2004 Water Use Efficiency Proposal

Project Information Form

Applying for: ❑ Urban **X Agricultural**

1. (Section A) **Urban or Agricultural Water Use Efficiency Implementation Project**
   - ❑ (a) implementation of Urban Best Management Practice, #_____
   - ❑ (b) implementation of Agricultural Efficient Water Management Practice, #_____
   - ❑ (c) implementation of other projects to meet California Bay-Delta Program objectives, Targeted Benefit # or Quantifiable Objective #, if applicable _____
   - ❑ (d) Specify other: _____

2. (Section B) **Urban or Agricultural Research and Development; Feasibility Studies, Pilot, or Demonstration Projects; Training, Education or Public Information; Technical Assistance**
   - ❑ (e) research and development, feasibility studies, pilot, or demonstration projects
   - ❑ (f) training, education or public information programs with statewide application
   - **X (g) technical assistance**
   - ❑ (h) other

3. Principal applicant (Organization or affiliation): **California Polytechnic State University Foundation**

4. Project Title: **Technology Transfer to Irrigation Districts**

5. Person authorized to sign and submit proposal and contract:

Name, title	**Jill Keezer Sponsored Programs Director**
Mailing address	**Cal Poly State University Foundation** **Building #38, Room 103** **San Luis Obispo, CA 93407**
Telephone	**(805) 756-1123**
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Contact person (If different):	Name, title	
	Mailing address	
	Telephone	
	Fax.	
	E-mail	

7. Grant funds requested (dollar amount): *(from Table C-1, column VI)*	**$1,350,000**
8. Applicant funds pledged (dollar amount):	**$ 450,000**
9.Total project costs (dollar amount): *(from Table C-1, column IV, row n)*	**$1,800,000**
10. Percent of State share requested (%) *(from Table C-1)*	**75%**
11. Percent of local share as match (%) *(from Table C-1)*	**25%**
12. Is your project locally cost effective? *Locally cost effective means that the benefits to an entity (in dollar terms) of implementing a program exceed the costs of that program within the boundaries of that entity.* *(If yes, provide information that the project in addition to Bay-Delta benefit meets one of the following conditions: broad transferable benefits, overcome implementation barriers, or accelerate implementation.)*	❑ (a) yes X **(b) no**

13. Is your project required by regulation, law or contract?
If no, your project is eligible.

If yes, your project may be eligible only if there will be accelerated implementation to fulfill a future requirement and is not currently required.

Provide a description of the regulation, law or contract and an explanation of why the project is not currently required.

❑ (a) yes
X (b) no

14. Duration of project (month/year to month/year): **December 2005 to February 2007**

15. State Assembly District where the project is to be conducted: **Affects all irrigated portions of California**

16. State Senate District where the project is to be conducted: **Affects all irrigated portions of California**

17. Congressional district(s) where the project is to be conducted: **Affects all irrigated portions of California**

18. County where the project is to be conducted: **San Luis Obispo**

19. Location of project (longitude and latitude) **State of California**

20. How many service connections in your service area (urban)? **n/a**

21. How many acre-feet of water per year does your agency serve? **n/a**

22. Type of applicant (select one):

❑ (a) City
❑ (b) County
❑ (c) City and County
❑ (d) Joint Powers Authority
❑ (e) Public Water District
❑ (f) Tribe

❑ (g) Non Profit Organization

X (h) University, College

❑ (i) State Agency

❑ (j) Federal Agency

❑ (k) Other

- ❑ (i) Investor-Owned Utility
- ❑ (ii) Incorporated Mutual Water Co.
- ❑ (iii) Specify _____

23. Is applicant a disadvantaged community? If 'yes' include annual median household income.

    (Provide supporting documentation.)

❑ (a) yes, _____ median household income

X (b) no

2004 Water Use Efficiency Proposal
Signature Page

By signing below, the official declares the following:

The truthfulness of all representations in the proposal;

The individual signing the form has the legal authority to submit the proposal on behalf of the applicant;

There is no pending litigation that may impact the financial condition of the applicant or its ability to complete the proposed project;

The individual signing the form read and understood the conflict of interest and confidentiality section and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant;

The applicant will comply with all terms and conditions identified in this PSP if selected for funding; and

The applicant has legal authority to enter into a contract with the State.

_____	_Jill Keezer, Sponsored Programs Director__	_____
Signature	Name and title	Date

Technology Transfer to Irrigation Districts

Statement of Work

Section One: Relevance and Importance

This proposal is for the Irrigation Training and Research Center (ITRC) of California Polytechnic State University, San Luis Obispo (Cal Poly) to provide *Technical Assistance* to irrigation districts in California for a 3-year period, as well as identify new opportunities for water conservation and improved water management. Funding would support vitally needed technical services and expert assistance for irrigation district modernization projects. This proposal addresses "all" of the CALFED Quantifiable Objectives by assisting irrigation districts with their implementation. Technical assistance provided by ITRC through this proposal will address the "how to" questions that accompany difficult and complex water policy changes.

ITRC is proposing a technical services program to mirror and expand an existing program sponsored by the US Bureau of Reclamation (USBR) Mid-Pacific Region. Since its start in 1994, an estimated $2.0 million dollars have been expended by irrigation districts as a result of participation with ITRC in the technical services program. All of the projects were the result of modernization of the district operations and represent cash outlays by the districts. This does not include the additional cost incurred by the districts for equipment, labor, or facilities use. This cost share component of the USBR contract with ITRC represents well over a 50% cost share by the local irrigation districts to participate in these modernization efforts. Due to many requests from irrigation districts outside of the USBR Mid-Pacific Region, this proposal would expand this popular program to include all of the districts in California.

California's irrigation districts are actively involved with modernization efforts. These activities range from small changes in day-to-day operations to fairly large and expensive automation projects. Some districts are just getting started with modernization planning and others have progressed through several years of increasingly sophisticated approaches using the latest in industrial technology. District-level activities done in support of efficient water management practices (EWMPs) include infrastructure upgrades and new equipment to improve water control, extensive usage of recirculation systems, water ordering and billing software systems, incorporation of hand-held dataloggers, improved flow measurement programs, and the rapid adoption of SCADA[1] systems.

External pressures on districts (energy costs, competition for water supplies, restrictions on return flows, etc.) are pressing the need to identify, quantify, and link CALFED's goals with specific recommendations for modernization. The motivation to achieve energy savings, environmental enhancement and the adoption of modern on-farm technologies is leading to more advanced applications requiring state-of-the-art expertise in upgrading the complex operations of districts.

[1] Supervisory Control and Data Acquisition. ITRC is a world leader working with irrigation district SCADA systems and has extensive experience with many system configurations ranging from simple sensors to complete canal and pumping plant automation.

Irrigation districts are generally aware of the potential to improve their operations, but they often lack the necessary detailed knowledge or experience with modern water control and measurement technologies. In addition, each irrigation district has distinct hydrologic, engineering, operational and agronomic conditions, which affects how it can meet specific quantifiable objectives (QOs). Even quantifying the expected outcomes or estimating the costs of particular modernization actions frequently benefits from technical assistance outside the districts. Detailed water balances and an assessment of performance parameters such as irrigation efficiency are part of the framework used by ITRC and the districts in deciding between various modernization options.

