 8.0 mgd to 1,800 acres. The average annual application was 5.0 ft. The wastewater was applied by furrow irrigation and the application rate was based upon land availability and crop appearance. In 1955, wastewater was mostly applied to cotton with a double crop of wheat and small amounts of alfalfa or grasses. The high application rate and using furrow irrigation resulted in groundwater mounding beneath a portion of the land application site (LAS). A pumping program was developed in the early 1970s that utilized 27 wells to pump groundwater to a nearby lake system (Fedler, 2000).

In 1986, the city of Lubbock purchased the land application site and additional land for growth. They also changed the furrow irrigation to center pivot irrigation. In 1986, the flow had increased to 12.0 mgd. The LAS consisted of 5,200 acres with 2,950 acres under 31 center pivot systems. The average annual application rate was 4.6 feet In 1999, the City purchased another 4,000 acres of land with approximately 2,400 acres under center pivot irrigation. Approximately 5.5 mgd of secondary treated effluent was applied to the site for an average annual application rate of 2.6 ft (Fedler, 2000).

When the City took over the LAS, not only was there a groundwater mound present, but the groundwater had nitrate levels above the drinking water standard of 10 mg/l N. The City modified the old groundwater pumping program to recycle groundwater unto a park, a golf course and farm land to utilize the nitrogen. With the new design and a new management approach the nitrates were reduced in the groundwater.

**Muskegon, Michigan**

The Muskegon County wastewater plant was built in 1974 as a land application demonstration project on 11,000 acres of sandy unproductive soil (EPA, 1980b). The County Commissioners started planning for the project in the later 1960s. The wastewater is collected in downtown Muskegon and pumped to the plant for treatment and storage. The first step is a complete mix aerated lagoon with a 1.5 days detention time. The wastewater then flows to an aerated settling lagoon where it is retained for three days to allow the solids to settle. Only enough aeration is provided to keep the system from going anaerobic. Each settling lagoon is used for two years before it requires cleaning. During the cleaning, the wastewater is diverted to a second settling lagoon. After settling the wastewater is held in two storage lagoons until it is used for crop irrigation (Biegel et al., 1998). Each storage lagoon is 850 acres with 5.1 billion gallons of storage capacity. The wastewater is used to irrigate 5,100 acres of cropland. Corn, soybeans and alfalfa are the crops grown. The cropland is drained with 200 miles of subsurface drains which returns clean water to the Muskegon River. The system provides excellent treatment with the discharge effluent quality typically having BOD < 2.0 mg/l, suspended solids < 10 mg/l, total phosphorus < 0.05 mg/l and dissolved oxygen > 5.5 mg/l. The plant has a design capacity of 43 mgd.

The plant was expected to have a life of 40 years based upon the soil phosphorus sorption capacity. Hu el al. (2006) estimated the maximum phosphorus sorption capacity (based upon one day isotherm tests) has been increased by 2-4 times since 1973 and the maximum actual phosphorus sorption capacity of the Muskegon soils could be much higher than the one-day isotherm test. They concluded the life of the Muskegon system has been significantly extended by wastewater application.

**Tallahassee, Florida**

In 1965, the new southwest wastewater treatment plant was constructed. The City began development of a 850 acre site for spray irrigation with the potential of disposing of 11.0 mgd. In 1966, the spray irrigation system began operation with an initial flow of 0.25 mgd that was increased to 1.0 mgd by the summer of 1969.

In 1972, Overman (1979) began a three-year study on the site for EPA. For the study a crop rotation of coastal Bermuda grass and rye grass was used. Coastal Bermuda grass had a growing season from May until November and rye grass would have a growing season from November until May. Wastewater was applied at a rate of 3.0 in/wk.

Until 1980, spray irrigation was limited to 120 acres southwest of the City. A new 1,840 acre spray irrigation site southeast of Tallahassee started operation in 1980. The site is operated by a farmer under contract to the City. Corn and sorghum are grown on the site.

The mass of nitrogen in the wastewater effluent and fertilizer is tracked by the City at both spray irrigation sites. Davis et al. (2010) estimated the nitrate loading to the southeast site peaked at 1.3 million lb/yr in 1986 when fertilizer application was highest. Since 1986, the load has decreased to about 705,000 lb/yr. The decline was due to a reduction and eventual elimination of fertilizer application. It is estimated the nitrate loading will decrease to about 200,000 lb/yr after improvements are made to the wastewater plant to reduce the effluent nitrate concentration to 3.0 mg/l in 2013. The nitrate loading to the southwest site was initially low in 1966 when wastewater application began and peaked at 300,000 lb/yr in 1980. The nitrate loading abruptly decreased after 1980 when wastewater was diverted to the southeast site and has been under 22,000 lb/yr.

**Pennsylvania State University**

Penn State's "Living Filter" wastewater reuse system was started in 1963. The original 1963 system was designed to handle only part of the University wastewater (0.5 mgd). (EPA, 1976). The wastewater received secondary treatment either with trickling filter or activated sludge. In 1983. the system was expanded to take all of the wastewater from the 35,000 student University plus wastewater from half of the surrounding town of State College (Ferguson, 1983). Today the site consists of 600 acres of cropland and forest. It is probably the most documented system in the world.

The effluent is applied at a rate of 2.0 inches/week. Wastewater is applied the year around. The system is unique in that it has no storage. The type of vegetative cover includes cropland (mostly corn and hay), hardwood forest, a pine plantation, a spruce plantation and gameland consisting of mixed fields and forests. In the winter, wastewater is applied to forestland and reed canary grass.

Water quality monitoring was started a year before the "Living Filter" system was put into operation. An intensive monitoring program has been maintained over the years for both research and quality control. There have been many research projects conducted over the years. The latest study has been on how land cover differences could influence estrogen transport through the soil profile and the persistence of hormones at a land application system after more then 25 years of wastewater application (Woodland et al., 2014).

**Cheyenne, Wyoming**

The City of Cheyenne has discharged wastewater to a stream since the 1800s. In 1973 the wastewater flow was 7.0 mgd (Pound and Crites, 1973b). Wyoming Hereford Ranch (WHR) was started in 1881 and for years has used the stream for irrigation. It had water rights to 17 $ft^3$/sec of flow. WHR constructed a reservoir about a mile downstream from the City wastewater treatment plant. The reservoir originally had about 100 ac-ft capacity. WHR used it to irrigate 1,200 acres of grass and hay and 130 acres of alfalfa by flood irrigation. They attempted to irrigate the entire area three time a year on April 1, June 1 and August 10. Each watering took approximately five weeks. (Sullivan et al., 1973). Cattle grazed on the irrigated area in the winter. WHR consisted of 60,000 acres and had 2,700 head of cattle in the 1950s, 1960s and early1970s and was the third largest Hereford ranch in the U.S. In 1978 the ranch changed owners and the herd was greatly reduced in size and large tracts of land were sold.

**Seabrook Farms, New Jersey**

Seabrook Farms a large vegetable processing company located in Cumberland County, New Jersey, was started in the early 1900s. They recognized the problem of stream pollution from their operation in the late 1930s, but during the war little pollution control was attempted because of a shortage of construction materials. Only two lagoons were constructed in the 1940s and by 1946 were totally inadequate. During the next two years engineering studies were done, but no economical feasible pollution control solution was found. Seabrook asked Dr. C. Warren of Thornthwaite and Associates to join their effort to investigate the disposal of wastewater by irrigation. After some experimental tests in a wooded area during the winter and spring of 1950, the Seabrook land application system was constructed to occupy an area adjacent to the experimental area. Initially 72 sprinklers were installed (Henry et al., 1954). The sprinklers each covered a little over an acre and were designed to apply 8 in/day. Soils in the wooded site were sandy with low silt and clay content. Wastewater from the plant was screened and pumped to a canal which conveyed it 1.7 miles to the wooded disposal site. Two major pumping stations were located along the canal which removed wastewater from the canal to irrigate crops. During the first few years, the plant shut down in the winter and the disposal area received no wastewater. In the winter of 1953, winter processing of potatoes made it necessary to operate the disposal system during the winter. The wastewater flow was highly variable ranging from a few hundred thousand gallons in the winter to 16 mgd during the height of the packing season. BOD ranged from 200 mg/l to around 2,000 mg/l depending upon the product being processed. Nitrates were < 1.0 mg/l in the wastewater. Annual application of wastewater was 1.25 billion gallons distributed over 320 acres. Sanitary waste was treated separately, so the land applied wastewater contained no sanitary waste. The system operated successfully from 1950 until the plant was closed in 1976. Henry et al. (1954) reported the average daily BOD loadings in 1950, 1951 and 1953 were 276, 220 and 117 lb/ac. Nitrate concentrations in the groundwater test wells average 5.70. 1.50 and 2.20 mg/l in 1950, 1951 and 1953, respectively. Sullivan et al (1973) concluded that after 23 years the system was providing high quality purification.

**Dalton, Georgia**

Dalton Utilities developed a land application system (LAS) in 1984. The site consisted of 9,600 acres and is the largest forested LAS in the U.S. The site contains loblolly and longleaf pines, black oak, ash, box elder, eastern swamp cottonwood, American elm and sweet gum. Nearly 19,000 spray heads irrigate the forest. There are 76 spray fields. Impact style spray heads are mounted on 3 ft risers and each delivers wastewater over a 60 ft diameter. The original LAS underwent a major redesign and expansion in 1999 (Dalton Utilities, 2018). Trees are selectively harvested and replanted in-house to maintain the integrity of the system. The topography ranges from flat to relatively steep. Soil depths vary from 1.75 ft to 4.0 ft (Crites and Reed, 2002).

Dalton Utilities operates four wastewater treatment plants. Two of the plants are activated sludge plants and two are membrane filter plants. Average flow ranges from 20 to 25 mgd. They have the capacity to treat 40 mgd on average and 66 mgd on any single day. The majority of the wastewater flow is from the carpet industry. Dalton is known as the carpet capital of the world. Maximum flow from the carpet industry occurs on week days. To level out flow to the LAS a 170 acre reservoir was built to store effluent.

