New Research

Three new research projects have begun with matching funding from the U.S. Department of the Interior, U.S. Geological Survey, and UWRL.

USU researchers developing "A Conceptual Hydrologic Model of a Closed Desert Basin: Great Salt Lake Desert," are Christopher J. Duffy, Civil and Environmental Engineering, project leader; J. McCalpin, assistant professor in Geology; J. P. Riley, Civil and Environmental Engineering; and Eugene K. Israelson. USU.

This study will contribute to a better understanding of the fundamental hydrologic/hydrologic processes affecting the present day circulation of water in arid desert basins, the proposal says.

A companion project, "A Comprehensive Study of Water Cycling in the Great Salt Lake Basin: Hydrogeology of the West Desert Region," is specifically oriented to determining the evaporation potential of the West Desert region, including atmospheric circulation.

Project leader is Gail L. Bingham, associate professor, Soil Science and Biometeorology. Working with him are Lawrence E. Hipps, assistant professor, Soil Science and Biometeorology; J. Clair Batty, professor of Mechanical Engineering; and J. Paul Riley, professor of Civil and Environmental Engineering.

The study is "Toxicity and Environmental Health Hazards of Petroleum Products in Wells Used for Drinking Water in the Intermountain West."

This project will provide information on types and amounts of volatile and nonvolatile petroleum products in groundwater and toxic effects of selected petroleum contaminants in animals.

Project leader is Robert D. R. Parker, associate professor, Biology. Working with him are R.P. Sharma, professor, Animal, Dairy & Veterinary Science; and R. Ryan Dupont, research assistanat professor, Environmental Engineering.

At UWRL

Scientists Study Hazardous Wastes

By Jillyn Smith
USU Information Services

Hazardous waste disposal studies at the Utah Water Research Laboratory are aimed at understanding and taking advantage of the ability of soil microbes—bacteria and fungi—to break down chemicals.

The ultimate goals of the studies are to treat hazardous wastes and at the same time to preserve the integrity of land and groundwater and protect public health.

"If we look at ourselves from Mars," said USU environmental engineer Ronald L. Sims, "we would see a society that dumps chemical wastes into its drinking water."

Properly planned and managed disposal of wastes in soil does not have to result in the degradation of water supplies. "We want to improve natural soil processes, rather than overwhelm them," Sims said. "If we exceed the assimilation capacity of the soil for the wastes, we can kill the 'bugs' and wastes can migrate and contaminate groundwater with hazardous substances.

It is known, for instance, that bacteria break down certain toxic chemicals into less poisonous chemicals through different biochemical pathways than fungi. In some instances, it may be important to manipulate the soil to encourage growth of bacteria rather than fungi.

"The first step is to look at the behavior and rate of degradation of chemicals. Certain substances may become more toxic under certain circumstances," he said.

"The chemical waste problem developed since the 1940s with the expansion of industry," said Judith L. Sims, a research soil scientist at UWRL. "We created many hazardous chemicals with no thought about disposal."

Dumping chemicals into water has proved unsatisfactory and dangerous. The chemicals may persist and contaminate waters far from their source, causing environmental and public health problems.

"Economics forces people to do the expedient thing without considering the consequences," she said. "But we have come a long way since 1972 in cleaning up our rivers."

Ron and Judy Sims, with funding from the U.S. Environmental Protection Agency, are conducting several studies dealing with hazardous wastes in soils. They are looking at in place treatments for surface-contaminated soils, immobilization of metals associated with industrial wastes, and are evaluating the capacity of different soils for assimilating wastes.

Other UWRL researchers involved in these projects include R. Ryan Dupont, Joan McLean, and Darwin Sorensen.

(continued on page 2)
Hazardous Wastes Studies

(continued from page 1)

Their research also involves colleagues and graduate students drawn from other disciplines, including chemistry, biology, engineering, soil science, and animal, dairy, and veterinary sciences. They are also cooperating with the Utah Bureau of Solid and Hazardous Wastes and the U.S. Geological Survey.