The Public Trust Doctrine recognizes that sagacious water use by all segments of California is a key to a healthy economy and environment. Furthermore, legislative and judicial decisions related to water marketing are opening the possibility for large scale water transfers. However, unresolved technical issues prevent irrigation districts from rapidly modernizing; thus, multiple opportunities to be more energy efficient in the pumping and distribution of agricultural water are missed. Also, these unresolved issues prevent us from having a clear idea of the amount of conservable water that is available. This proposal will help address these issues.

In all cases, irrigation modernization has ultimately been successful where collaborative partnerships developed around a teamwork approach. ITRC serves as a key team member in the first stage when irrigation districts are evaluating new strategies and overall modernization planning is being done. ITRC works cooperatively with project civil engineers and construction contractors to ensure essential attention to details. The Rapid Appraisal Process (RAP) diagnostic evaluation used by ITRC is a critical step in districts appraising the cost and impacts of implementing modernization projects. To ensure success as projects move forward, ITRC provides technical oversight and quality control to districts through independent technical review of proposed designs and control methods, development of comprehensive specifications, first-hand evaluations of the latest technology in the irrigation field, and field verification of SCADA and automation projects.

The services provided by this proposal would directly address the following EWMPs throughout California:

EWMP6.	Increase flexibility in water ordering by, and delivery to, the water users within operational limits.
EWMP7.	Construct and operate water supplier spill and tailwater recovery systems. Develop plans to recover spill and improve efficiency.
EWMP8.	Optimize conjunctive use of surface and groundwater.
EWMP9.	Automate canal structures.
EWMP10.	Water Measurement and Water Use Report.

Section Two: Technical/Scientific Merit, Feasibility

The ITRC has been an active leader in water conservation and modernization projects at numerous irrigation districts in the western U.S. The work done by ITRC in the past 20 years has had a major impact on water conservation and water management programs in large parts of the western U.S. Its training classes and extensive technical collaboration in numerous projects as an independent expert have been very popular with stakeholders from many backgrounds. Water Use Efficiency program support is needed for ITRC to continue our creative approaches to solving complex, multi-stakeholder issues over water supplies for irrigation and the environment in the state.

The ITRC serves as a valuable extension to the in-house expertise of federal and state agencies and irrigation districts. A major component of ITRC is the knowledge and experience of qualified senior technical experts that can make proper design and modernization decisions. Prior to making recommendations for modernization, each irrigation district receives a Rapid Appraisal Process (RAP) conducted by senior ITRC engineers. It is critical that modernizations and SCADA recommendations are made by irrigation professionals with an extensive understanding of the issues related to irrigation water control.

Through the proposed technical services program, ITRC will bring unique multiple resources to irrigation districts through the following:

- Prior experiences in a wide range of successful water conservation and drainage reduction programs, both national and international, with urban and agricultural aspects.
- Excellent contacts among water district personnel and the private irrigation sector.
- Concurrent projects with other agencies and private organizations, which have enhanced and complimented CALFED water conservation efforts.
- Intimate ties with the large Cal Poly University irrigation/drainage teaching program.
- Special expertise in such topics as Supervisory Control and Data Acquisition (SCADA) systems, canal and pipeline automation, flow measurement, and on-farm irrigation.
- Access to excellent training facilities at Cal Poly University, including the unique Water Delivery Modernization Facility, the John Merriam On-Farm Irrigation Practices Field, and the ITRC conference facilities.

In addition to making proper recommendations for modernization, ITRC is able to synthesize the technical details of a project with the concepts of water delivery service into a functional design that is easy to use and efficient.

This proposal for the provision of technical assistance incorporates the following set of guiding principles:

- Maximize the benefits received from CALFED collaboration over the largest possible number of irrigation districts.
- Work cooperatively with other agencies to maximize the water management efforts.
- Foster the role of private industry to assist irrigation districts in implementing efficient water management practices.

- Increase the base of students trained in irrigated agriculture who will contribute professionally after graduation in improving water management.

The proposed *Technical Assistance* would consist of two major components. The first component will target the benefits of direct technical assistance to individual irrigation and/or water districts. The second component will be a variety of training and technology transfer programs.

Direct Technical Assistance to Individual Irrigation Districts

The ITRC will provide independent technical expertise for specific water conservation programs for individual irrigation districts, at their request. Examples of the type of assistance to be provided are:

- Reviews of modernization and water management plans.
- RAP visits to review operation plans and to help districts develop strategies for improved water delivery.
- Development of guidelines and assistance with quality control for districts that may be interested in setting up on-farm irrigation evaluation and scheduling programs.
- Independent review of plans or guidelines prepared by consulting engineers for irrigation district modernization or water management programs.
- Assistance with the specification and quality control of SCADA (Supervisory Control and Data Acquisition) systems.
- Assistance with implementation of water measurement programs.
- Assistance with other modernization efforts, such as improving pumping plant operations, water ordering, pressure control, etc., for improved water and energy management.
- Development of water balances to identify true water conservation potential and to target appropriate activities.
- A very specialized program of selecting automation algorithms and tuning those algorithms, for pump and canal gate automation with upstream, downstream, and flow control.

Technical assistance programs in partnership with ITRC have been identified as a positive program by many irrigation districts. The proposed CALFED-supported technical assistance will have multiplying benefits because it allows a district to allocate financial resources and spend its own (and CALFED's) funds more wisely, while serving as a good example for neighboring districts.

The real need is a specialized service that ITRC uniquely offers – a comprehensive overview of the internal processes used by irrigation districts for manipulating water as a package. Rather than focusing on the concrete and steel of individual structures, ITRC is able to envision a complete new modernization plan that systematically encompasses the entire district. The concepts of water delivery, on-farm water management, and spill reduction/recirculation are all integrated into a single overall strategic plan for districts. Priorities are then set to begin the modernization process.

ITRC can act as an "advocate" for irrigation districts in the often-complex activities associated with modernization. As such, it can serve as a team member with the district, consulting engineer, integrator, etc. to ensure that the district receives the best possible solution for the best price.

With automation projects, for example, ITRC has found it necessary to be involved in the process from the beginning concepts (where and why) to the specifications of the system, to final quality control assurance after installation. ITRC also is the only entity in California with an established procedure to tune sophisticated canal control algorithms (and to select the appropriate algorithms), and then to follow up with field verification. In an effort to cut costs for districts, and to speed up implementation of automation projects, ITRC has recently adopted a "universal" programming language (ISaGRAF) with its algorithms that can be quickly downloaded into PLCs of all the major brands.

This ability to select the proper control strategy, relatively quickly model canals, tune algorithms, provide about 80% of the PLC programming in a standard package, and then provide in-field quality assurance, should enable automation to quickly expand in California. The days of very slow programming and trial-by-error automation can be put behind us.

The ITRC provides a necessary link between engineering recommendations and operational strategies. In typical consulting projects, a common error is that there are no workable strategies that go along with hardware or equipment details for routing water through the system with a high level of service. By integrating hardware or automation recommendations with a modern operations plan, along with paying careful attention to details, technical assistance from ITRC is able to ensure public investments provide maximum benefits.

Rapid Appraisal Process (RAP)

The ITRC has pioneered work on a rapid appraisal method for irrigation district modernization. Specifically, ITRC frequently conducts rapid appraisals for irrigation districts through the existing USBR Mid-Pacific Region technical services program or through direct contracts with individual irrigation districts. Approximately sixty such appraisals have been conducted in the U.S. The ITRC procedure has been informal, and relies upon the experience and technical knowledge of key personnel with extensive experience in irrigation modernization. A typical ITRC appraisal requires 1-2 days of field time, plus 3-8 days of office time. Additional time is required to develop specific engineering recommendations for topics including modernizing physical infrastructure, planning specifications for SCADA, water measurement designs, or specific canal gate automation algorithms.

