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UTAH WATER RESEARCH LABORATORY

Logan, Utah



WATER MANAGEMENT: PARTNERSHIPS FOR
FUTURE DIRECTIONS
JULY 1, 2001- JUNE 30, 2003



In its most recent evaluation of the 54 water resources research centers in the United States, the U.S. Department of the Interior, U.S. Geological Survey, declared the Utah Water Research Laboratory to be "... one of the top [water] Centers nationally with a very strong research, education, information transfer, and collaborative (intrastate) program. Extramural, state, and university discretionary support is very strong and commendable. The collaboration of the Center with state agencies and the role that the Center plays in water resource planning in the State exemplifies the kinds of arrangements which the authors of the Water Resources Research Act of 1964 envisioned. This is an exemplary Center in nearly every respect."¹ This evaluation is applicable for the period of July 1999 through June 2004 when the Center will be evaluated again.

¹U.S. Department of the Interior, U.S. Geological Survey, Letter dated October 19, 1999, from Henry J. Vaux, Jr., Evaluation Panel, Water Resources Research Act. Evaluation of the Section 104 Program, Center for Water Resources Research, Utah State University.

UTAH WATER RESEARCH LABORATORY

WATER MANAGEMENT: PARTNERSHIPS FOR FUTURE DIRECTIONS

RESEARCH AND TESTING
EDUCATION SUPPORT
OUTREACH

July 1, 2001- June 30, 2003



Dr. Mac McKee - Interim Director
Dr. Ronald C. Sims - Interim Associate Director

**UTAH STATE UNIVERSITY
COLLEGE OF ENGINEERING
LOGAN, UTAH 84322-8200
<http://www.engineering.usu.edu/uwrl>**

Foreword

The Utah Water Research Laboratory (UWRL) is a stand-alone facility located at Utah State University (USU) on the Logan River, Logan, Utah. The UWRL operates within an academic environment and collaborates with government and private sectors to address technical and societal aspects of water-related issues, including quality, quantity, distribution, and conjunctive use. This is accomplished through providing more than 100,000 square feet of state-of-the-art laboratory, computer facilities, and office space. The research, education, and outreach efforts of the UWRL are currently funded at an annual rate of approximately \$10 million with money obtained from the state and grants and contracts from federal and private sources. The accomplishments of associated faculty, students, staff, and collaborators are reported here in an effort to communicate to audiences external to USU, including clients, financial supporters, future potential supporters, alumni, and the public. The information presented illustrates the role of the UWRL in advancing and integrating water resources, hydraulics, and environmental engineering to improve the decision-making processes that will affect stewardship of water in a regional as well as global context. This report presents the UWRL program, including research, testing, education support, and outreach activities for the period from July 1, 2001 through June 30, 2003.

In the past year, the Utah Water Research Laboratory and Utah State University have seen the beginning of a number of changes with regard to water research and education. The UWRL, along with other water programs on campus, is in a transitional phase that will bring greater opportunities to faculty, staff, and students. At the time of publication of this report, the UWRL administration is in the process of changing, as our former Director, Dr. Ronald C. Sims, moves up to become the Head of the Department of Biological and Irrigation Engineering (BIE) and a search for new UWRL leadership gets underway. Some of the faculty at the UWRL will now have joint appointments in BIE and some will have appointments in the Department of Civil and Environmental Engineering (CEE). Also during the past year the President of USU called for a "Water Initiative" to review research and curriculum in the water area across campus and recommend changes that can produce greater coordination in both. The year just ending saw the creation of the Water Dynamics Laboratory (WDL), housed within the USU Research Foundation. The WDL will market in the private sector the results of applied research done at the UWRL and other units on campus. These changes are creating new opportunities to move water resources research and education into new and needed directions. These changes and this period of transition are reflected in many sections of this report. This year also saw a major fire at the UWRL, which caused substantial damage to the Environmental Quality Laboratory (EQL) wing. As this report goes to press, we have nearly completed our recovery from the fire and we are looking forward to occupying a newly remodeled—and improved—EQL. In much the same way, the UWRL looks forward to new

partnerships—with other departments and colleges at USU, with state and federal water resources agencies, and with private stakeholder groups—and will continue to play a role of leadership in the area of water resources research in the 21st Century.

This report is organized to illustrate the UWRL approach to conducting both fundamental and applied research and testing that supports higher education at the B.S., M.S., Ph.D., and post-doctoral levels. To accomplish this mission, the UWRL forms collaborations with private and government organizations that support UWRL participation through competitive financial awards, in-kind services, personnel exchange, contracts, etc. Typically a team of faculty members directs and coordinates a project in collaboration with the project sponsor. Student involvement takes the forms of graduate student research projects, senior design projects, and laboratory testing, with the majority of involvement at the graduate level. Products of research and testing projects typically include theses, dissertations, professional publications, technologies, patents, posters, presentations at professional meetings, and special reports formatted for clients.

If you are interested in obtaining more information or in sponsoring research or testing, please contact Dr. Mac McKee at mmckee@cc.usu.edu or one of our staff listed in the Current Personnel Listing section of this report. Additional information can also be found at the UWRL web address:

<http://www.engineering.usu.edu/uwrl>

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I. Introduction

The UWRL is uniquely positioned to form collaborations with USU departments, other academic institutions and water centers, government, and private sector organizations involved in addressing water issues. The strong and consistent support of the State of Utah illustrates the importance of water and the creation of knowledge to manage water in Utah and the surrounding western states. The scope of projects ranges from multimillion dollar partnerships related to soil and groundwater remediation with national impacts, to small scale projects related to outreach to a specific city or county public sector audience. The UWRL mission, the strategy used to accomplish the mission, a summary of accomplishments, examples of benefits delivered to the state, and an overview of future directions for the UWRL follow.

Mission Statement

The mission of the Utah Water Research Laboratory includes the following activities that are related to stewardship of water quantity and quality:

- Facilitate research that supports education and teaching within a university environment.
- Conduct research that is directed at solving multimedia water-related problems of state, national, and international scopes.
- Cooperate with academic departments and other academic research units in generating, transmitting, applying, and preserving knowledge in ways that are consistent with the land grant university mission of Utah State University.
- Conduct research that provides for a technically informed water-related policy that can be used to ensure and improve human health and environmental assets in Utah, the United States, and the world.
- Facilitate research, testing, and design activities that involve training university students to provide services to audiences that are external to the university.
- Provide research-based training on water-related subjects to governmental and private organizations and to the general public.

The UWRL Mission Statement is based on the philosophy that activities related to water science and engineering be organized to integrate research, testing, and design components with university and public education. The context for water includes multimedia aspects that incorporate atmosphere and surface and subsurface earth components, and that address environmental as well as public health issues.

Strategy

The strategy utilized by the Utah Water Research Laboratory to accomplish the mission stated above involves a commitment to support the following activities:

- Facilitate state-of-the-art research and testing that encompass multimedia water-related issues addressing state, national, and international challenges.
- Provide research-based academic experiences in water-related topics for undergraduate and graduate university students to enhance their theoretical and practical skills.
- Provide financial assistance for graduate students to facilitate recruitment of excellent students in academic departments.
- Provide an academic environment where water-related problems are addressed through the process of obtaining academic degrees.
- Form partnerships with public and private agencies to pursue important problems that can also be used to help train students.
- Provide outreach services for local, state, national, and international agencies, and for citizens desiring information on water-related issues.
- Provide facilities and services for physical model studies of hydraulic structures related to design, analysis, and field testing.
- Cooperate with the Departments of Civil and Environmental Engineering and Biological and Irrigation Engineering and other academic departments at USU to recruit and retain faculty.
- Work collaborately as engineers with water-related scientists from other colleges and departments to address local, state, national, and international water problems.

Accomplishments

Accomplishments of the UWRL can be measured in part through its research products, the academic training to which it has contributed, and the outreach programs it supports. Its research products include research projects, dollars brought into USU for support of research and educational opportunities, and publications generated by its faculty to convey the benefits of research to potential users (see Section VII for listings of projects awarded, and Section VIII for publications).

The UWRL provides financial support to graduate students and research opportunities to undergraduate students as they work toward completion of their education. Fellowship award amounts vary, with the average at approximately \$12,000 per year for M.S. students and \$15,000 for Ph.D. students. Senior students in Civil and Environmental Engineering often provide technical services to private industry and local and state government agencies as a part of their required senior design project.

In addition to refereed journal publications, projects supported through the UWRL provide outreach information in the form of short courses, field training, newsletters, brochures, and videos.

The following table provides a numerical summary of the accomplishments of the UWRL for 2002 and 2003 in the areas of research, academic training facilitated, and outreach:

Activity	2002	2003
Research Products		
Number of Projects Awarded	41	33
Dollar Value (\$ Millions)	4.1	1.8
Publications (Refereed)	11	N/A
Academic Training Facilitated		
Number Research Fellowship Awards	64	69
Senior Design Projects (Number Students)	4	11
Number Graduate Students (CEE Dept.)	12	23
Number Undergraduate Students Supported	43	76
Outreach Products		
Short Courses and Field Training	25	17
Newsletters, Brochures, Videos	5	6

Benefits to the State of Utah

Research conducted by the UWRL benefits the citizens of the State of Utah in numerous ways. Current projects at the UWRL are found in every county of the state. Examples of current, past, and expected future benefits provided by the UWRL are:

- The UWRL is currently working with the Utah Department of Environmental Quality (UDEQ), Drinking Water Division, to address national regulations and requirements regarding Source Water Protection Plans in Utah. The assistance includes the development of new tools and methods for source water assessment of the risk of contamination of surface water supplies in Utah. This is especially important under drought conditions as they currently exist in Utah.
- On-site wastewater treatment training and technology transfer for State of Utah personnel in the Utah Department of Environmental Quality (UDEQ) and local health departments continued in FY 2002-2003. Undergraduate and graduate students participate through projects that involve hands-on, real-world activities. Utah health department staff and other Utah On-Site Wastewater Treatment professionals were trained in site characterization, treatment, and monitoring on-site systems and source water protection aspects of on-site systems. Additional information can be found at the UWRL web site: <http://www.engineering.usu.edu/uwrl/training>.
- A Utah on-site professional association was initiated in FY 2000 to provide a forum for on-site stakeholders to address problems and to identify on-site challenges and solutions within a professional organization. The professional association (Utah On-Site Wastewater Association [UOWA]) continued to grow in FY 2003 and to involve Utah businesses, citizens, local elected officials, and regulators in addressing on-site systems in Utah.
- UWRL faculty are currently assisting UDEQ personnel in the evaluation of state needs regarding Total Maximum Daily Loads (TMDLs) for Utah's lakes, rivers, and streams, and the impacts of proposed land use changes on water quality.
- Results of our laboratory investigations continue to provide cost-saving methods for improving the performance and safety of dams and of dam spillways in Utah, and can be expected to play an important role in future dam safety rehabilitation in the state. In addition, UWRL

faculty and staff continue to develop procedures that consider risks associated with the performance of dams. In FY 2003, we have been requested to assist the State of Utah to develop a plan and methods of management to minimize sediment release from dams during draw-down events. The UWRL has received U.S. EPA funding to assist the state.

- UWRL faculty serve on state and local advisory panels as part of our outreach and service activities, including the Utah Drinking Water Board (Dr. Laurie McNeill), Utah Water Quality Board (Dr. Ronald C. Sims), the Utah Solid and Hazardous Waste Board (Dr. William J. Doucette), Lake Powell Technical Advisory Committee (Dr. Darwin L. Sorensen), Salt Lake County Solid Waste Management Council (Dr. R. Ryan Dupont), and the Utah On-Site Wastewater Association (UOWA) (Dr. Ronald C. Sims, Ms. Judith L. Sims, and Dr. Darwin L. Sorensen).
- A geographic information system (GIS) approach is under current development by UWRL faculty to improve statewide water use estimations to forecast future water needs.
- Real-time management of irrigation systems in the Sevier River Basin is being implemented using computer (artificial neural network) models to increase the efficiency of basin-wide water management. This is especially useful when the total quantity of water decreases as in the current drought in Utah.
- Computer models for managing the quality of streamflows and improving the operational efficiency of Weber Basin water treatment plants continue to be developed and are expected to be transferable to other river systems in Utah.
- UWRL faculty are currently involved in improving drinking water treatment and plant performance in Utah with regard to coagulation and arsenic removal processes. We are also working closely with the Utah Water Quality Alliance through Dr. Laurie McNeill.
- Monitoring of fish populations within the Sevier River drainage is a cooperative project with the State of Utah Division of Wildlife Resources and the Sevier River Bridge Canal Company to guide long-term water allocation and enhancement of native fish in the Sevier River Basin. Similar assistance is being provided for the Virgin River Basin.



Future Directions

Water Problems in the Future: The relative scarcity of water is growing due to population and economic growth, pollution, and diversification of the types of demands that humans place on the available water resource (e.g., water quality maintenance, endangered species protection). With increasing scarcity comes a greater need to more intensively manage the resource and a widening interest on the part of an ever more diverse set of stakeholders to have a seat at the water resources decision-making table. These things—a need for more intensive management and a diversifying decision-making public—require that we be able to generate and deliver better information about the current and future states—both quantity and quality—of our water resources.

Paramount among water quality maintenance and improvement management issues is crafting the policy and regulations necessary to protect the quality of drinking water sources. Should managers of drinking water supply watersheds have authority to prohibit certain activities in these watersheds when current water quality is substantially better than drinking water source criteria? Improvements in measurement technology and mathematical models of pollutant transport are needed to allow improved accuracy of risk assessments for current or proposed future land uses in environmentally sensitive watersheds. With better risk assessments the uncertainty in setting policy and making decisions that affect property values, recreational opportunities, and ecosystem protection can be reduced to levels more acceptable to a broader spectrum of stakeholders.

In spite of an increasing need for better, more decision-relevant information about our water resources systems, investments in traditional water resources data collection (e.g., point stream flows, snow pack, soil moisture, water quality, etc.) is declining at the federal and state levels, making it more difficult each year to meet this information need. However, investments in new data collection methods are increasing—such as satellite imagery of land cover, snow cover, ocean surface temperatures, etc.; radar estimation of precipitation, aircraft and satellite imagery for estimation of evapotranspiration—that might be used to back-fill the decline in the availability of traditional data.

Research is needed to develop the data that are now becoming available from emerging remote sensing sources into useful information for all temporal and geographical scales of water resources management. Further, the products of this research must be of practical use to the water resources managers who are now losing access to traditional data sources; they must also be of use to a wider range of stakeholders who have heterogeneous technical backgrounds and skill levels, but who are now demanding a role in water resources decision-making.

The faculty, staff, and resources of the UWRL, in coordination with water scientists across campus, are well-suited to respond to these new research needs and emerging water resources problems.

Strengthening Ties Across Campus: The past academic year has brought significant changes to water research and education at USU. Reorganization of the Departments of Biological and Irrigation Engineering and Civil and Environmental Engineering has created opportunities for the UWRL to work more closely with the faculty of both departments. The integration of the UWRL into both departments has expanded the areas of water resources research that can be addressed at USU and has strengthened the ability to address large-scale and complex land/water systems that include irrigation components. In the future, the faculty and staff of the UWRL will work more closely with the Biological and Irrigation Department (see Figure 1) to identify and pursue research opportunities of common interest. In addition, the changing nature of water resources problems in the state, the nation, and around the world, coupled with advances in modern technology, have prompted researchers at the UWRL to seek collaboration with faculty from other departments within the College, especially with the Departments of Electrical and Computer Engineering and Mechanical and Aerospace Engineering. The “Water Initiative” promulgated by President Hall in the past year has provided a forum for water researchers from all across campus to come together and begin to address common curriculum problems and identify opportunities for collaborative, interdisciplinary research on water issues. In coordination with the USU Research Foundation, the “Water Dynamics Laboratory” (WDL) was founded this year at USU to market the products of water research in the private sector. Working relationships between the UWRL and the WDL have already been established. The faculty and staff at the UWRL have welcomed the opportunity to participate in the broadening of research and educational efforts in the water sector and look forward to establishing the strong, interdisciplinary partnerships that will be needed to address the newly emerging water resources research problems that confront Utah, the nation, and the world.

Strengthening Partnerships for the Future: The water problems of the future are complex and their solution will require the development and application of new sets of tools. Water managers at all levels of government will require education and training in order to grapple with these new problems and take advantage of the new tools that will be developed to deal with them. The UWRL is well-positioned to provide the basic and applied research capabilities that will be needed to support water managers and stakeholder groups at local, state, national, and international levels. The faculty and staff at the UWRL are committed to strengthening our ties with resources management agencies at all levels, to listening to them and their stakeholders as they articulate their concerns about water management problems, and to working with them to find ways to solve those problems. The UWRL will provide facilities and financial support to university students to become water resource engineers and specialists and, through research-based training in new water challenges, will provide the future leaders of water management in Utah, the United States, and the world.