The interdisciplinary approach is essential, Ron says, "You can't just have a doctor and an engineer and get more done than with 1,000 doctors or 1,000 engineers."

USU is one of the first schools in the country to have an academic hazardous waste program, he said.

The researchers have compiled for EPA current knowledge about soil treatment of hazardous chemicals in a 372 page booklet titled "Review of In Place Treatment Techniques for Contaminated Surface Soils."

The review is available from UWR Publications for $25. Please request by title.

In the laboratory, the research is being expanded to breakdown of five industrial chemical wastes: separator sludge and slop oil emulsion solids from oil refineries; creosote and pentachlorophenol (PCP) in used wood preservatives; and toluene, used to dip cattle to prevent scabies, a mite infestation. They are using two soil types selected by the EPA, and plan eventually to expand their studies to include other chemicals.

"The EPA has no idea how to manage toxaphene," Judy says. "Runners usually re-use the solution, then dump the sludge in the fields about every four months. We need to know how fast it breaks down in order to tell cattle dippers how much to apply to soil in one place and how to manage it."

Regional EPA funding is being applied to study specific waste problems in Utah, Ron said. Two Salt Lake County mining sites are on the EPA's National Superfund Priority List, begun in 1980. As of October 1984 the list contained 762 sites, nine of them in Utah.

"Mine tailings often contain toxic concentrations of metals such as chromium and cadmium, Ron and Judy, in cooperation with Joan Mclean, are looking at how these metals may be immobilized in the soil."

They are concerned that the contaminated land not be irreversibly removed from use. "You may not want to grow crops on land with a concentration of metals, but it should continue to have some societal use," Judy said.

"Our goal is management to minimize risks," says Judy. "It's a case to treat the chemicals before they reach groundwater."

Ground Water

The 15th Biennial California Ground Water Conference will be held September 23-24, 1985, at the Bahia Hotel in San Diego, California, sponsored by the University of California Water Resources Center in cooperation with the California Department of Water Resources and the California Water Resources Control Board.

With the theme "California Ground Water Quality--Issues of Today/Strategies for Tomorrow," the conference will feature speakers who will discuss current ground water quality problems in California and describe the complex issues associated with these problems. These problems and issues cross state boundaries, and are equally important for Utah and the other western states.

The conference will be followed by one and one-half days of panel discussions that will concentrate on the development of strategies to deal with the identified problems. The panel discussions will be held at the California Water Resources Control Board and are being facilitated by the Water Resources Center. Open discussion and comments from attendees will be encouraged at the panel.

For further information, please contact the Water Resources Center, University of California, Davis, California; telephone (916) 752-1944.

News Notes


K. Park, Darwin L. Sorensen, Judith L. Sexton, and John Adams presented "Mobility and Fate of Halogenated Hydrocarbons From Wastewater Applied to Soil."

Lauren Hastings and Ronald Sims presented "Techniques for the Immobilization of Metals Associated with Industrial Wastes in Land Treatment Systems."


In addition, Dr. James also discussed "Urban Water: Too Much Too Little--What Are the Social and Institutional Issues?" at the Natural Hazards Research and Applications Workshop, Boulder, Colorado, July 7-10, 1985.

McNeill Retires

William N. "Mac" McNeill retired from the Utah Water Research Laboratory this June.

McNeill began his career at USU as a research meteorologist in 1968, after his retirement from the U.S. Air Force as a senior master sergeant. His first assignment was the UWR water quality modification projects. His next assignment was to establish a gaging program to collect runoff data from the Price River drainage basin.

During the past three years Mac has worked on the rainfall simulator, sunshine simulator, wind tunnel, and soil water quality equipment, and getting effective performance from the first salt gradient solar pond in the country.

Aquarius extends best wishes to Bill McNeill in his retirement.

News Notes

NEW PERSONNEL

The laboratory is making a concentrated effort to enhance its capability in water quality instrumentation. New additions to the Utah Water Research Laboratory staff include: Research Technicians, Jean M. Ihnes; Michael Walsh; and Kerri Sales; Lab Technician, Susan Knight; and Research Aide, Jan Surface, all in the Water Quality area, and Gene Thompson, a department clerk in the secretarial support service.