Continued Assistance with Modernization Implementation Activities

The ITRC has found that once irrigation districts decide to modernize, they may need periodic technical assistance during the implementation of district improvements. It is anticipated that periodic, limited assistance will be provided to those water agencies that have begun to modernize based on prior ITRC recommendations. This may include assisting districts during their first attempts at implementing new approaches and by working with the districts and their consulting engineers and equipment firms to facilitate implementation of the new technologies.

Examples of technologies, which have required continuing assistance, are:

- Water ordering software development
- Remote monitoring and remote control systems
- Automation of pumping plants which supply canals
- Use of Variable Frequency Drive (VFD) pumps
- Hand Held Data Recorders for downloading turnout information
- Flow measurement programs

Water Balance Studies

The ITRC has noted that many of the numbers which individual irrigation and/or water districts use as facts when describing evapotranspiration (ET) and consumptive use have considerable margins of error. Sometimes the errors associated with poor measurement techniques or equipment can add up to be larger than the quantity of water that a project is trying to conserve. As the competition for water resources intensifies, it will become more important to improve our estimates of water balances within regions and districts – i.e., to determine exactly how much water enters and exits various boundaries (surface, subsurface, and atmospheric).

The critical first step in achieving on-the-ground actions that conserve or protect water supplies is many times a detailed water balance accounting by the water agency, which explicitly recognizes uncertainties. When this is combined with an understanding of the internal processes, it allows one to quantify the realistic potential for meeting objectives, in addition to prioritizing investments at different levels in the system, including project facilities and on-farm programs.

Water Measurement

Water measurement is a requirement of the Central Valley Project Improvement Act and a central feature of many other water settlement agreements and transfers. In certain areas of California, irrigation districts have had difficulty implementing cost-effective water measurement programs and regularly need specialized design or program development assistance. ITRC will perform studies and possibly participate in local demonstrations to help identify low cost appropriate methods of water measurement to individual water users as part of district modernization as the need is identified.

Portable Measurement Equipment

Assistance from ITRC in documentation and evaluation of spilled water, drainage flows, and even the flow rate of the main canals continues to be requested by irrigation districts. ITRC will provide portable equipment to interested districts for several reasons:

- Technology transfer (demonstrating new technologies such as Doppler flow meters)
- Demonstration of the concepts and use of smart sensors and dataloggers
- Documenting performance (and the need for improved performance)

This work will include expanding the number of portable units that are available to these entities including portable water level sensors, portable SCADA systems, and portable flow measurement systems. This work also includes assistance in setup and initial operation of the units.

Training, Special Studies and Technology Transfer Programs

CALFED Water Use Efficiency objectives involve leveraging the resources and technical capacities of multiple partners. Addressing the technical issues involved with irrigation modernization requires a range of training and technology transfer programs that deal with the complex issues faced in real-world situations. For example, the training courses sponsored through the Water Use Efficiency program will offer in-depth instruction that target specialized topics of modern water control faced by managers and water users.

The activities contained in this component of the proposal outline the ways in which ITRC will contribute resources to irrigation districts that need help designing and implementing irrigation modernization related projects. These will include:

- Training classes to be held both at ITRC and at the irrigation districts. These classes include subjects such as:
  - Water delivery modernization
  - Basic principles for operators and water masters
  - Flow measurement
  - On-farm irrigation system design
  - On-farm irrigation system management
- Special studies, as needed for purposes such as identifying water conservation potentials, or understanding cause/effect/solutions for technical problems.
- In-house specialty training for federal and state water agency personnel.
- Newsletter articles and reports on study results, demonstrations and new technologies directed at informing and educating irrigation district personnel and irrigation professionals.
- On-farm irrigation evaluation programs during the summers.

<u>Training Classes</u>

Water Delivery Modernization Training. It is desirable from on-farm irrigation efficiency and agronomic standpoints that irrigation district water delivery networks (pipelines and/or canals) deliver water with a high degree of flexibility and reliability. One aspect of modernization is

financial; physical improvements are often quite expensive. An equally important aspect is awareness of modernization needs and options. The successful "School of Irrigation for Irrigation Districts", which has been held annually in the Fall at ITRC, will be continued. This school provides two sets of classes: one for irrigation district operators, and another for managers and engineers. The classes vary from 1-2 days in length each, and cover topics such as:

- Flow measurement in canals
- Flow measurement in pipelines
- General principles of modernization
- Advanced concepts in canal modernization
- SCADA systems
- Determining district water balances
- Hand Held Data Recorders

Water Conservation Coordinator Training. The Agricultural Water Management Council and USBR require a designated water conservation coordinator from each irrigation district as part of their water management plan. ITRC has developed materials and curriculum to assist the water conservation coordinators in developing and implementing effective water management plans. This 1-2 day training will be updated annually and provided as part of the Irrigation District Training Classes.

Annual Designer/Manager School of Irrigation. This 2-week school has been developed and held at ITRC for the last 10 years. This is an excellent program for persons who are designing and managing on-farm irrigation systems. There is no other such technical program available for these people in California. The need is very basic: Unless irrigation designers know how to properly design an irrigation system for good uniformity and simple management, on-farm irrigation efficiencies will be low. Typically, irrigation system designers have no formal university irrigation training and they must have this type of class available in order to supplement their rudimentary hands-on, on-the-job training. ITRC works closely with the Irrigation Association in its Designer Certification program; these classes help designers prepare for those exams.

This proposal will help support the continuation of the Annual Designer/Manager School of Irrigation. The goals are directly in line with CALFED's QOs to improve on-farm irrigation, reduce drainage problems, and enhance groundwater and surface water qualities. Other funding partners for this program may include the California Energy Commission, and contributions from private industry. Again, there is simply no other equivalent training program in the western U.S.

Classes provided in this school will include:

- Basic soil/plant/water relationships (1 day)
- Basic hydraulics (1 day)
- Basic pumps (1 day)
- Advanced pumps (2 days)
- Row crop drip irrigation (1 day)

- Fertigation (1 day)
- Drip system design (3 days)
- Irrigation scheduling, salinity, and drainage (2 days)
- Sprinkler irrigation design (2 days)

Local 1-day and 2-day classes on Flow Measurement, Irrigation District Operation, SCADA, On-Farm Irrigation Scheduling, and other topics. Many districts need support for occasional short courses for their system operators, board members, and farmers.

On-Farm Irrigation Evaluation. In the early 1980's, ITRC developed, on behalf of the Water Conservation Office of the Calif. DWR, a 2.5-day class on Irrigation Evaluation techniques. That class has been offered twice per year since then with DWR funding. This class will continue to make a very important contribution to water conservation in California. It provides a standardized format for definitions of Irrigation Efficiency, and for the procedures to be used in measuring Irrigation Efficiency and Distribution Uniformity for on-farm irrigation. As a result of this standardized training, it is now much easier for persons to communicate regarding irrigation efficiency. Without continued training, there will be a wide mix of varying perceptions of what irrigation efficiency is, and how it can be measured. A clear perception is absolutely necessary if valid water conservation programs within districts are to be developed.