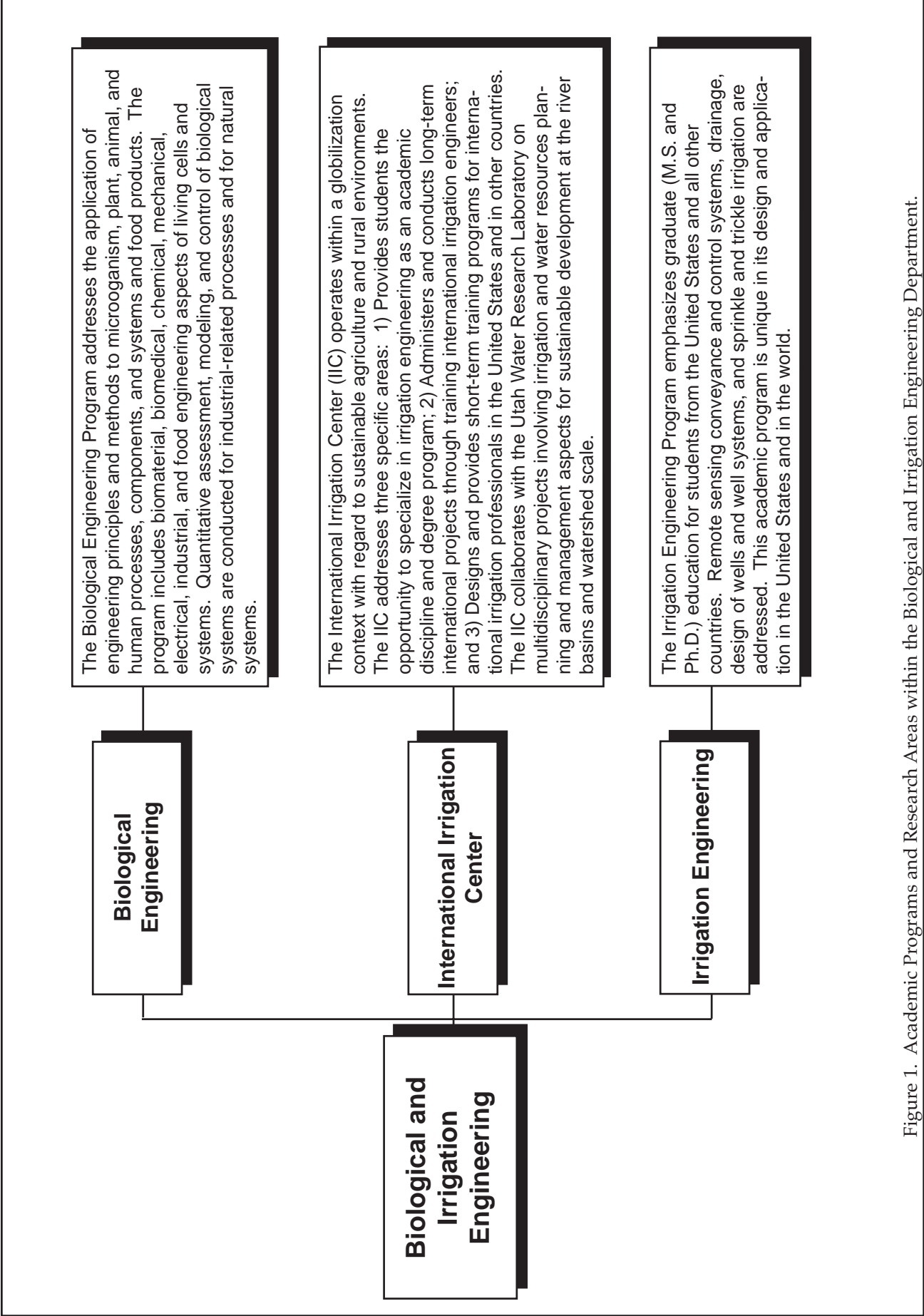


Figure 1. Academic Programs and Research Areas within the Biological and Irrigation Engineering Department.

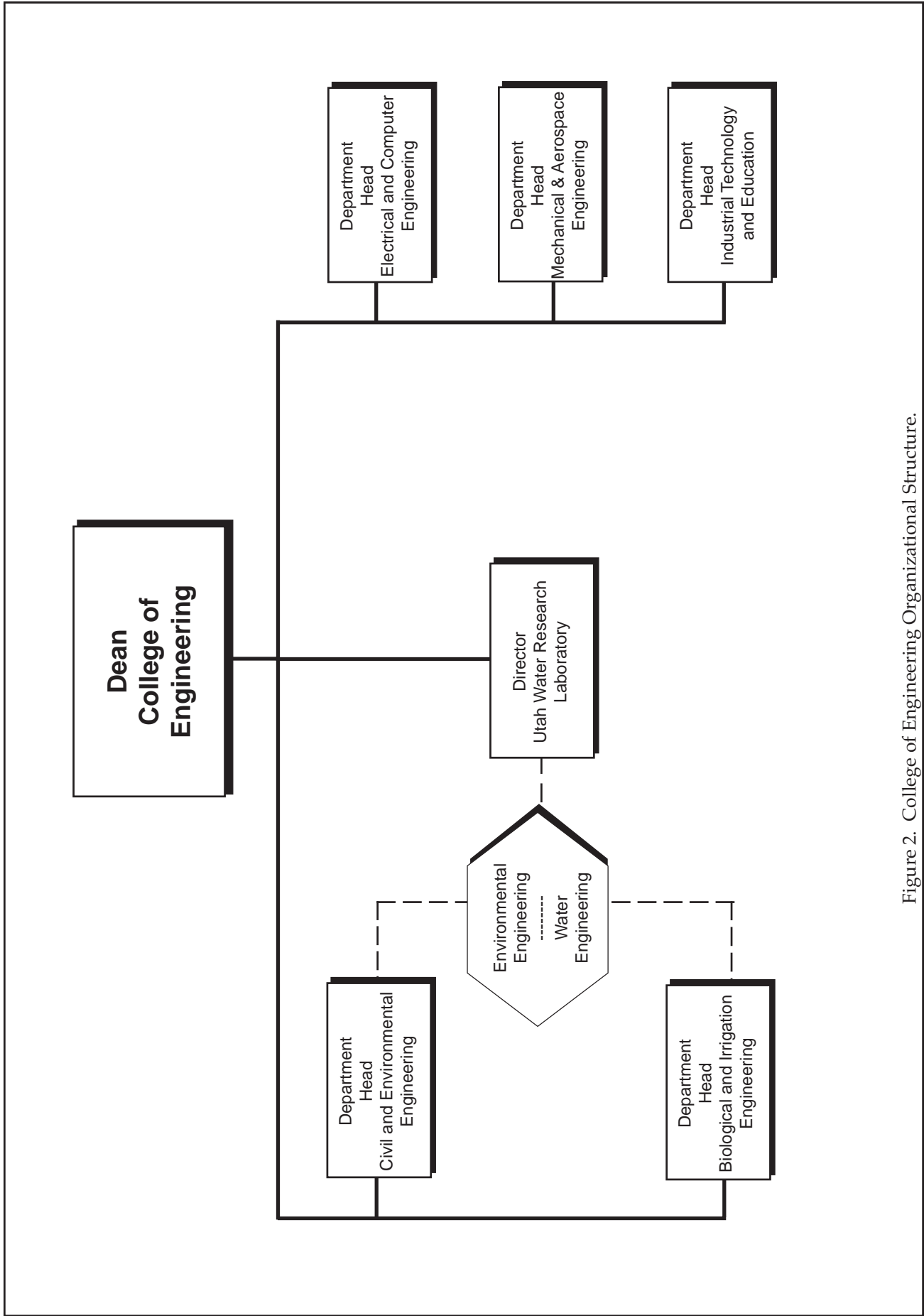


Figure 2. College of Engineering Organizational Structure.

II. Background

In the early 1950's, Utah State University (USU) faculty and administrators began planning for an integrated facility for interdisciplinary water resources research. In 1959, the Utah State Legislature authorized the establishment of the Utah Water Research Laboratory (UWRL). Funding for the original structure was provided by the Utah Legislature, with supplemental funding from the National Science Foundation (NSF) and the National Institutes of Health. The building was dedicated in 1965, and faculty from a wide range of academic departments began using the facility. By 1975, the research program had outgrown the facility. The Environmental Quality Laboratory was housed in makeshift construction behind the Hydraulics Laboratory, and office space was scarce. Additional funding was obtained from the Utah State Legislature, and, in 1980, the present UWRL building was completed.

UWRL's first director was Dr. Vaughn E. Hansen (1964 to 1966). He was replaced by Dr. Jay M. Bagley who served until 1976. Dr. L. Douglas James was director from 1976 to 1991. Dr. David S. Bowles, after serving as Acting Director, was appointed Director in 1992 and stepped down in 1996. Dr. Ronald C. Sims served as UWRL Director from 1996 to 2003. Currently, Dr. Mac McKee is the Interim Director.

The UWRL also houses the Utah Center for Water Resources Research (UCWRR), the second largest of 54 U.S. centers. The Center administers the U.S. Geological Survey 104 funding program, performs coordinating roles for water research in Utah, and represents the State of Utah at regional and national levels. Today, multidisciplinary faculty work together in Environmental Engineering, Groundwater, Fluid Mechanics and Hydraulics, Hydrology, Natural Systems Engineering, Water Education, and Water Resources Management to support the mission of the UWRL.

The UWRL is one of six units comprising the College of Engineering, under the leadership of Dean H. Scott Hinton with the other five units organized as academic departments (see Figure 2). Faculty are organized within the UWRL into the Water Engineering Division and the Environmental Engineering Division. The Water Engineering Division is affiliated with the Department of Civil and Environmental Engineering (CEE), and the Environmental Division is affiliated with both the CEE Department and the Department of Biological and Irrigation Engineering (BIE). The UWRL Director works closely with the Heads of the CEE and BIE Departments and the Division Heads to coordinate academic coursework and UWRL programs. Faculty members within the two divisions typically have joint appointments at the UWRL and in either CEE or BIE, and students also work in both units. This coordination allows for a larger and more diverse educational environment for undergraduate and graduate students. The collaboration of the UWRL and the academic departments within the College of Engineering facilitates an integration of coursework, faculty skills, and hands-on research, testing, and training in water engineering and science that is unique in the United States.

The UWRL also collaborates with other academic and research units at USU and at other universities in Utah as well as outside of Utah. Examples of projects and partnerships that illustrate these types of collaboration are provided on the UWRL web address: <http://www.engineering.usu.edu/uwrl>.

Administration, Structure, and Function



Dr. Mac McKee

Administration

The administration and organization of the UWRL are shown in Figure 3. Dr. Mac McKee is the UWRL Interim Director. He is assisted by Dr. Ronald C. Sims, Interim Associate Director. The research program at the UWRL is coordinated primarily with the academic programs in the two divisions of the CEE and BIE Departments, as described previously. Dr. R. Ryan Dupont is Environmental Engineering Head (Figure 4), and Dr. Jagath J. Kaluarachchi is Water Engineering Head (Figure 5). Our International Program involves collaboration with developing and developed nations, and involves faculty and students in both the Environmental Engineering and the Water Engineering Divisions. Support areas include: Administrative Services and Infrastructure, supervised by Ms. Jan Urroz; Publications and Information Dissemination, coordinated by Ms. Ivonne Harris; and the Business Office, supervised by Ms. Tamara Peterson. In addition, the Environmental Quality Laboratory is managed by Ms. Joan McLean, and the Hydraulics Laboratory is managed by Dr. William J. Rahmeyer.

Water-related centers at the UWRL add depth and enhance the overall UWRL program. These include: Environmental Management Research Program (EMRP) co-directed by UWRL research engineers Dr. Daniel P. Ames, Ms. Bethany Neilson, and Mr. Jeffery Horsburgh; Institute for Dam Safety Risk Management (IDSRM) headed by Dr. David S. Bowles; Institute for Natural Systems Engineering (INSE) headed by Dr. Thomas Hardy; International Irrigation Center (IIC) managed by Dr. Humberto Yap-Salinas; the International Office for Water and Science Education (IOWSE) managed by Mr. Geoffrey G. Smith; the Utah Center for Water Resources Research (UCWRR) headed by Dr. Mac McKee; the Utah On-Site Wastewater Treatment Training Program coordinated by Ms. Judith L. Sims, and the Water Dynamics Laboratory (WDL) managed by Dr. Richard Peralta.



Dr. Ronald C. Sims

Expertise originating within the two UWRL divisions and eight centers in the areas of water resources, hydraulics, and environmental quality is integrated for addressing current challenges with regard to ecological engineering, water and environmental stewardship, and risk management. Subprograms within the Environmental Engineering Division that link environmental quality with current challenges are described in Figure 6. Subprograms within the Water Engineering Division that link water resources and hydraulics with current challenges are described in Figure 7. Specific research and testing projects are directed at addressing water-related needs that are supported by a mix of institutions, clients, and UWRL staff through cooperative and collaborative efforts. Specific projects identified in Section VII demonstrate that applications address issues at local, state, regional, and global scales. UWRL physical facilities and staff technical capabilities provide strong leveraging of all projects. In addition, the organization and management of all research and testing projects at the UWRL serve to support the academic programs at undergraduate and graduate levels. The following sections of this report provide more details about the UWRL divisions and its affiliated centers.

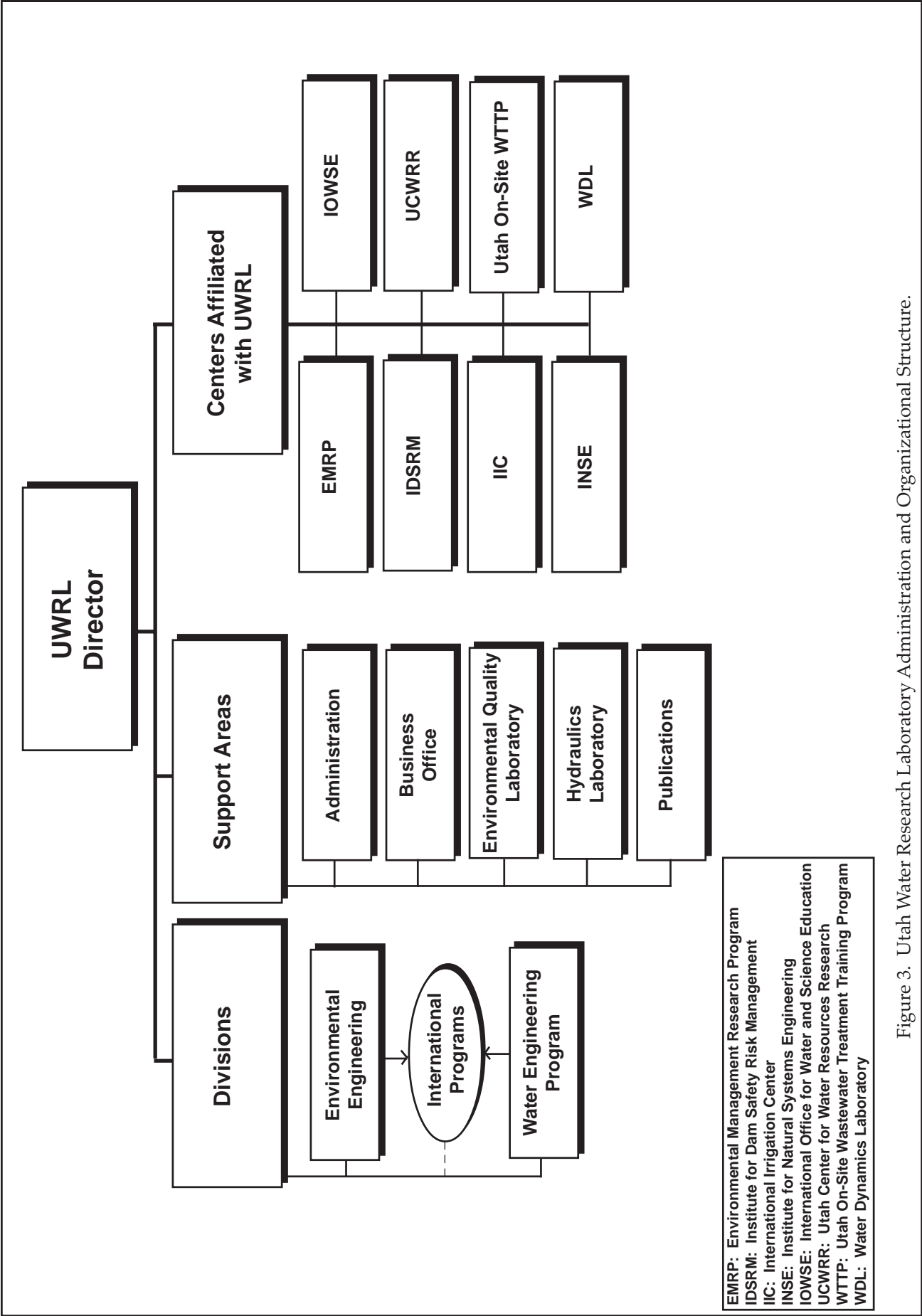


Figure 3. Utah Water Research Laboratory Administration and Organizational Structure.

