

# Laboratory Program

## HISTORY

The U.S. Water Conservation Laboratory is part of the Agricultural Research Service (ARS), the major research arm of the U. S. Department of Agriculture. The primary mission of ARS is to help meet the nation's food and fiber needs. ARS works closely with the State Experiment Stations, State Departments of Agriculture, other government agencies, public organizations, farmers, ranchers, and industry. The organizational structure of ARS is designed to insure active research programs and to provide maximum responsiveness to the needs and problems of the public.

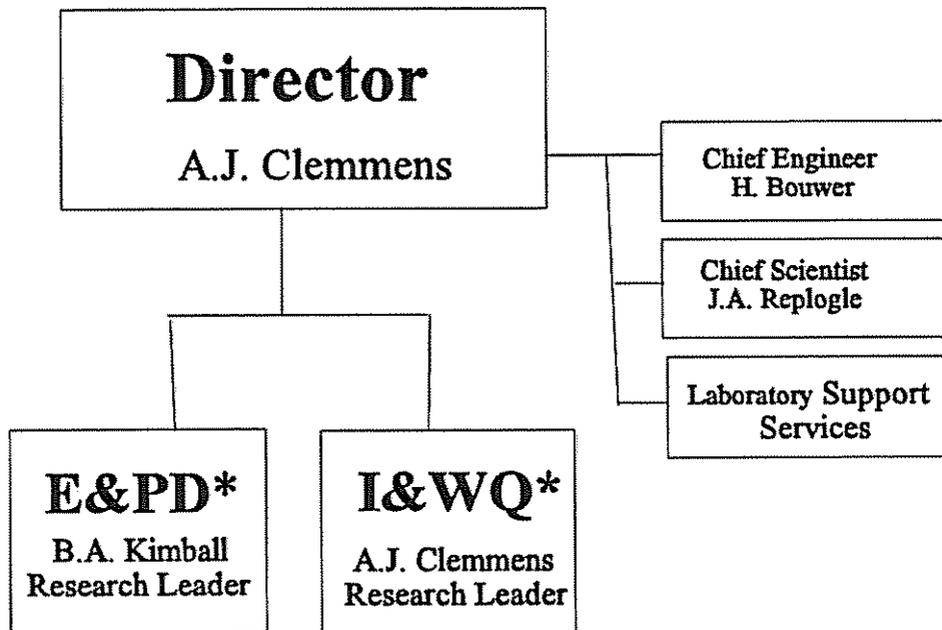
The U. S. Water Conservation Laboratory was established in central Arizona in 1959 to develop methods to conserve surface and groundwater used for agriculture. Research focuses on more efficient use of water and reduction of water losses in the soil-plant-atmosphere continuum. More recently, research has expanded to include studies in water quality, new crops with low water requirements, and effects of increased carbon dioxide on crop production, water use, and climate. The research is national in scope with international impact and deals with both present and potential problems. Although research results are documented primarily in technical literature, the staff also works directly with other State and Federal agencies.

In addition, the staff works closely with industry and individuals to facilitate technology transfer. New concepts and prototype equipment are tested cooperatively under actual conditions. The Laboratory does both theoretical and applied research at field sites and in laboratories. Facilities are well equipped for these purposes. Specialized electronic and mechanical prototype equipment is made in-house. Basic equipment to support the research programs includes electronic instrument calibration apparatus, data acquisition and processing computers, controlled environmental rooms, sophisticated water flow calibration, control and measuring devices, and a spectral imaging analyzer system. Specialized laboratory analytical instruments consist of a mass spectrometer, gas and high performance liquid chromatographs, automated titrator, solution analyzer, infrared gas analyzer, electrophoretic equipment, and cytological microscope.

The research teams are composed of engineers and scientists trained in various disciplines. The disciplines represented are civil, agricultural, and hydraulic engineering; soil and biological sciences; physics; chemistry; and plant physiology and genetics. Support staff consists of agricultural, biological, and physical science technicians, an electronics engineer, a computer systems manager, a program analyst and a machinist. Administrative support includes secretaries, clerks, and maintenance personnel.

The total Laboratory research effort operates under two research groups that interact in a multi-disciplinary, cooperative manner: the Irrigation and Water Quality (I&WQ) and the Environmental and Plant Dynamics (E&PD) Management Units.