Public access to the LAS is restricted except for tours, birdwatchers and special hunts for deer, turkeys and ducks. In 2001, a quota deer hunt was started to control the deer population and in 2004 a turkey hunt was added. In 2011, a youth duck hunt was started.

## Summary and Conclusions

- Land application of wastewater in the U.S. began in the 19th century. By the late 19th century it was considered the safest and best method for wastewater disposal. The first comprehensive reviews of wastewater treatment were published in the 1890s.
- The food processing industry started using land treatment systems in the 1940s and 1950s. In 1964 it was estimated there were 2,200 land treatment systems in the U.S. A 1976 report estimated there were about 3.400 land treatment systems in the U.S. and from 10 to 20 percent of all wastewater treatment plants used land application.
- With the passing of PL92-500 in 1972 there was a renewed interest in land treatment. EPA in 1977 issued a new policy that land treatment had to be considered for all projects funded by EPA. EPA published the first land treatment systems design manual in 1977 and numerous other publications on land treatment in the 1970s.
- Muskegon Michigan land application system constructed in 1974 is the largest municipal land application system using cropland operating in the U.S. today. Dalton Utilities in Georgia operates the largest forest land application system in the U.S.

## References

Biegel, C.M., L. S. Lee, J. G. Graveel, and J. J. Vorst. 1998. Muskegon County Wastewater Management: An Effluent Application Decision. J. Nat. Resour. Life Sci Edu. 27:137-144.

Crites, R.W., S.C. Reed, and R.K. Bastian. 2000. Land Treatment Systems for Municipal and Industrial Wastes. McGraw-Hill Book Co. New York, NY.

Crites, R.W. and S.C. Reed. 2002. Slow Rate Land Treatment. EPA Wastewater Technology Fact Sheet, U.S. EPA Municipal Technology Branch, Washington, DC. Fact Sheet No EPA 882-F-02-012.

Crites, R.W. and G. Tchobanoglous. 1998. Small and Decentralized Wastewater Management Systems. McGraw-Hill Book Co. New York, NY.

Crites, R.W. and A. Uiga. 1977. Relative Health Factors for Municipal Wastewater Treatment Processes. U.S. EPA Office of Water Program Operation, Washington DC. Report No. EPA 430/9-77-00.

Dalton Utilities. 2018. Wastewater Treatment Facilities and Land Application. Dalton Utilities, Dalton GA. https//www.dutil.com/wastewater-facilities.

Davis, J.H., B.G. Katz and D. W. Griffin. 2010. Nitrate-N Movement in Groundwater from the Land Application of Treated Municipal Wastewater and Other Sources in the Wakulla Springs Springshed, Leon and Wakulla Counties, Florida, 1966-2018, U.S. Geological Survey, Reston VA.

Fedler, C. B. 2000. Impact of Long-Term Application of Wastewater. International Meeting of ASAE, Chicago, IL. July 9-12, ASAE, 2950 Niles Road, St.Joseph, MI. ASAE Paper No. 002055.

Ferguson, B.K. 1983. Environmental Planning for Wastewater Land Application: Lessons Learned from Penn State's "Living Filter". Landscape Planning, 10:205-218.

Henry, C.D., R. E. Moldenhauer, L. E. Engelbert, E. Truog and R. A. Webster. 1954. Sewage Effluent Disposal Through Crop Irrigation. Sewage and Industrial Wastes, 26(2):123-135.

Hu C., Tian Zhang, Y. H. Huang, Mohamed F. Dahab, D. Kendrick, and R. Surampalli. 2006. Muskegon Wastewater Land Treatment System: Fate and Transport of Phosphorus in Soils and Life Expectancy of the System. Eng Life Sci, 6(1):17-25.

Hutchins, W.A. 1939. Sewage Irrigation Practiced in the Western States. USDA, Washington, DC. Tech. Bul. No. 675.

Jewell, W.J. and B.L. Seabrook. 1979. A History of Land Application as a Treatment Alternative. U.S. EPA Office of Water Program Operation, Washington DC. Report No. EPA 430/9-79-012.

Loehr, R.C. (Editor). 1977. Land as a Waste Management Alternative. Ann Arbor Science Publications, Ann Arbor, MI. 811 pgs.

Overman, A.R. 1979. Wastewater Irrigation at Tallahassee Florida. U.S. EPA Robert S. Kerr Environmental Research Laboratory, Ada OK. Report No. EPA 600/2-79-151.

Overcash, M.R. and D. Pal. 1979. Design of Land Treatment for Industrial Wastes, Theory and Practice. Ann Arbor Science Publishers, Ann Arbor, MI.

Pound, C.E. and R. W. Crites. 1973a. Wastewater Treatment and Reuse by Land Application, Volume I- Summary. U.S. EPA Office of Research and Development, Washington DC. Report No. EPA-660/2-73-006a.

Pound, C.E. and R. W. Crites. 1973b. Wastewater Treatment and Reuse by Land Application, Volume II. U.S.EPA Office of Research and Development, Washington DC. Report No. EPA-660/2-73-006b.

Rafter, G.W. and M.N. Bayer. 1894. Sewage Disposal in the United States. D. Van Nostrand C., New York, NY. 595 pgs.

Rafter, G.W. 1897. Sewage Irrigation. U.S. Geological Survey Water Supply and Irrigation Papers, Report 3, U.S. GPO, Washington DC.

Rafter, G.W. 1897. Sewage Irrigation Part II. U.S. Geological Survey Water Supply and Irrigation Papers, Report 22, U.S. GPO, Washington DC.

Reed, S.C. and R.W. Crites. 1984. Handbook on Land Treatment Systems for Industrial and Municipal Wastes. Noyes Data, Park Ridge, NJ.

Sopper, W.F. and L.T. Kardos (Editors). 1973. Recycling Municipal Wastewater and Sludge Through Forest and Cropland. Pennsylvania State University Press, University Park, PA.

Sullivan, R.H., M.M. Cohn and S.S. Baxter. 1973. Survey of Facilities Using Land Application of Wastewater. U.S. EPA Office of Water Program Operation, Washington DC. Report No. EPA 430/9-73-006.

Thomas, R.E. 1973. Land Disposal II: An Overview of Treatment Methods. Journal Water Pollution Control Federation, 45(7):1476-1484.

U.S. Environmental Protection Agency. 1976. Land Treatment of Municipal Wastewater Effluent: Case Histories. U.S. EPA Technology Transfer Seminar Publication, EPA, Washington, DC.

U.S. Environmental Protection Agency. 1977. Process Design Manual for Land Treatment of Municipal Wastewater. U.S. EPA CERI, Cincinnati, OH. Report No. EPA 625/1-77-008.

U.S. Environmental Protection Agency. 1980a. Muskegon County Wastewater Management System. U.S. EPA Robert S. Kerr Environmental Research Laboratory, Ada OK. Report No. EPA 905/2-80-004.

U.S. Environmental Protection Agency.1980b. Protocol Development: Criteria and Standards for Potable Reuse and Feasible Alternatives. U.S. EPA, Washington, DC. Report No. EPA 570/9-82-005.

U.S. Environmental Protection Agency. 1981. Process Design Manual for Land Application of Municipal Wastewater. U.S. EPA CERI, Cincinnati, OH. Report No. EPA 625/1-81-013.

U.S. Environmental Protection Agency. 1992. Guidelines for Water Reuse. U.S. EPA, Washington, DC. Report No. EPA 625®-92-004.

U.S. Environmental Protection Agency. 2004. Guidelines for Water Reuse. U.S. EPA, Washington, DC. Report No. EPA 625®-04-108.

U.S. Environmental Protection Agency. 1981. Process Design Manual for Land Application of Municipal Wastewater. U.S. EPA CERI, Cincinnati, OH. Report No. EPA 625®-06-016.

U.S. Environmental Protection Agency. 2012. Guidelines for Water Reuse. U.S. EPA, Washington, DC. Report No. EPA 600®-12-618.

Woodward, E.E., D. M. Andrews, C. F. Williams and J. E. Watson. 2014.

Vadose Zone Transport of Natural and Synthetic Estrogen Hormones at Penn State's "Living Filter" Wastewater Irrigation Site. J. Environ. Qual., 43:1933-1941.¤

# Water for Food Global Conference

An important conversation about water and food security will take place April 29-30, 2019. The **Daugherty Water for Food Global Institute** will be held at the Nebraska Innovation Campus in Lincoln.