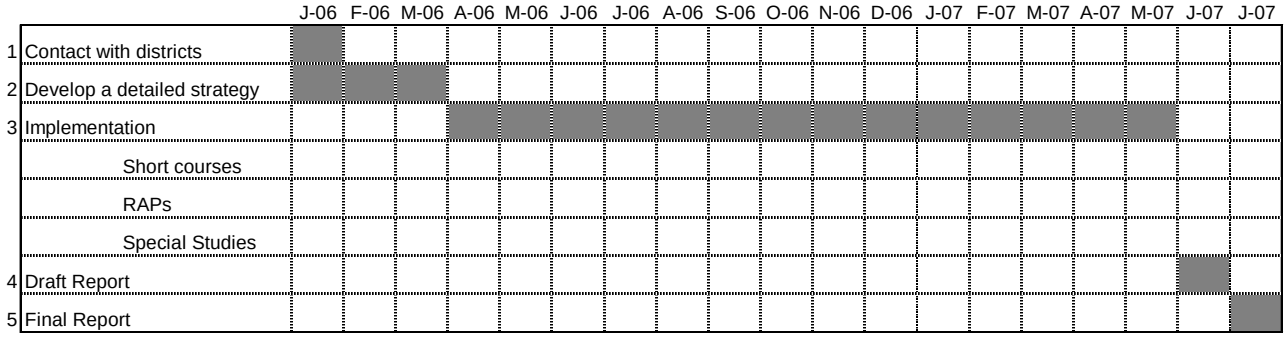
Special Studies

This action item includes the provision to conduct short, well-defined special studies, which may be needed. Such studies may range from quantification of evaporation losses from sprinklers to participation of ITRC personnel in DWR/district brain-storming sessions. It may also include larger studies such as the definition of the Irrigation Efficiency in some cases. Such studies will only be done after thorough consultation with the CALFED program manager. Examples of such studies, which occurred during the USBR Technical Services contract, are:

- Clarification of Irrigation Efficiency, Irrigation Sagacity, and Distribution Uniformity concepts and definitions. This work resulted in a published report through the American Soc. of Civil Engineers, Water Resources Division. It is very important for districts that are considering water transfers. ITRC now has well-established procedures, and there are numerous locations within the state that could benefit from an excellent water balance.
- Development, testing, and calibration of a simple flow measurement device for Solano Irrigation District fixed rate accounts. SID needed a simple and inexpensive flow measurement device for its small land holdings that presently receive water from a simple alfalfa valve. ITRC tested a simple vertical pipe with a notched weir; the device met the requirements of simplicity and accuracy.
- Development of the ITRC Flap Gate – a simple automatic upstream control gate that is inexpensive and requires no external power. Several hundred of these gates have been installed in Turlock, Chowchilla, Alta, and other irrigation districts.
- Definition of a procedure to make automated canal gates work equally well at high flow rates and low flow rates. Canal gates typically work well in either one of those conditions, but not in both. A procedure was developed to characterize gates and insert a correction factor in the controller code, which eliminates this problem and provides stable control.

Schedule

The following is a simple bar chart for the proposed program:



Section Three: Monitoring and Assessment

It is expected that the technical services provided to irrigation districts in this proposal will help them to more effectively manage available water supplies. Region-specific quantifiable objectives (QOs) will form the foundation for investigations and modernization planning done through this technical assistance proposal. The first step in the monitoring process for each irrigation district is an analysis of the potential water savings or achievable water quality goals through the development of detailed water balances or other pertinent performance indicators. Quantifying the potential for modernization projects to address specific QOs and continued monitoring during implementation are major reasons for districts requesting ITRC technical expertise in the past.

The ITRC has worked on a number of district-level water balance studies as part of assessing the potential benefit of doing certain water use efficiency projects. This includes using analytical tools necessary to determine irrigation performance measures such as irrigation efficiency and irrigation sagacity, both of which require a detailed irrigation water balance. The computations used in water balances done through this technical assistance will benefit from the precision of the crop evapotranspiration model refined by ITRC in previous water balance studies.

Through the RAP and in-depth analysis of the internal processes of day-to-day district operations, specific actions will be identified and recommended based on innovative but cost-effective solutions. With the detailed water balance studies and enhanced data management capability that participating districts usually evolve to, assessing the costs and benefits of separate modernization items is uniquely possible. Monitoring and more accurate measurements of inputs and processes are core strategies of district modernization. This focus on better measurement and more realistic, verifiable water balance figures gives irrigation districts more confidence in starting out on new projects and also provides them a way to measure the results.

Each irrigation district utilizing technical assistance as part of this proposal will receive detailed recommendations with discussions of suggested strategies, along with a framework (e.g., annual water balance tables) for assessing the benefits of the proposed actions. This information is transmitted to districts in site surveys, reports, presentations, and through the arrangement or compilation of GIS datasets. Copies of all materials would be submitted to the Office of Water Use Efficiency.

Quarterly progress reports will be submitted to CALFED through the Office of Water Use Efficiency. These reports will provide a brief synopsis of what was accomplished in each cooperating irrigation district, and what the plans are for the following quarters. Copies of all final work products will be provided along with quarterly reports.

Previous technical services programs operated by ITRC have generated a tremendous amount of interest in new ideas for water management and modernization. Although water conservation results are nearly impossible to quantify due to the nature of the scope of work for this type of contract, the following is a sample of the typical results that are being achieved as districts continue to modernize in California.

Merced Irrigation District (MID) was formed more than 80 years ago. There are more than 140,000 acres of farmland located within the District's boundaries, of which approximately 70 percent are irrigated with the District water. The District serves nearly 2,000 Merced County growers, who produce over 25 different crops each year, including almonds, corn, alfalfa, and cotton.

In the early 1990s, MID personnel began attending the technical assistance classes at the ITRC. At the time, the District had about 15% operational spill, which is typical for non-modernized districts. MID implemented an aggressive modernization program over the next 10 years and has reduced the operational losses to less than 1%.

Modernization included items such as a new Supervisory Control and Data Acquisition System (SCADA), new flow measurement devices, and new management strategies for delivering water with better service to their customers. Recent modernization activity done in 2004 includes the installation of Long Crested Weirs for better water level control.

There are 2 key points in the example from MID. These points are critical for the future modernization of irrigation districts.

1) The modernization actions were simple and did not rely on expensive options such as **computer modeling, expensive pipelining studies, concrete lining canals, etc**.

2) The time for modernization takes time. A ten-year time frame is typical for districts to achieve measurable results.

Qualifications of the Applicants and Cooperators

Resumes *(of the project manage)*
The resume for Dr. Stuart Styles is included as Attachment A. Others who will be participating in the technical services include Dr. Charles Burt, Beau Freeman, Dan Howes, and Franklin Gaudi. The resume for Dr. Charles Burt is also included in Attachment A.

External Cooperators
There are no external cooperators specifically identified for this program. The following is a list of the California irrigation/water districts that are part of the USBR-MPR technical services program. ITRC has had long-term relationships with these districts and has helped in the planning and implementation of many water conservation projects.

Previous water use efficiency grant projects
1. ITRC-USBR Technical Services Contract. Since the start of the ITRC-USBR Technical Services program in 1994, an estimated $2.1 million dollars have been tracked as money expended by irrigation districts as a result of participation with ITRC in the technical services program. All of the projects were the result of modernization of the district operations and represent cash outlays by the district. This does not include the additional "in-kind" cost incurred by the districts for equipment, labor, or facilities use. The grants provided to ITRC during this time period were approximately $2 million. This cost share component of the USBR contract with ITRC represents well over a 50% cost share by the local irrigation districts to participate in this modernization effort. Below is a list of the federal water districts who have worked with ITRC.