# Laboratory Organization



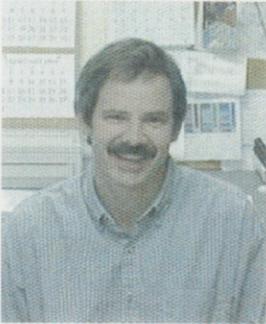
## Mission

The mission of the U. S. Water Conservation Laboratory (USWCL) is to conserve water and protect water quality in systems involving soil, aquifers, plants, and the atmosphere. Research thrusts involve developing more efficient irrigation systems, improving the management of irrigation systems, developing better methods for scheduling irrigations, developing the use of remote sensing techniques and technology, protecting groundwater from agricultural chemicals, commercializing new industrial crops, and predicting the effect of future increases of atmospheric CO<sub>2</sub> on climate and on yields and water requirements of agricultural crops.

### \*Management Units

EP&D - Environmental and Plant Dynamics  
I&WQ - Irrigation and Water Quality

## LABORATORY MANAGEMENT



**ALBERT J. CLEMMENS, B.S., M.S., Ph.D., P.E., Laboratory Director, Research Leader for Irrigation and Water Quality, and Supervisory Research Hydraulic Engineer**

Surface irrigation system modeling, design, evaluation, and operations; flow measurement in irrigation canals; irrigation water delivery system structures, operations management, and automation.



**HERMAN BOUWER, B.S., M.S., Ph.D., P.E., Chief Engineer and Research Hydraulic Engineer**

Water reuse; artificial recharge of groundwater; soil-aquifer treatment of sewage effluent for underground storage and water reuse; effect of groundwater pumping on stream-flow; surface water-groundwater relations.



**JOHN A. REPLOGLE, B.S., M.S., Ph.D., P.E., Chief Scientist and Research Hydraulic Engineer**

Flow measurement in open channels and pipelines for irrigation; irrigation water delivery system structures, operations, and management.



**BRUCE A. KIMBALL, B.S., M.S., Ph.D., Research Leader for Environmental and Plant Dynamics and Supervisory Soil Scientist**

Effects of increasing atmospheric CO<sub>2</sub> and changing climate variables on crop growth and water use; free-air CO<sub>2</sub> enrichment (FACE) and CO<sub>2</sub> open-top chambers and greenhouses; micrometeorology and energy balance; plant growth modeling.

## **LABORATORY SUPPORT SERVICES**

### **COMPUTER FACILITY**

T.A. Mills, Computer Specialist

The computer facility oversees all Laboratory and Location Administration Office computer equipment and applications. The facility is responsible for recommending, purchasing, installing, configuring, upgrading, and maintaining the Laboratory's Local and Wide Area Networks (LAN, WAN), computers, and peripherals. The LAN consist of multiple segments of 10 Base-T, 100 Base-T hubs and one 100VG hub. The LAN is segmented using a high speed switching hub. Segments are made up of CAT 3, CAT 5 and standard Ethernet. This configuration currently provides over 200 ports to six Laboratory buildings. Internet service is provided by Arizona State University (ASU) via a Point-to-Point T-1 line. Our Laboratory also provides Internet access to the Western Cotton Research Center by an additional T-1 line through our router. The Laboratory maintains a Class C block of Internet addresses operating under the domain [uswcl.ars.ag.gov](http://www.uswcl.ars.ag.gov). The Laboratory LAN is comprised of several servers operating under Windows NT 4.0. End users operate mainly under Windows 95 and Windows NT 4.0 with a few OS/2 workstations. Services such as E-Mail, print, file, remote access, and backup are provided by the LAN. The Laboratory maintains its own Web Server, which can be accessed at [www.uswcl.ars.ag.gov](http://www.uswcl.ars.ag.gov).

The Laboratory is currently in the process of adding three fiber optic gigabyte backbone segments.

### **LIBRARY AND PUBLICATIONS**

Stefani Morgan, Publications Clerk

Library and publications functions include maintenance of records and files for publications authored by the Laboratory Research Staff, including publications co-authored with outside researchers, as well as for holdings of professional journals and other incoming media. Support includes searches for requested publications and materials for the Staff. Library holdings include approximately 2200 volumes in various scientific fields related to agriculture. Holdings of some professional journals extend back to 1959.

The U.S. Water Conservation Laboratory List of Publications, containing over 2000 entries, is maintained on PROCITE, an automated bibliographic program. The automated system provides for sorting and printing selected lists of Laboratory publications and is now accessible on LAN by the Research Staff and on the USWCL home page ([www.uswcl.ars.ag.gov](http://www.uswcl.ars.ag.gov)) by the public. Publications lists and most of the publications listed therein are available on request.