Aquarius extends a warm welcome to these new employees.

RESEARCHERS LEAVE

Two researchers at the Utah Water Research Laboratory have left Utah State University. They are Ed Romans Adams and Rangesan Narayanan.

Dr. Adams, associate professor at the Utah Water Research Laboratory and the Department of Civil and Environmental Engineering, is now the Director of the Center for the Management, Utilization, and Protection of Water Resources at Tennessee Technological University, Cookeville, Tennessee.

Rangesan Narayanan, research associate professor at UWR and the Economics Department, has joined the faculty at the University of Nevada, Reno, as associate professor in the Division of Ag. and Resources Economics.

Aquarius wishes them success in the challenges of career development.

UWRL Prepares

"Water Quality Insights" For Debaters

The nationwide topic selected for high school debate this fall is: "What the federal government should establish a comprehensive national policy to protect the quality of water in the United States."This opens an important opportunity to professionals, academics, and researchers in the water community.

The challenge prompted the UWRL to solicit information on water quality science and position papers on water policy from experts around the country.

Their responses were used to prepare 344 pages of "Water Quality Insights," in two volumes. The work attempts to capture the scientific and management issues of water quality control for development by the high school debaters of the United States.

The volumes introduce water quality protection as a debate issue and points to make in proposing a policy or to use in showing the inadequacy of a policy proposed by others. They then upon this theme with overviews of the political, legal, hydrologic, economic, environmental and pollution aspects of water quality control. Nine position papers are included with statements on important water quality issues.

The affirmative evidence is presented in three sections. They provide information on present policy inadequacies, components needed in a comprehensive policy, and the advantages to be gained through better policy. Each section is introduced with an overview of how plans can be defended in topics associated with numbered items of evidence (746 affirmative supporting items).

Handbook

A handbook for "Erosion and Sedimentation in Utah, A Guide for Control" has been completed by C. E. Israelson, J.E. Fletcher, F.W. Haws, and C.K. Israelson, and will soon be ready for distribution.

The handbook, which includes rainfall erosivity maps, was prepared for use in predicting erosion and runoff from disturbed sites. It also reviews the effectiveness of erosion control measures and commercially available products.

The handbook will be available at cost. Ordering information will be announced in the next Aquarius.
Instream Flow Report Completed

Water flowing in streams is valuable for recreati
ons, and is essential for fish and wild-
life. If these instream flows are increased in order to enhance recrea-
tion activities, what conflicts arise with established with-
drawals for such uses as agriculture, industries, and households?

In a recently completed study at UWR, an analytical model was used to display the tradeoff between the minimum loss in benefits to offstream water users when more water is preserved for various instream uses and the environmental gains. This type of information provides de-
cision makers with quantitative data for dealing with the growing water allocation issue.

A report on "A Methodology for Estimating In-
stream Flow Values for Recreation," has been completed by Kyle R. Cook, W. Dean Adams, Dennis B. George, Vincent A. Lamarra, and Richard A. Hanson.

In background, disinsection of municipal water supplies with chlorine has long been standard practice, however, chlorine reacts with organic compounds in water to form trihalomethanes (THMs), which have been shown to be carcinogenic or cancer caus-
ing. In order to protect the public, the Environmental Protection Agency has specified a maxi-
mum contaminant level of 100 µg/l for THMs in public drinking water supplies serving communities of

Cost effective compliance with this standard requires information on the amount and seasonal variation of production of organic compounds from mountain streams and reservoirs, correlation of this data with THM forma-
tion, and monitoring of THMs in the water supply networks. This information can then be used to develop a management plan for the demands were derived, and the corresponding compensating varia-
tions of consumers, from alteration of instream flow, were quantified.

A copy of the report, please request Water Resource Planning Series, UWRL/P-05/01. Cost is $5.00.