By attending, you will be an active participant in:

- a rich variety of plenary sessions, concurrent sessions, technical seminars and workshops led by a experts from around the world
- networking with international experts in food and water security
- side-events and receptions that are both entertaining and educational
- interactions with companies and organizations active in the water and food security space, both large and small
- a renewed passion and sense of urgency for your work in this field
- sharing of ideas, efforts and collaborations to use resources effectively

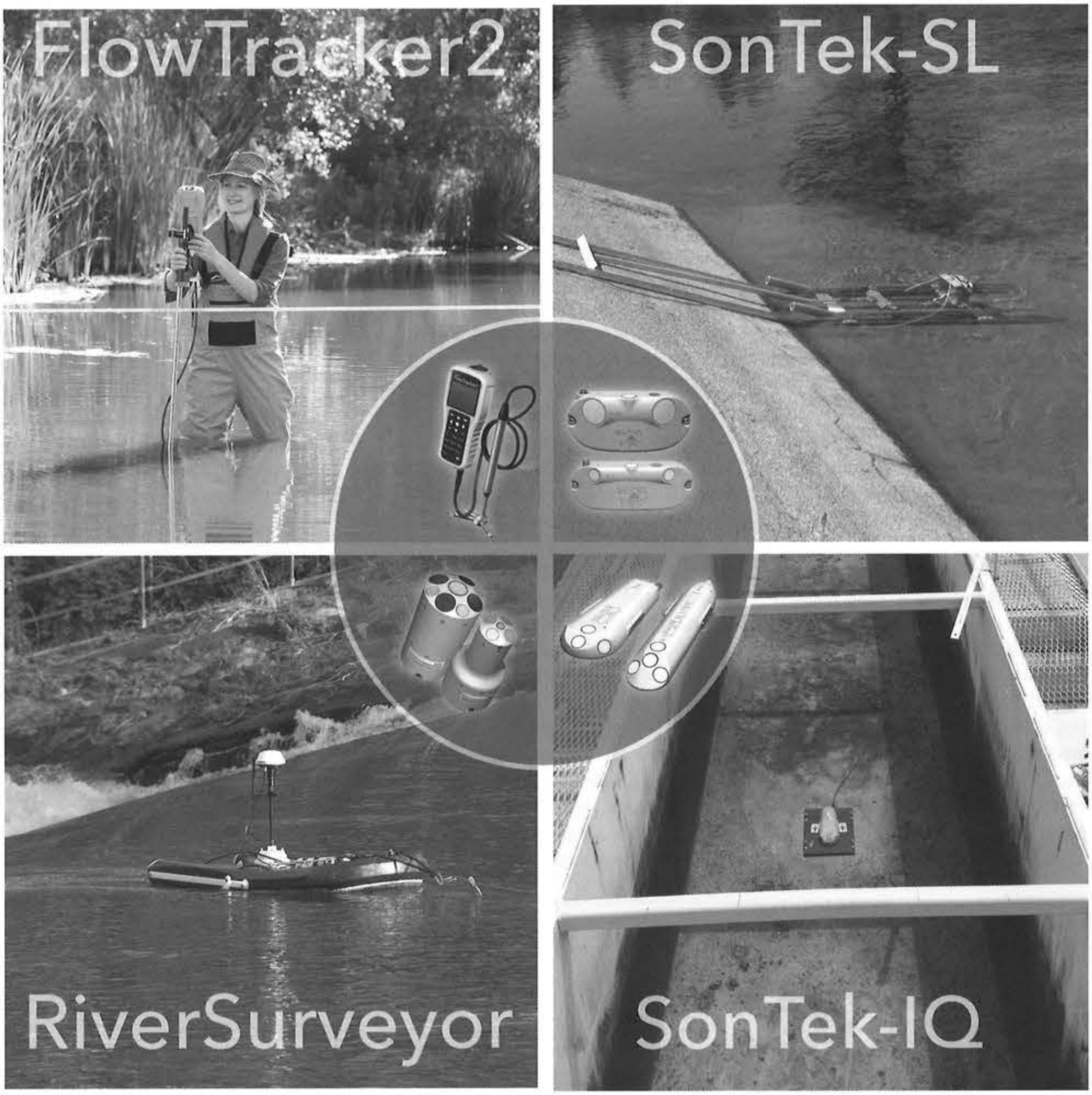
The conference theme is *Water for a Hungry World: Innovation in Water and Food Security*, focusing on the next generation of research, smart technology, policy development and best practices that are achieving breakthroughs in this vitally important mission. Registration will open in January. For more information, visit waterforfood.nebraska.edu.¤

# ITRC News

The **Irrigation and Training Research Center** has a number of opportunities for continuing education, and has recently published the resumes of Cal Poly BRAE students and graduates. Short courses include:

- Designer/Manager School of Irrigation (March and July/August)
- Agricultural Irrigation System Evaluation (June)

For more information, visit www.itrc.org.¤


FlowTracker2
SonTek-SL
RiverSurveyor
SonTek-IQ

## Arizona Conference (continued)

subscribers and the water sector. WRF is a nonprofit, charitable and educational organization which funds, manages, and publishes research on the technology, operation and management of drinking water, wastewater, reuse, and stormwater collection, treatment and supply systems — all in pursuit of ensuring water quality and improving water services to the public.

A large organizing committee assisted with the planning of the Conference (see sidebar).

## Pre-Conference Workshop

The *Pre-Conference Workshop on Irrigation District Modernization* was taught by **Charles Burt**. The Workshop covered strategies of irrigation district modernization, and technical details that have proven successful in irrigation projects throughout the U.S. and abroad. Problems and failures were also discussed. Topics included recirculation of return flows, regulating reservoirs, the difference between improving a single structure versus modernizing a system, canal lining, automation of canals and pumps with PLC-based control and more simple hydraulic structures, SCADA, special considerations of VFDs, pipeline options, and philosophies of modernization. The *ASCE Manual of Practice No. 131, Canal Automation for Irrigation Systems*, was the primary reference for the Workshop. The Workshop was well attended, with 25 participants.

## Tuesday Field Tour

The Tuesday morning tour visited the Riparian Preserve, Salt River Project's Eastern Canal, and the Town of Gilbert drinking water treatment plant. In 1986, Gilbert made a commitment to reuse 100 percent of its effluent water. The Town's desire to create innovative and unique ways to combine water resource development with wildlife habitat, educational and recreational opportunities led to the development of the Riparian Preserve in 1999. The Riparian Preserve is one part of the property known as Water Ranch, which extends from Greenfield Road east to Higley Road, encompassing the majority of the land between Guadalupe Road and the utility easement. Water Ranch includes the Southeast Regional Library building, the Salt River Project Eastern Canal, and the Town of Gilbert Drinking Water Treatment Plant.

## Conference Program

The Conference started off with John Shadegg, former U.S. Representative from Arizona, giving a luncheon talk. He provided some insights into how the legislative process works in

Tuesday lunch speaker John Shadegg.

Washington, DC. The Opening Plenary Session had some very interesting, big-picture talks from Steve Hvinden, Bureau of Reclamation; Dave Roberts, Salt River Project; Clint Chandler, Arizona Department of Water Resources; John Albert, Water Research Foundation, and Cheryl Zittle, Salt River Project.

Kristan VandenHeuvel from WRF organized an excellent panel session on the use of recycled water in agriculture with Brent Haddad, University of California Santa Cruz; Kara Nelson, University of California Berkeley, Anne Thebo, The Pacific Institute; Bahman Sheikh, Bahman Sheikh Water Reuse Consulting; and Shannon Spurlock, Denver Urban Gardens. Channah Rock

# Arizona Conference Plannning Committee

**Brian T. Wahlin**, Co-Chair, WEST Consultants, Inc., Tempe, Arizona

**Eduardo Bautista,** Co-Chair, ARS, U.S., Department of Agriculture, Maricopa, Arizona

**Taylor Ahrensdorf**, Stantec Consulting Services, Inc., Phoenix, Arizona

**James E. Ayars**, Consultant, Clovis, California

**David E. Bradshaw**, Imperial Irrigation District, Imperial, California

**Hassan A. Elsaad**, Salt River Project, Phoenix, Arizona

**Peggy B. Graham**, Advanced Drainage Systems, Longmont, Colorado

**Sara Harper**, Dewberry, Sacramento, California

**Aung K. Hla**, Bureau of Reclamation, McCook, Nebraska

**Randy Hopkins**, Provost & Pritchard Consulting Group, Clovis, California

**Erling A. Juel**, Greenfields Irrigation District, Fairfield, Montana

**Reed R. Murray**, U.S. Department of the Interior, Provo, Utah

**David T. Phelps**, Stantec Consulting Services Inc., Phoenix, Arizona

**Aldo R. Pinon-Villarreal**, Angelo State University, San Angelo, Texas

**Nelson W. Plummer**, Water Resources Consultant, Scottsdale, Arizona

**W. Martin Roche**, Consulting Engineer, Grass Valley, California

**Channah M. Rock**, University of Arizona, Maricopa, Arizona

**George Sabol**, Stantec Consulting Services Inc., Phoenix, Arizona

**Anne Thebo**, Pacific Institute, Oakland, California

**Kristan C. VandenHeuvel**, The Water Research Foundation, Alexandria, Virginia

**Clinton Williams**, ARS, U.S. Department of Agriculture, Maricopa, Arizona from the University of Arizona also organized a panel discussion on water reuse in irrigated agriculture that focused on recommendations towards safe and sustainable solutions to climate variability. Panel members included Amy Sapkota, University of Maryland; Channah Rock, University of Arizona; Sean Ellis, University of Delaware; Charles Gerba, University of Arizona; and Manan Sharma, Agricultural Research Service.

The Poster Session featured 13 presentations from students from Arizona State University, New Mexico

Cal Poly poster presenters. Back Row: Mary Hambly, Dylan Goodwin, Ryan Emory, Grant Doerksen, Kent Norman, Matt Caviglia. Front Row: Erika Gomez, Flor Espino, and Zoe Glick.

State University, and CalPoly.

Lunch and dinner talks covered a wide range of topics. George Seperich from Arizona State University gave a very entertaining talk on adult education. He discussed two excellent opportunities for adult education: the Water Manger Certificate Program run by the Agribusiness and Water Council and Project CENTRL run by the Center for Rural Leadership.

Dinner speaker Guy Carpenter.

Guy Carpenter, Carollo Engineers, gave an interesting talk on public perception of water reuse. He asked a very provocative question: who would eat a roach that had been autoclaved and was free of germs and disease? Not many, because of the perception that the roach is contaminated. This is the type of preconceived notions that reclaimed water has to fight.

Larry Mays from Arizona State University gave a fascinating talk on ancient water technologies with examples from almost every continent.

Thursday lunch speaker Larry Mays.

