A. Cover Page

1. **Project Title:** New Fertigation Book

2. **Project Leader/Director:**

Dr. Charles Burt
Chairman (ITRC) and Professor Emeritus (BRAE)
Irrigation Training & Research Center (ITRC)
BioResource and Agricultural Engineering Dept.
Cal Poly State University
San Luis Obispo, CA 93407-0730
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3. **Cooperators**: ITRC. No letter is attached because ITRC is submitting this proposal; this project will have access to ITRC's photos and original Fertigation book files.

4. **Supporters**: This is in response to a specific request from CDFA for proposals

5. **CDFA Funding Request:** Year 1: $101,662
   Year 2: $122,815
   Total: $224,477

6. **Agreement Manager**:

Cal Poly Corporation
Melissa Mullen, Sponsored Programs Manager
Building 38, Room 102
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B. Executive Summary

1. **Problem:** There is a lack of high-quality and comprehensive educational/training materials related to the application of nitrogen fertilizers through irrigation water ("fertigation").

   In the Sept. 9, 2014, Conclusions of the Agricultural Expert Panel titled "Recommendations to the State Water Resources Control Board Pertaining to the Irrigated Lands Regulatory Program", in fulfillment of SBx2.1, recommendation #3 (of 8 total) was that the program should incorporate:

   > *Development of a very strong, comprehensive, and sustained educational and outreach program. Such a program will require different materials and presentation techniques for different audiences, such as individuals who may need certification, managers of irrigation/nutrient plans, irrigators, and farmers/managers.*

   This recommendation was given because of the lack of sufficient high-quality materials that are pragmatic, and which combine the disciplines of agronomy, irrigation, and soil science. It should also be noted that for most farmers, farm managers, and foremen, the whole arena of chemicals and fertigation is intimidating.

   The ITRC *Fertigation* book is over 20 years old, and includes neither the latest information on injection equipment and controllers, nor information on important regulatory subjects such as the A/R (Application/Removal) ratio of N by crops.

2. **Objectives, Approach, and Evaluation:** The initial objective is to improve the understanding of good fertigation practices by practitioners (i.e., farmers, foremen, farm managers). The improved understanding will hopefully result in farmers implementing better irrigation and fertilization practices. Those good practices will improve crop yields while protecting the environment.

   This project will develop educational tools that can be used in a variety of situations by growers, consultants, educators, extension agents, and students.

   The approach is to write an up-to-date *Fertigation* book that will serve as a valuable reference tool for practitioners. This will require assembling recent information regarding injection equipment, controllers, regulations, chemicals, plant responses, fertility testing, farmer practices, fertilizer dealer recommendations, etc., and then updating the current *Fertigation* book.

   The book will be available via the ITRC website. Its availability will be advertised widely in a variety of ways including, but not limited to, presentation at grower meetings, at the CII conference, mass emails, and via notices posted by irrigation districts and electric utilities and the Farm Bureau.

3. Audiences

The audience for this material is huge because there is so little information available that is actually usable. Several audiences are listed below:

a. *Regular students at Cal Poly*. This is listed first, because it is often overlooked in such programs that appear to look for audiences of farmers. The fact is that the future leaders, farmers, and consultants are currently students. Formal classes provide a very structured environment for learning, combining a variety of approaches and physical laboratories. The book will be used as the primary material for the fertigation class that is taken by irrigation students, earth science students, and horticultural science students.

b. *Individuals who want to learn on their own.* The book will be an ideal reference for individuals who are self-starters and who want the knowledge but may not be able to travel for face-to-face courses. The people who fall into this category include farmers, consultants, fertilizer sales persons, and extension agents.

c. *Water quality coalitions,* which will be responsible to implementing short courses for farmers on the subjects of water and nutrient management – both of which this naturally covers. While they may be able to find volunteers to teach, those volunteers need ready-made reference materials for presentation.

d. *Extension agents who are charged with providing training.* In reality, very few extension agents have an extensive background in fertilizers, irrigation, and the combination of the two. They need material for their own self-study, and to use in their workshops.

e. *Certified crop advisors and certified agricultural irrigation managers,* who need to know the material and also need continuing education credit.

f. *Farmers, farm managers, and irrigation foremen*. Ultimately, this is the audience that will be impacted by all of the above. They are responsible for the final implementation of best management practices that this material will explain and describe.

C. Justification

1. Problem: There is a lack of high-quality and comprehensive educational/training materials related to the application of nitrogen fertilizers through irrigation water ("fertigation"). This is a complex topic that requires knowledge of irrigation timing and uniformity, as well as how that combines with fertilizer requirements, injection equipment, and plant/soil/water responses. The challenge is to move the research information from the classroom into the field.