Aquarius
Utah Water Research Laboratory
Utah State University
Logan, Utah 84322-0200

Trihalomethane Compounds Study Completed

A report on "Evaluation of Trihalomethane Source and Production" has been completed by John H. Logan, R. Dean Adams, Dennis B. George, Vincent A. Lamarra, and Richard A. Hanson.

As background, disinsection of municipal water supplies with chlorine has long been standard practice; however, chlorine reacts with organic compounds in water to form trihalomethanes (THMs), which have been shown to be carcinogenic or cancer caus-
ing. In order to protect the public, the Environmental Protection Agency has specified a maxi-
mum contaminant level of 100 µg/l for THMs in public drinking water supplies serving communities of over 75,000.

Cost effective compliance with this standard requires information on the amount and seasonal variation of production of organic compounds from mountain streams and reservoirs, correlation of this data with THM forma-
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Utah Water Research Laboratory
Utah State University
Logan, Utah 84322-0200

Trihalomethane Compounds Study Completed

A report on "Trihalomethane Compounds and Their Precursors in Salt Lake County, Evaluation of Trihalomethane Source and Production," has been completed by Kyle R. Cook, W. Dean Adams, Dennis B. George, Vincent A. Lamarra, and Richard A. Hanson.

In background, disinsection of municipal water supplies with chlorine has long been standard practice; however, chlorine reacts with organic compounds in water to form trihalomethanes (THMs), which have been shown to be carcinogenic or cancer caus-
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Utah Water Research Laboratory
Utah State University
Logan, Utah 84322-0200
Researchers To Revise EPA Manual

Utah Water Research Laboratory has been awarded a contract to evaluate comments that EPA has received on a draft land treatment demonstration manual, review regulatory policy issues, and prepare a revised version of the guidance manual.

All owners/operators of hazardous waste land treatment facilities are required to perform a treatment demonstration to determine the effectiveness of their methods and site for the land treatment of specific hazardous wastes. A draft manual providing guidance, interpretations, suggestions, and references on treatment demonstrations was prepared and reviewed.

UWRL has been funded to evaluate and assess comments and policy issues and prepare the revised guidance manual for hazardous waste land treatment demonstrations.

Environmental engineers and soil scientists at UWRL have extensive experience in research concerning land treatment of hazardous wastes. Participating on the project are Ronald C. Sims, principal investigator and project leader; Judith L. Sims, research soil scientist, R. Ryan Dupont, research assistant professor, and Jean E. McLean, research soil chemist.

Cleave Named To Shuttle Crew

Astronaut Mary Cleave, former research scientist at UWRL, has been announced as a crew member for Space Shuttle Mission 61-B presently scheduled for launch in late November from the Kennedy Space Center in Florida.

The mission is scheduled for 7 days and its primary purpose is to deploy three communications satellites. Additional mission objectives are to conduct two extravehicular activities to study space construction techniques and to continue with experimentation of the Continuous Flow Electrophoresis System (CFES).

Other astronauts are Brewster Shaw, Bryan D’Connor, Woody Spring, and Jerry Ross. They will be accompanied by Rodolfo Neri Vela who will conduct experiments on behalf of his native country, Mexico, and Charlie Walker from McDonnell Douglas who will operate the CFES.

More Alternatives Studied For Great Salt Lake

UWRL researchers have been assisting the Utah Division of Water Resources in evaluating various possible management alternatives for the easterly portion of the Great Salt Lake.

The study team included D. George Chadderdon, Jr., J. Paul Riley, Alberta J. Seierstad, Darvin L. Sorensen, and Norm Stauffer.

Two possible in-lake diking configurations were evaluated. One was an enclosure of the Farmington Bay by a dike extending southward from the southern tip of Antelope Island and a second dike following the route of the now submerged Syracuse Causeway.

The second was enclosure of the easterly portion of the lake (continued on page 4)
From the Director....

Debaters Consider Government Role In Protecting Water Quality

Many Aquarius readers will be contacted by high schoolers preparing debate cases for and against a resolution "That the federal government should establish a comprehensive national policy to protect the quality of water in the United States." Many of us have perspectives that we would like to convey to them and wonder how we can do it effectively.