Conference technical session topics included:

- Water reuse
- Non-traditional water conservation through design and construction techniques
- Infrastructure
- Evapotranspiration
- Irrigation and water management
- Groundwater
- Regulatory issues
- Western US infrastructure updates

## Friday Field Tour

The Friday tour featured the newly constructed Pima-Maricopa Irrigation Project. The tour was hosted by David DeJong, who is incredibly knowledgeable of the history of the project. After DeJong provided a little background history, the tour then focused on various elements of the system that P-MIP has constructed during the past 10 years. This began at the Ashurst Hayden Diversion Dam improvements completed by San Carlos Irrigation and Drainage District in 2011 and included a visit to the construction of the Florence-Casa Grande Canal Reach 1. The tour then went to the off-reservation Pima Canal MP 11.3 check structure and its appurtenances, before visiting the Southside Canal and the flood protection system. The tour also included a visit to the 4 Mile Post Lift Station, as well as a visit to the Community's first Managed Aquifer Recharge facility.¤

### Exhibitors

- Advanced Drainage Systems
- Aqua Systems 2000 Inc.
- George Cairo Engineering, Inc.
- HUESKER, Inc.
- Hydro Component Systems, LLC
- Infra Pipe Solutions,
- Irrigation Training & Research Center
- PipeMedic by QuakeWrap
- Rubicon Water
- WEST Consultants, Inc.

### Sponsors

- Davids Engineering, Inc.
- GEI Consultants, Inc.
- Hydro Component Systems LLC
- MBK Engineers, Inc.
- Provost & pritchard Consulting Group
- WEST Consultants, Inc.

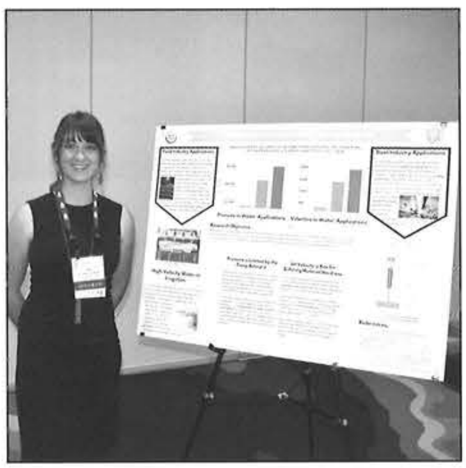
# USCID 12th International Conference, Phoenix


Corey Park (left) and Lou Leonardi represent Pipe Solutions Ltd.

Charles Burt, Irrigation Training and Research Center, presents Irrigation District Modernization Workshop.

Sara Harper, Dewberry; and Brian Wahlin, WEST Consultants.

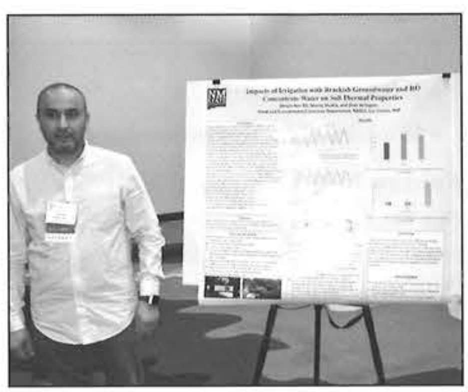

Jeff Verhines (left) and George Sabol, Stantec Consultants.



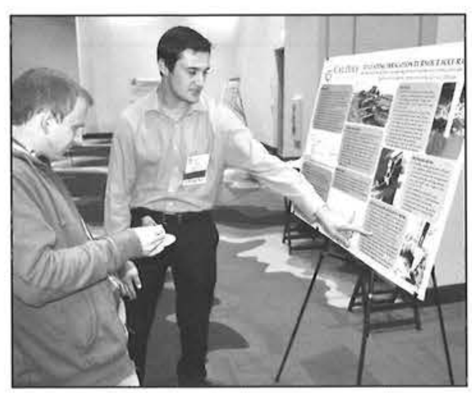
Mary Hambly, Cal Poly.


Hassan Elsaad (left), Salt River Project; and Firat Sever, PipeMedic by QuakeWrap.


Michael Ballard, MACE An In-Situ Company; and Zoe Glick, Cal Poly.

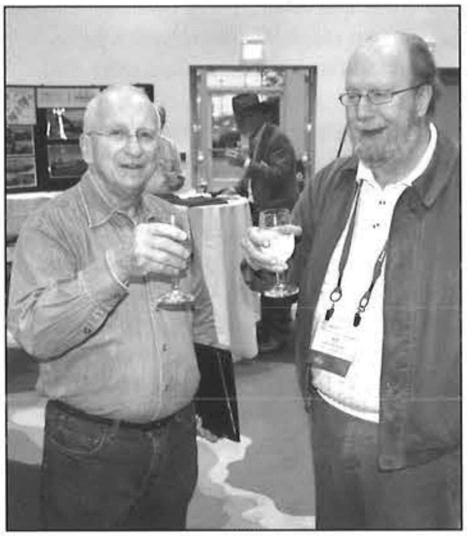


Akram Ben Ali, New Mexico State University.



Ryan Fulton, Davids Engineering; and Kent Norman, Cal Poly.

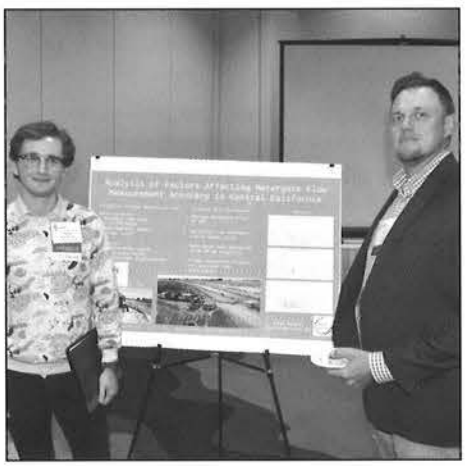
# October 15-19, 2018



John Replogle (left), ARS, USDA, retired; and Jeff Bradley, WEST Consultants.

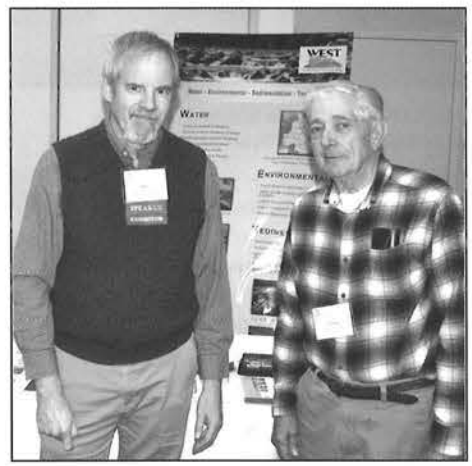

Carly Cox, George Cairo Engineering.


Roy McClinton, HUESKER.



Dylan Goodwin (left) and Kyle Feist, Cal Poly.


Peter Moller (left), Rubicon Water, and Philip Govea, Turlock Irrigation District.




Bert Clemmens (left), WEST Consultants; and Chuck Caruso, AGRIMEX.


Curt Pierce, New Mexico State University.

Justin Hopkins (left), Solano Irrigation District; and Stewart Soreson and Chase Herder, Aqua Systems 2000.


Jerry Gibbens (left), Northern Water; and Shane Scott, Hydro Component Systems.

## Scholarship and Awards (continued)

**Julia Reese** is an undergraduate student at the University of Idaho, with a double major in civil engineering and agricultural systems management. Passionate about water conservation and efficient water use, after graduation she hopes to pursue a career as a consulting engineer in the irrigated agriculture industry.

USCID President Brian Wahlin presents the Summers Engineering Scholarship to Julia Reese.

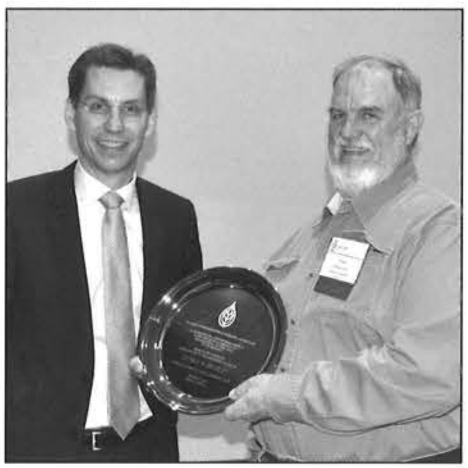
The Summers Engineering Scholarship, was endowed by Joseph Summers in 1989. The recipient receives a $1,000 scholarship, as well as registration and travel expenses for the annual USCID conference.

**Jeffrey R. Bradley** is a water resources expert with 42 years of experience in hydraulics, hydrology and sedimentation. He is internationally recognized for his work on mud and debris flows and their effects on alluvial fan flooding. He has written more than 75 professional papers and reports and is the editor of two books. He is a Fellow of the American Society of Civil Engineers.

Brian Wahlin and Jeff Bradley.

The USCID Service to the Profession Award recognizes a person or organization that advances the understanding of irrigation and drainage through a long and distinguished career.

**Thomas W. Gill** received the USCID Merriam Improved Irrigation Award, which was endowed by John Merriam in 1999. The award is presented to an individual who has contributed to efficient water management and the value of flexible irrigation water supply. Gill is a Hydraulic Engineer at the Bureau of Reclamation's Hydraulic Laboratory in Denver. Much of his work involves helping irrigation districts to incorporate electronic communication and control technologies in the daily operation of water delivery systems.¤



Brian Wahlin and Tom Gill.

# Geosynthetics for Canal Lining

During the session on Non-Traditional Water Conservation through Design and Construction techniques at the recent USCID International Conference in Phoenix, Herve Plusquellec gave a presentation on the *Use of Geosynthetics for Lining Irrigation Canals*. The use of geosynthetics is considered one of the most important developments in civil engineering of the last 50 years. The geosynthetics industry has pervaded all sectors of civil engineering to the point that their use is routinely considered at the design stage. Geosynthetics have been used for waterproofing over 300 dams, some approaching 200 meters high, indicating the confidence of dam engineers in this waterproofing technology.