## **ELECTRONICS ENGINEERING LABORATORY**

D.E. Pettit, Electronics Engineer

The electronics engineering laboratory provides design, development, evaluation, and calibration functions of electronic prototypes in support of U.S. Water Conservation Laboratory research projects. Other responsibilities include repairing and modifying electronic equipment and advising staff scientists and engineers in the selection, purchase, and upgrade of electronic equipment. Following are examples of work orders performed in 1999:

- Continued to design hardware and software for the GEN II probes.
- Designed and constructed a five-channel narrow band infra-red amplifier board with temperature monitor and power regulators.
- Continued GEN II probe software modifications.
- Installed LPKF circuit board mill machine and the following software packages: (1) ORCAD Schematic Capture, (2) ORCAD Printed Circuit Board, (3) Circuit CAM, and (4) Board Master. These four software packages interconnect and were backed-up to a CD ROM disk. The CD ROM writer hardware was installed for archiving shop project designs which include schematics, printed circuit board files, computer aided design (CAD) computer aided machine (CAM) mill machine files and writeups on operations.
- Designed schematic capture parts and printed circuit board footprints for the appropriate ORCAD libraries being used in the five-channel infra-red amplifier.
- On-site training by LPKF representatives plus self-packing training of both Circuit CAM, Board Master, and ORCAD programs.

## **MACHINE SHOP**

C.L. Lewis, Machinist

The machine shop provides facilities to fabricate, assemble, modify and repair experimental equipment in support of U.S. Water Conservation Laboratory research projects. The following are examples of work completed in 1999.

Stainless steel cylinders 10 - 12" in diameter were modified for sewage effluent irrigation and recharge studies. Modification included removal of 2½" tubes, plugging ¼" pipe holes and 2½" tube holes. A ¾" stainless steel coupling was welded into place 1" from bottom of each cylinder. A 13" x 13" x 3/16" stainless steel plate was welded to the bottom of each cylinder.

A static head probe for measuring irrigation well discharges was fabricated. The probe was fabricated from schedule 40 pvc pipe 6" diameter 12" in length. The pvc pipe was cut in half with a horizontal saw mill cutter @ ± .002, 3⅛" holes were drilled and reamed for press fit pins, 3⅛" holes were drilled and reamed for body fit pins.

Modification to Z chipping machines used to produce guayule homogenate were made. Modifications included design and fabrication of adjustable stabilizing legs. The legs were fabricated from ¾" round cold rolled steel tubing, ⅛" wall and ¾" cold rolled steel channel ⅛" wall. Shredded panels were modified by welding ¼" x ¼" square cold rolled @ ⅛" spacing.

Using Microsoft Access, an inventory data base was developed to track and control use of 1248 items kept in supply by the shop for use in the support of research programs. The inventory consists of a wide variety of items from adhesives and bolts to vises and zerks.

## USWCL OUTREACH ACTIVITIES

During 1999, the USWCL staff participated in numerous activities to inform the public about ARS and USWCL research, to solicit input to help guide the USWCL research program, to foster cooperative research, and to promote careers in science. A summary of activities follows:

**“Experiments for the Classroom.”** The USWCL web site contains experiments suitable for high school science classes.

**Arizona State University Center for Agribusiness Policy Studies, February 4.** Terry Coffelt, John Replogle, Ed Barnes, and Brian Wahlin provided an exhibit at the annual “Stratum ‘99 Conference,” which is attended by area government and agribusiness representatives.

**Arizona High School Science Bowl, Glendale Community College, Arizona, February 20.** Terry Coffelt, Brian Wahlin, and Mike Wiggett served as rule judges of science bowl. Gail Dahlquist, Dave Dierig, and Skip Eshelman were moderators. The science bowl is an annual science knowledge competition among Arizona high school students.

**Arizona Science Center, March 6-7.** Brian Wahlin, Ed Barnes, Terry Coffelt, and John Replogle staffed an “On-the-Farm” exhibit featuring agricultural irrigation. The Arizona Science Center in Phoenix is a heavily attended hands-on science attraction for young (and not-so-young) people.

**Arizona Ag Day Exhibit, March 10.** Ed Barnes, Brian Wahlin, and Shirley Rish provided a USWCL exhibit at the annual Arizona Ag Day celebration in downtown Phoenix. Attendance at the event was estimated at 6,000, and many USWCL and ARS materials were distributed.

**Earth Day at McKemy Middle School, March 23; and Evans Elementary School, April 8.** Ed Barnes visited McKemy Middle School and Brian Wahlin visited Evans Elementary School. They provided hands-on exhibits and distributed USWCL and ARS materials.

**Soil, Water, and Groundwater Management Symposium, Tohono O’odham Farming Authority, Eloy and Casa Grande, Arizona, March 24-25.** Doug Hunsaker and Fedja Strelkoff presented information on USWCL software for surface irrigation simulation, design, and management.