The last issue of Aquarius described the "Water Quality Insights" that UWRL prepared for distribution. It presents a valuable starting point for high school debaters. Effective interaction by Aquarius readers with these inquiring students however, can do much more.

Some ideas for meeting particular needs are:

1. Informal debates. Invite high school debaters to your office for "debate evidence sharing." By this time, the good debaters will have cases prepared and would very much appreciate an opportunity to discuss their ideas with water experts. Small group talks can be particularly effective as a natural reluctance of the debaters to share their ideas before rivals.

2. Technically sound judging. Identify knowledgeable professionals who would be willing to debate judges, and work with your state debate coordinators in placing these individuals in key meets (usually held on Fridays and Saturdays). Without technically qualified judges, meets will be decided by rhetoric.

3. Pick up good ideas. Attend debate meets, particularly the finals, and listen. Environmental protection needs fresh ideas, and this exercise is sure to create some good ones.

As members of the water resources community, we should be pleased to assist debaters and debate coaches with information on this very complex set of scientific, economic, political, and legal issues that surround water pollution control policy.

Let's let the high schoolers know we're concerned with their "water education" and support them as they prepare material for this debate season.

L. Douglas James

UWRL Participates In Wasatch Front Water Management Study

The Wasatch Front area of Utah is one of rapid population expansion and limited available water supplies. As part of the ongoing effort to meet predicted tremendous water supply needs, the Utah Division of Water Resources and U.S. Bureau of Reclamation are now jointly completing a comprehensive water resource planning effort entitled the "Wasatch Front Total Water Management Study."

The purpose of that study is to evaluate the presently developed and potential water supplies along the Wasatch Front in order to achieve better water management and utilization of the resource.

As part of the "Wasatch Front Total Water Management Study," Vaughn Hansen Associates in association with CH2M HILL and the Utah Water Research laboratory were selected to complete an "Identification and Assessment of Certain Water Management Options for the Wasatch Front."

This study included an analysis of three selected water supply options: 1) water reuse, 2) dual water systems, and 3) groundwater development. For each option present levels of development were assessed and quantified, constraints to further development were determined, and a preliminary range of costs for the development of each option were projected.

UWRL researchers participating were Trevor C. Hughes and L. Douglas James.

More information on this study can be obtained from the Utah Division of Water Resources in Salt Lake City.

THM Precursors Studied

In Deer Creek Reservoir

Megan J. White and V. Dean Adams have completed a report entitled "A Study of Trihalomethane Precursors in Deer Creek Reservoir."

Deer Creek Reservoir is a multiple use reservoir located below Heber City, Utah, on the Provo River. It serves as a drinking water source for metropolitan Salt Lake City. Treated drinking water from the reservoir has consistently had high levels of trihalomethanes, sometimes exceeding standards established by EPA. The reservoir has a high nutrient input and is experiencing accelerated eutrophication.

Studies characterizing water quality and examining alternatives to protect it are being coordinated by the U.S. Bureau of Reclamation and the Utah Department of Health.

In this study, Deer Creek Reservoir and tributaries were monitored from May to December 1983 for the occurrence of trihalomethane (THM) precursors in the reservoir and nutrient dynamics of the reservoir system.

Microcosms were used to study the effect of phosphorus loading, sediment, algal growth, and application of algicide on THM precursor production in the reservoir system.

Results of the study will be incorporated into a reservoir operation strategy that will provide safe drinking water for Wasatch Front areas.

Copies of the report can be obtained by requesting Water Quality Series UWRL/Q-85/01 from UWRL Publications. Cost is $5.00.

AQUARIUS
a newsletter for the Utah Center for Water Resources Research
Utah Water Research Laboratory
Utah State University

Utah State University is committed to a policy of equal opportunity in student admissions, student financial assistance, and faculty and staff employment and advancement, without regard to race, color, religion, sex, age, national origin, or handicap.
- NEWS NOTES -

New faces at Utah State University this fall include Vijay K. Gupta and William J. Doucette.