In the Sept. 9, 2014, Conclusions of the Agricultural Expert Panel titled "Recommendations to the State Water Resources Control Board pertaining to the Irrigated Lands Regulatory Program", in fulfillment of SBx2.1, recommendation #3 (of 8 total) was that the program should incorporate:

> *Development of a very strong, comprehensive, and sustained educational and outreach program. Such a program will require different materials and presentation techniques for different audiences, such as individuals who may need certification, managers of irrigation/nutrient plans, irrigators, and farmers/managers.*

This recommendation was given because there is a lack of sufficient high-quality materials that are pragmatic, and which combine the disciplines of agronomy, irrigation, and soil science. It can also be noted that:

- There is a very small number of students who take formal irrigation and fertilizer classes in college, despite the fact that the subject of fertigation (application of fertilizers via irrigation water) increases in complexity as technology and techniques advance, meaning that a well-trained cadre is needed.
- The vast majority of nitrogen fertilizer on drip-irrigated crops is applied via fertigation. The fertilizer will not move into the root zone in our arid areas if it is applied with any other method, at least with permanent crops. In other words, a discussion of fertilizer types and conversions must be accompanied by an excellent discussion of the means to apply the fertilizer.
- Fertigation and spoon-feeding provide the best precision and control for nitrogen fertilization applications. However, fertigation sophistication is marginal, at best, among most California farmers.
- There is a very limited number of consultants and university extension staff who understand the complexities of fertigation, including chemicals, injection techniques, safety, the nitrogen cycle, plant uptake requirements, etc. Therefore, to reach a large number of farmers, it will be important that farmers have individual access to excellent training materials. Or, if workshops are provided by extension agents or consultants, they should have standardized, excellent reference materials available that they can use.
- The whole nature of chemical injection, and the complexities of nitrogen, is intimidating to most practitioners (i.e., farmers, irrigation foremen, etc.). A good book can explain things in a useful manner

The ITRC *Fertigation* book is over 20 years old, and includes neither the latest information on injection equipment and controllers, nor information on important regulatory subjects

such as the A/R (Application/Removal) ratio of N by crops. Other "chemigation" or "fertigation" books are available but they are not comprehensive by any means. Those found in other states focus on center pivot sprinkler irrigation, rather than the irrigation methods that are common in California.

California is unique because of the wide variety of crops, water qualities, soil types, climates, and irrigation methods found throughout the state that require the use of different fertigation techniques. For example, fertigation with ammonium-based fertilizers can cause infiltration problems on the east side of the San Joaquin Valley but has no such impact on the high lime soils on the west side of the valley. Poor results with furrow irrigation fertigation are more related to the poor irrigation practices than to anything dealing with the fertilizer itself. And the complex interactions of some fertilizers among themselves and the irrigation water can cause serious plugging and uniformity problems with drip/micro. Injectors are typically installed incorrectly, without proper safety equipment, and the vast majority of fertigation is still done with slug dosages rather than with proportional spoon-feeding. The increase in organic farming requires special techniques for fertigation, especially with drip irrigation. Farmers need to know the proper combinations: the whys and how-to-do points.

2. **FREP Mission and Research Priorities.** FREP's mission is to encourage and enhance good fertilizer management. FREP has not funded a comprehensive educational effort of this nature before, but has rather focused on other pieces of the picture.

   The irrigation methods in California have changed, and drip/micro systems are the primary method of irrigation for numerous crops. Fertilizers and other chemicals must be injected through the irrigation system for drip/micro; there is no choice. Yet the practices are, in general, rudimentary. Meanwhile, we have increasing nitrate problems in the aquifers. Farmers need help in their purchasing and management decisions.

   Providing excellent and usable information about fertigation is absolutely consistent with FREP's mission.

3. **Impact.** Impacts of new tools are impossible to accurately predict, but it is certain that if FREP does <u>not</u> invest in a whole range of pragmatic educational and training efforts and materials, there will be much-slower-than-desired improvement in current fertilizer and water management practices.

4. **Long-Term Solutions**. Education is not a short-term solution. These educational materials will remain valid for at least 20 years.

5. **Related Research**. Part of this proposal, as described in the work plan, will be to identify existing research results that can be put into the book and class modules. Of particular interest are topics related to total N removal during harvest (for the A/R ratio), and timing of uptake. In addition, it will be important to identify the latest fertigation equipment and controllers that are available; this information is not published in research literature but is available online and through the Irrigation Association trade shows (in which the project leaders are active).