However, the irrigation sector is lagging behind other civil engineering sectors. In many countries, rigid lining, either cast-in-situ or precast concrete panels, is still the preference of irrigation agencies and consultants for lining of irrigation canals, despite the well-known deterioration of concrete over time.

The geosynthetics industry has developed a large number of geomembranes which have been use for lining of irrigation canals such as PVC, the series of polyethylene of different density, bituminous geomembranes and geocomposite materials which consist in a combination of geomembranes with geotextiles.

Plusquellec discussed the importance of the selection of geomembrane for a specific application depending on the soils and climatic conditions. A gain in one quality may be countered by a loss in another one. Stronger is not necessarily better. Plusquellec then discussed various methods of installation of geomembranes, either exposed or protected with concrete, brick or other material. The type of geomembrane and its thickness are most important decisions at design stage.

The overall cost of the lining system should be used for cost comparison of alternative solutions, including preparation of the base, and protection materials, and not limited to the cost of the geomembrane.

*Herve Plusquellec is the author of a 2004 ICID publication on the use of geomembranes for canal lining. He is now working to revise that publication, and would appreciate any communication from the readers of this newsletter about the use of geomembranes by U.S. irrigation districts. Contact him at hplusquel@gmail.com.*¤

# Northern Water and Gross Dam Projects in Colorado

*By Gerald Gibbens, Northern Water, Berthoud, Colorado*

*Editor's note: The following article is based on a presentation by Gerald Gibbens during the recent USCID Conference in Arizona.*

## Introduction

Colorado's average precipitation yields 14 million acre-feet of water annually in our streams and rivers. More than 60 percent of this water exits the state and supplies water to several downstream states and Mexico. Managing water resources in Colorado is challenging due to variable climatic conditions, aging infrastructure and increasing funding needs. Colorado's population has ballooned from one million in 1930 to more than five million today, and could nearly double by 2050. With an unpredictable water supply and growing demand, Colorado could experience a water supply gap of up to 560,000 acre-feet by 2050. Meeting that gap in a balanced, sustainable manner is an issue that affects every Coloradan.

## Colorado's Water Plan

Colorado's Water Plan is the framework for the state's water challenges. It guides future decision-making with a collaborative, balanced and solutions-oriented approach. It sets measurable goals needed to ensure the state's most valuable resource is protected and available for generations to come. The Plan contains several measurable objectives, including reducing the supply-demand gap; municipal and industrial conservation; land-use planning that incorporate water saving actions; maintaining agricultural productivity; increasing water storage; watershed health, environment and recreation; funding; and education, outreach and innovation.

## Water Storage Projects

Several water supply agencies in Colorado are implementing water storage projects that will address the Water Plan's objective to increase storage by 400,000 acre-feet. The following highlights projects that are currently in the process of being implemented along Colorado's Northern Front Range.

### Gross Reservoir Expansion

Gross Reservoir Expansion, being undertaken by Denver Water, will raise Gross Dam by 131 feet; the raised dam will be 471 feet high, and the tallest dam in Colorado. Reservoir storage will be about 119,000 acre-feet, increasing reservoir volume by 77,000 acre-feet, and making it Denver Water's largest reservoir on the East Slope. The reservoir will store water diverted from the Fraser River on the West Slope and conveyed to the East Slope through the existing Moffat Tunnel. The new supply will meet demand, reliability and resiliency needs. Program cost is $464 million (2025 dollars), and is being paid for by Denver Water and the City of Arvada.

Project schedule:

- NEPA/404 Permit: 2003-2017
- Dam Design: 2018-2020
- Site Development: 2020
- Full Quarry: 2020-2025
- Dam Surface Preparation: 2021-2022
- RCC Placement: 2022-2025
- First Fill: 2026

### Northern Integrated Supply Project

The Northern Integrated Supply Project, being undertaken by Northern Water on behalf of 15 towns, municipalities, and rural domestic water districts, will provide 40,000 acre-feet per year of new reliable firm supply. NISP will divert water from the Cache la Poudre and South Platte Rivers (both on the East Slope) to two new reservoirs and deliver that water via pipelines and the Poudre River for participants' water use. NISP includes:

- Glade Reservoir — 170,000 acre feet, with a 300 foot zoned earth-fill dam
- Galeton Reservoir — 45,000 acre-feet, with a 75-foot zoned earth-fill dam
- Five pump plants
- Pipelines to deliver water for exchange with two irrigation companies and for delivery to participants
- Improvements to an existing canal to divert water off the Poudre River near the canyon mouth.

NISP program cost is $1.1 billion and is participant funded and driven. Project schedule:

- 2004 — Begin NEPA compliance
- 2018 — Release of FEIS, and continued work on water quality certification
- 2019 — Anticipated Record of Decision
- 2017-2021— Design
- 2021-2025 — Construction
- First Fill — 2025-2026

### Chimney Hollow Reservoir

The Chimney Hollow Reservoir project, bring undertaken by Northern Water on behalf of 12 Windy Gap municipalities, rural domestic water districts and industrial water users, is the key component of the Windy Gap Firming Project. The new reservoir will be located on the East Slope and consists of an 350-foot-high asphalt core rockfill dam, providing 90,000 acre-feet of storage, with 30,000 acre-feet per year of firm water supply. It will store Windy Gap water diverted from the Colorado River on the West Slope and conveyed to the East Slope through existing Colorado-Big Thompson Project facilities. The reservoir and surrounding open lands will also create new public open space. Program cost is $575 million and is participant funded.

Project Schedule:

- NEPA 404 Permit — 2003-2017
- Dam Design — 2016-2019
- Financing — 2017-2019
- Construction — 2020-2023¤

# Salt River Project Irrigation Lateral Capacity Tool

*by Bert Clemmens, Brent Travis and Brian Wahlin, WEST Consultants, Inc., Tempe, Arizona; and Jorge Garcia, Salt River Project, Phoenix, Arizona*

*Editor's note: This paper was presented during the USCID Arizona Conference. A color version is available from USCID.*

**ABSTRACT**

The Salt River Project (SRP) has a partnership with the City of Goodyear to supply water to the City for the development of a drinking water treatment plant. The connection point form SRP to the City of Goodyear is still being evaluated. In order to supply water to the City of Goodyear, SRP solicited assistance from WEST Consultants, Inc. (WEST) to evaluate the capacity of existing lateral canals in the project area. The proposed treatment plant is south and west of the main SRP service area. So SRP decided to evaluate lateral canals that receive water from the western end of the Grand Canal (Canal 2). Twelve lateral canals along the Grand Canal were evaluated. SRP has rated capacities for these canals, but over time, development has occurred, with each leg of a canal possibly piped by a different developer/contractor. The net result was considerable uncertainty in actual capacity. WEST developed a spreadsheet template that includes automatic calculation of backwater between structures. Structure and canal elevations were surveyed so that actual capacity was not subject to variations in survey datum. This presentation describes the spreadsheet template and how it was used to determine lateral capacity.

## Introduction

SRP lateral canals consist of canal or pipeline sections divided by check structures. While most of the system was originally canals, much of the system has been converted to pipelines as development took place. When a canal was converted into a pipeline, the check structure was replaced with a head box. These head boxes performed the same function as a check structure. On the upstream side, the pipeline enters the head box. The head box includes a weir wall with a gate below the weir. If the gate is closed the water raises up in the head box until it spills over the weir. These weirs are operated by the zanjero to control water levels for delivery gates. On the downstream side, a pipeline exits to head box to continue the pipeline downstream. If water is not delivered to turnout structures from a head box, sometimes the head box is no longer used to control water surface elevation, and therefore is considered abandoned.

The canals analyzed included lateral canals off the Grand Canal from 35th Avenue to roughly 115th Avenue in Phoenix. The Grand Canal is designated as canal 2. Laterals are designated by the number of mile downstream. Thus lateral 2-23 is a lateral off the Grand Canal that is roughly 23 miles downstream from the canal heading. The study evaluated Lateral canal from 2-15 to 2-23 plus drains that supplied the Buckeye Feeder Canal at roughly 115th Avenue and Broadway Road in Phoenix. Figure 1 shows a map of SRPs