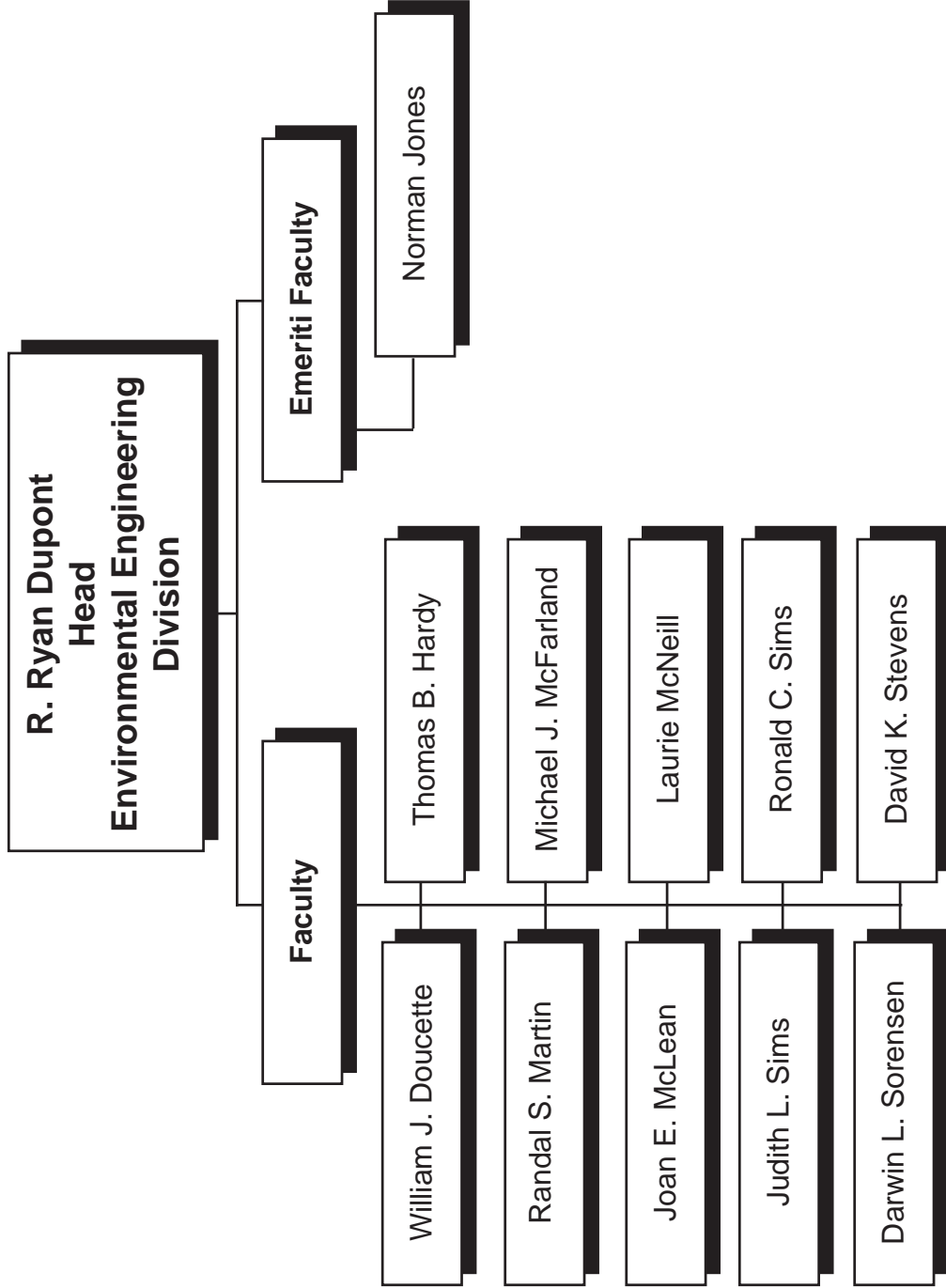


Figure 4. Utah Water Research Laboratory Environmental Engineering Division Organizational Structure.

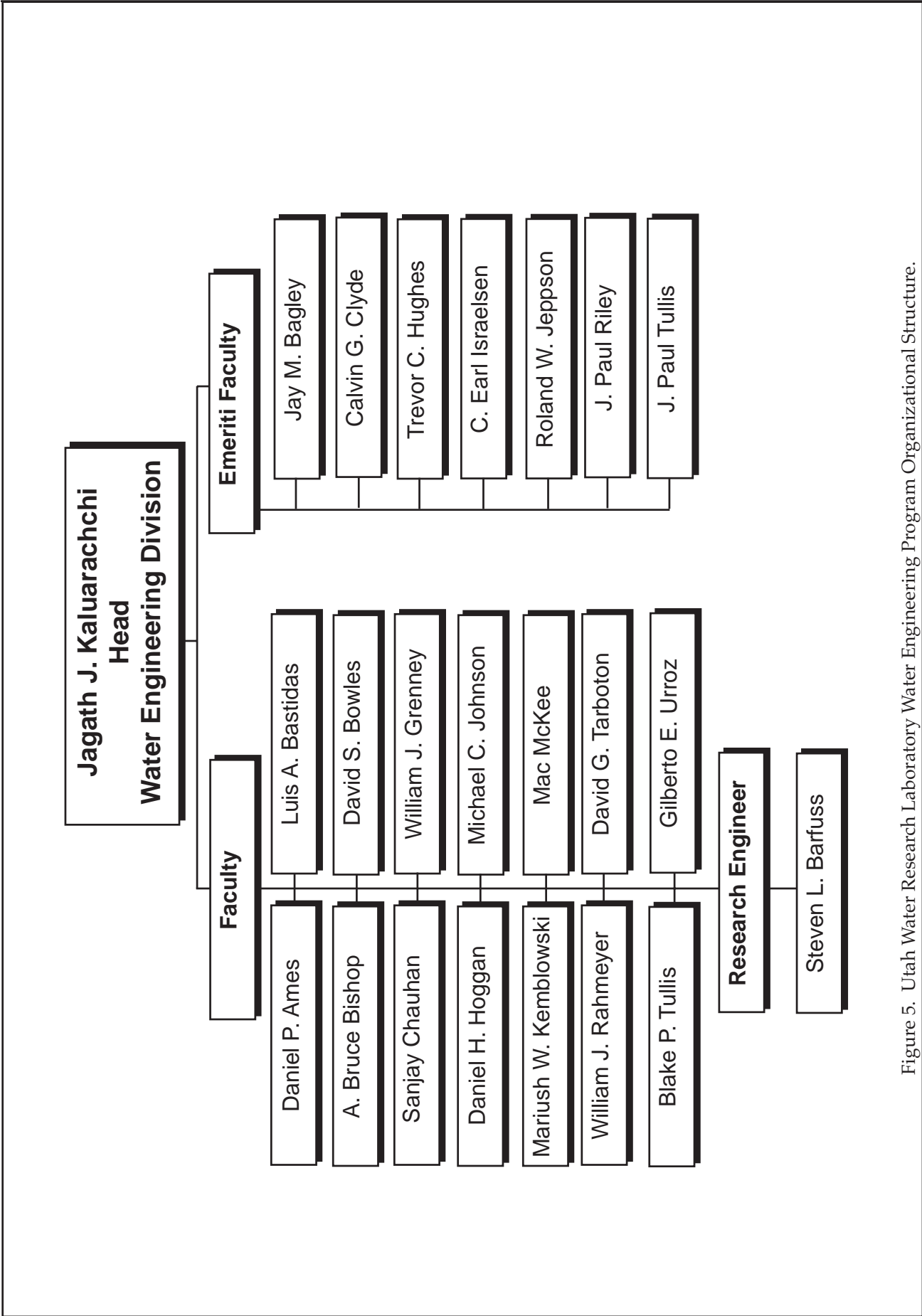


Figure 5. Utah Water Research Laboratory Water Engineering Program Organizational Structure.



Dr. R. Ryan Dupont

Environmental Engineering Division

Faculty within the Environmental Engineering Division are indicated in Figure 4. These faculty have joint appointments with the UWRL and with the Civil and Environmental Engineering (CEE) and Biological and Irrigation Engineering (BIE) Departments within the College of Engineering. The Environmental Engineering Division has focused research programs in Hazardous and Toxic Waste Management, Bioprocess Engineering, Geoenvironmental Engineering, Management of Air Quality Impacts, Water Treatment Science, and Natural Systems Engineering. A multimedia thrust within each program is carried out by a multidisciplinary group of engineers and scientists conducting basic and applied laboratory and field research in such areas as: fate and transport of toxic and hazardous contaminants in plant, soil and surface / groundwater environments; performance evaluation and design of biological and plant-based hazardous waste remediation systems; modeling and measurement of basin-scale water quality and ecosystem impacts of water resources and basin development; water and wastewater treatment; behavior and treatment of toxic metals in drinking water; infrastructure degradation; airborne particulates and visibility impacts; and natural systems physical habitat simulation modeling. The Environmental Quality Laboratory supports the experimental research program within the Division. Research in environmental engineering conducted at the UWRL is supported by a variety of funding sources including the State of Utah, industry, U.S. Environmental Protection Agency (USEPA), U.S. Geological Survey (USGS), National Science Foundation (NSF), Department of Defense (DoD), Department of Energy (DoE), and other federal agencies, consulting firms, and other private organizations.

Courses offered for academic credit in Environmental Engineering at the undergraduate and graduate level are listed in Section IV "Education Support." Information is provided that includes course title, instructor, and CEE course number.

For additional information on the undergraduate and graduate academic degree programs in environmental engineering, please contact Dr. R. Ryan Dupont at: rdupo@cc.usu.edu.

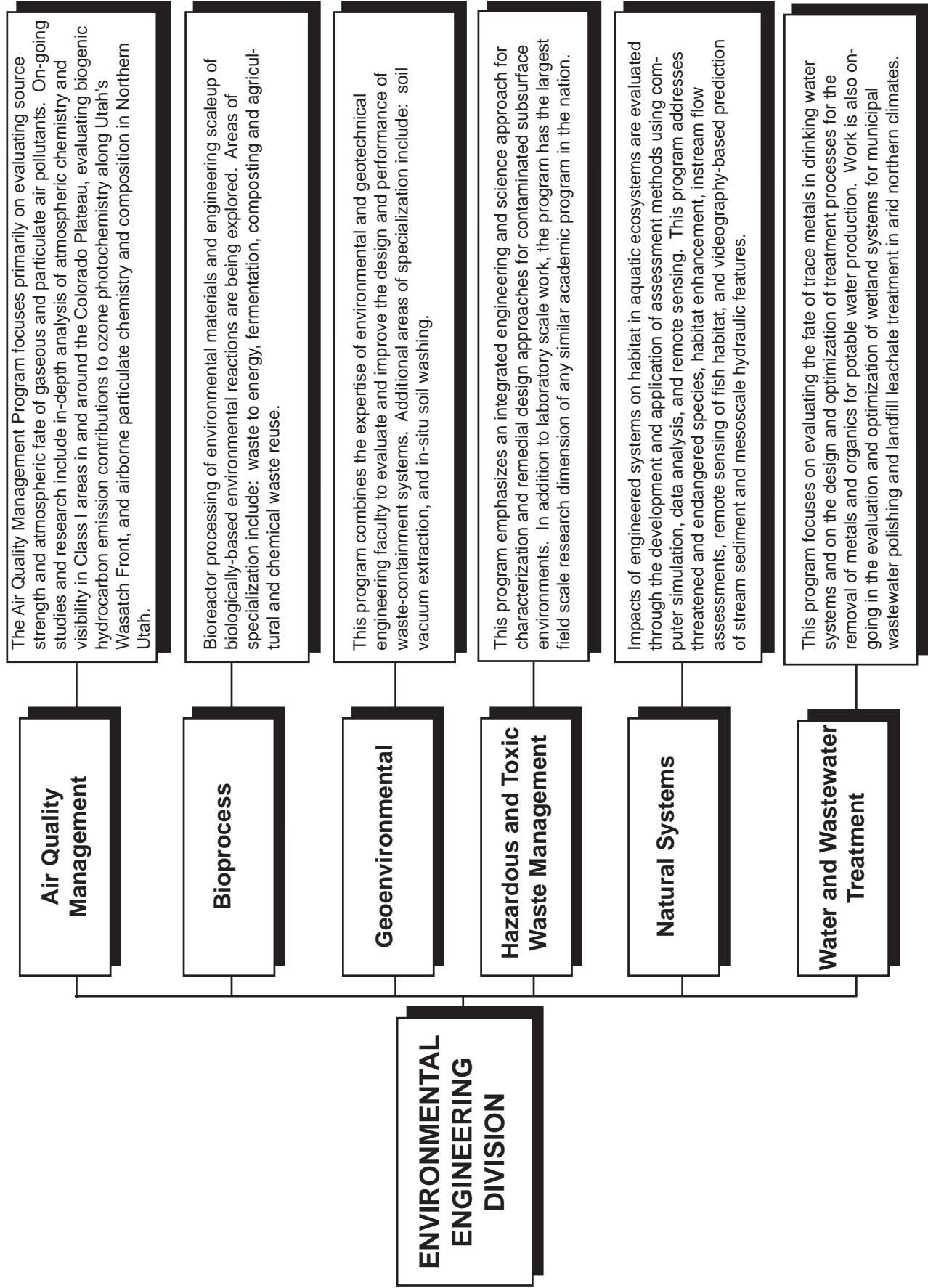


Figure 6. Environmental Engineering Division Subprograms.



Dr. Jagath J. Kaluarachchi

Water Engineering Program

Faculty within the Water Engineering Program are indicated in Figure 5. These faculty have joint appointments with the UWRL and with the Civil and Environmental Engineering (CEE) Department. The Water Engineering Program is supported by state and federal research funds. Speciality areas within the program include: Fluid Mechanics and Hydraulics, Groundwater, Hydrology, Water Resources Planning and Management, and Ecohydraulics. The academic curriculum supporting research is one of the most comprehensive offered in the U.S. Elements of ongoing research projects are routinely and effectively incorporated into the classes. The program combines research, training, and experience to understand the water issues and water resources management challenges in Utah, the United States, and the world.

Fluid mechanics, based on fundamental principles of conservation of mass, energy, and momentum, is the logical core for all water-related engineering research programs. Hydrology is a branch of geoscience concerned with the origin, distribution, movement, and properties of waters of the earth. The hydrology program at USU has strength in both theoretical and applied aspects of modern hydrology. A particular emphasis of the program is on spatial representation of hydrologic processes using geographic information systems. Groundwater engineering is concerned with the transport of fluids in the subsurface environment. Current research activities cover a well-balanced variety of topics, from theoretical (e.g., stochastic analysis of transport of contaminants in groundwater) to practical problems (e.g., design of cleanup technologies for gasoline-contaminated sites). Water resources engineers need a sound understanding of how water storage, delivery, and other management systems function. A focus area of the research program is to develop decision-support systems for sustainable water quantity and quality management in the United States and in developing regions of the world. Other areas include real time reservoir flood operations and dam safety risk management. Ecohydraulics focuses on multidisciplinary studies involving legal, institutional policy, and technical assessment frameworks for the integration of hydrology, operations modeling, water quality, channel maintenance, and fish habitat requirements in the determination of instream flows in water resource systems.

Courses offered for academic credit, including undergraduate and graduate, in Water Engineering are listed in Section IV, "Education Support."

For additional information on the academic graduate program, as well as undergraduate courses in water engineering, please contact Dr. Jagath J. Kaluarachchi at: jkalu@cc.usu.edu.