6. **Contribution to the Knowledge Base**. The real contribution will be the organization of existing information into a usable format, and the synthesis of that information into usable recommendations.

7. **Grower Use**. If new nitrogen and irrigation management plans are required by regulation, growers will constitute an immediate audience. However, most growers are beginning to understand that a combination of good water-plus-fertilizer management program will increase production and possibly decrease expenses. Therefore, this information will be welcomed by progressive farmers.

D. Objectives

The end objective is to improve the application of good fertigation practices by practitioners (i.e., farmers, foremen, farm managers). An improved understanding of fertigation will hopefully result in farmers implementing better irrigation and fertilization practices. Those good practices will improve crop yields while protecting the environment.

This project will develop an up-to-date *Fertigation* book that will serve as a valuable reference tool for practitioners. This will require assembling recent information regarding injection equipment, controllers, regulations, chemicals, plant responses, fertility testing, etc., and then updating the current *Fertigation* book.

The book will be made available on the ITRC website. The availability of the book, targeted portions, will be advertised widely in a variety of ways including, but not limited to, presentation at grower meetings, at the CII conference, mass emails, and via notices posted by irrigation districts and electric utilities and the Farm Bureau.

The book will be used in a regular class offered annually at Cal Poly in fertigation, plus in at least two short courses provided per year by ITRC. Those classes will not be funded by this project.

The outline of both the book is as follows:

1. Introduction
2. Safety
    a. Labels
    b. Injector safety issues
    c. Hoses, fittings
    d. Backflow prevention
    e. California codes
    f. Containment structures
3. Common chemical injectors – Standard units and proper configuration
    a. Venturis, such as Mazzei and Netafim
    b. Diaphragm pumps
    c. Water powered pumps
    d. Piston pumps

    e. Gravity boxes
    f. Sizing
    g. Chemical resistance
    h. Location relative to filters
4. Automated chemical injectors
    a. Various designs
    b. Proportional control
    c. Flow measurement of chemical and irrigation water
5. Special injectors
    a. SO_2
    b. Gypsum
    c. Other dissolved solid fertilizers
6. Injection techniques for various irrigation methods
    a. Moving versus stationary system considerations
        i. Continuous moving such as pivots and linear moves
        ii. Continuous move systems such as furrows and border strips
        iii. Stationary systems such as hand move and drip/micro
    b. Centralized versus mobile injection units
    c. Variations in chemical injection rates versus time
    d. Chemical travel time in pipelines
7. Irrigation principles, nitrogen leaching, and fertilizer uniformity
    a. Irrigation Distribution Uniformity (DU)
    b. Irrigation scheduling, and common errors
    c. Fertilizer leaching processes
    d. Preferential flow
    e. Broadcasting versus fertigation
    f. Uniformity of chemical flow through the irrigation system
    g. Proper timing and quantities of fertilizer
8. Nitrogen transformations and processes
    a. Nitrogen cycle
    b. Nitrogen transformations
        i. Fixation
        ii. Mineralization
        iii. Immobilization
        iv. Denitrification
        v. Volatilization
9. Nitrogen fertilizers and their conversions and properties
    a. Ammonium
    b. Nitrate
    c. Ammonia
    d. Organic Nitrogen fertilizers
    e. Urea
10. Nitrogen uptake
    a. Uptake versus removal
    b. Mechanisms for uptake
    c. Rates of uptake over the crop season

    d. Cation-anion balances
    e. Effects on soil pH
    f. Ammonium vs. Nitrate nutrition
11. Other nutrient processes
    a. N
    b. P
    c. K
    d. Others
12. Solubility and compatibility of fertilizers
    a. Solid fertilizer
        i. Conditioners
        ii. Solubility
    b. Compatibility
        i. Jar test
        ii. Basic mixing rules
        iii. Liming with Ammonia
    c. Corrosion, etc.
13. Specific fertilizer materials
    a. Common fertilizer compounds in California
    b. Understanding fertilizer labels
    c. Safety with some specific nitrogen fertilizers
14. Plant and soil testing
    a. Types of tests
        i. Soil
        ii. Soil water extract
        iii. Available nutrients
        iv. Petiole samples
        v. Plant tissue
        vi. Leaf sampling
        vii. Plant sap
        viii. Irrigation water nitrogen content
    b. Proper sampling
    c. Describing nutrients (milliequivalent, ppm, etc.)
15. Specific Crop requirements
    a. Key crops in California
    b. Usage versus growth stage
    c. Special considerations
    d. Crop removal versus uptake
16. Computations on rates and amounts of N fertilizer injection
    a. Cost comparison of fertilizers
    b. Relative conversions
    c. Total N available versus what is needed
    d. Verifying efficiency
    e. Calculating dosages, timing
17. Drip system maintenance for high uniformity of nitrogen fertilizer injection
18. Infiltration problems related to fertigation