Arvin-Edison Water Storage District

Banta-Carbona Water District
Bella Vista Water District
Broadview Water District

Chowchilla Water District
Clear Creek Community Service District
Colusa County Water District
Colusa Drain Mutual Water Company
Corning Water District

Delano-Earlimart Irrigation District
Dunnigan Water District

Exeter Irrigation District

Feather Water District
Firebaugh Canal Water District
Fresno Irrigation District

Garfield Water District
Glenn-Colusa Irrigation District
Glide Water District
Goleta City Water District

Hills Valley Water District

Ivanhoe Irrigation District

James Irrigation District

Kanawha Water District
Kern-Tulare Water District
Klamath Irrigation District
Klamath Wildlife Refuge

Lindmore Irrigation District
Lindsay-Strathmore Irrigation District
Lower Tule River Irrigation District

Madera Irrigation District
Maine Prairie Water District
Maxwell Irrigation District
Meridian Farms Water Company

Natomas Central Mutual Water Company

Orange Cove Irrigation District
Orland-Artois Water District
Orland Unit Water Users Association

Pacheco Water District
Panoche Water District
Patterson Water District
Pelger Mutual Water Company
Plain View Irrigation District
Pleasant Grove-Verona Mutual Water Company
Porterville Irrigation District
Princeton-Codora-Glenn Irrigation District
Provident Irrigation District

Ragg Gulch Water District
Reclamation District 108
Reclamation District 1004
Roberts Ditch Irrigation Company, Inc.

San Benito County Water District
San Juan Suburban Water District
San Luis Water District
Santa Ynez River Water Conservation District
Saucelito Irrigation District
Shafter-Wasco Irrigation District
Solano Irrigation District
Southern San Joaquin Municipal Utility District
Stone Corral Irrigation District
Sutter Mutual Water Company
Sutter-Butte Mutual Water Company

Tea Pot Dome Water District
Terra Bella Irrigation District
Thomes Creek Water District
Tranquillity Irrigation District
Tri-Valley Water District
Tulelake Irrigation District

West Stanislaus Water District
Westlands Water District

2. ITRC-DWR Technical Services Contract. ITRC was the recipient of a CALFED technical assistance grant in 2001 that covered about 18 months. Work completed under this contract included five district-wide Rapid Appraisal Process (RAP) projects, one specific site technical assistance project, and two statewide technical documents.

The scope of work for this contract was broad and covered most of the technical activities of the ITRC. ITRC has a reputation for being an independent and reliable resource for expert technical assistance. Activities potentially covered under this scope of work included:

The Expert Technical Assistance Program of ITRC focuses on the two major aspects of irrigation:
Irrigation Projects (district and regional levels) Assistance to irrigation districts to develop water conservation programs Water balance computations for irrigation districts Rapid Appraisal Process (RAP) for irrigation projects Help districts locate qualified companies and equipment for modernized systems Development of irrigation project modernization guidelines Modern canal control design including: Supervisory Control and Data Acquisition (SCADA) systems installation Flow control and measurement Electric power usage Control logic algorithms for automatically controlled gates
Irrigation Systems (on-farm and landscaping levels) Irrigation system evaluations and recommendations Distribution and Uniformity analyses Evaporation and Salinity studies Assistance with improved irrigation efficiency design and management Maximizing drip and microspray system potential Automation of irrigation systems

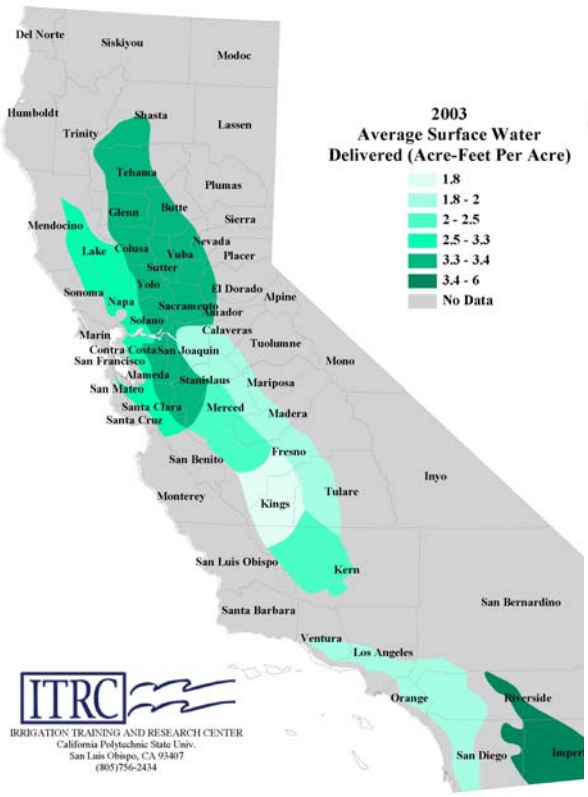
Outreach, Community Involvement and Acceptance

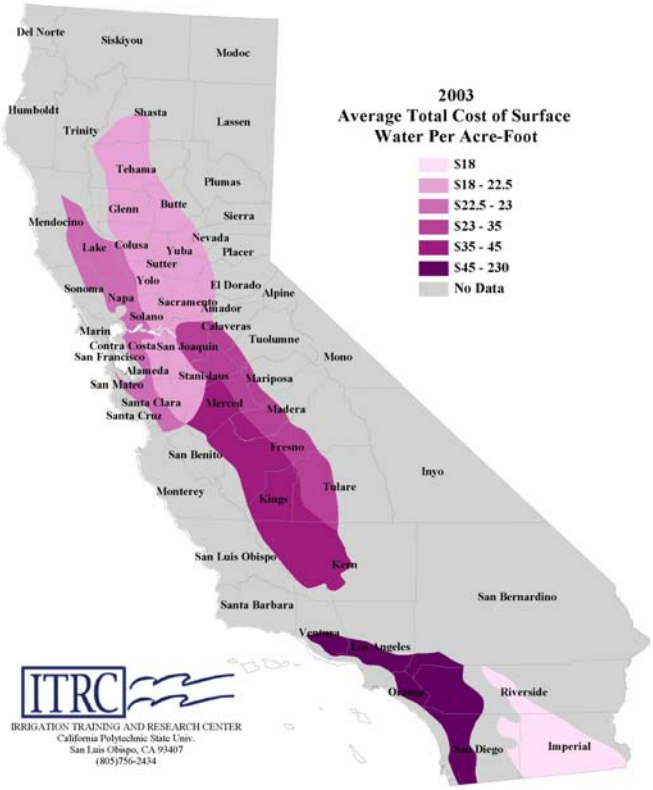
Outreach

The technical services will be provided to some irrigation districts that traditionally have not been able to afford for irrigation professionals to properly review their operations. Some irrigation districts have been set up and operated for almost 100 years with a simple, yet flexible water supply. These districts will be the ones most impacted with tightening water supplies. Few irrigation districts are really capable of providing the level of service necessary to support on-farm automation.

District modernization programs have served as a catalyst for other water conservation programs in districts. A successful strategy starts by targeting a visible problem in the district. Newsletters and presentation meetings open to general audiences or for board members allow for promoting win-win modernization solutions and the role of modern engineering techniques.

The following figures are an example of the type of information generated and provided by the ITRC to water agencies, irrigation districts and media outlets.





Training, Employment, and Capacity Building

The ITRC proposal will provide training to irrigation district personnel. It is estimated that about 400 persons receive training every year. ITRC employs 30 persons. About 20 of these are

students who are provided with an excellent opportunity to receive professional engineering training. This proposal will directly increase the base of students trained in irrigated agriculture who will contribute professionally after graduation in improving water management in California.