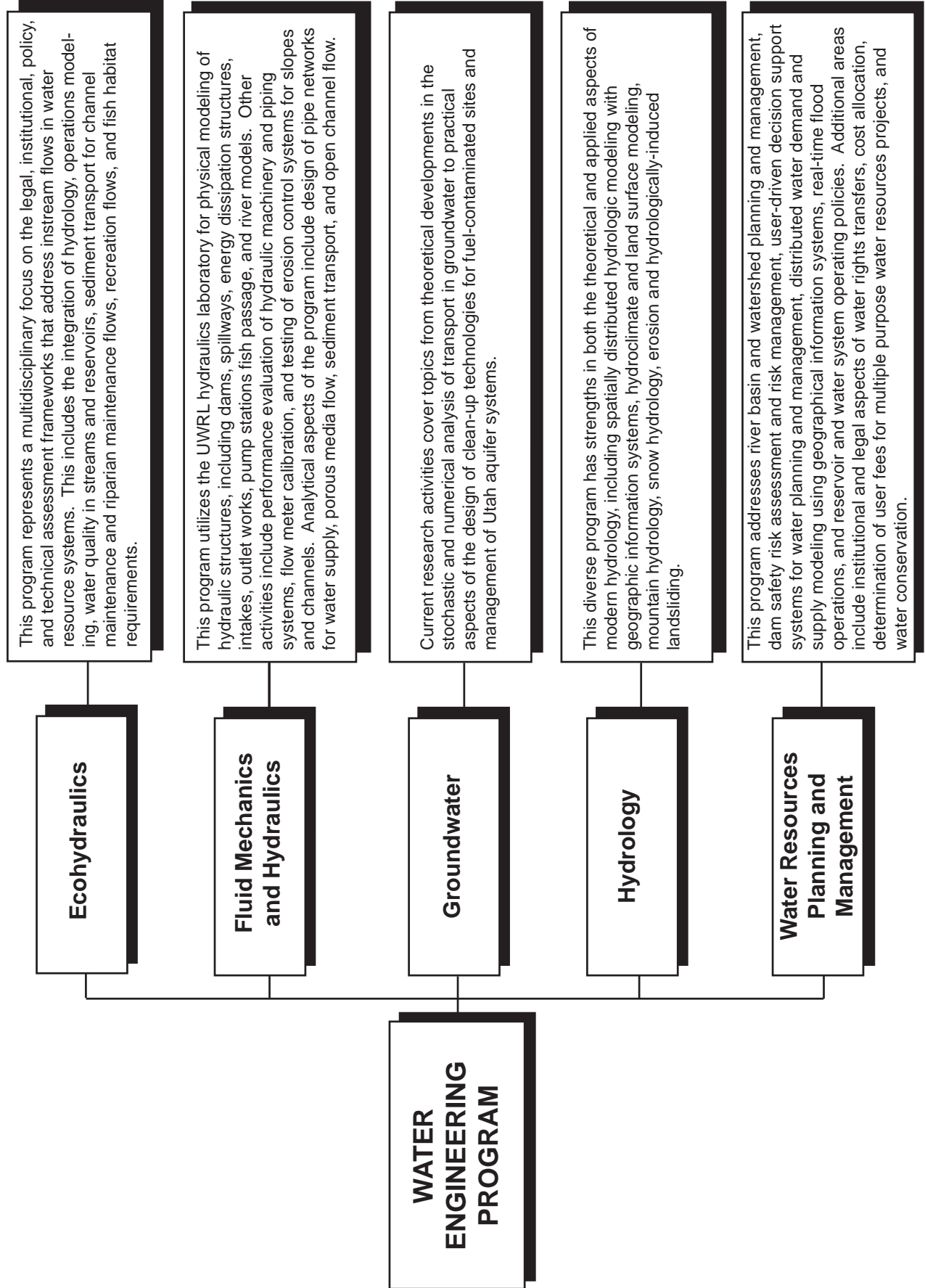


Figure 7. Water Engineering Program Subprograms.

International Program

Throughout its history, the UWRL has actively provided technical expertise and training services related to international water resources and environmental problems. UWRL personnel have implemented several major technical assistance and training projects and numerous smaller projects in water resources, with funding from the World Bank, the Inter-American Development Bank, the Asian Development Bank, the U.S. Agency for International Development, FAO, the OAS, and various countries. The result is substantial improvements in the efficiency of water management, maintenance or improvement of water quality, implementation of integrated water resources planning and development policies, increased well-being of water users, and improvement of public health conditions in many developing countries.

A long tradition of interdisciplinary collaboration with other USU colleges is a major strength of UWRL international programs. Almost all international projects have required faculty from different colleges to work together. As a result, the UWRL has a significant number of associated faculty who are experienced in working on problems as a team, which greatly enhances the capability of the UWRL to quickly and successfully implement international projects. The UWRL can provide senior faculty, all with many years of international experience in the water sector, from Civil and Environmental Engineering, Irrigation Engineering, Economics, Sociology, Political Science, and other disciplines as necessary.

The UWRL, working in cooperation with the Departments of Civil and Environmental Engineering and Biological and Irrigation Engineering, actively recruits international students for educational opportunities in graduate programs in environmental engineering, hydrology, water resources, and hydraulics. At present, international students comprise approximately three-quarters of the graduate enrollment in these programs.

For additional information on UWRL international projects in the water sector or water-related graduate programs, please contact Dr. Mac McKee at: mmckee@cc.usu.edu.

Reclamation of contaminated sediments taken from navigation canals in The Netherlands. The process utilizes silvaculture techniques to grow trees as an energy source.

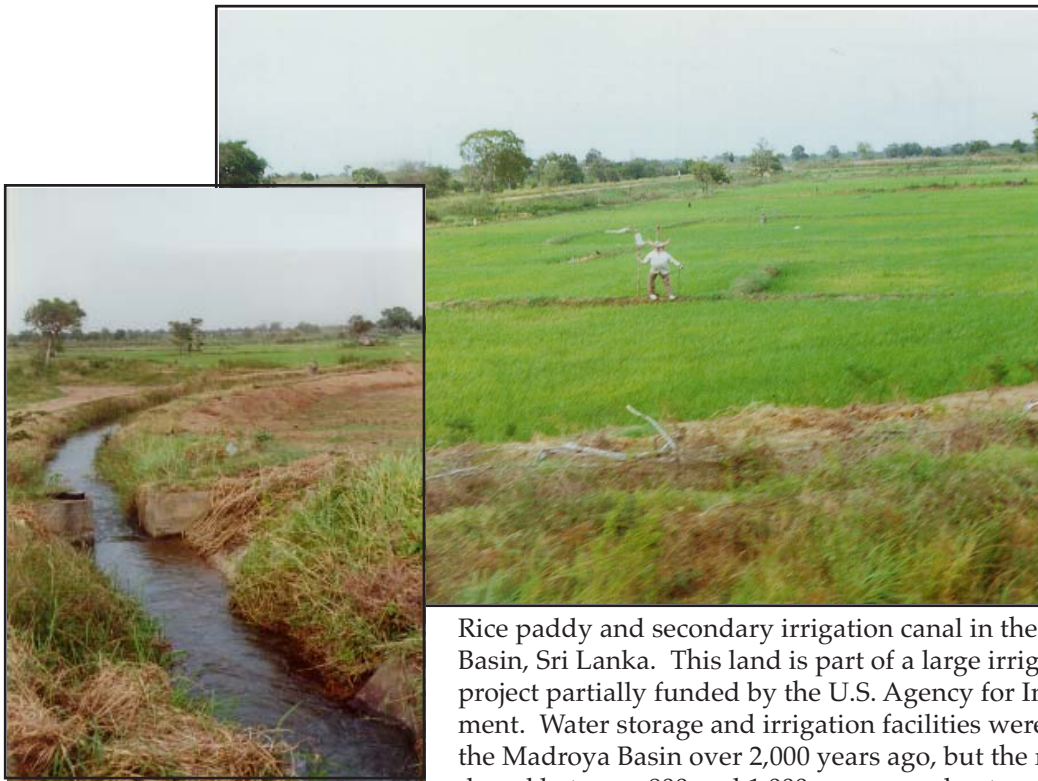


Alterra Green World Research Center is associated with Wageningen University, The Netherlands. UWRL and BIE faculty worked at Alterra in 2002 to develop research collaborations and to learn about approaches to water quality management, agriculture sustainability, and sediment restoration and reuse.



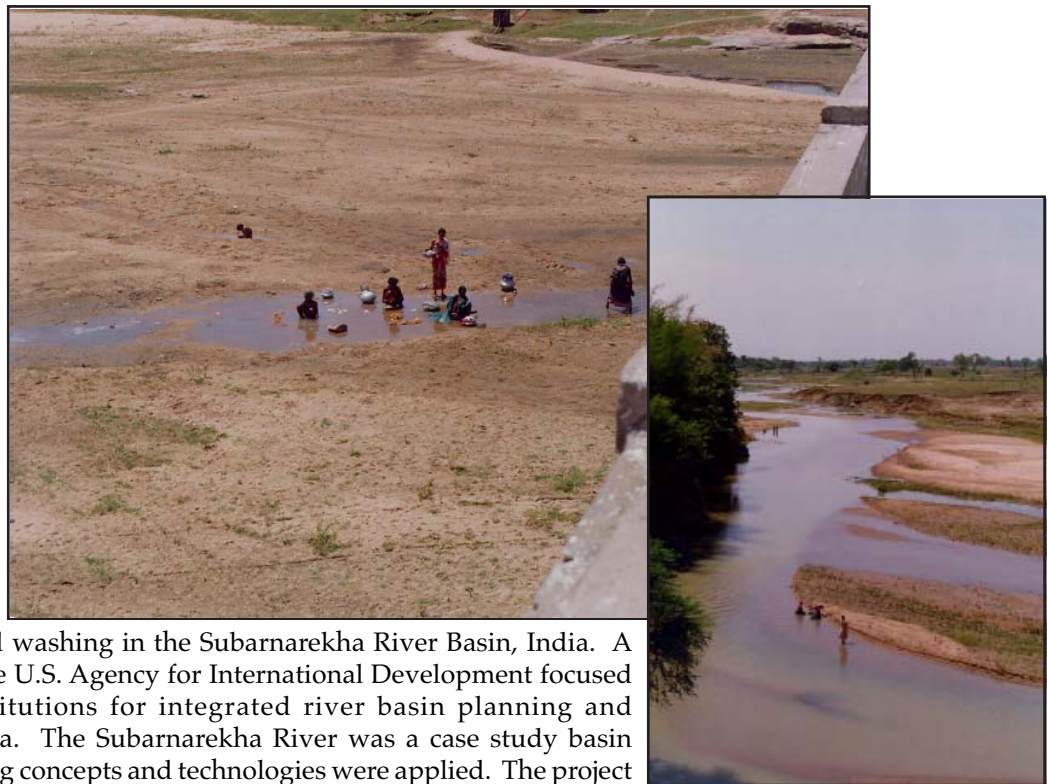
UWRL and BIE faculty worked in collaboration with Alterra Research Center, The Netherlands, and the Republic of Tatarstan, Russia, to develop methods to protect human health and the environment of the City of Nizhnekamsk, the third largest city in Tatarstan and 950 km east of Moscow. The Kama River at Nizhnekamsk is shown in the photograph.





Rice paddy and secondary irrigation canal in the Madroya River Basin, Sri Lanka. This land is part of a large irrigation and drainage project partially funded by the U.S. Agency for International Development. Water storage and irrigation facilities were widely developed in the Madroya Basin over 2,000 years ago, but the region was abandoned between 800 and 1,000 years ago due to military conflict.

Modern irrigation facilities are almost identical in size and location to those that were constructed two millennia ago. The paddy field shown—which lay in jungle since it was abandoned long ago—is the first crop of rice to be grown in the region in nearly 1,000 years.

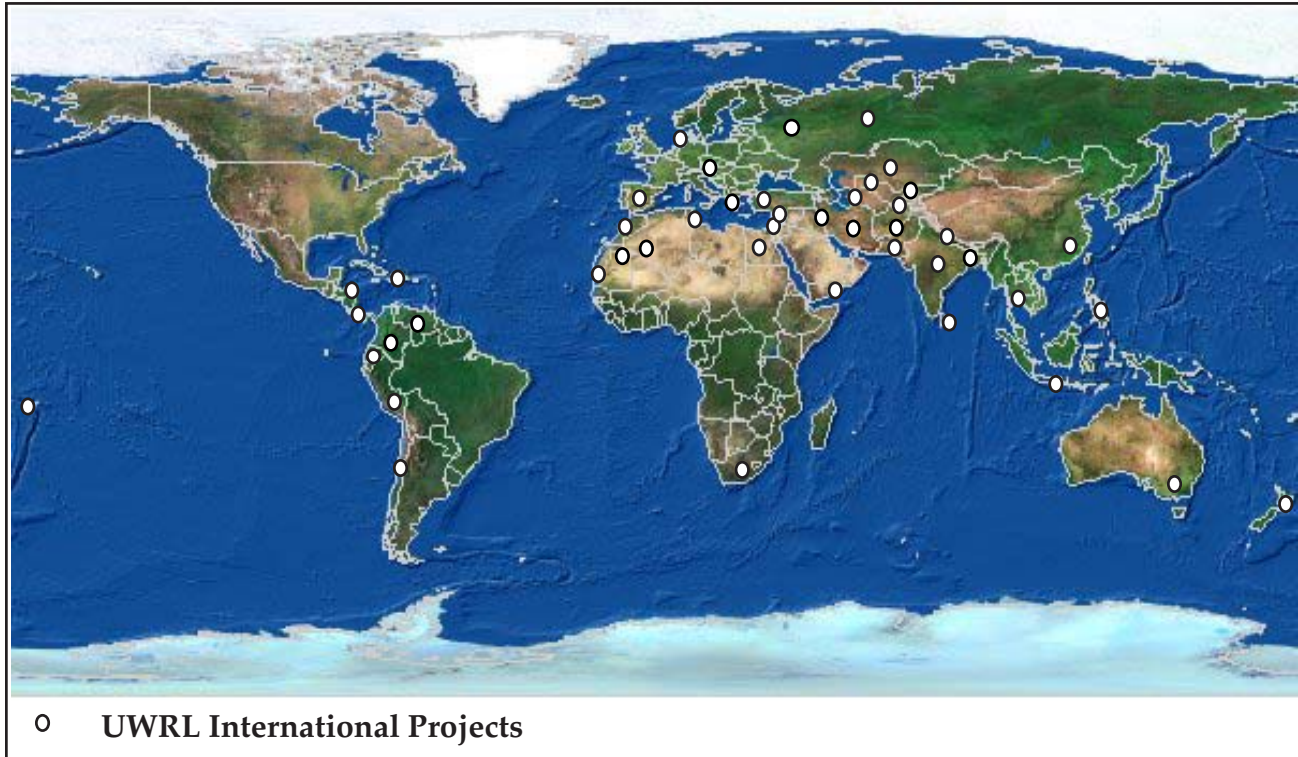


Families bathing and washing in the Subarnarekha River Basin, India. A project funded by the U.S. Agency for International Development focused on developing institutions for integrated river basin planning and management in India. The Subarnarekha River was a case study basin wherein new planning concepts and technologies were applied. The project showed how changes in the operation of aquifers and surface water reservoirs could provide an increase in agricultural production in the basin of about 20 percent, improve deliveries to municipal and industrial users, while at the same time substantially reducing severe water quality problems in the Subarnarekha.



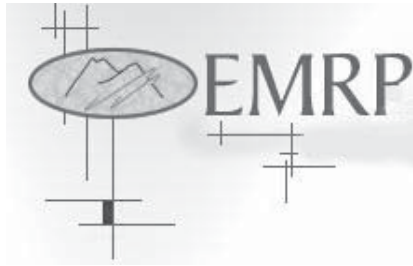
The pump house that provides municipal water supplies from the spring of Ein Sultan to the city of Jericho, West Bank, Occupied Palestinian Territories. Under the Israeli military occupation, Palestinian access to water supplies has been seriously curtailed since 1967, and Palestinians have been severely limited in their ability to maintain water supply systems. A project funded by the US Agency for International Development under the auspices of the Oslo II peace accords sought to find ways to increase Palestinian water supplies. Because of the dependable flow of water provided by Ein Sultan, Jericho is the oldest city on the planet, having been more-or-less continuously occupied for about 9,000 years.

Personnel from the UWRL have worked on water resources projects and training programs in more than 40 countries throughout the world.