E. Work Plans and Methods

The **method** of updating the *Fertigation* book can be outlined as follows:

1. Review the existing content.
2. Identify any re-structuring that is needed.
3. Identify specific technical components that need to be expanded, either as tables, graphics, or text.
4. Using literature searches plus interviews (with farmers, researchers, fertilizer salesmen, fertigation equipment companies, and soil science laboratories), fill in the missing or outdated sections.
5. Develop graphics, tables, etc.
6. Perform computations and specific research to develop data for new graphs/tables of concepts such as the Applied/Removed relationship with ET
7. Edit the complete book.
8. Publish the book electronically.

The **work plan** is outlined in the table below. The yellow cell indicates the key deliverable date of June 30, 2017. The work plan is for a total of 2 years.

Fertigation Book by Cal Poly ITRC			2015		2016				2017	
			3	4	1	2	3	4	1	2
Initial Organization	1		X							
Information Gathering	2a	Review old Fertigation book, define improvements	X							
	2b	Literature and web search	X	X						
	2c	Interviews with farmers, fertilizer dealers, researchers etc.	X	X	X					
	2d	Collect new information on injectors, costs, etc.	X	X	X					
	2e	Examination of codes	X	X						
Organization of Book	3	Organization of information		X	X					
Write book	4a	Writing of texts		X	X	X	X	X		
	4b	Development of graphics		X	X	X	X	X		
	4c	Editing (on-going)		X	X	X	X	X		
	4d	Completion of book								X
Outreach activities	6a	Cal Poly Fertigation Class (Spring quarters)				X				X
	6b	e-mails, advertisements						X		X
	6c	Participation in grower meetings sponsored by others such as SCE and PG&E							X	X
	6d	Fertigation short courses at ITRC				X				X
Attendance at FREP conferences	7	Attend Fall conferences for 2 years		X				X		
Reporting	8	Quarterly		X	X	X	X	X	X	X

F. Project Management, Evaluation, and Outreach

1. **Management.** The technical management will be provided by Dr. Charles Burt. Dr. Burt will also be the primary author of the book and the scripts. Students will be used for much of the data gathering to give them some experience and also to keep the costs down. They will also be used for some of the graphics development.

   Dr. Burt has been successfully directing projects of similar complexity and magnitude for about 30 years, so there are no problems anticipated. ITRC has its own bookkeeper to keep track of expenses and time, so accurate weekly financial status is well known. ITRC also has the software, computer facilities, etc. that are needed to accomplish the work.

   To provide a solid reference book that is both academically acceptable and pragmatic for use by practitioners, there must be substantial up-front work that captures state-of-the-art practices, chemicals and hardware….as well as current trends. This information is not available through classic peer-reviewed research papers. Therefore, a substantial effort must be made to travel around the state to visit with practitioners, manufacturers, consultants, and vendors.

   The work will be organized as follows:
   Dr. Burt will be personally involved in organizing and reviewing every step, and will also have a major responsibility for final writing. He will provide direction to the others. However, he will also be involved in the details such as conducting some interviews and visits, and researching special topics. Dr. Burt will also attend most of the meetings, and conduct the short courses and workshops.

   Undergraduate and graduate students, under close supervision and with detailed instructions, will make extensive field visits to obtain data (e.g., typical Fertigation practices with crop "x"), to organize data, to take photos of modern equipment and practices, and to do some work on initial organization. Dr. Franklin Gaudi will spend about 2 weeks total in the field assisting with this work.

   Office staff must field calls, assist with making copies, help to organize trips, etc.

   Sierra Layous will use her organizational and technical skills to work with Dr. Burt on the organization of accumulated information, and will assist in some of the writing and development of tables and figures.

   Monica Holman will be involved in filling research gaps, development of tables and figures, writing, and with the final organization of the book.

   The three key professionals, with additional information in the attached resumes, are:
   1. Dr. Charles Burt
   2. Sierra Layous
   3. Monica Holman

CV's have not been attached for others listed in the budget, because they have relatively small roles in the project – except for students. We do not yet know the names of the students, and they will have fledgling cv's, in any case.

4. **Evaluation**. The following additional measures will be used:
    a. Students in the Cal Poly fertigation class (one taken for credit) will be required to evaluate the overall book, and specific sections.
    b. An evaluation form will also be completed by participants in the Fertigation short courses.