Information Dissemination

In addition to specific tasks and short courses for individuals at irrigation districts, Cal Poly ITRC has provided information dissemination in many arenas. One of the key areas is with the publication of reports on-line through the website www.itrc.org.

a. An annual report will be published on the Cal Poly ITRC website (www.itrc.org).
b. Articles will be supplied to Calif. DWR Water Conservation Office newsletter.
c. Articles will be supplied to USBR Mid-Pacific Region Water Conservation Office newsletter.
d. Professional papers will be generated as appropriate.

Innovation

The proposed *Technical Assistance* will help irrigation districts with the implementation of innovative projects that will reduce true irrigation system losses, protect environmental resources, and help to prevent water supply conflicts. Technology in the agricultural water sector is changing at a rapid pace, particularly with the widespread adoption of micro-computers in sensors and communication equipment. ITRC is in a unique position to independently evaluate the performance of various technologies or devices. Through the teamwork approach involving district staff, ITRC engineers, civil/construction engineers and planners, and partners in various agencies, innovative solutions are worked out. ITRC's experience with state-of-the-art technologies and years of field research are critical to this creative thinking process.

Recent innovations include the development of the ITRC Weir Stick (used at numerous irrigation districts with weirs) and the ITRC Float Valve (primarily Delano-Earlimart Irrigation District). These devices have made a significant impact on the districts who have implemented their use. Both of these devices are described in detail on the ITRC website.

Benefits and Costs

Project Implementation Costs (Budget)

Applicant: California Polytechnic State Universtion Foundation

THE TABLES ARE FORMATTED WITH FORMULAS: FILL IN THE SHADED AREAS ONLY
Section A projects must complete Life of investment, column VII and Capital Recovery Factor Column VIII. Do not use 0.

Table C-1: Project Costs (Budget) in Dollars)

	Category (I)	Project Costs $ (II)	Contingency % (ex. 5 or 10)[2] (III)	Project Cost + Contingency $ (IV)	Applicant Share $ (V)	State Share Grant $ (VI)	Life of investment (years) (VII	Capital Recovery Factor (VIII)	Annualized Costs $ (IX)
	Administration[1]								
	Salaries, wages	$809,389	0	$809,389	$205,936	$603,453	0	0.0000	$0
	Fringe benefits	$264,336	0	$264,336	$56,872	$207,464	0	0.0000	$0
	Supplies	$219,310	0	$219,310	$55,622	$163,688	0	0.0000	$0
	Equipment	$0	0	$0	$0	$0	0	0.0000	$0
	Consulting services	$0	0	$0	$0	$0	0	0.0000	$0
	Travel	$40,299	0	$40,299	$14,904	$25,395	0	0.0000	$0
	Costs)	$466,667	0	$466,667	$116,667	$350,000	0	0.0000	$0
(a)	Total Administration Costs	$1,800,000		$1,800,000	$450,000	$1,350,000			$0
(b)	Planning/Design/ Engineering	$0	0	$0	$0	$0	0	0.0000	$0
(c)	Equipment Purchases/Rentals/ Rebates/Vouchers	$0	0	$0	$0	$0	10	0.0000	$0
(d)	Materials/Installation/ Implementation	$0	0	$0	$0	$0	0	0.0000	$0
(e)	Implementation Verification	$0	0	$0	$0	$0	0	0.0000	$0
(f)	Project Legal/License Fees	$0	0	$0	$0	$0	0	0.0000	$0
(g)	Structures	$0	0	$0	$0	$0	0	0.0000	$0
(h)	Land Purchase/Easement	$0	0	$0	$0	$0	0	0.0000	$0
(i)	Environmental Compliance/Mitigation/ Enhancement	$0	0	$0	$0	$0	0	0.0000	$0
(j)	Construction	$0	0	$0	$0	$0	0	0.0000	$0
(k)	Other (Specify)	$0	0	$0	$0	$0	0	0.0000	$0
(l)	Assessment	$0	0	$0	$0	$0	0	0.0000	$0
(m)	Report Preparation	$0	5	$0	$0	$0	0	0.0000	$0
(n)	**TOTAL**	$1,800,000		$1,800,000	$450,000	$1,350,000			$0
(o)	Cost Share -Percentage				25	75			

1- excludes administration O&M.
2 - Contingencies are not permitted by the university.

Labor costs (including consultants), equipment, supplies, and travel justification

Salaries And Wages: The salary rates are based on the California State University and Cal Poly Foundation established salary rate paid during the 2004-2005 Academic year (July 1 – June 30). Faculty in the California State University system teach a full twelve units each of three Academic quarters per nine month Academic year. The salary and wage rates for all employees

include an annual projected 4.5% salary increase. The rates shown are for budgetary purposes; the actual rates in effect at the time the work is performed will be charged to the project. The administrative/clerical staff provide important direct support on project work such as, but not limited to, assistance with technical report preparation, editorial review, and distribution.

Faculty & Staff Benefits: Faculty and staff fringe benefits include a benefit package consisting of FICA, State Unemployment Insurance (SUI), Worker's Compensation, non-industrial leave, medical, dental, and life insurance benefits, and retirement benefits (PERS). Rates vary with the number of dependents and type of coverage. An historic average of 34% - 57% is used for budgetary purposes and is determined by the work the employees are doing and the environment in which they do their work. Benefits for faculty summer salary and overload compensation include FICA, SUI and Workers Compensation and is calculated at 10% - 13.7%. Only actual rates in effect for each individual at the time the work is performed will be charged to the sponsor.

Student Benefits: Student/Intermittent benefits include FICA (when applicable), SUI, and Worker's Compensation. A historical average of 2.4% - 11.7% is used for budgetary purposes and is determined by the work the employees are doing and the environment in which they do their work. Only actual rates in effect for each individual at the time the work is performed will be charged to the sponsor.

Operating Expenses: ***Supplies (Printing, photocopying, miscellaneous supplies)***
Materials and supplies in support of this project include general office supplies, course training supplies, simulation studies, and site visit supplies and materials. These include printer paper, printer cartridges, planning board, binders, transparencies, posterboard, white board markers, presentation/ display boards and paper, sheet protectors, folders, graph papers, tape measures, notepads and notebooks, labels, plotting paper, ink and heads, network switches, film developing costs, rental of items such as LCD projector and digital camera, wiring, sensors, electrical hardware, material for the portable SCADA and Flow Measurement demonstration units, valves, cables, piping, dataloggers, fasteners, plywood, safety glasses, batteries, media storage and certificates. Printing, photocopying and color copying expenses in support of this project include copies of existing reports and copies of the final report. The rate charged for photocopies is based on historical data of cost recovery. The current rate approved by the Cal Poly Foundation and charged to projects is $0.05 times the total number of pages copied.

Communications. Communications expenses include the costs of phone, fax, and postage. These costs are based on historical estimates. Only actual expenses will be charged to the project.

Computer Usage: The Cal Poly Irrigation Training and Research Center (ITRC) charges computer usage time to projects when ITRC computers are used for project work. The rates charged are based on historical data of cost recovery. The current rate approved by the Cal Poly Foundation and charged to projects is 1.5 xs the total average number of hours charged to project work.