- | | |
|------------------------|---------------------------|
| 1. Afghanistan | 24. Netherlands |
| 2. Albania | 25. New Zealand |
| 3. Australia | 26. Nicaragua |
| 4. Bangladesh | 27. Pakistan |
| 5. Chile | 28. Palestine |
| 6. China | 29. Peru |
| 7. Colombia | 30. Philippines |
| 8. Costa Rica | 31. Republic of Tatarstan |
| 9. Czech Republic | 32. Russia |
| 10. Dominican Republic | 33. Samoa |
| 11. Ecuador | 34. Senegal |
| 12. Egypt | 35. South Africa |
| 13. India | 36. Spain |
| 14. Indonesia | 37. Sri Lanka |
| 15. Iran | 38. Tajikistan |
| 16. Iraq | 39. Thailand |
| 17. Jordan | 40. Tunisia |
| 18. Kazakhstan | 41. Turkey |
| 19. Kyrgyzstan | 42. Turkmenistan |
| 20. Mali | 43. Uzbekistan |
| 21. Mauritania | 44. Venezuela |
| 22. Morocco | 45. Yemen |
| 23. Nepal | |

Centers Affiliated with the Utah Water Research Laboratory



Environmental Management Research Program

The Environmental Management Research Program (EMRP) is a research unit of the Utah Water Research Laboratory (UWRL) focused on integrated watershed management and systems analysis of environmental problems. Founded in 1998, EMRP combines the research talent and experience of several UWRL professors, research engineers, and graduate and undergraduate students in Civil and Environmental Engineering, Biological and Irrigation Engineering, Computer Science, and other disciplines. EMRP provides software development, watershed and water quality modeling, and GIS data analysis service to internal and external entities directed at solving integrated watershed and environmental management-related problems of a variety of scales.

EMRP projects have included TMDL water quality modeling and data analysis in both Utah and Idaho, water quality and quantity modeling training seminars (specifically using the EPA BASINS software package), development of a sourcewater protection analysis tool, and the development of custom GIS and data visualization and analysis tools for integrated watershed information management. Additionally, EMRP researchers have developed probabilistic modeling approaches for integrated stakeholder-based watershed management, and continue to do research in new and innovative areas of physical and statistical modeling.

EMRP is co-directed by UWRL Research Assistant Professor, Dr. Daniel P. Ames, and Research Engineers, Ms. Bethany Neilson and Mr. Jeffery Horsburgh. EMRP employs a number of undergraduate and graduate students as software engineers, programmers, and research assistants. These students gain a broad and practical experience in water quality modeling, data analysis, and the development of engineering software tools. Some of the key research and development areas of EMRP include:

- Training seminars on the use of EPA BASINS water quality modeling software.
- Advanced Geographic Information System Tools for Programmers.
- Watershed Decision Support Systems.
- Digital Elevation Model analysis software for watershed and channel network delineation and hydrologic model setup.
- 3-D Terrain Visualization and Modeling.
- Water Quality/Quantity Data Management.
- Sourcewater Protection Software.
- Probabilistic Collaborative Decision Modeling.
- Total Maximum Daily Load (TMDL) water quality analysis.

For more information contact: Dr. Daniel P. Ames, Ms. Bethany Neilson, or Mr. Jeffery Horsburgh <<http://emrc.usu.edu/>>.



Institute for Dam Safety Risk Management

The Institute conducts research to advance the state of the practice in risk-based approaches to dam safety management. Founded in 1999, its roots go back more than two decades at Utah State University. Approaches developed by the Institute are now being used by engineers, private and government dam owners, and regulators in many countries. These approaches help to improve the understanding and management of the risks associated with owning and operating dams with a goal of improving public safety. In addition to developing approaches for individual dams, the Institute has pioneered portfolio risk assessment for groups of dams. This approach is now a standard of practice in Australia and is being applied by the U.S. Army Corps of Engineers and in other countries.

The Institute has a growing program in real-time reservoir flood operations to provide advanced software tools for forecast-based operations and advanced warning of spillway releases from major reservoirs, such as the Folsom Project above Sacramento, California. Our research program includes strengthening the following supporting areas for dam safety risk management: geotechnical and seismic analysis; flood hydrology and dam break modeling; risk modeling including uncertainty analysis; spillway gate reliability analysis; risk evaluation and communication; and dam failure consequence estimation, including evacuation effectiveness and life loss estimation incorporating GIS techniques.

The Institute organizes and hosts specialized national and international workshops. It also organizes conferences, provides professional training, and have prepared and reviewed guidelines for the ASCE, USSD, ICOLD, CEA, USBR, and ANCOLD. Institute faculty have played a facilitation, coordination, or review role for risk assessment applications to more than 400 dams for dam owners and regulators in association with engineering firms in the US and overseas. They have also advised on incorporating risk management into dam safety programs at corporate, statewide, and national levels.

Core Institute faculty is David Bowles (Director), Loren Anderson, Terry Glover, and Sanjay Chauhan. Graduate students are an important part of the research program. Strong links are maintained with the UWRL spillway modeling group.

For more information contact: Dr. David S. Bowles at David.Bowles@usu.edu, or the UWRL website.



Institute for Natural Systems Engineering

Researchers in this unique program develop, test, and apply a wide range of analytical tools suitable for integration within multidisciplinary assessment frameworks. Research focuses on all aspects of physical, chemical, and biological processes necessary to evaluate impacts in watershed systems. Development, testing, and application of analysis tools and assessment frameworks range across basic life history of aquatic species, spatial sampling of river corridors using remote sensing, GPS and hydro-acoustics, 2- and 3-dimensional hydraulic modeling, and habitat modeling.

For more information contact: Dr. Thomas B. Hardy at: hardy@aaron.uwrl.usu.edu, or the UWRL website.



International Irrigation Center

The International Irrigation Center (IIC) operates within a globalization context with regard to sustainable agricultural and rural environments. The IIC addresses three specific areas: (1) provides students the opportunity to specialize in irrigation engineering as an academic discipline and degree program; (2) administers and conducts long-term international projects through training international irrigation engineers; and (3) designs and provides short-term training programs for international irrigation professionals in the United States and in other countries. The IIC collaborates with the Utah Water Research Laboratory on multidisciplinary projects involving irrigation and water resources planning and management aspects for sustainable development at the river basins and watershed scale.

For more information contact: Dr. Humberto Yap-Salinas hyaps@cc.usu.edu, or their website <<http://www.irri-net.org/projects/IIC/IIC.htm>>.



WATER EDUCATION

International Office for Water and Science Education

The International Office for Water and Science Education (IOWSE) promotes water education projects through a cooperative effort among educators, scientists, and local entities. By adapting projects to local needs, IOWSE also provides inservice training for its users in addition to coordinating information as a resource center for national and international water education programs and needs.

By facilitating the production and marketing of water education materials, the IOWSE provides special services to individuals and groups with water-related interests or needs. IOWSE also focuses on promoting and carrying out adult education programs, as well as specialized training for substitute teaching.

Two major programs are run out of IOWSE, the Substitute Teaching Institute and the Elementary CORE Academy.

For more information contact Mr. Geoffrey G. Smith at: gsmit@cc.usu.edu, or the UWRL website.



Utah Center for Water Resources Research

The Utah Center for Water Resources Research (UCWRR) was established by the Water Resources Research Act of 1964 and is currently eligible to receive grants under the provisions of Section 104 of the Water Resources Research Act of 1984. Purposes of the UCWRR are to 1) foster interdepartmental research and educational programs in water resources; 2) administer the State Water Research Institute Program funded through the U.S. Geological Survey at Utah State University for the State of Utah; and 3) provide University-wide coordination of water resources research.

The governing body for the Utah Center for Water Resources Research is a council composed of the deans of the Colleges of Agriculture, Engineering, Natural Resources, Science, and Humanities, Arts, and Social Sciences; directors of the Utah Agricultural Experiment Station, the Utah Water Research Laboratory, and the Ecology Center; and the Vice President for Research. The UCWRR office is located at the Utah Water Research Laboratory. All University faculty engaged in water resources education or research are considered associates of the center. The center promotes and coordinates the development of research and instructional programs that will further the training of water resource scientists and engineers. It maintains liaison relationships with appropriate state, national, and international organizations and agencies having similar objectives.

For more information contact Dr. Mac McKee at: mmckee@cc.usu.edu, or the UWRL website.



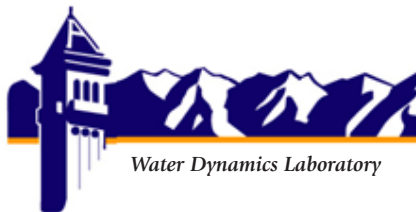
Utah On-Site Wastewater Treatment Training Program

The Utah On-Site Wastewater Treatment Training Program was established in January 1998. The mission of the training program is to assist in the protection of public health and the environment by providing technology transfer, training, and information dissemination in on-site wastewater treatment to stakeholders in Utah and the surrounding region, and by raising the level of public awareness and knowledge in on-site wastewater treatment issues.



The Program provides classroom and field training to site evaluators, regulators, designers, operators and maintenance personnel in support of the statewide certification program for on-site wastewater professionals. About 12% of all Utah households use on-site wastewater treatment systems, and in six of the twelve local health department regions, this percentage is as high as 30 to 60%. About 3,500 new systems are added annually in Utah.

For more information contact Ms. Judith L. Sims at: jsims@cc.usu.edu, or the UWRL website.



Water Dynamics Laboratory

The Water Dynamics Laboratory (WDL), a part of the Utah State University Research Foundation, assists Utah State University and supports the Utah Water Research Laboratory in achieving its mission by providing student support and training through contracts and projects that utilize the UWRL physical facilities of the UWRL Hydraulics Laboratory. WDL-supported students, staff, and faculty are involved in the areas of hydraulic testing, calibration, physical model design, development and testing for rivers, dams, and spillways, and performance testing of valves, pipes, and flow meters that are presently used as industry standards.



Employing students in the Civil and Environmental Engineering Department to work in the hydraulics laboratory at the UWRL produces several positive results. The students receive a real-world hands-on experience performing engineering tasks as they assist with WDL projects performed at the laboratory. Employment also provides opportunities for faculty/client/student interaction. After graduation, many students are hired by past laboratory clients. A high percentage of undergraduate student employees at the UWRL have pursued advanced degrees at USU because of the experience gained while working at the laboratory on WDL projects.

For more information contact Mr. Steve Barfuss at: barfuss@cc.usu.edu, or the UWRL website



III. Facilities



The 102,000 square-foot UWRL facility contains offices and laboratories that house engineers, scientists, laboratory technicians, and students from a variety of engineering and water science disciplines. Designed to meet the needs of these disciplines, the UWRL has well-equipped environmental quality and hydraulics laboratories; computer facilities; conference rooms; and administrative, faculty, staff, and student offices.

Environmental Quality Laboratory



The 11,000-square foot Environmental Quality Laboratory (EQL) at the UWRL is equipped for analyses of organic and inorganic constituents in air, water, and soil. The EQL consists of chemistry, microbiology, radiological, and analytical instrumentation laboratories; two constant temperature rooms; bioassay and research project areas; and refrigerated sample storage area.



A safety plan for the EQL has been submitted to and approved by the Environmental Health and Safety Office (EHSO), Utah State University, in compliance with the Occupational Safety and Health Administration standard entitled "Occupational Exposure to Hazardous Chemicals in Laboratories." The EQL plan includes information on chemical hygiene and proper handling and disposal of hazardous substances, including radioisotopes. All laboratory personnel are required to attend the laboratory safety seminar provided by the EHSO. EQL instrumentation and facilities are listed in the following table:

Organic Chemicals

- 6 Gas Chromatographs with 5 Detectors
- 2 High Performance Liquid Chromatographs with UV & Fluorescence Detectors
- 2 GC/MS Instruments
- Headspace Autosamplers for Volatile Chemicals
- Supercritical Fluid Extractor

Inorganic Elements

- Inductively Coupled Plasma-Mass Spectrometer
- Atomic Absorption Spectrometer with Graphite Furnace and Mercury/Hydride Atomizers

Radiochemical Analyses

- 2 Liquid Scintillation Counters for Tritium, ^{14}C , ^{32}P , ^{35}S , and ^{125}I
- 2 Biological Oxidizers used for Soils, Biosolids, and Plants

Anion Analyses

- Dionex LC25 Ion Chromatograph
- Dionex LC25 Ion Chromatograph with UV/VIS for CR^{+6}

Microbiology and Toxicity

- Microbics Toxicity Analyzer for microtox measurement of cellular toxicity and mutatox measurement for mutagenicity
- Ames Salmonella/Mammalian Microsome Assay
- ATP analysis with integrating photometer
- Gilson Respirometer for microbial respiration





Additional analytical instrumentation includes a total dissolved organic and inorganic carbon analyzer, surface area (BET) analyzer, universal fractionator for separation of particles and macromolecules, laser photometer and a DSP interferometric refractometer for molecular size analysis of separated particles and XAD resin chromatography and a freeze dryer for concentrating humic substances from water or soil extracts.

Field Instruments and Analyses

Water Quality

- YSI Dissolved Oxygen/Conductivity
- Hach Colorimeter for Nutrients, Fe, Mg
- Portable GC/FID instrument
- 2 Gastech Gastechotor Carbon Dioxide/Oxygen Analyzer
- A Gidding Soil Corer and Standard Soil Augers
- Portable Mud Rotary Drill (Deep Rock, Inc.) for observation well installation, and groundwater sampling to depths of approximately 120 feet
- Redi Flo2 Electric Pump (Grundfos Pumps Corp.) for purging ground water from sampling wells
- ES 125 single channel Seismograph for shallow refraction surveys of soil and stratigraphy, and depth to water table



Air Sampling

- High Volume Sampler
- Personal Monitoring Pumps
- Combustible Gas Meter
- Real-time monitors for CO and O₂
- Stainless steel whole air canisters, collection media and supports
- DO Meters
- MSA Detector Kits
- Draeger Detector Kits
- Air Velocity Meters





Hydraulics Laboratory

The 50,000 square-foot hydraulics section of the Utah Water Research Laboratory contains a variety of flumes, channels, pumps, pipelines, and equipment and instrumentation for conducting hydraulic research, model studies, valve testing, and flow meter calibrations. Water is supplied by gravity flow up to rates exceeding 200 cfs from an upstream reservoir through a 48-inch diameter pipe to the laboratory. The reservoir supplies a constant pressure head of 25 feet to the main laboratory level and 35 feet to the lower laboratory level. A network of steel piping (18-, 24-, and 36-inches in diameter), located under the floor, supplies water to various parts of the laboratory. Other under-the-floor channels conduct water from the experiments back to the river, to recirculating pumps, or to precise flow measurement facilities. Laboratory research is supported by a carpentry and machine shop that houses necessary stationary and hand tools for physical model construction, custom steel and acrylic fabrication, and heavy equipment maintenance. The laboratory uses two forklifts, a mobile crane, and two skid-loaders to aid in the construction of experiments.



Also contained within the Hydraulics Laboratory is a 400 square-foot rainfall simulator, and a sunlight simulator integrated with a tiltable soil-filled test flume. These facilities enable students and faculty to conduct a wide range of studies related to erosion, runoff, infiltration, and crop production.



Laboratory facility summary:

NIST Traceable Flow Measurement Equipment

- 1,000-lb weigh tank
- 30,000-lb weigh tank
- 300,000-lb weigh tank (under construction 2003)
- 835-ft³ volumetric tank
- 3,545-ft³ volumetric tank
- Master venturi meters (48-inch, 24-inch, 12-inch, 6-inch, 2-inch)
- 48-inch ultrasonic meter



Pressure Measurement Equipment

- Adjustable-range pressure transducers/transmitters
- Precision pressure gauges
- U-tube manometers (blue fluid and mercury)



Data Collection Equipment

- Data acquisition software and hardware
- Digital data analyzer
- Multimeters
- Decibel meters
- Accelerometers
- Thermometers



Pipe and Fitting Inventory

- US steel pipe sizes (1/2-inch through 60-inch)
- Uncommon steel pipe sizes (upon request)
- Control valves (1/2-inch through 48-inch)
- Elbows, reducers, tees, etc., for pipeline simulation tests
- Flange clamps for flanges other than 150 pounds
- Dresser couplings (2-inch through 48-inch)

Flow and Pressure Capabilities

- Reservoir: 11 psi upper level, 15 psi lower level at shutoff, over 200 cfs maximum
- 1 stage, 100-hp vertical turbine pump, 1770-rpm, 5000-gpm runout, 70-ft shutoff
- 2 stage, 200-hp vertical turbine pump, 1770-rpm, 5000-gpm runout, 170-ft shutoff
- 10 stage, 100-hp vertical turbine pump, 1770-rpm, 1000-gpm runout, 680-ft shutoff
- 350-hp centrifugal pump, 1780-rpm, 3000-gpm runout, 580-ft shutoff
- 15-ft constant head tank



Test Flumes

- 6-ft x 8-ft x 500-ft concrete flume
- 5-ft x 6-ft x 50-ft wood/plexiglas sectional model flume
- 4-ft x 4-ft x 80-ft wooden high velocity erosion control flume
- Tilting 3-ft x 4-ft x 24-ft steel/plexiglas research flume
- Tilting 2-ft x 3-ft x 24-ft steel/plexiglas research flume



IV. Education Support

Undergraduate and graduate students are involved in research, testing, design, training, technology transfer, and outreach activities at the UWRL. Engineering graduate students with science and/or engineering academic backgrounds are recruited to participate on projects for theses and dissertations, and are competitively supported through UWRL- and client-supported assistantships. These students are primarily associated with the Department of Civil and Environmental Engineering; however, students can also be affiliated with other academic departments and interdisciplinary academic units. A description of education support activities, including graduate course offerings, theses and dissertations awarded, senior design projects, and scholarship offerings follows.