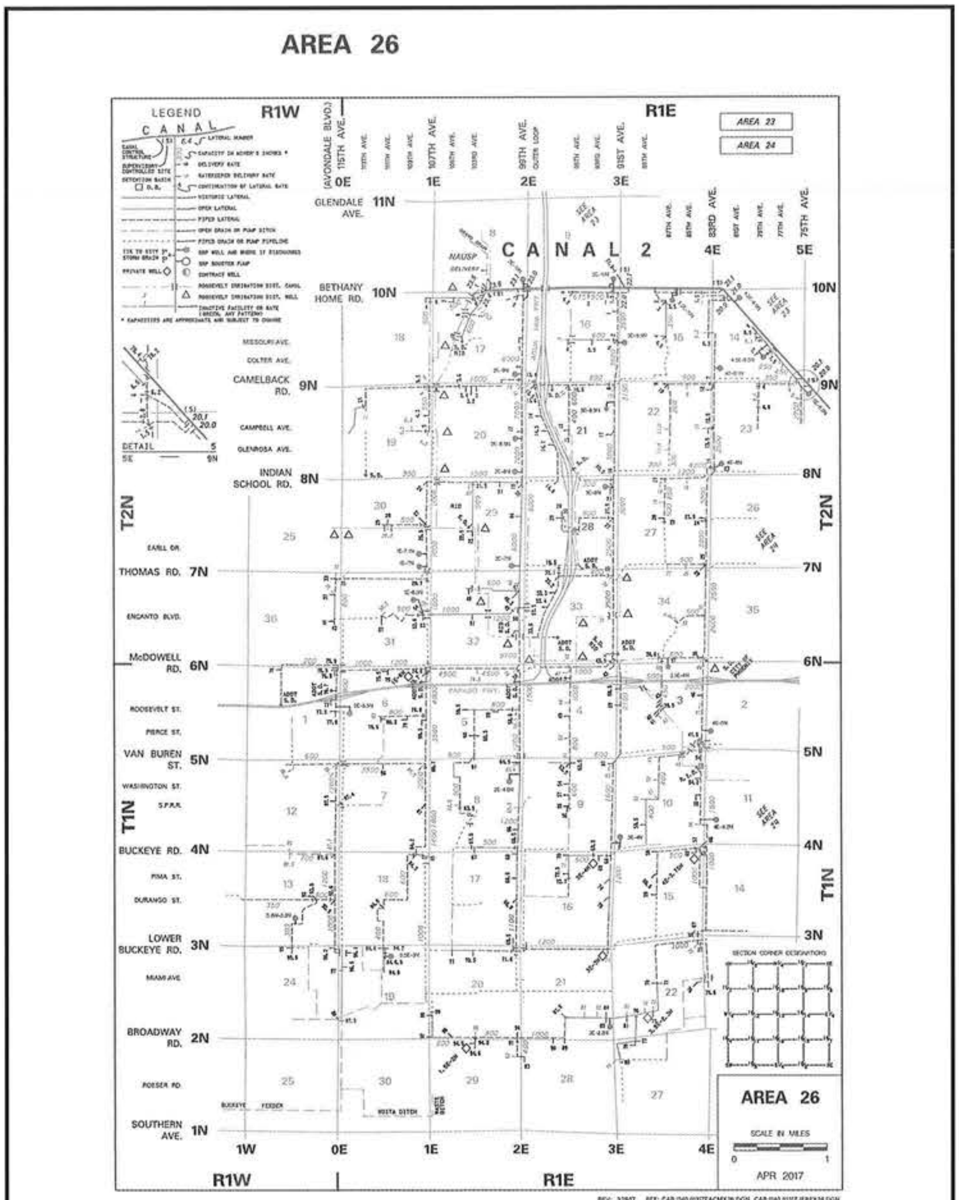



Figure 1. SRP Service Area 26.

Area 26, including laterals from 2-21 to 2-23. Figure 2 shows a map of Area 24, including laterals from 2-13 to 2-20. Pink highlighted laterals were excluded from the study since water could not be sent the Buckeye Feeder Canal from these canals.

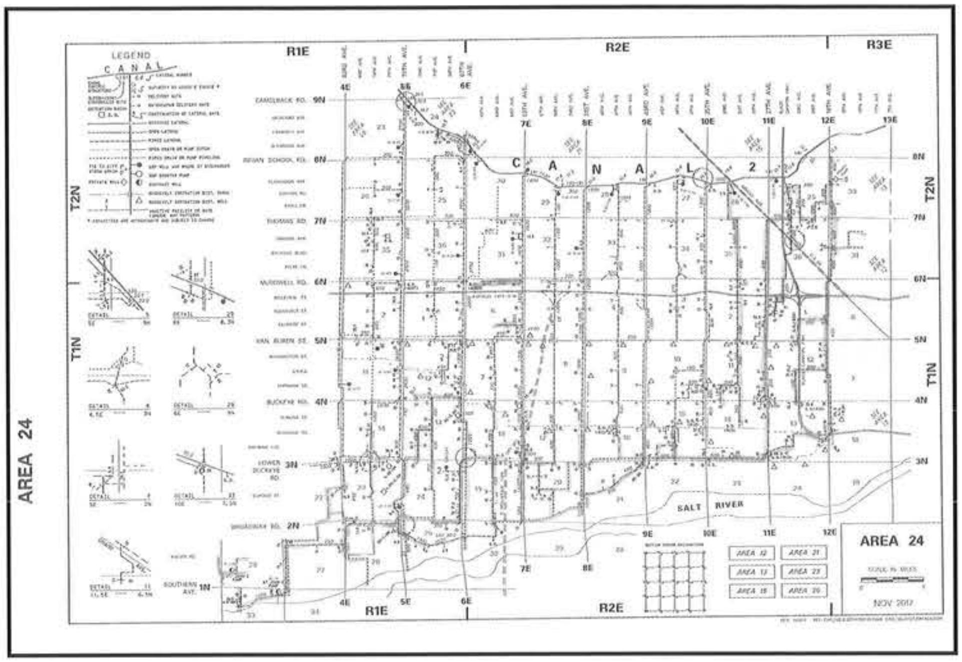



Figure 2. SRP Service Area 24.

## SRP Requirements

SRP irrigation laterals consist of a series of canal or pipeline segments that are interrupted by water control or check structures. These check structures allow the water level to be checked up so that the water level in the lateral is sufficiently high so that the proper rate of flow can be delivered to water users at that location. These check structures have gates so that water can pass downstream and weirs so that water will continue to flow downstream regardless of how the gates are set.

There are two types of irrigation laterals: canals and pipelines. Pipelines have headboxes that have weirs and undershot gates within the structure that serve as check structures, while canals have a simple check gate structure across the canal. SRP provided estimates of the water level upstream from check structures required to make deliveries. This was called the Highwater Level. For canals, a depth below the top of the structure (TOS) was provided. For pipeline headboxes, this proved to be inconsistent. Instead, SRP decided to define the desired water level on the upstream side of pipeline headboxes as 6 inches above the weir.

One SRP requirement is that the water level at one check structure cannot be so high that it backs up on the next check structure upstream. For pipelines, SRP's requirement is that the backwater from the downstream structure should be 0.2 feet below the weir in the headbox. This means that the total drop in water level at pipeline headboxes is 0.7 feet. For canal structures, SRP's requirement is that the backwater from the downstream structure should be 0.5 feet below the highwater level upstream from the structure. These criteria were used to develop estimates of lateral capacity in between check structures based on backwater curves.

Additional SRP requirements include a minimum manhole energy loss of 0.2 feet. For channels, a minimum of 0.5 feet of freeboard is required, except upstream from broad-crested weirs which can have a freeboard of 0.2 feet. Channels should have an M1 backwater curve. The general requirements for a pipeline lateral is shown in Figure 3.

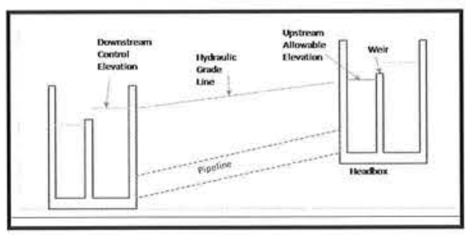



Figure 3. Schematic diagram of backwater curves showing control and allowable elevations.

## Backwater Template

To satisfy SRP requirements under this project, WEST Consultants Inc. (WEST) developed a template for the development of backwater curves in the various laterals. The backwater curve starts at the downstream check structure, which has one of two options:

- Downstream (D/S) Channel Headbox
- Upstream (U/S) Channel Headbox

The backwater is calculated upstream through two types of elements:

- Pipeline
- Channel

The backwater ends at the upstream check structure, which has two options:

- Upstream Pipeline Headbox
- Upstream Channel Headbox

The section of lateral between the two headboxes is often comprised of many structures, including several sections of canal, several sections of pipeline, manholes, and various other transitions. The template was set up so that after selecting one of the components described above, the user is required to select a transition between it and another component. The following transition elements were included in the template:

- Headbox to Pipeline
- Headbox to Channel
- Channel to Channel
- Channel to Pipeline
- Pipeline to Pipeline
- Pipeline to Channel
- Pipeline to Headbox
- Channel to Headbox
- Pipe Bend
- Manhole

The template system provides calculation in blocks of 10 rows. The calculations from one block to the next assumes that information will be provided in the proper cell in the block above it. At the start of each 10-row block, the user enters the block type from a drop-down menu. The user is responsible for assuring that the blocks are selected in the proper sequence. When the block is selected, data from the template are copied into the rows below where the block type was selected. Rows without data are automatically hidden. Once this data is copied, the user can change any of the values or change any of the calculations. This provides the user a great deal of flexibility to alter the calculations as needed to match unique situations.

The user manually enters the flow rate in Arizona Miner's Inches (MI). The program automatically computes the energy level at each component in the system. It also calculates whether the actual freeboard satisfies SRP's freeboard requirement and computes the difference between the actual energy level at the upstream headbox and the allowed level. If the freeboard requirement is met and the actual level is below the allowed level (positive value), then the capacity is greater than the discharge value entered. The discharge is gradually increased until the criteria is no longer met. The highest flow rate that meets the criteria within 10 MI is considered the capacity of this reach of the lateral.

## Process

For each lateral, the process was to start at the structure defining the downstream end of each branch and compute the hydraulic grade line to the upstream structure. A schematic showing the basic layout is shown in Figure 3. SRP as-built drawings were used to determine stationing. Canal and culvert distances were determined by measurements on an aerial image. Structure elevations were determined with surveying instruments. All surveys were referenced to SRP benchmarks based on the National Geodetic Vertical Datum of 1929 (NGVD29). And the horizontal control was the North American Datum of 1983 (NAD83). For all canal check structures and pipeline head boxes the Top of the Structure (TOS) was surveyed. These elevations were used as the basis of the calculations. The distance from the TOS to the weir crest within the headbox was provided by SRP personnel on an Area Map. The project area included SRP Areas 24 and 26. The details of the check structures are show in Figures 4 and 5. For canals and drains, cross-sections were measured both upstream and downstream of any check structure, including top of canal and toe (or invert). These elevations were used directly in the backwater calculations.

For pipeline structures, pipe invert elevations were taken from the plans. This only influenced the backwater curve if the pipe was not full, or in an open channel condition. This only occurred in a few places. Since these plan elevations were not considered highly accurate, no attempt was made to collect more detailed data or to more closely try to reconcile the hydraulic grade line.

SRP personnel also made note of check structures that were no longer used to control water surface elevation. When starting downstream, the calculations for a single worksheet progressed upstream until a check structure was used to control head. A single capacity was determined for each worksheet. Thus, the capacity was between these two check structures and did not always align with the capacities on SRP maps. The worksheet name is based on the downstream structure. In some cases, a single headbox serves multiple structures. In these cases, the turnout name was chosen arbitrarily.