Domestic Travel: Travel consists of approximately 15 round trip site visits for up to 3 key personnel to irrigation districts in California, with an average stay of 5 days each trip. The average per diem and lodging rate is $86 per person per day, for an estimated per diem and lodging total of $19,350. The estimated costs of vehicle travel are $6,045 based on 19,500 estimated miles. The current rate approved by the Cal Poly Foundation and charged to projects for vehicle use is $0.36/mile. Only actual travel expenses will be charged to the project at the allowable rate.

Indirect Costs: Cal Poly State University's Federal negotiated indirect rate is 35% of modified total direct costs which do not include equipment, tuition or that part of subcontracts over $25,000.

Cost Share: The amount of cost share that will be received during the 18-month time period of this proposal is $450,000. This is through the long-term technical services contract with USBR. The cost share contributed by irrigation districts is hard to estimate. It could be as low as the USBR match or greater than the $2 million total technical services program.

Describe the potential benefits and information to be gained in terms of water use efficiency.

The following table was listed as mandatory for all grant applicants. It doesn't seem to apply for a technical services grant. We have documented results where the service that was provided by ITRC was done for about $300,000. The cost of projects that the ITRC recommended was about $8 million. The reduced diversions were in the range of 30,000 to 40,000 acre-feet per year after the project. These reductions represent permanent reductions in the water diversions. See the ITRC website for more details (ADD LINK******)

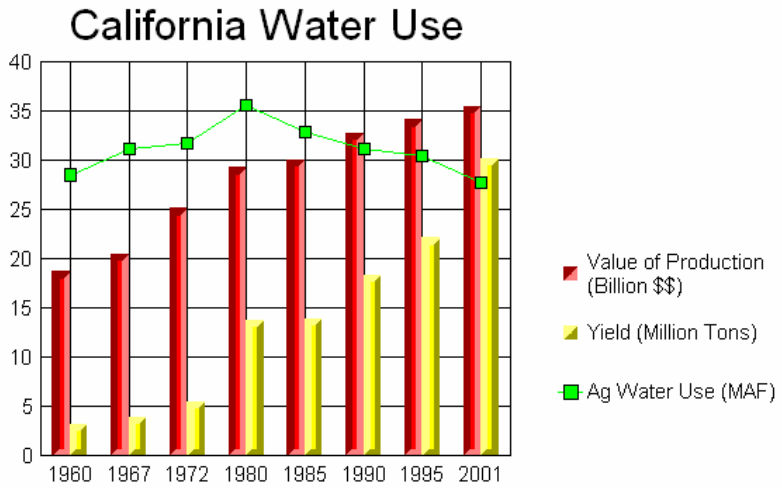
Table C-5 Project Annual Physical Benefits (Quantitative and Qualitative Description of Benefits)

	Qualitative Description - Required of all applicants[1]				**Quantitative Benefits - where data are available [2]**
	Description of physical benefits (in-stream flow and timing, water quantity and water quality) for:	Time pattern and Location of Benefit	Project Life: Duration of Benefits	State Why Project Bay Delta benefit is Direct[3] Indirect [4] or Both	Quantified Benefits (in-stream flow and timing, water quantity and water quality)
Bay Delta					0
Local				**Not applicable.**	

[1] The qualitative benefits should be provided in a narrative description. Use additional sheet.
[2] Direct benefits are project outcomes that contribute to a CALFED objective within the Bay-Delta system during the life of the project.
[3] Indirect benefits are project outcomes that help to reduce dependency on the Bay-Delta system. Indirect benefits may be realized over time.
[4] The project benefits that can be quantified (i.e. volume of water saved or mass of constituents reduced) should be provided.

Compare the potential benefits to be gained to the anticipated costs.

The agricultural water purveyors have responded tremendously by changing outdated policies for delivering water and by also taking steps to modernize their systems. The figure shows the trend in California of increasing crop yields compared to the water diverted for agricultural use.



The vision of the ITRC is to be recognized as the foremost resource for irrigation modernization solutions that conserve energy, water, and the environment while simultaneously obtaining more "crop per drop". ITRC has been at the forefront in directing irrigation districts to improved "water delivery service" in order to help irrigators get more yield with decreasing water supplies.

Informal training of irrigation professionals **began in 1985** at the ITRC. Since that time, hundreds of short courses have been held, thousands of professionals have received technical training, and millions of dollars have been used to pay Cal Poly water students for working on technical assistance contracts.

Attachment A
Resumes

Name and Academic Rank: **Stuart Styles**
Research Engineer
(Director, Irrigation Training and Research Center)

Degrees:

2001 University of California, Davis, CA
Doctorate of Engineering - Agricultural Engineering

1988 California Polytechnic State University, San Luis Obispo, CA.
Masters - Business Administration.

1984 California Polytechnic State University, San Luis Obispo, CA.
BS - Agricultural Engineering.

Number of Years of Service on this faculty: **12**

Other related experience:

Teaching (12 years):

Instructor for BRAE 340 (irrigation water management), BRAE 312 (water hydraulics), and BRAE 433 (structural engineering - concrete design emphasis

Instructor for numerous short courses taught through the Irrigation Training and Research Center at Cal Poly. Some of the classes include basic soil-plant-water relations, pumps, drip irrigation, irrigation scheduling, irrigation evaluations, flow measurement, canal operations, and ditchrider training

Developed new short course for the Irrigation Association titled the Certified Agricultural Irrigation Specialist (CAIS). This certification was the first one to be developed in almost 15 years for the agricultural certification program.

Industrial (9 years):

Boyle Engineering Corporation. Senior Engineer (1989-1993). Project Manager to provide agricultural engineering services to the Imperial Irrigation District in El Centro, California. Services are in support of the on-farm water conservation projects generated by the IID/Metropolitan Water District Water Transfer Agreement. Project Manager to design open channel water measurement structures (Replogle Flumes) for several agricultural clients. Previous work included supplying portable flumes to DWR mobile labs for furrow survey evaluations. Projects include the design of over 200 flumes to be placed at each field within the New Columbia Ranch (Newhall Land and Farming Company - Firebaugh, CA). Project Engineer for preliminary design of irrigation distribution facilities serving 12,000 acres of existing vegetable row crops and artichoke farming land around Castroville in Monterey County, California. This project represented a large scale project to utilize reclaimed wastewater as a new source of irrigation water for an area.

BioResource and Ag Engineering Department, Cal Poly San Luis Obispo. Construction Engineer (1987-1989). Responsible for design and construction of the Water Delivery Automation Facility built at California Polytechnic State University in San Luis Obispo, California. Experience involved planning, design, engineering, project management and installation of major components of the $1+ million facility.

Palo Verde Irrigation District (Blythe, CA). Assistant Engineer (1984-1986). Experience with irrigation district maintenance and engineering operations, concrete canal lining design and construction, drainage and canal invert design, and supervision of installations.

Consulting, patents, etc:

Newhall Land and Farming Company – evaluation for modernization of facilities

World Bank – researcher for the World Bank funded "Modern Water Control and Management Practices in Irrigation: Methodology Development and Studies for Evaluating the Impact on Performance." The goal of the project was to provide valuable insight to policy makers, planners, designers, and researchers about the levels of service provided by irrigation projects, the results of those levels of service, and the key factors which influence the ability to obtain various levels of service. Countries evaluated included Iran, Turkey, Malaysia, Egypt, India, and Thailand

State(s) in which registered:

1989 Professional Engineer (Civil) - CA
Certified Irrigation Designer (CID) - Drip, Surface
Certified Agricultural Irrigation Specialist

Principal publications:

"Conceptualizing Irrigation Project Modernization Through Benchmarking and the Rapid Appraisal Process." 2004. Journal of Irrigation and Drainage Engineering. ASCE 53(2): 145-154. Burt, C.M. and S.W. Styles. Published by John Wiley & Sons, Ltd.