5. **Outreach**. The RFP states that at least three outreach activities must occur per year. The workplan has been designed to complete the project in 2 years, therefore requiring a total of 6 outreach activities. These will be:
    a. 2 – one day short courses on Fertigation per year, using materials being developed for the book. The people who attend these short courses are a mix of farmers, consultants, and equipment manufacturers/dealers.
    Total = 4 short courses
    b. **2 – presentations in grower workshops**, to be determined at a future date. It is anticipated that these will be in conjunction with efforts organized by the Farm Bureau, PG&E, SCE, or others.

    Total = 2 grower presentations.

G. Budget Narrative

Personnel Expenses
The salary rates are based on the California State University and Cal Poly Corporation established salary rate paid during the 2014-2015 Academic year (July 1 – June 30). Faculty in the California State University system's duties consists of a full fifteen units each of three Academic quarters per nine month Academic year. The salary and wage rates for all employees include a projected 4.5% salary increase per year. On the actual rates in effect at the time the work is performed will be charged to the project.

Charles Burt, Chairman (ITRC) and Professor Emeritus (BRAE Dept.)
Year 1: 7.7% FTE, calendar year
Year 2: 10.6% FTE, calendar year
Sierra Layous, Senior Irrigation Engineer (ITRC)
Year 1: 5.77% FTE, calendar year
Year 2: 12.02% FTE, calendar year
Franklin Gaudi, Project Manager (ITRC), Lecturer (BRAE Dept.)
Year 1: 3.3% FTE, calendar year
Year 2: 0.7% FTE, calendar year
Stuart Styles, Director (ITRC), Professor (BRAE Dept.)
Year 1: 0.3% FTE, calendar year
Year 2: 0.3% FTE, calendar year

Monica Holman, Technical Writer/Editor (ITRC)
Year 1: 19.95% FTE, calendar year
Year 2: 31.7% FTE, calendar year
Administrative Support (ITRC)
Year 1: 5.9% FTE, calendar year
Year 2: 5.9% FTE, calendar year
Graduate Student Engineers (ITRC/BRAE)
Year 1: 28.85% FTE, calendar year
Year 2: 27.64% FTE, calendar year
Undergraduate Student Engineers (ITRC/BRAE)
Year 1: 28.85% FTE, calendar year
Year 2: 25% FTE, calendar year

Fringe Benefits and Employer Payroll Taxes
Faculty summer work include FICA, SUI and Workers Compensation and are calculated at 10.9%. Full time benefits for Corporation employees include a benefit package consisting of FICA, State Unemployment Insurance (SUI), Worker's Compensation, non-industrial leave including vacation and sick leave, medical, dental, and life insurance benefits, and retirement benefits (PERS) and are calculated at 56.7% in Year 1 and 57.7% in Year 2. Student benefits include FICA (when applicable), SUI, and Worker's Compensation and are calculated at 4.9%. Only rates in effect at the time the work is performed will be charged to the sponsor.

Operating Expenses

Supplies and Materials: General office and site visit supplies and materials include but are not limited to printer paper, printer cartridges, planning boards, binders, folders, notepads, notebooks, pressure gauges, batteries, and media storage.

Communications and Printing: Communications expenses include the costs of phone, fax, and postage. These costs are based on historical estimates. 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 Corporation and charged to projects is $0.05 times the total number of pages copied. 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 documented and approved by the Cal Poly Corporation and charged to projects is 1.77 times the total number of hours charged to project work.

Travel: The reimbursement rates are based on the rates specified by the California Department of Personnel Administration and in the 2105 CDFA Grant Procedures Manual.

Year 1	TOTAL =	$12,535					
Travel consists of about 35 days of site visits for key to fertilizer dealers, manufacturers and farmers							
	throughout California.						
Lodging	$3,850	1	room at	$110	per night for	35	nights
Per diem	$2,750	50	days at	$55	per day		
Incidentals	$250	50	days at	$5	per day		
Mileage	$4,600	8000	miles at	$0.575	per mile		
	$11,450						
Travel in Year 1 also includes attendance by key personnel at the FERP Fall 2015 Conference:							
Lodging	$440	2	room at	$110	per night for	2	nights
Per diem	$275	5	days at	$55	per day		
Incidentals	$25	5	days at	$5	per day		
Mileage	$345	600	miles at	$0.575	per mile		
	$1,085						
Year 2	TOTAL =	$5,360					
Travel consists of about 15 days of site visits for key to fertilizer dealers, manufacturers and farmers							
	throughout California.						
Lodging	$1,650	1	room at	$110	per night for	15	nights
Per diem	$825	15	days at	$55	per day		
Incidentals	$75	15	days at	$5	per day		
Mileage	$1,725	3000	miles at	$0.575	per mile		
	$4,275						
Travel in Year 1 also includes attendance by key personnel at the FERP Fall 2015 Conference:							
Lodging	$440	2	room at	$110	per night for	2	nights
Per diem	$275	5	days at	$55	per day		
Incidentals	$25	5	days at	$5	per day		
Mileage	$345	600	miles at	$0.575	per mile		
	$1,085						