For more information concerning the Water Engineering and Environmental Engineering academic programs contact Dr. Loren Anderson, Head of the CEE Department at: loren@cc.usu.edu; for Environmental Engineering information contact Dr. R. Ryan Dupont at: rdupo@cc.usu.edu; for Water Engineering Program information contact Dr. Jagath J. Kaluarachchi at jkalu@cc.usu.edu.

Environmental Engineering- and Water Engineering-Related Courses

CEE Course Number	Title	Instructor
1880	CEE Orientation and Computer Applications	William J. Rahmeyer
2870	Sophomore Seminar	Loren R. Anderson
2890	Environmental Engineering Sophomore Seminar	R. Ryan Dupont
3030	Uncertainty in Engineering Analysis	Gilberto E. Urroz
3430	Engineering Hydrology	Jagath J. Kaluarachchi
3500	CEE Fluid Mechanics	William J. Rahmeyer
3510	CEE Hydraulics	Gilberto E. Urroz
3610	Environmental Management	Darwin L. Sorensen
3640	Water and Wastewater Engineering	R. Ryan Dupont
3670	Transport Phen. in Bio-Environmental Systems	David K. Stevens
3780	Solid and Hazardous Waste Management	Michael J. McFarland
3870	Professional/Technical Writing in CEE	Sonia Manuel-Dupont
3890	Environmental Engineering Design I	R. Ryan Dupont
4200	Engineering Economics	A. Bruce Bishop
4790	Environmental Engineering Design II	R. Ryan Dupont
4880	Civil Engineering Design III	R. Ryan Dupont
4930	Independent Study	Loren R. Anderson
5250	Environmental Engineering Cooperative Practice	R. Ryan Dupont
5430/6430	Groundwater Engineering	Mariush W. Kembrowski
5440/6440	GIS in Water Resources	David G. Tarboton
5450/6450	Hydrologic Modeling	David S. Bowles
5460/6460	Water Resources Engineering	Daniel H. Hoggan
5470/6470	Sedimentation Engineering	William J. Rahmeyer
5540/6540	Fluid Mechanics	Blake P. Tullis
5550/6550	Hydraulics of Closed Conduits	Blake P. Tullis
5560/6560	Environmental Hydraulics	William J. Rahmeyer

CEE Course Number	Title	Instructor
5610	Environmental Quality Analysis	Joan E. McLean
5620	Aquatic Chemistry	William J. Doucette
5670	Hazardous Chem. Handling and Safety	William J. Doucette
5680/6680	Soil-Based Hazardous Waste Management	Ronald C. Sims
5690/6690	Natural Systems Engineering	Thomas B. Hardy
5700/6700	Field Sampling Techniques for Natural Systems Eng.	Thomas B. Hardy
5710	Pollution Prevention and Industrial Ecology	R. Ryan Dupont
5720/6720	Natural Systems Modeling	Thomas B. Hardy
5730/6730	Analysis and Fate of Environmental Contaminants	William J. Doucette
5790	Accident and Emergency Management	R. Ryan Dupont
5810/6810	Biochemical Engineering	David K. Stevens
5830/6830	Management and Utilities of Biological Solids and Wastewater	Michael J. McFarland
5860	Air Quality Management	Randal Martin
5870	Hazardous Waste Incineration	R. Ryan Dupont
5880	Remediation Engineering	R. Ryan Dupont
6300	Earth Structures	Loren R. Anderson
6310	Environmental Geotechniques	Loren R. Anderson
6330	Ground Reinforcement, Improvement and Treatment	Loren R. Anderson
6400	Physical Hydrology	David G. Tarboton
6410	Water Resource Systems Analysis	Mac McKee
6420	Engineering Risk Assessment and Risk Management	David S. Bowles
6430/5430	Groundwater Engineering	Mariusz W. Kemblowski
6450/5450	Hydrologic Modeling	David S. Bowles
6460/5460	Water Resources Engineering	Daniel H. Hoggan
6470/5470	Sedimentation Engineering	William J. Rahmeyer
6480	Subsurface Flow and Transport Processes	Jagath J. Kaluarachchi
6490	Integrated River Basin/Watershed Planning and Management	Mac McKee
6500	Open Channel Hydraulics with an Emphasis on Gradually Varied Flow	William J. Rahmeyer
6510	Numerical and Statistical Methods for Civil Engineers	Gilberto E. Urroz
6520	Applied Hydraulics	CEE Staff
6530	Unsteady Flows in Open Channels and Numerical Solutions of St. Venant Eq.	CEE Staff
6540/5540	Fluid Mechanics	Blake P. Tullis
6550/5550	Hydraulic Design	Blake P. Tullis
6560/5560	Environmental Hydraulics	William J. Rahmeyer
6580	Intermediate Fluid Mechanics	Gilberto E. Urroz
6600	Environmental Chemistry of Inorganic Contaminants	Joan E. McLean
6630	Process Dynamics in Environmental Engineering Systems	David K. Stevens
6640	Physical and Chemical Environmental Process Engineering	Michael J. McFarland
6650	Biological Processes in Environmental Engineering	Ronald C. Sims
6680/5680	Soil-Based Hazardous Waste Management	Ronald C. Sims
6690/5690	Natural Systems Engineering	Thomas B. Hardy

CEE Course Number	Title	Instructor
6700/5700	Field Sampling Techniques for Natural Systems Engineering	Thomas B. Hardy
6710	Environmental Engineering Microbial Ecology	Darwin L. Sorensen
6720	Natural Systems Modeling	Thomas B. Hardy
6730/5730	Analysis and Fate of Environmental Contaminants	William J. Doucette
6750	Eco-Hydraulics for Natural Systems Engineering	Thomas B. Hardy
6800	Environmental Seminar	R. Ryan Dupont
6810/5810	Biochemical Engineering	David K. Stevens
6830/5830	Management and Utilization of Biological Solids and Wastewater	Michael J. McFarland
6900	Directed Reading	Loren R. Anderson
6930	Special Problems	Loren R. Anderson
6970	Thesis Research	Loren R. Anderson
6990	Continuing Graduate Advisement	Loren R. Anderson
7310	Fundamentals of Soil Behavior	Loren R. Anderson
7430	Stochastic Hydrology	Mariush W. Kemblowski/David G. Tarboton
7460	Advanced Topics in Hydrology	David G. Tarboton
7580	Advanced Finite Element Analysis in Fluid Mechanics	CEE Staff
7970	Dissertation Research	Loren R. Anderson
7990	Continued Graduate Advisement	Loren R. Anderson

Theses and Dissertations Awarded

2002 DOCTOR OF PHILOSOPHY

Jain, Shaleen. Multiscale Low-Frequency Hydroclimatic Variability: Implications for Changes in Seasonality and Extremes. Major Professor: Dr. Upmanu Lall.

Lee, John-Seok. Uncertainty Analysis in Dam Safety Risk Assessment. Major Professor: Dr. David S. Bowles.

Prasad, Rajiv. Watershed-Scale Hydrology: Influences of Spatial Variability of Snowpack in a Semiarid, Mountainous Environment. Major Professor: Dr. David G. Tarboton.

Rashid, Mamun. Biodegradation of Hydrocarbons Using Alternate Electron Acceptors: Theoretical Development and Model Applications. Major Professor: Dr. Jagath J. Kaluarachchi.

2002 MASTER OF SCIENCE

Cox, Nathan Christian. Major: Civil and Environmental Engineering. Major Professor: Dr. Michael C. Johnson.

Lewis, Kerry Ladell. Major: Civil and Environmental Engineering. Major Professor: Dr. William J. Doucette.

Lundell, Martin Peter. Major: Civil and Environmental Engineering. Major Professor: Dr. R. Ryan Dupont.

Mabrouk, Mahmoud A. Major: Civil and Environmental Engineering. Major Professor: Dr. Mac McKee.

McCoy, Sean. Major: Civil and Environmental Engineering. Major Professor: Dr. William J. Rahmeyer.

Slaugh, Dwight Alexander. Major: Civil and Environmental Engineering. Major Professor: Dr. William J. Rahmeyer.

2002 MASTER OF ENGINEERING

Dent, Jordeane L. Major: Civil and Environmental Engineering. Major Professor: Dr. Darwin L. Sorensen.

Timmons, Kelly B., Jr. Major: Civil and Environmental Engineering. Major Professor: Dr. Mariush W. Kemblowski.

2003 DOCTOR OF PHILOSOPHY

Ames, Daniel Peder. Bayesian Decision Networks for Watershed Management. Major Professor: Dr. Upmanu Lall.

Benson, Lowell Scott. Relationship Between Sorption/Desorption and the Bioavailability of Trichloroethylene at Hill Air Force Base Site OU-5. Major Professor: Dr. William J. Doucette.

Istanbulluoglu, Erkan. Quantification of Stream Sediment Inputs from Steep Forested Mountains. Major Professor: Dr. David G. Tarboton.

Savage, Bruce M. Reverse Flow Tubes and Their Application in Upstream Fish Passage. Major Professor: Dr. Roland W. Jeppson.

Tan, Huagao. Flow over Skew Side Weirs. Major Professor: Dr. Gilberto E. Urroz.

2003 MASTER OF SCIENCE

Bingham, Scott Ronald. Major: Civil and Environmental Engineering. Major Professor: Dr. Blake P. Tullis.

Francom, Jared. Major: Civil and Environmental Engineering. Major Professor: Mr. Steven L. Barfuss.

Khadam, Ibrahim Mohammed. Major: Civil and Environmental Engineering. Major Professor: Dr. Jagath J. Kaluarachchi.

Khalil, Abedalrazq F. Major: Civil and Environmental Engineering. Major Professor: Dr. Mac McKee.

Ladhawala, Jignesh P. Major: Civil and Environmental Engineering. Major Professor: Dr. William J. Doucette.

McMullin, Garrett Lee. Major: Civil and Environmental Engineering. Major Professor: Dr. Michael C. Johnson.

Miller, Ashley Suzanne. Major: Civil and Environmental Engineering. Major Professor: Dr. William J. Rahmeyer.

Moncur, Kade D. Major: Civil and Environmental Engineering. Major Professor: Dr. Darwin L. Sorensen.

Oldham, Jeremy Von. Major: Civil and Environmental Engineering. Major Professor: Dr. Randal S. Martin.

Russo, Vito Michael. Major: Civil and Environmental Engineering. Major Professor: Dr. Mac McKee.

Smart, Bronson Sid. Major: Civil and Environmental Engineering. Major Professor: Dr. Gilberto E. Urroz.

Smith, Tyler Stuart. Major: Civil and Environmental Engineering. Major Professor: Dr. William J. Rahmeyer.

Terry, Spencer H. Major: Civil and Environmental Engineering. Major Professor: Dr. Michael J. McFarland.

Teton, Elese D. Major: Civil and Environmental Engineering. Major Professor: Dr. Darwin L. Sorensen.

2003 MASTER OF ENGINEERING

Hansen, Rick A. Major: Civil and Environmental Engineering. Major Professor: Dr. Blake P. Tullis.

Miller, Suzanne. Major: Civil and Environmental Engineering. Major Professor: Dr. R. Ryan Dupont.

Rahman, Julia Laila. Major: Civil and Environmental Engineering. Major Professor: Dr. Laurie S. McNeill.

Strahl, David L. Major: Civil and Environmental Engineering. Major Professor: Dr. David G. Tarboton.

Senior Design Projects

The senior design project was initiated in Fall 1997 and provides opportunities for each senior student in water engineering and environmental engineering to work in a team environment with other students on a practical problem identified and supported by a university collaborator. USU partners include industry, government agencies, other research institutions, and private consulting firms. Student teams work under the direction and supervision of mentors comprised of university and client staff. The basic elements of the senior design project include: (1) design, (2) build, and (3) test/monitor. The senior design project begins in the spring semester of the junior year, with emphasis on problem definition and conceptualization, and progresses through the design, data collection, and results presentation phases of the project in the students' senior year. The facilities and resources of the UWRL are utilized in the design, fabrication, assembling, and testing of many of the water engineering and environmental engineering senior design projects. Several design projects have been donated to the UWRL since the design projects were started that provide working models that are used for teaching and demonstration for students and for the general public.

Spring 2001 - Spring 2002

Quail Creek Pipeline Gravity Based Return Flow System Design to Achieve Thermal Modification Within the Virgin River to Improve Roundtail Chub and Woundfin Habitat. Advisor: Dr. Thom Hardy. Student Team: Kevin Hall, Daniel Jeon, Jeremy McGrath, McKay Anderson.

Spring 2002 - Spring 2003

Evaluation of the Source and Potential Control Methods for PM10 and PM2.5 in Cache County, Utah. Advisor: Dr. Randy Martin. Student Team: Tom Bradley, Demetrio Cabanillas, Hosam Jamal.

Feasibility Design for the Management of the Lake Powell Pipeline for Washington County Water Needs and Virgin River Roundtail Chub and Woundfin Habitat. Advisor: Dr. Thom Hardy. Student Team: Cassy Kristensen, Tiffany Leo, Clint Rogers, Mindy Wouden.

Proposal for Monitoring of the Logan City Lagoon Effluent Wetland Treatment System. Advisor: Dr. R. Ryan Dupont. Student Team: Wil Pineda, Jacob Rukavina, Erik Dettenmaier, Jenny Paget.

If you are interested in obtaining more information on senior design projects, or in sponsoring a senior design project in Environmental Engineering, contact Dr. R. Ryan Dupont at: rdupo@cc.usu.edu; in the Water Engineering Program, please contact Dr. Jagath J. Kaluarachchi at: jkalu@cc.usu.edu.

Scholarships

Graduate student scholarships are competitive and are generally available from two primary sources: (1) internal UWRL-supported assistantships, and (2) client-supported assistantships. Approximately 22 internal UWRL-supported assistantships are available each academic year. The number and type of client-supported assistantships vary, but average approximately 37 per year. Assistantships are renewable based on demonstrated productivity. Over the period of time addressed in this report, 69 graduate students affiliated with the UWRL received scholarships and/or fellowship support.

UWRL High School Summer Research Interns

UWRL faculty designed and implemented a High School Summer Research Internship program in 2002 for area high school students to work on research projects under faculty direction within the Division of Environmental Engineering. The purpose of this internship was to provide outstanding junior and senior high school students with research experiences including laboratory and field testing, research methods, and interpretation of experimental data. Outstanding students were nominated by high school science advisors, and eight students from three area high schools were awarded internships. Students learned about the field of environmental engineering through working with faculty, USU students, and research technicians. As a result, interns were better prepared to make decisions concerning a university education and careers in environmental engineering. Each Research Intern prepared a poster summarizing his/her research experiences for presentation to the College of Engineering and UWRL administration, faculty, students, and staff.





V. Outreach

The mission of the UWRL includes outreach activities related to public service, information dissemination, technology transfer, and short courses. These activities are provided for the benefit of Utah state agencies, elected officials, Utah citizens, and the nation. Outreach is provided by faculty, staff, and students associated with the UWRL. Additional outreach is provided through our World Wide Web (WWW) site addresses that include: [<http://www.engineering.usu.edu/uwrl>], Utah Water Journal [<http://www.engineering.usu.edu/uwrl/uwj>], and Utah On-Site Wastewater Treatment Training Program [<http://www.engineering.usu.edu/uwrl/training>].

For more information on UWRL outreach activities, including public service, information dissemination, technology transfer, short courses, and field training, refer to the specific website addresses provided, or contact Ivonne Harris at: iharr@cc.usu.edu.

Public Service

UWRL faculty serve on state and local advisory panels to provide technical expertise, input, and review of water-related issues. Specific panels include: Utah Water Quality Board, Utah Solid and Hazardous Waste Board, Lake Powell Technical Advisory Committee, Salt Lake County Solid Waste Management Council, the State of Utah Wastewater Treatment Plant Operator Certification Committee, and the Utah Drinking Water Board.