**Governor’s Committee for Best Management Practices for Particulate Matter 10.** Bert Clemmens presented an overview of the USWCL research program to the ad hoc technical advisory committee that reports to the Governor’s Committee.

**Scottsdale, Arizona, Public Meeting, May 26.** Herman Bouwer spoke on sewage, salt, and nonpoint pollution of groundwater in the Salt River Valley and long-range water issues at the Scottsdale Civic Center, Scottsdale, Arizona.

**Summer Agricultural Institute, June 18.** USWCL hosted 30 elementary and junior high teachers for one day as part of the week-long Summer Agricultural Institute. The program encourages teachers to incorporate agricultural information into school curricula.

**Minority Hiring, Sept.-Dec.** Five minority work-study students were hired from Arizona State University and the University of Arizona.

**Maricopa Agricultural Center Field Trip, Sept. 8.** Ed Barnes, Tom Clarke, Stacy Richards, and Mike Baker hosted a field trip at Maricopa Agricultural Center for students in two University of Arizona classes in Agricultural and Biosystems Engineering. The event featured demonstrations of current research in applying remote sensing to farm management. Guest lectures also were presented to the classes on Sept. 13 and 15 in Tucson.

**Joint Outreach-Education Programs for Students.** In October, USWCL entered into an agreement with the University of Arizona Maricopa Agricultural Center and the Natural Resource Education Center to cooperate in providing science and agricultural programs for junior and senior high school students to educate and to encourage careers in science.

**Central Arizona Water Conservation District (CAWCD), November 2.** Bert Clemmens met with officials of CAWCD to discuss their research needs in water conservation.

**ARS Irrigation and Drainage Exhibit at the International Irrigation Show, November 7-9.** John Replogle and Shirley Rish coordinated an exhibit on irrigation and drainage (I&D) research at the annual Irrigation Association International Show in Orlando, Florida. The exhibit featured a hands-on display of the "Directory of ARS I&D Researchers and Research" on the ARS web site. Registered attendance was over 7000, and the ARS exhibit was well attended. The Irrigation Association provided complimentary exhibit space, and the exhibit was otherwise supported by Dale Bucks, National Program Leader for Water Quality and Water Management. The exhibit booth was staffed by members of the National Program Staff and I&D researchers from ARS locations at Phoenix, Arizona; Ft. Collins, Colorado; Florence, South Carolina; and Lincoln, Nebraska.

## **SAFETY**

T. Steele

The Laboratory Safety Committee enjoys well-deserved respect from the employees. The committee takes its duties seriously and has worked diligently to insure compliance with all EPA and OSHA regulations and radiological safety protocols. Employees are encouraged to report all safety concerns, even those that might seem trivial.

In addition to several standing committee members, six other members serve three year terms, with two members rotating off each year. Current committee members are Terry Coffelt, Doug Hunsaker, Paulina Harner, Brian Wahlin, Stacy Richards, and Stephanie Johnson, rotating members; Bud Lewis (shop), Francis Nakayama (radiological/chemical), and John Replogle (hydraulics lab), standing members.

It is a time-consuming commitment, and requires judicious management of time and work priorities. Serving on the safety committee, however, is gratifying in terms of its record of accomplishments. Following are some of the results of the committee's efforts in 1999:

- Procurement and installation of new free standing chemical storage buildings on the grounds of the Western Cotton Laboratory.
- Disposal of radiological sealed and unsealed sources that resulted in a significant reduction of radiological materials at the location.

The Lab staff thanks the committee for their good work on our behalf.

## **STUDENTS AT USWCL**

**J. Askins**

The USWCL has enjoyed a mutually beneficial relationship with students from nearby Arizona State University and the University of Arizona over the years. Students come under work-study agreements and student federal appointments. They perform a variety of tasks from collecting samples to solving computer problems, numbering vials to writing protocols, and weighing soil to processing and analyzing non-soil data. Students who work in the clerical/administrative area have worked in personnel and safety as well as doing general clerical work such as filing and copying. Operation of ARS automated systems, publication clerk duties, and literature searches are also performed. Graduate students A.B. Cousins from Arizona State University and T.J. Brooks, J.M. Triggs, P. Tomasi, Jamie Ludke, and Chandra Holifield from the University of Arizona have authored or co-authored contributions to this issue. Jon Tel, a master's degree student from Delft Technical University, The Netherlands, worked on a more accurate radial gate calibration for Salt River Project.

The students and visiting scientists benefit from the income and experience, and we benefit from their enthusiasm, up-to-date expertise, and energy. Some have stayed on after graduation, even earning Ph.D.s under ARS assistance programs.