Consultants: The budget lists $1,000 for consultants in Year 1, and $400 in Year 2. This is to pay people such as fertilizer consultants who work for soils laboratories, and who expect to be paid for their time when we ask detailed questions about recommendations that are not found in published literature. The specific consultants have not yet been identified, and we do not know what their rates will be. So this is an estimate based on 5 people at slightly less than $300 per person.

Indirect Costs:

Cal Poly State University's Federal negotiated indirect rate is 38.5% of modified total direct costs, effective July 1, 2015. Modified total direct costs exclude equipment, capital expenditures, charges for patient care, participant support costs, tuition remission, rental costs of off-site facilities, scholarships, and fellowships as well as that portion of each subgrant and subcontract in excess of $25,000. **However, the sponsor allows indirect costs on Personnel costs (salary and benefits/employer payroll taxes) only at a rate of 10%, therefore the 10% indirect rate is applied only to those costs.**

SECTION 1: APPENDICES
Resumes

Charles M. Burt, Ph.D., P.E., D.WRE

Charles Burt is the Chairman for the Cal Poly Irrigation Training and Research Center (ITRC). With over 40 years of agricultural irrigation and drainage experience, he has been involved with projects related to numerous aspects of on-farm irrigation, fertigation, canal modernization, water balance studies, and efficiency. Dr. Burt's experience includes extensive field and design experience in Fertigation, drip, sprinkler, and surface irrigation; canal / pipeline / pump modernization; and work experience in 26 countries. Dr. Burt is the author or co-author of over 120 articles and study guides related to on-farm irrigation and modernization, including the popular book *Fertigation*.

Education

Ph.D. Engineering, Utah State University, Logan
M.S. Agricultural and Irrigation Engineering, Utah State University, Logan
B.S. Soil Science (with honors), Cal Poly State University, San Luis Obispo

Registration

Registered Professional Engineer:

- Civil (California RCE 28995), Agricultural (California AG 430), Irrigation (Utah 5662)

Certified Irrigation Designer through the Irrigation Association:

- Agricultural Drip Irrigation, Surface Irrigation, Sprinkler Irrigation; Irrigation Manager

Areas of Expertise

Agricultural irrigation; fertigation; hydraulics; drainage; on-farm irrigation; canal modernization; efficiency of water and energy.

Affiliations

American Society of Agricultural and Biological Engineers; American Society of Civil Engineers; Water Resources Engineering Div.; The Irrigation Association – Previous chair of numerous committees; California Irrigation Institute; United States Committee on Irrigation and Drainage (USCID) – Board member; Phi Kappa Phi;

Co-founder of Friends of the Central Highlands (NGO to assist Montagnards in Vietnam); Founder of SEEM (South East Asia Ethic Minority Missions, Inc.); Editorial Board of Irrigation and Drainage Systems (Kluwer Academic Publishers, The Netherlands); Active participant in various organizations (ASCE, IA, USCID) with task committees, organizing specialty conferences and sessions at regular conferences. For example, service as chairman of 7/02 USCID conference held in SLO; 11/05 USCID conference held in Portland; 11/2011 in San Diego, planned 11/2012 in Reno; co-chair of 12/2014 in Phoenix.

Relevant Experience

Irrigation Training and Research Center (ITRC), Cal Poly State University, San Luis Obispo, CA, Chairman – Founder, former director, and current chair of self-supporting center focused on providing pragmatic irrigation training and technical expertise to industry, farmers, irrigation districts, and state/federal agencies. Examples include:

- Senior or sole author of text and reference books on topics such as fertigation, drip/micro design, pumps, irrigation management, surface irrigation, farm irrigation evaluations, irrigation selection.
- Original chairman of the designer certification program for The Irrigation Association.
- Water balance and water rights studies for irrigation districts
- Improvement of on-farm irrigation management. Surface, sprinkler, and drip methods. Evaluation procedures, demonstrations, water conservation program implementation.
- Variable speed electric drive and power consumption projects
- Technical assistance for secondary waste water irrigation projects and nitrogen management.
- Work throughout the western US in over 200 districts on a variety of projects related to ET, on-farm irrigation, the improvement district pipelines, canal modernization, SCADA, etc.