Information Dissemination

UWRL outreach activities with regard to information dissemination include establishing the following Internet sites:

- Training in on-site wastewater treatment in support of the State of Utah certification program for on-site wastewater treatment professionals is provided by the Utah On-Site Wastewater Treatment Training Program at the UWRL. Undergraduate and graduate students participate through projects that involve hands-on, real-world activities. Additional information can be found at the UWRL web site: <http://www.engineering.usu.edu/uwrl/training>.
- An on-line journal, the “Utah Water Journal,” is a collaboration between USU and state, local, and private organizations involved in stewardship issues that include managing and protecting Utah’s water quality and quantity. The Utah Water Journal is available free of charge on-line at: <http://www.engineering.usu.edu/uwrl/uwj>.
- Feature articles that highlight UWRL research projects in the state are made available on-line from time to time. A recent example is the “Virgin River Basin-Wide Habitat Assessment” project (<http://www.engineering.usu.edu/uwrl/waterlab>), which is bringing together city, county, state, federal, university, and private groups within the Virgin River Basin in southwest Utah to work collaboratively to solve water resource allocation problems in a rapidly growing area while also working toward recovery of threatened and endangered native fish species.

Technology Transfer

UWRL staff involvement in conducting technology transfer to audiences external to USU includes the areas listed below:

- UWRL faculty are assisting Utah Department of Environmental Quality personnel in the evaluation of state needs regarding Total Maximum Daily Loads (TMDLs) for Utah's lakes, rivers, and streams.
- Improved forecasting of the Great Salt Lake will directly benefit future emergency management and planning. Great Salt Lake forecasts are anticipated to be useful for better prediction of the onset, severity, and cessation of droughts in Utah.
- Results of our laboratory investigations continue to provide cost-saving methods for improving the performance of dam spillways in Utah and can be expected to play an important role in future dam safety rehabilitation in the state.
- The use of vegetation for reclaiming mining areas is being investigated through the development of phytoremediation techniques at the UWRL to assist Utah and other intermountain areas with metal-contaminated soil and ground water.
- A more realistic approach to assessing the impacts of altered flow regimes on drifting feeding fish species (i.e., trout) is expected to provide resource managers with a tool to make better decisions on protecting Utah fisheries resources.
- Computer models for managing the quality of stream flows and improving the operational efficiency of Utah Weber Basin water treatment plants continue to be developed and are expected to be transferable to other river systems in Utah.

Short Courses and Field Training

UWRL staff provide short courses both on site at USU and off site within the State of Utah, regionally, as well as globally. Generally offered from one- to five-days duration, short courses are tailored to meet the needs of the requestor. A list of short courses, field training, and involvement of UWRL staff are indicated below.

FY July 2001 - June 2002

“Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, Provo, Utah, September 20, 2001. Judith L. Sims and Peg Cashell.

“Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, Richfield, Utah, October 11, 2001. Judith L. Sims and Peg Cashell.

“Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, Heber City, Utah, October 19, 2001. Judith L. Sims and Peg Cashell.

“Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, November 8, 2001. Judith L. Sims and Peg Cashell.

“Design, Inspection, and Maintenance of Alternative Systems.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, December 4-5, 2001, Judith L. Sims and Peg Cashell.

“Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, Moab, Utah, December 13, 2001, Judith L. Sims and Peg Cashell.

“Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, Heber City, Utah, March 27, 2002. Judith L. Sims and Peg Cashell.

“Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, Cedar City, Utah, April 11, 2002. Judith L. Sims and Peg Cashell.

“Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, May 9, 2002. Judith L. Sims and Peg Cashell.

“Design, Inspection, and Maintenance of Alternative Systems.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, May 21-22, 2002. Judith L. Sims and Peg Cashell.

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- “EPA Basins Training Course.” Utah State University, Logan, Utah, August 20-24, 200. David K. Stevens and Bethany Neilson.
- “EPA Basins Training Course.” Utah State University, Logan, Utah, January 14-18, 2002. David K. Stevens and Bethany Neilson.
- “EPA Basins Training Course.” Utah State University, Logan, Utah, May 6-10, 2002. David K. Stevens and Bethany Neilson.
- “Isotope Hydrology and Dam Safety.” Tunis, Tunisia. One-week Regional AFRA Training Course. Sponsored by the International Atomic Energy Agency (IAEA), Vienna, Austria, April 2002. David S. Bowles and Y. Travi.
- “Physical Habitat Simulation and Habitat Time Series - (PHABSIM-Windows).” Utah State University, Logan, Utah, May 2002. Thomas Hardy.
- “Physical Habitat Simulation and Habitat Time Series - (PHABSIM-Windows).” Tennessee Valley Authority, Knoxville, Tennessee, June 2002. Thomas Hardy.
- “Risk-based Decision Making in Dam Safety Management: Current Practice in the USA and a Personal Perspective.” Invited keynote presentation at the ANCOLD Risk Workshop, “The Development of Risk-based Decision Making in Dam Management,” Auckland, New Zealand, November 2001. David S. Bowles.
- “Soil Evaluation and Percolation Testing.” Utah On-Site Wastewater Treatment Training Program, Provo, Utah, September 18-19, 2001. Judith L. Sims and Peg Cashell.
- “Soil Evaluation and Percolation Testing.” Utah On-Site Wastewater Treatment Training Program, Richfield, Utah, October 9-10, 2001. Judith L. Sims and Peg Cashell.
- “Soil Evaluation and Percolation Testing.” Utah On-Site Wastewater Treatment Training Program, Heber City, Utah, October 17-18, 2001. Judith L. Sims and Peg Cashell.
- “Soil Evaluation and Percolation Testing.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, November 6-7, 2001. Judith L. Sims and Peg Cashell.
- “Soil Evaluation and Percolation Testing.” Utah On-Site Wastewater Treatment Training Program, Moab, Utah, December 11-12, 2001. Judith L. Sims and Peg Cashell.
- “Soil Evaluation and Percolation Testing.” Utah On-Site Wastewater Treatment Training Program, Heber City, Utah, March 25-26, 2002. Judith L. Sims and Peg Cashell.
- “Soil Evaluation and Percolation Testing.” Utah On-Site Wastewater Treatment Training Program, Cedar City, Utah, April 9-10, 2002. Judith L. Sims and Peg Cashell.
- “Soil Evaluation and Percolation Testing.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, May 7-8, 2002. Judith L. Sims and Peg Cashell.

FY July 2002 - June 2003

- “Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, Heber City, Utah, September 12, 2002. Judith L. Sims, Peg Cashell, and Richard Jex.
- “Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, Richfield, Utah, October 3, 2002. Judith L. Sims, Peg Cashell, and Richard Jex.
- “Design, Inspection, and Maintenance of Alternative Systems.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, November 5-6, 2002. Judith L. Sims, Peg Cashell, and Richard Jex.
- “Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, April 10, 2003. Judith L. Sims, Peg Cashell, and Richard Jex.
- “Design, Inspection, and Maintenance of Conventional Systems.” Utah On-Site Wastewater Treatment Training Program, Cedar City, Utah, May 1, 2003. Judith L. Sims, Peg Cashell, and Richard Jex.
- “Design, Inspection, and Maintenance of Alternative Systems.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, May 13-14, 2003. Judith L. Sims, Peg Cashell, and Richard Jex.
- “EPA Basins Training Course.” Utah State University, Logan, Utah, March 3-7, 2003. David K. Stevens and Bethany Neilson.
- “EPA and Aqua Terra Consultants, BASINS/HSPF Training Course.” Chicago, IL, February 4-6, 2003. Bethany Neilson.
- “Event Trees in Dam Safety Risk Assessment.” Three-day Workshop for Waterways Experiment Station, US Army Corps of Engineers, Vicksburg, Mississippi. June 2003, David S. Bowles and Loren R. Anderson.
- “Folsom Reservoir Release Forecast Model.” Two-day Training Workshop for Central Valley Operations Office, U.S. Bureau of Reclamation, Sacramento, California, December 2002. Sanjay S. Chauhan, J.D. Mathias, and David S. Bowles.
- “Physical Habitat Simulation and Habitat Time Series - (PHABSIM-Windows).” Bellingham, Washington, March 2003. Thomas Hardy
- “Physical Habitat Simulation and Habitat Time Series - (PHABSIM-Windows).” Utah State University, Logan, Utah, May 2003. Thomas Hardy

“Soil Evaluation and Percolation Testing.” Utah On-Site Wastewater Treatment Training Program, Heber City, Utah, September 10-12, 2002. Judith L. Sims and Peg Cashell.

“Soil Evaluation and Percolation Testing.” Utah On-Site Wastewater Treatment Training Program, Richfield, Utah, October 1-2, 2002. Judith L. Sims and Peg Cashell.

“Soil Evaluation and Percolation Testing.” Utah On-Site Wastewater Treatment Training Program, Logan, Utah, April 8-9, 2003. Judith L. Sims and Peg Cashell.

“Soil Evaluation and Percolation Testing.” Utah On-Site Wastewater Treatment Training Program, Cedar City, Utah, April 29-30, 2003. Judith L. Sims and Peg Cashell.

“Specialty Short Course on the Modular Modeling System (MMS).” Utah State University, Logan, Utah, June 2003. Luis Bastidas.

VI. Finances

Revenues and expenditures for the fiscal year from July 1, 2002 through June 30, 2003, are shown in Figure 8, and are representative of fiscal years 2002 through 2003. Categories of revenues include State of Utah, federal, private, and Utah State University. Revenues from the State of Utah total 26% of the UWRL budget, and federal and private sector support totals 74%. Categories for expenditures include research, education support, outreach, and UWRL program administration. Research expenditures include those costs associated with faculty salary, supplies and expendables, publication, and travel. Education support includes expenditures related to undergraduate and graduate stipends and travel. Outreach activities costs are related to information dissemination, short courses, and salary for staff and faculty directly involved in outreach activities. Program administration includes the UWRL Director's Office, Business Office, publication support, and secretarial support for the faculty. Our expenditures indicate that research is the main activity, accounting for approximately 65% of the total budget, with education support next. Outreach and program administration expenditure categories are similar at 19% and 4%, respectively.

Sources of Support

The UWRL is supported by the State of Utah, Utah State University, and other collaborators that include a variety of private and government agencies. Support from the State of Utah and Utah State University, over the last two years, amounts to approximately \$2.5 million on an annual basis. Additional state resources are frequently provided by the Utah Department of Environmental Quality and the Utah Department of Natural Resources, for specific problem-solving tasks. Additional collaborators typically provide a total of \$6.5 million for grant, contract, task, and outreach-related activities on an annual basis. Examples of UWRL clients over the two-year period addressed in this report include:

- American Water Works Association Research Foundation
- Electric Power Research Institute
- Hydroplus International
- MBI International
- National Association of Local Health Boards
- National Cooperative Highway Research Program
- National Science Foundation
- U.S. Bureau of Land Management
- U.S. Bureau of Reclamation
- U.S. Department of Agriculture
- U.S. Department of Defense
- U.S. Department of Energy
- U.S. Department of Justice
- U.S. Department of State
- U.S. Department of the Interior
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- U.S. Geological Survey
- Utah Department of Environmental Quality
- Utah Department of Natural Resources

The UWRL has also been involved with hydraulic testing, evaluation, and calibration activities for private firms. Revenues and expenditures for these projects are in addition to those indicated in Figure 8.

Accurate Measurement Systems
ADS Corporation
Airvac
Atlanta Corrugating
BIF
Boeing-Rocket Dyne
Buckeye Technologies
Calibron
CCI
CH2M Hill
Cherokee Culvert
Cla-Val Company
Contech
Control Center
Crane
Daniel Industries Canada
Ecofiber
Energy Flow Systems
Energy Northwest
Flow products
Flowserve
Franson Noble Engineering
Freese and Nichols
GEI
Gerand Engineering Company
Green & Biotech

Greenfix America
HDR Engineering, Inc.
Henry Pratt Company
JM Manufacturing Co.
McCrometer
Metso Automation
Milliken Valve Co
N.A. Green
National Corrugated Steel Pipe Assoc.
NSF International
Panametrics
Paul Hastings/JM Mfg
PRC Flow Measurement and Control, Inc.
Primary Flow Signal
Profile Products
Renaissance Instruments
Rochester Gas and Electric
Soil Retention
Toshiba International Corporation
Tracom
Triad Measurement and Equipment, Inc.
Tsumi Pump
Tyco Valves and Controls
University of Iowa
Valcor
Wyatt Engineering