The procedure for determining capacity was as follows. The worksheet named "Lateral" was copied and named according to the downstream turnout. The TOS elevation from survey was entered for the downstream headbox. Then either the depth to highwater (for canals) or distance to the weir crest (for pipelines) was entered. This was used to determine the downstream energy head to start the backwater calculation. For pipeline, the pipe size, roughness, and elevations were determined from the plans. For canals, cross-section and roughness was determined from the plans, but elevations were determined from survey. Structures were added from downstream to upstream either according to plans, or if plans were missing for canals from measurement from aerial photos. Plan numbers were entered so that the calculation could be verified in most cases.

These calculations were carried to the upstream headbox where the TOS elevation and other details were added, similar to the downstream headbox. Note that the user enters the same information for a structure regardless of whether it is upstream or downstream. The actual backwater calculations occurred automatically, except in a few cases where manual entry is required to more accurately define conditions (e.g., where a downstream canal depth just above critical depth is entered when the calculations result in critical depth). The spreadsheet automatically summarizes the allowable head and whether or not freeboard is satisfied just below the capacity to make it easier to verify these constraints. The capacity typically started at the SRP stated capacity and then was decrement up or down. The highest capacity in 10 MI increments that satisfied all the criteria was considered the calculated capacity.

## Example

Figure 4 shows details for a section of Area 26 along Lateral 2-23 and 2-22. The numbers in the middle of each grid element is the section number. Short dashed lines are pipelines. Blue means canal and red means drain. The solid red line are open canals. Gold long dashed line is an open drain. The letter M in a purple box means that the headbox is considered a manhole. The large blue labels along the laterals is the SRP


Figure 4. A section of SRP Service Area 26 with additional details. (North is up)

capacity in MI. The capacity analysis attempted to verify these capacities. The black and green numbers with arrows are the turnout name. The gold numbers are the distance from the TOS to the high water. The red numbers are the distance from TOS to the weir.

Lateral 2-22 flows along the east side of Section 16. A side branch of lateral 2-23 flows along the west side on Section 16. The Excel worksheet for the section between 2-22-75 to 2-22-74 is shown in Figure 5. While on the map, the section looks like it is all canal, there is a short section of pipeline not shown on the Map. This is likely a road culvert. Figure 5 shows the overall flow of the program. The discharge in MI is shown in the upper right. Below that are the head available and whether or not the freeboard is acceptable. There is also a note that says that freeboard is the limiting factor for this capacity. Note that there is still almost a foot of available head (0.972). The station numbering comes from the plans. Plan numbers are usually noted in the comment section. For this example, the section of canal shown is not constrained by freeboard. The short pipe section that follow is not full. In this case the user has to assure that the energy grade line is appropriate. The sequence of elements for this example are: D/S Channel Headbox, Headbox to Channel, Channel, Channel, Channel to Pipeline, Pipeline, Pipeline to Channel, Channel, Channel to Headbox, and Upstream Canal Headbox. Note that for Headbox to channel transition, the head loss is specified and the loss coefficient is calculated. This results from optimization conflicts is computing this head loss directly.

## Limitations to Capacity

The constraint to delivery of water to the Buckeye Feeder Canal is described below.

- The highwater elevation just upstream from turnout 2-23-98 limits drainage flow from the east.
- The drain along 115th Avenue is limited by a crossing over a drainage structure just north of Buckeye Road.

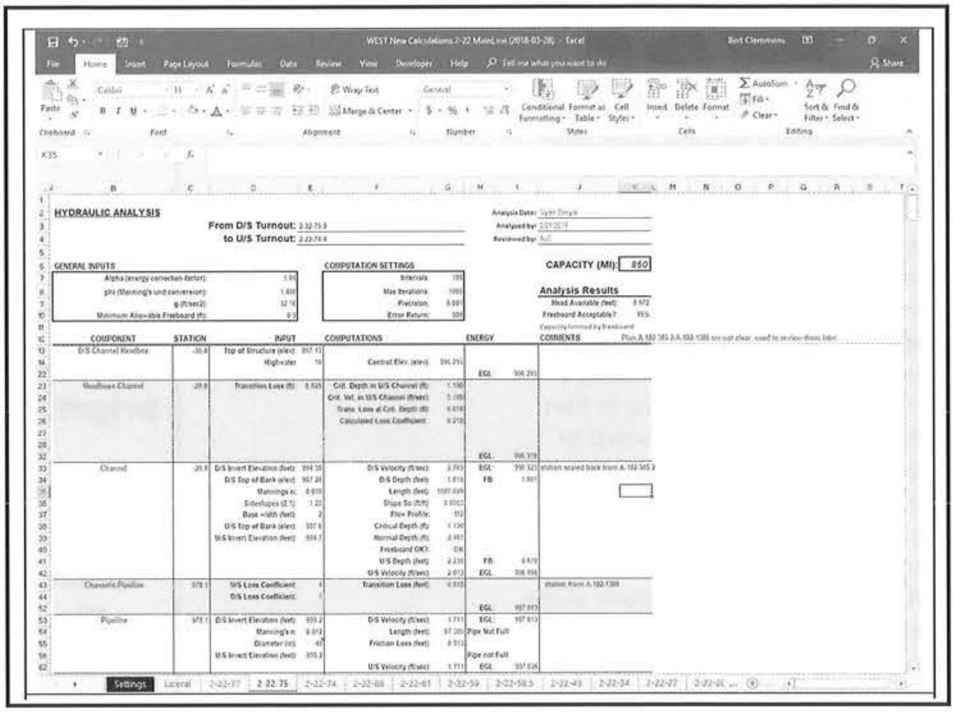



Figure 5. Spreadsheet Calculations for Lateral 2-23.0.

- Capacity is restricted along the branch of 2-23 that follows 107th Avenue just north of Buckeye Road.
- The capacity of the branch of lateral 2–23 along 99th Avenue south of McDowell Road is constrained by the freeboard in concrete canals in the vicinity of turnout 2-023-66 just north of Buckeye Road.
- The capacity of 2-22 is limited between Buckeye Road and Lower Buckeye Road, again by canal freeboard.
- The capacity of 2–21 is limited below turnout 2-21-71 where the pipeline turns to a canal, roughly ½ mile south of Lower Buckeye Road and 87th Avenue.
- Capacity to bring water from 2–20 along Lower Buckeye Road is somewhat limited.
- Bringing water from laterals further east is limited by these capacities.

## Conclusions

The spreadsheet template approach was an effective way to organize the large number of calculations required to evaluate lateral capacities over about 120 miles of irrigation lateral canals. The worksheets provide a useful platform for maintaining the data in a format where calculations can be reviewed and modified as needed. The worksheets describing existing conditions can be copied and new structures added or subtracted to evaluate the influence of proposed alternatives.

## References

Henderson, F. M. 1966. Open Channel Flow. Macmillan Publishing Company, Inc. New York.

Giles, R. V. 1962. Shaum's Outline of Theory and Problems of Fluid Mechanics and Hydraulics. McGraw Hill Book Company, New York.¤

## President's Message (continued)

Conference together! And, the Conference was a success, with more than 150 attendees from the U.S., Canada, Pakistan, and the Philippines.

This high attendance brings up another interesting point. Up until recently, USCID has organized two conferences per year: one in the spring and one in the fall. During the 2016 USCID fall Conference in Fort Collins, the USCID Board voted to drop back to only one conference per year. The thought process was that it was difficult to generate enough interest and content for two conferences per year in addition to the extra time commitment and expense required for two conferences per year. Thus, on the surface, dropping down to one conference per year seemed like a "no-brainer." However, things are not always as straightforward as they seem. USCID heavily relies on the money generated from conferences in order to survive. There was a concern that if we went down to one conference a year, then USCID would not generate enough income to continue operations. Despite this concern, the Board voted unanimously to go to one conference per year. And now, two years later, I am happy to report that going to one conference per year has not hurt USCID but instead has actually helped the organization. Now, it seems, we are attracting more attendees to our single conference.

So, what's the point of these stories? Well, I first wanted to point out that USCID is constantly looking for ways to improve to better serve its members. It appears that going to one conference per year has been very well received by all of our members. Thus, if you have any suggestions on how USCID can improve to better serve its members, I would love to hear them!

Second, if you are interested or passionate about a topic that USCID has not covered in a conference (or even a topic that we haven't covered in a while), I encourage you to bring that idea to the board's attention. Maybe your idea would turn into a conference theme that would benefit all the members of USCID.

USCID is a volunteer organization and in order to continue to function, it relies on volunteers. Thus, I encourage you to volunteer to help USCID fulfill its mission. There are several ways to volunteer, such as:

1. Join USCID
2. Attend a conference
3. Join a conference planning committee
4. Write an article for the newsletter
5. Join the USCID Committee on Technical Activities
6. Join the Committee on Long-Range Planning

If you are interested in helping USCID in any capacity, I would love to hear from you!

*Brian Wahlin*
President, USCID¤



### USCID Newsletter Advertisers, Spring 2018

# DWFI Launches Rwanda Research Project

*By Vivian Nguyen, Program Coordinator, Daugherty Water for Food Global Institute, Lincoln, Nebraska*

This fall, staff at DWFI launched a new research project in Rwanda. While Rwanda has an economy that is growing eight percent each year, much of the population remains in poverty. As agriculture is the main economic driver in Rwanda, the Rwandan government has recognized the need to develop irrigation as a means to alleviate poverty, increase food security and mitigate risk from climate-induced droughts. Between now and 2024, the Rwandan government hopes to double the area that is irrigated. To achieve this goal, the government has been implementing and evaluating a variety of irrigation methods with farmers. In addition, there is a small but growing entrepreneurial community that is providing agronomic and irrigation services.