International Irrigation & Drainage Projects, Various Clients, Consultant – Dr. Burt has worked with private and international donor projects in Canada, Mexico, El Salvador, Honduras, Costa Rica, Colombia, Dominican Republic, Mali, Spain, Peru, Portugal, Morocco, Tunisia, India, Iran, Pakistan, Thailand, Vietnam, Saudi Arabia, Taiwan, Philippines, China, Chile, and Egypt, Tajikistan, and Bulgaria.

BioResource and Agricultural Engineering Department, Cal Poly State University, San Luis Obispo, CA, Professor – Instructor and course material developer for multiple undergraduate and graduate irrigation courses from 1978-2011, including the class Fertigation.

JM Lord, Inc., Fresno – Chief engineer and minor partner (81-82)

Wren-Oneal Co, Fresno – On-farm irrigation system design, installation, and sales (76-78)

Keller Engineering, Logan, UT – Irrigation system design (75-76)

US Army (3 years) – Two years in Vietnam. Combat demolition specialist, helicopter rappelling team, S-5 team, recon. patrols. (67-70).

Farm worker – During high school and before/during university

List of Recent Publications/Conferences – Charles M. Burt

Burt, C.M. 2009. Applications of Technology. Keynote speech for USCID Conference Irrigation and Drainage for Food, Energy, and the Environment. Salt Lake City. Nov. 3.

Burt, C.M. 2009. Water Conservation's Role in California Water Transfers. Presented at the annual Technical Conference of the Irrigation Association. San Antonio, TX. December.

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Orvis, S., C. M. Burt, and L. Perez U. 2011. Characteristics of Irrigation Pump Performance in Major Irrigated Areas of California. Sixth International Conference on Irrigation and Drainage. US Committee on Irrigation and Drainage. Nov. 15-18. San Diego, CA

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Burt, C.M. 2012. The Irrigation Sector Shift From Construction to Modernization: What is Required for Success. Irrig. And Drainage. Published online in Wiley Online Library (wileyonlinelibrary.com) DOI: 10.1002/ird.1703. 8 p.

Burt, C.M. 2013. Irrigation System Regulating Reservoirs. Proceedings of ICID Conference. Marden, Turkey. Sept. 2013.

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Howes, D.J., C. M. Burt, and L. J. Hoffman. 2014. Evaluating Net Groundwater Use from Remotely Sensed Evapotranspiration and Water Delivery Information. Presented at the International Irrigation Association Technical Conference in Phoenix, AZ. December.

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List of Current Research/Outreach Activities through ITRC– Charles M. Burt

1. Teach approximately 25 short courses/year with ITRC. These are 1-3 days long, and include topics such as: Fertigation, Row Crop Drip Design, Basic Hydraulic, Basic Pumps, Advanced Pumps, Irrigation Scheduling, Drip Design, Irrigation Evaluation and Flow Measurement.
2. Provide talks to a variety of organizations each year, including PG&E field days, grower organizations, professional groups (such as soil erosion, Calif. Irrig. Institute, Calif. Ag. Irrigation Dealers Assoc.)
3. Direct irrigation evaluation teams from Cal Poly each summer.
4. Direct modernization projects for a variety of irrigation districts – including CCID, GCID, San Luis Canal Co., Modesto ID, Wind River IP, Orchard Mesa ID, Merced ID, Uncompahgre Valley WUA, Flathead IP, Wapato IP, Patterson ID, West Stanislaus ID, Santiam WCD, Colorado River Indian Tribes. Work with many other districts on small projects – such as Fresno ID, Madera ID, and others.
5. Director of ITRC portion of project to design secondary waste water disposal center pivot irrigation system for South Tahoe Public Utility District – with a goal of maximum N uptake, and minimal N leaching or runoff.
6. Former director, current technical advisor for project to use secondary waste water effluent for irrigation by LACSDs in the Palmdale and Lancaster area. Approximately 30 center pivots are scheduled, with nutrient management actively employed.
7. Work on various confidential court cases on subjects such as personal injury from irrigation systems, water rights, and water conservation.

Sierra Layous, M.S., P.E.

Sierra Layous (née Orvis) is a Senior Irrigation Engineer for the Cal Poly Irrigation Training and Research Center (ITRC). With a strong academic background and working for the ITRC since 2006, she has been involved with projects related to many aspects of irrigation, municipal water, and natural resources. Ms. Layous's experience includes district-wide modernization planning, automation and SCADA systems, international projects, agricultural and municipal system water and energy auditing, as well as online class development. Ms. Layous has authored or co-authored a number of articles and presentations in the field of irrigation.