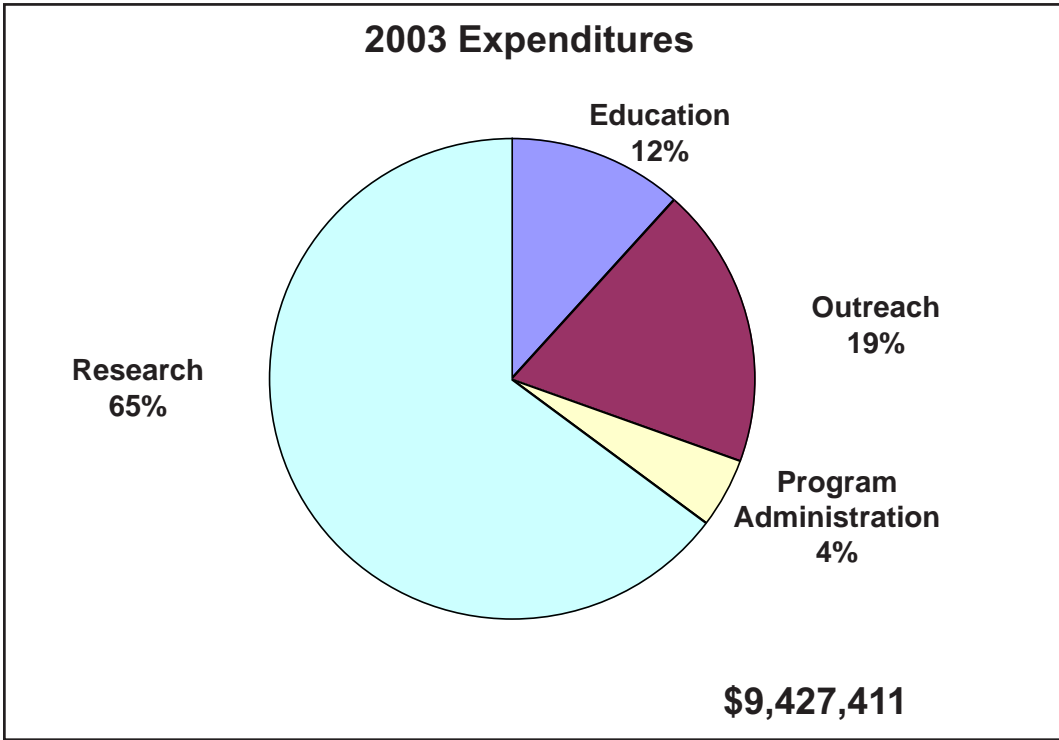
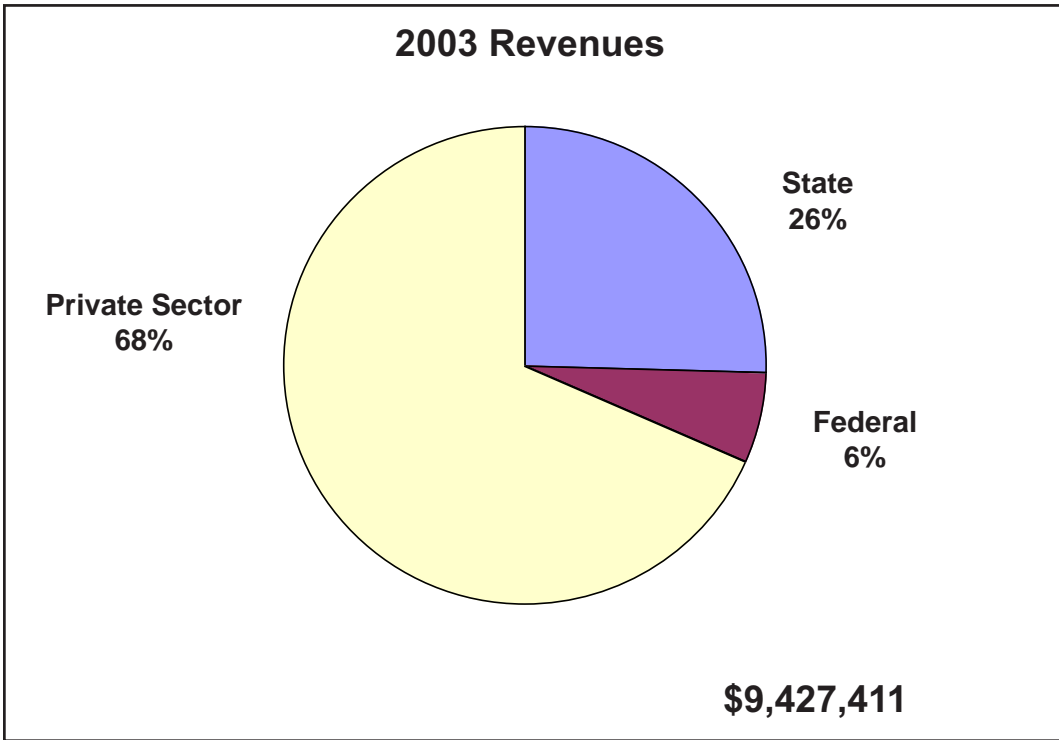
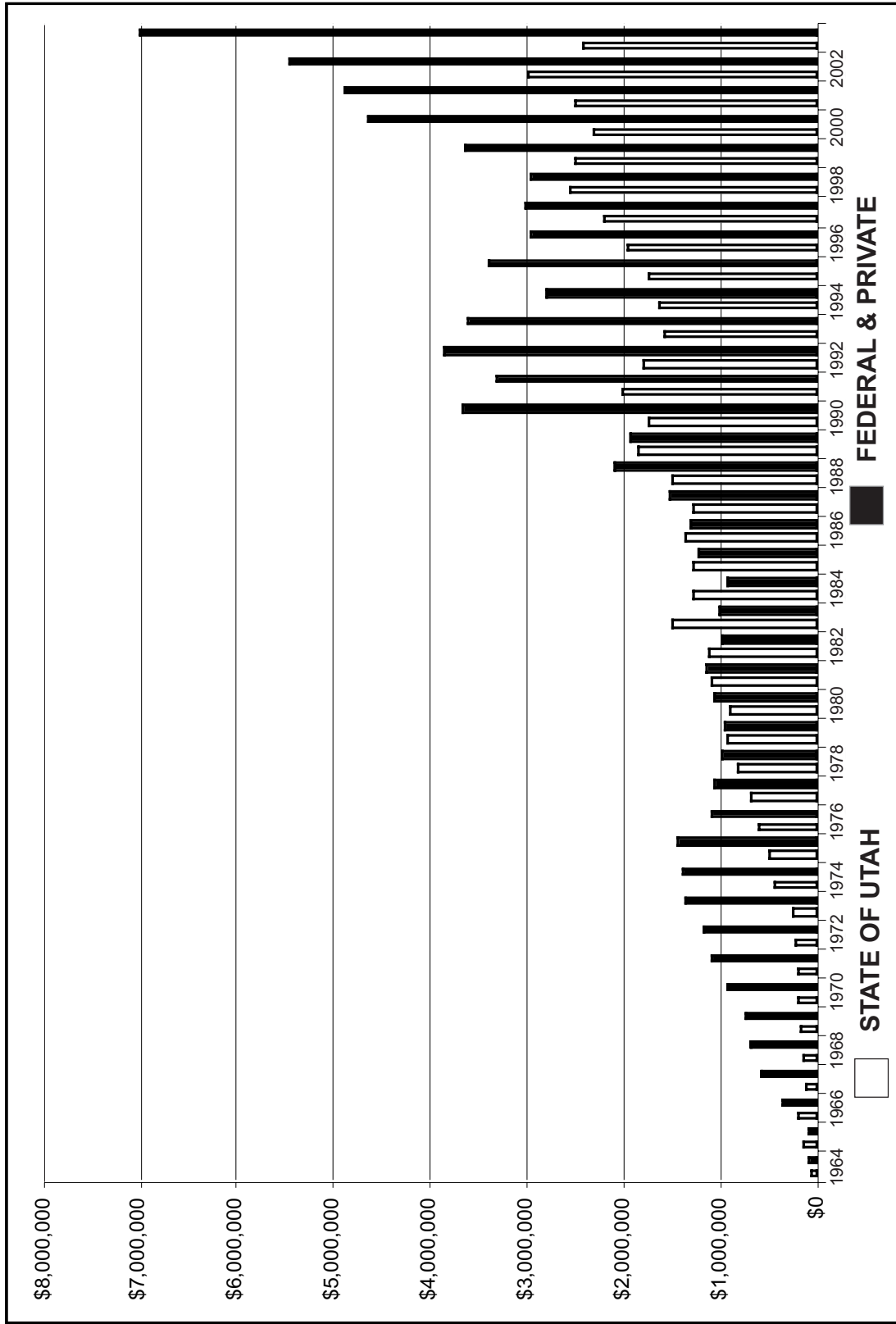


Figure 8. Revenues and Expenditures for Fiscal Year July 1, 2002 - June 30, 2003.



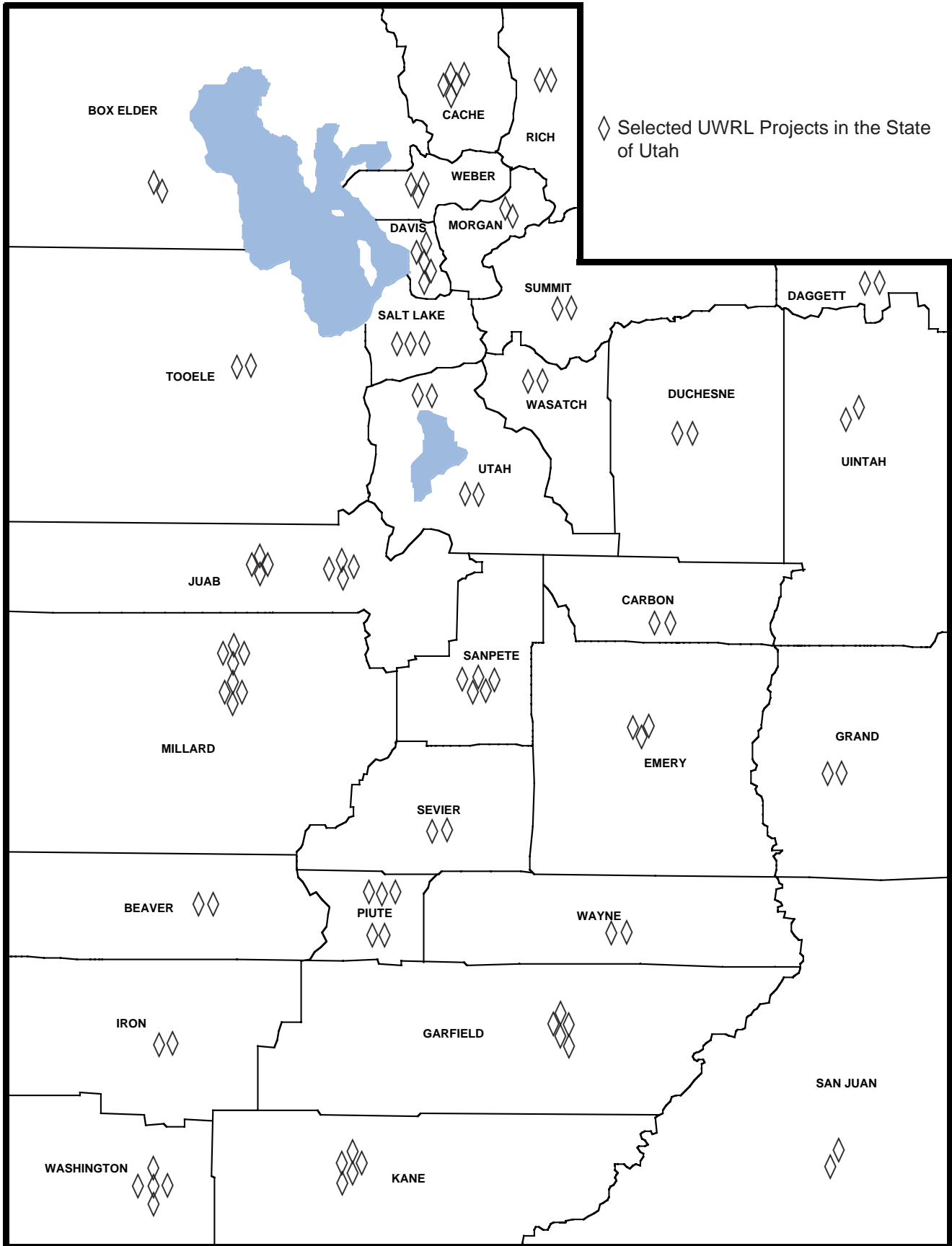
Total revenues constitute the addition of State of Utah and Federal & Private Revenues.

Figure 9. History of UWRL Funding.

Figure 9 shows the history of funding of the UWRL with regard to revenue sources. At present, total annual UWRL revenues are approximately \$9.4 million. Two categories are identified: (1) State of Utah, and (2) private and federal combined. USU support generally has provided one percent or less of the UWRL total revenue sources over the 38-year period of the UWRL activities. Figure 9 also shows an increasing trend in both state support and federal/private support. Significant increases in federal and private support have been made possible through leveraging of state support. State support has been used to provide state-of-the-art facilities and faculty expertise, as well as graduate student support of collaborative projects that involve state-federal and state-private collaborative activities. This institutional teaming approach to common water issues has provided significant added value in terms of quality and quantity of new knowledge generated. In addition, our students who graduate with engineering hands-on experience of multi-institutional projects add increased capability and competence to water professionals entering the employment market.

Our desire at the UWRL is to encourage and facilitate collaboratively-supported research and testing projects that provide educational opportunities for university students.

For more information on collaborative research opportunities with the UWRL, please contact Dr. Mac McKee at: mmckee@cc.usu.edu.



VII. Summary of Projects

UWRL research and testing projects for 2002-2003 fiscal years are identified below. Descriptive titles, project sponsors, and principal investigators are indicated and the year of project initiation. Additional information concerning individual projects can be obtained by contacting the principal investigator. Selected projects within the State of Utah are indicated by the “◇” symbol and are shown on the state map.

Title/Topic	Source of Funds	Principal/Co-Principal Investigator
FY 2002		
Process Performance Indicators for Arsenic Removal◇	American Water Works Association (AWWA)	Laurie S. McNeill
Provo River Flow Study◇	Bio-West, Inc.	R. Craig Addley
Long-Range Streamflow Forecasting Using Climate Information	City of Denver, Water Department	Connely Baldwin
Water Analysis for City of Glendale, California Water and Power	City of Glendale, California	Laurie S. McNeill
Development and Classification of Shasta River Digital Multi-Spectral Imagery System	Coastal California Fish and Wildlife Office	Thomas B. Hardy
Two-Dimensional Flow Modeling	Colorado Department of Natural Resources	R. Craig Addley
Below Sevier Bridge Reservoir (Yuba) Fish Sampling◇	Consolidated Sevier Bridge Reservoir Company	Thomas B. Hardy
Model Building and Comparison Study in the Oostanaula Watershed	Electric Power Research Institute (EPRI)	David K. Stevens
Integrated Watershed Information Management Tool Kit	Idaho National Engineering and Environmental Laboratory (INEEL)	David K. Stevens
Evaluating the Plant Uptake of Disopropanolamine (DIPA) and Sulfolane in a Laboratory-Scale Wetlands System◇	Komex International	William J. Doucette
Evaluation of Innovative Technologies for Remediation of Soils and Groundwater Contaminated by Chlorinated Hydrocarbon◇	MBI International	R. Ryan Dupont
Survey of Boron and Hexavalent Chromium	McGuire Environmental Consultants, Inc.	Laurie S. McNeill

Title/Topic	Source of Funds	Principal/Co-Principal Investigator
Hexavalent Chromium Removal from Drinking Water	McGuire Environmental Consultants, Inc.	Laurie S. McNeill
Scoping Study for Feather-Yuba Real Time Flood Operations	MKB Engineers	David S. Bowles
Development of a Guide and Video Tape on On-Site Wastewater Treatment and Disposal Systems for Use by Local Boards of Health	National Association of Local Board of Health	Judith L. Sims
Two-Dimensional Instream Flow Modeling (Oak Grove Fork/Clakamas)	Pacific Power and Light Company	James Shoemaker
Bench Scale Reactors for Determining the Fate of Pharmaceuticals in Municipal Water Treatment Facilities	Pfizer, Inc.	William J. Doucette
Guadalupe River Flood Control Project	Ruth and Going, Inc.	William J. Rahmeyer
Sevier River Basin Water Resource Management Network	Sevier River Water Users Association	Mac McKee
Pipe Culvert Database and Data Gathering Model	State of Utah, Department of Transportation	William J. Grenney
GIS-Based Watershed Data Viewer and Water Quality for the United States Bureau of Reclamation Western Region	United States Bureau of Reclamation	David K. Stevens
On-Line Instructional Module on Rainfall Runoff Modeling	United States Department of Commerce, National Weather Service (NWS)	David G. Tarboton
Hydraulic Modeling of Intake Well for Fusegate Spillway, Terminus Dam, Lake Kaweah, California	United States Department of Defense, Army	William J. Rahmeyer
Partnership between Utah State University and An-Najah National University, Nablus, Palestine	United State Department of State	Jagath J. Kaluarachchi
Folsom Reservoir Emergency Operation Study: Uncertainty Simulation of Reservoir Release Forecast Model	United States Department of the Interior, Bureau of Reclamation	David S. Bowles

Title/Topic	Source of Funds	Principal/Co-Principal Investigator
Developing Training Materials for Basin/ Hydrologic Simulation Program Fontram Modeling Workshops	United States Environmental Protection Agency	David K. Stevens
Source Water Protection Plan for Utah◇	United States Geological Survey	Ronald C. Sims
Improve Accuracy of Design Discharge Calculations◇	University of Utah	William J. Grenney
Sevier River Basin Long-Term Fish Monitoring◇	Utah Division of Wildlife Resources	Thomas B. Hardy
Virgin River Basin Integrated Resource Management and Recovery Program◇	Washington County Water Conservancy District	Thomas B. Hardy
Two Dimensional Hydraulics and Habitat Modeling	Watershed Systems Group	Jennifer Ludlow
FY 2003		
Evaluating Hyporheic Zone Biodegradation/ Attenuation of MTBE and Other Oxygenates	American Petroleum Institute (API)	Ronald C. Sims
Developing Training Materials for Basins/ HSPF Modeling	Aqua Terra	David K. Stevens
Underwater Mapping at Sevier Bridge Reservoir, Utah◇	Bowen, Collins, & Associates	Thomas B. Hardy
Bathymetric Mapping of the Little Harguala Pumping Plant Forebay in Central Arizona	Central Arizona	James Shoemaker
Newton Reservoir TMDL Project, Utah◇	Cirrus Ecological Solutions, L.C.	Daniel P. Ames
Otter Creek TMDL Support, Utah◇	Cirrus Ecological Solutions, L.C.	Daniel P. Ames
Modeling Flows of Three River Sites	Colorado Division of Wildlife	R. Craig Addley
WinHSPF Modeling Building Support from Aqua Terra	Electric Power Research Institute (EPRI)	David K. Stevens

Title/Topic	Source of Funds	Principal/Co-Principal Investigator
Emery County Resource Management/ Conflict Resolution Network◇	Emery County Water Conservancy District	Mac McKee
Integrated Watershed Information Management Tool Kit	Idaho National Engineering and Environmental Laboratory (INEEL)	David K. Stevens
Hydraulic Loss Coefficients for Culverts	National Cooperative Highway Research Program	Blake P. Tullis
Physical Model of Success Dam Model	Owen, Ayers and Associates	William J. Rahmeyer
Demonstration of Hydraulic Control (Phytostabilization) of Shallow Groundwater Using Tree Plantings and Department of Defense Installations	Parsons, Texas	William J. Doucette
Pollution Prevention◇	SES	Michael J. McFarland
Lower Sevier River Basin Long Term Fish Community Monitoring◇	Sevier River Water Users Association	Thomas B. Hardy
On-Site Wastewater Training◇	State of Utah, Department of Environmental Quality (DEQ)	Judith L. Sims
Managing the Impacts of Small Reservoir Sluicing◇	State of Utah, Department of Environmental Quality (DEQ)	Mac McKee
Reservoir Release Model for the Upper Sevier◇	United States Bureau of Reclamation	Mac McKee
GIS-Based Analyst Tools for Forest Roads	United States Department of Agriculture, Rocky Mountain Research Station	David G. Tarboton

VIII. Publications

The publications listed below have been restricted to peer-reviewed publications in professional journals for UWRL/collaborator projects, primarily for the year 2002. Research reports, presentations, and specially formatted reports are not included.

- Bowles, D.S. and S.S. Chauhan (2002). Understanding and Managing the Risks of Aging Dams: Principles and Case Studies. *International Journal of the Central Board of Irrigation and Power*, New Dehli, India.
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