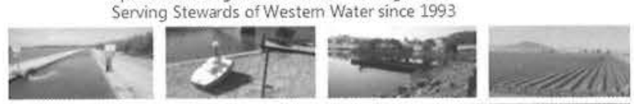
During November, Nick Brozovic, DWFI director of policy; Caleb Milliken, DWFI program associate; and Vivian Nguyen, DWFI program coordinator; traveled to Rwanda to learn more about the variety of business models being used for smallholder irrigation service provision. The team met with participants in irrigated agriculture, including government leaders, non-government staff, entrepreneurs, and smallholder farmers to gain better understanding of what is happening on the ground in Rwanda. An important goal of the research is to use entrepreneurial tools and methods – such as a business model template – to understand the financial sustainability and scaling potential of the diverse range of existing irrigation provision business models.

The team is producing reports and case studies on the business models reviewed, and will return to Rwanda in 2019 to continue their research.

During their time in Rwanda, the DWFI team worked closely with Volta Irrigation, a group comprised of undergraduate students at the African Leadership University who believe farming is the main livelihood of the poor and a mainstay of many countries' economies. Using mostly locally produced materials, Volta Irrigation has designed a low-cost, efficient and eco-friendly pumping system called "Alma Volta." The system integrates an inverter, a battery, a pump and a stationary bicycle to produce energy for irrigation. With Alma Volta, a farmer can pull and push 400,000 liters of water, enough to irrigate 40 hectares of farmland, with just 20 minutes of pedaling. The system can be built and maintained by local farming cooperatives, who in turn expect to decrease the cost of irrigating their farmlands by 75 percent and increase their productivity 12 fold.¤







# New Members

## Corporate Member

### Geosyntec Consultants, Inc.
Attn: Rob Annear
900 Broken Sound Parkway NW, #200
Boca Raton, FL 33487
Office: 561-995-0900
E-mail: rannear@geosyntec.com
Internet: www.geosyntec.com

## Institutional Member

### Daugherty Water for Food Global Institute
Executive Director
Attn: Peter McCornick
2021 Transformation Drive, #3220
Lincoln, NE 68588
Office: 402-472-5145
E-mail: pmccornick@nebraska.edu
Internet: waterforfood.nebraska.edu

## Individual Members

### Rob Annear
Senior Principal
Geosyntec Consultants, Inc.
900 Broken Sound Parkway NW, #200
Boca Raton, FL 33487
Office: 971-271-5906
E-mail: rannear@geosyntec.com

### Lacey Bodnar
Research Project Manager
Daugherty Water for Food Global Institute
2021 Transformation Drive, #3220
Lincoln, NE 68588
Office: 402-472-5145
E-mail: lbodnar@nebraska.edu

### Grant Doerksen
California Polytechnic State University
1400 Stafford Street, #A7
San Luis Obispo, CA 93405
Office: 209-535-0086
E-mail: grantdoerksen@gmail.com

### Ryan Emory
California Polytechnic State University
26082 Cresta Verde
Mission Viejo, CA 92691
Office: 949-637-7344
E-mail: remory98@att.net

### Eric Franson
Franson Civil Engineers
1276 South 820 East, #100
American Fork, UT 84003
Office: 801-756-0309
E-mail: efranson@fransoncivil.com

### Kate Gibson
Research Project Manager
Daugherty Water for Food Global Institute
2021 Transformation Drive, #3220
Lincoln, NE 68588
Office: 402-472-5145
E-mail: kgibson@nebraska.edu

### Mary Hambly
California Polytechnic State University
P.O. Box 442
Paso Robles, CA 93447
Office: 805-835-9301
E-mail: mehambly@calpoly.edu

### Leon Li
Geosyntec Consultants, Inc.
900 Broken Sound Parkway NW, #200
Boca Raton, FL 33487
Office: 971-271-5906
E-mail: yli@geosyntec.com

### Dennis McCarvell
Elephant Butte Irrigation District
530 South Melendres
Las Cruces, NM 88005
Office: 575-526-6671
E-mail: dmccarville@ebid-nm.org

### Peter McCornick
Executive Director
Daugherty Water for Food Global Institute
2021 Transformation Drive, #3220
Lincoln, NE 68588
Office: 402-472-5145
E-mail: pmccornick@nebraska.edu

### Ariel Mosbrucker
Geosyntec Consultants, Inc.
900 Broken Sound Parkway NW, #200
Boca Raton, FL 33487
Office: 971-271-5906
E-mail: amosbrucker@geosyntec.com

### Christopher Neale
Director of Research
Daugherty Water for Food Global Institute
2021 Transformation Drive, #3220
Lincoln, NE 68588
Office: 402-472-5145
E-mail: cneale@nebraska.edu

### Abid Sarwar
Washington State University
24106 North Bunn Road
Prosser, WAS 99350
Office: 509-212-9459
E-mail: abid.sanwar@wsu.edu

### Eric Strecker
Geosyntec Consultants, Inc.
900 Broken Sound Parkway NW, #200
Boca Raton, FL 33487
Office: 971-271-5900
E-mail: estrecker@geosyntec.com

### Shoaib Ahmad Sugrio
Irrigation Department, Government of Pakistan
A/76. Ghulam Shah Kalhoro Colony Jail Road
Hyderabad, Sindh, Pakistan
Office: 92-321-288-6807
E-mail: shoaibsurgrio@gmail.com¤

## Necrology

**Bruce E. Coleman** passed away on January 19, 2018, in Coamo, Puerto Rico. He joined USCID in 1985.

# News of Members

**Brad J. Arnold** is now with the Santa Clara Valley Water District in San Jose, California.

**Jay W. Franson** has retired as President of Franson Civil Engineers in American Fork, Utah.

**Kate Gibson**, Program Coordinator, Daugherty Water for Food Global Institute, recently graduated with the eighth class of the Nebraska Water Leaders Academy, a one-year program that provides leadership training and educates participants about the vital role of rivers, streams and aquifers in the economic sustainability of the state.

**Peter McCornick**, Executive Director of the Daugherty Water for Food Global Institute, has been elected to the World Water Council Board of Governors. DWFI Director of Research **Christopher Neale** was elected as an alternate.

**Pooneh Pahlevani** has completed her studies at New Mexico State University and is now associated with WSP in Charlotte, North Carolina.

**Damien Pearson**, manager of the **Rubicon Water** office in Fort Collins, Colorado, has returned to the Rubicon office in Australia. **Darren McGregor** now leads the Fort Collins office. And, Darren has replaced Damien as the USCID Board Advisor from Industry.

**Brian Sauer** retired from the Bureau of Reclamation during mid-November. He lives in Meridian, Idaho.¤

## USCID Notes

*by Larry D. Stephens, Executive Vice President*

Congratulations to **Brian Wahlin**, WEST Consultants; and **Eduardo Bautista**, ARS, USDA, who served as Co-Chairs of the Planning Committee for the Arizona Conference held last October. Brian and Eduardo, and the 20 people who joined the Planning Committee, did an outstanding job of organizing the Conference. The tours, the invited speakers for meals and the plenary session, and the panel discussions and technical presentations were all outstanding. The Conference Cooperating Organization was the Water Research Foundation. WRF staff really made important contributions to the Conference. I hope there will be future opportunities for USCID and WRF to cooperate.

One special thanks goes to **Stuart Styles** at Cal Poly. He brought a team of students to the Arizona Conference and each of them made poster presentations, great additions to the Conference!

As noted in the page 1 box, USCID's 2019 Conference will be held in Reno, Nevada, on November 4-8. The Call for Papers is now online at www.uscid.org. The Conference Theme is ***Basin Water Management – Challenges in Water Management at the Basin Scale***. Conference Co-Chairs are **Sam Schaefer**, GEI Consultants; **Del Smith**, Bureau of Reclamation; and **Therese Ure**, Schroeder Law Offices. More members are needed for the Conference Planning Committee. The Planning Committee will have a one-day meeting in Reno to review abstracts and develop the Conference Program. Participation in the Planning Committee includes attending the meeting, reviewing draft papers and serving as session moderators during the Conference. Please join if you can — I'm sure you will find that participation is most worthwhile from a professional development and networking viewpoint. Send me an e-mail if you have any questions and/or if you can join the Planning Committee — stephens@uscid.org.

An important part of each fall USCID conference is the recognition of outstanding students and professionals. This year, **Julia Reese** from the University of Idaho was selected for the Summers Engineering Scholarship. **Jeff Bradley**, President of WEST Consultants, was named winner of the Service to the Profession Award and **Tom Gill**, Bureau of Reclamation, received the Merriam Improved Irrigation Award. Congratulations to each of these worthy people! Scholarship Applications and award nominations will be invited this summer for the Reno Conference. Past scholarship and award winners are listed on the USCID website — I urge you to review the past winners and make a nomination. The USCID Board of Directors will select the 2019 awardees when they meet during late summer.

As a Member of USCID, you are invited to participate in the activities of the International Commission on Irrigation and Drainage. The next ICID meeting will be held in Bali, Indonesia, during the first week of September 2019. An important part of the Bali meeting will be the Third World Irrigation Forum.

### USCID Meetings

**November 4-8**, Reno, Nevada. USCID Water Management Conference.

### ICID Meetings

**January 16-18, 2019**, 9th International Micro Irrigation Conference, Aurangabad, India.

**September 1-7, 2019**, 70th IEC and 3rd World Irrigation Forum, Bali, Indonesia.

**September 22-28, 2020**, 71st IEC and 24th Congress, Sydney, Australia.

You are invited to participate in the Forum, as outlined in the page 3 article of this Newsletter. Also, ICID has about 20 workbodies which address specific irrigation and drainage issues. Input from USCID is being sought by ICID. The ICID website is www.icid.org. Take the link to Workbodies and then the link to Permanent Committee on Technical Activities.

I hope to see many of you in Bali next September and in Reno next November.¤