Education

M.S. Civil and Environmental Engineering, Cal Poly State University, San Luis Obispo
B.S. BioResource and Agricultural Engineering, Cal Poly State University, San Luis Obispo

Registration

Registered Civil Engineer, California, 79253

Areas of Expertise

District-wide modernization planning; Automation and SCADA systems; GIS for mapping and calculations; Water and energy auditing; METRIC ET analysis, Conceptualization of challenging solutions.

Affiliations

American Society of Civil Engineers (ASCE); U.S. Committee on Irrigation and Drainage (USCID); The Irrigation Association (IA)

Relevant Experience

Cal Poly Irrigation Training and Research Center, San Luis Obispo, CA, Support Engineer – Select projects from 2006 to the present, including:

- Developed modernization plans for Modesto ID, CCID, SLCC, Orchard Mesa ID
- Developed water/energy auditing program for municipal water systems in PG&E's territory
- Developed re-build/modernization plan for Mexicali Valley irrigation systems after 2010 earthquake
- Designed web-based teaching modules for drip irrigation DU evaluation short course
- Analyzed in-situ compaction for canal seepage reduction
- Designed agricultural energy conservation programs for Southern California Edison
- Pumps (VFDs, standard), ADVs (flow measurement), AutoCAD
- Analyzed on-farm Distribution Uniformity (DU) calculation methods
- Water balance examinations for Mexicali Valley, Henry Miller RD, and others.

BioResource and Agricultural Engineering Department, Cal Poly State University, San Luis Obispo, CA, Lecturer – Taught Principles of Irrigation Laboratory from 2010-2011.

Central Coast Water Board, San Luis Obispo, CA, Irrigated Agriculture Waiver Student Assistant – Analyzed water quality monitoring data and pesticide use by region; developed fact sheets based on water quality monitoring findings; managed grower database.

Natural Resources Conservation Services, Templeton, CA, Engineer Intern – Created erosion control handouts using AutoCAD; designed Wildlife Watering Facility for EQIP client; calculated peak flows out of watersheds with TF-55 and ArcGIS; surveyed sites.

Monica J. Holman

Technical Writer/Web Administrator

EXPERTISE

Experience includes: research, writing, and editing of technical papers, reports, brochures, and other materials; website design and administration; network administration; graphic design.

EDUCATION

***Portland State University**, Portland, OR*

Master of Arts in **English**, 2003
Graduated summa cum laude. GPA: 4.0

Bachelor of Arts in **English**, 2000
Minor: German
Graduated summa cum laude. GPA: 3.99

EXPERIENCE

October 2003-presentCal Poly Irrigation Training and Research CenterSan Luis Obispo, CA

Technical Writer/Editor II

- Editing and/or writing technical and research papers, books, other publications, and reports
- Website design and maintenance. Responsible for design and maintenance of websites for ITRC, Cal Poly BRAE Department, and Cal Poly Tractor Pull Club. Proficient in HTML 5, CSS, PHP, MySQL, and Drupal
- Responsible for maintenance of ITRC network servers
- Development of materials for online training classes and online content moderator. Proficient in Moodle, Adobe Creative Suite, Adobe Captivate, Adobe Presenter, Articulate Presenter and Storyline
- Recent Projects:
  - Editing of *Canal Automation Systems* manual prepared by ASCE Task Committee on Recent Advances in Canal Automation.
  - Prepared and edited papers for publication in journals for ASCE, ASAE, USCID, IA, HESS, and other peer-reviewed journals.
  - Researched and prepared background materials, including graphics and graphs, for projects ranging from landscape irrigation to pesticides to irrigation system design.
  - Developed online materials for ITRC short courses, in the subject matters of Drip/Micro Irrigation System Evaluations, Flow Measurement, Landscape System Design, and Irrigation Auditing.
  - Assisted in the development of an entire ITRC online learning management system using Moodle. Site now includes 12 online courses.

Earlier Experiences

- Writing center consultant; attended special assistant seminars on writing style and teaching; tutored students in writing and editing essays, research and business papers, resumes, and grants. Portland State Univ.
- Created and ran drop-in after-school tutoring program; assisted in children's library operations, and tutored children in math, science, and reading. Wilsonville (OR) Public Library.
- Copy Editor. Edited articles and advertisements for daily student-run university newspaper, Portland State *Vanguard*