(http://www3.interscience.wiley.com/cgi-bin/fulltext/108563546/PDFSTART).

"Canal Velocity Indexing at Colorado River Indian Tribes (CRIT) Irrigation Project in Parker, Arizona using the SonTek Argonaut SL". 2003. Irrigation Association 24th Annual Irrigation Show Technical Proceedings, San Diego, California. Styles, S.W., Niblack, M.

"Water Delivery Service as a Determinant of Irrigation Project Performance." 2001. Doctorate of Engineering Dissertation. University of California, Davis, CA. Styles, S.W.

"Orchard Mesa Irrigation District (OMID) Water Management Study". Completed under contract for the USBR - Grand Junction Area Office. December 2000. 153 pages plus attachments. Styles, S.W. and Burt, C.M.

"Drip and Micro Irrigation for Trees, Vines, and Row Crops, with special sections on buried drip.", Irrigation Training and Research Center, Cal Poly San Luis Obispo, ISBN 0-9643634-0-2, 261 pages. Burt, C.M. and Styles, S.W.

Scientific and professional societies of which a member:

American Society of Civil Engineers
American Society of Agricultural Engineers
Irrigation Association
United States Committee on Irrigation and Drainage (USCID)

Honors and awards:

1994 Engineer of the Year – California/Nevada Section American Society of Agricultural Engineers
2004 Person of the Year – The Irrigation Association

Institutional and professional service in the last five years:

American Society of Civil Engineers - member
American Society of Agricultural Engineers - helped to organize the annual CA/NV section meeting held every year at the Tulare Farm Show where about 50-70 student are provided a free (or almost free) meal.
Irrigation Association - have just completed a 5 year stint on the Certification Board and the Board of Directors.

Professional development activities in the last five years:

Attend 2 conferences per year. Irrigation Association and USCID. Actively participate in committees and presentations.

CHARLES M. BURT, P.E., PH.D., PROFESSOR

Degrees:

Ph.D. Engineering, Utah State University, Logan, Utah, 1983.
M.S. Agricultural and Irrigation Engineering, Utah State University, Logan, Utah, 1975.
B.S. Soil Science, Cal Poly, San Luis Obispo, 1973.

Number of years of service on this faculty: 23 years

Other related experience:

Teaching/Industrial

Chairman of the Board (2000-present) and Director (1989-2000), Irrigation Training and Research Center, Cal Poly, San Luis Obispo.

Industrial

Extensive consulting for irrigation water delivery, drainage, water balances, and on-farm irrigation in the US and 24 countries.
Chief Engineer and Partner, JM Lord, Inc., Fresno, CA (1981 – 1982).
Irrigation System Designer, Wren-Oneal Co., Fresno, CA (1976 – 1978).
Irrigation System Designer, Keller Engineering, Logan, Utah (1975 – 1976).
Spec.5. U.S. Army (1967 – 1970).

Other

State(s) in which registered:

Registered Professional Engineer: Civil (California); Agricultural (California); Irrigation (Utah)
Certified Irrigation Designer and Manager (national, The Irrigation Association)

Principal publications of last five years - examples:

Riego por Goteo y por Microaspersion para Arboles, Vides y Cultivos Anuales. 2000. Irrigation Training and Research Center. Cal Poly, San Luis Obispo, CA ISBN 0-9643634-3-7. 334 p. C. M. Burt, S.W. Styles and J. A. Forero S.

Irrigation District Service in the Western United States. 2000. Journal of Irrigation and Drainage Engineering. ASCE 126(5):279-282. C. M. Burt and S.W. Styles.

Problems of Irrigation in Developing Countries: Discussion." 2000. Journal of Irrigation and Drainage Engineering. ASCE 126(3):197-199. H. Plusquellec and C. Burt

Drip and Micro Irrigation. 2000. Irrigation Training and Research Center. Cal Poly, San Luis Obispo, CA. ISBN 0-9643634-2-9. 292 p. C. M. Burt and S.W. Styles.

Selection of Irrigation Methods for Agriculture. 1999. On-Farm Irrigation Committee. Water Resources Division. ASCE. N.Y., N.Y. ISBN 0-7844-0462-3. C. M. Burt, A.J. Clemmens, R. Bliesner, J.L. Merriam, and L. Hardy. 129 p.

Guides to the Use of Air Release/Vacuum Relief and Continuous Acting Air Vents. 1999. Technical Manual 8 p. Agricultural Products, Inc. Ontario, CA.

Modern Water Control and Management Practices in Irrigation. Impact on Performance. 1999. Water Reports #19. 224 p. Food and Agriculture Organization of the United Nations. ISSN 1020-1203. ISBN 92-5-104282-9 C.M. Burt and S.W. Styles

Irrigation Performance Measures: Efficiency and Uniformity. Closure. 1999. C. Burt, A. J. Clemmens, K. H. Solomon, T.A. Howell, and T.S. Strelkoff. Journal of Irrigation and Drainage Engineering. ASCE 125(2):98-100.

Improved Proportional-Integral (PI) Logic for Canal Automation. 1998. J. Irrigation and Drainage Engineering. ASCE 124(1): 53-57. C.M. Burt, R.S. Mills, R.D. Khalsa, and V. Ruiz C.

Influence of Canal Geometry and Dynamics on Controllability. 1998. J. Irrigation and Drainage Engineering. ASCE 124(1): 16-22. Strelkoff, Deltour, Burt, Clemmens, and Baume.

Irrigation Performance Measures - Efficiency and Uniformity. 1997. Journal of Irrigation and Drainage Engineering. ASCE 123(6):423-442. C. Burt, A. J. Clemmens, T.S. Strelkoff, K.H. Solomon, R.D. Bliesner, L.A. Hardy, T.A. Howell, and D.E. Eisenhauer.

Accuracy of Irrigation Efficiency Estimates. 1997. Journal of Irrigation and Drainage Engineering. ASCE 123(6): 443-453 . A.J. Clemmens and C. Burt.

Scientific and professional societies of which a member:

US Committee on Irrigation and Drainage (USCID)

American Society of Civil Engineers (ASCE)

The Irrigation Association

American Society of Agricultural Engineers (ASAE)

Honors and awards:

Bronze Star Medal for Heroism; ARCOM for Heroism; ARCOM for Meritorious Service (U.S. Army)
Recipient of National Water and Energy Conservation Award by The Irrigation Association (1986)
Outstanding Agricultural Engineer award for the ASAE Pacific Region (1987)
1997 Person of the Year - The Irrigation Association
1999 Irrigation Person of the Year – Calif. Irrigation Institute
Sunkist Agriculture Faculty Award (1996); Plant Sciences Outstanding Faculty Award (2001)
ASCE Journal of I&D Engr. “Best Discussion Award” for 2000.
ASCE Royce J. Tipton Award for career excellence in soil and water (2002)

Institutional and professional service in the last five years:

Graduate coordinator of the M.S. in Engineering, Water Engineering program
Reviewer of professional papers.
Chairman, Friends of the Central Highlands (Vietnam), Inc. – a non-profit NGO
Helped organize various conferences for USCID, ASCE (I&D Division).
Developed and taught several dozen short courses and seminars at conferences, meetings.

Professional development activities in the last five years:

Dozens of projects on irrigation and drainage. See detailed resume.