**Gupta**

Dr. Vijay K. Gupta has joined the UWRL staff as Visiting Professor of Hydrology from the University of Mississippi, Oxford. Dr. Gupta has been active in research in water and solute transport in porous media, statistical modeling of space-time rainfall, and analytical modeling of hydrologic processes.

Dr. Gupta is the author of numerous publications in space-time rainfall, hydrologic response at the basin scale, stochastic structure of floods and droughts, theory of water transport in unsaturated soil, and solute transport in porous media. His expertise will be used to expand UWRL research capabilities in building a stronger program advancing theoretical hydrology for practical water resources management applications.

He received the Ph.D. degree in Hydrology in 1973 from the University of Arizona, and the M.S. degree in 1971 from Colorado State University.

**Aquarius** extends a warm welcome to Dr. Gupta.

**Doucette**

Dr. William J. Doucette has joined the UWRL and Civil and Environmental Engineering Department as Assistant Professor.

Dr. Doucette has just completed a PhD program in Organic Chemistry at Texas A&M University.

**Aquarius** welcomes Dr. Doucette to our campus.

**Sabbaticals**

Dr. Daniel H. Hoggan, professor of civil and environmental engineering, is on sabbatical leave September 1, 1985, to August 31, 1986, to work again with the Hydrologic Engineering Center, U.S. Corps of Engineers, Davis, California.

At the Engineering Center, Dr. Hoggan will perform research and technical assistance studies to improve the availability and application of hydrologic models and reservoir regulation models to water resources planning and management.

Duane G. Chadwick, associate professor of electrical engineering, is on sabbatical leave from UWRL August 1, 1985, to June 30, 1986.

Professor Chadwick is teaching at California State Polytechnic University, San Luis Obispo.

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**Attention Aquarius Readers!!**

You have been receiving *Aquarius*, a bimonthly newsletter of the Utah Center for Water Resources Research and the Utah Water Research Laboratory at Utah State University.

We hope you have enjoyed reading the water news we have reported and we want to keep you on our mailing list to receive future issues.

If you wish to continue to receive your free *Aquarius*, or to change your name and address, now is the time to do it. Please send this copy back with your instructions.

Yes, continue to send me the *Aquarius* newsletter.

Please correct my address label as I have indicated.

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Utah Water Research Laboratory
Utah State University
Logan, UT 84322-8200
More Alternatives Studied For GSL

(continued from page 1)

by three in-lake dikes, with the first extending southward from Antelope Island as in the first configuration, the second connecting Antelope and Fremont Islands, and the third extending north from Fremont Island to Promontory Point. Under this configuration all flows of the Bear and Weber Rivers would enter the impounded area.

Based on the results of this study, it appears that Farmington Bay could be freshened to salinity levels generally not suitable for freshwater recreation (3000 mg/l) only by importing very large quantities of fresh water from the Weber River system. The effect of natural concentration, by evaporation from the normally large surface area of the bay, is sufficient to keep the bay at salinity levels generally not suitable for freshwater use.

The researchers caution that attempts to lower the salinity concentrations of Farmington Bay could have some adverse impacts. They say that for more than a hundred years Farmington Bay has been the eventual repository of wastes from several population centers along the Jordan River and other communities adjacent to the bay, and natural inputs of nutrients and organic matter has occurred over geologic time. The high salinity levels have greatly inhibited the adverse effects normally resulting from high nutrient loadings.

The researchers suggest an alternative management option of attempting to maintain high salinity levels within the impoundment to inhibit biological activity.

Equilibrium salinity levels in the East Bay impoundment are less than those of the Farmington Bay (1400 mg/l) because of the combined large volumes of freshwater inflows from all three major surface tributaries of the Great Salt Lake. This study indicates that non-selective mixing of the three streams and concentrating effects of evaporation losses, result in water salinity levels which are too high for municipal and industrial purposes.

With respect to organic decomposition activity and the associated odor production, increased biological activity would result from freshening the waters along the east shore of the Great Salt Lake, particularly in the Farmington Bay area and causing odor and algae problems. If this management option were pursued as opposed to maintaining high salinity levels, additional water quality studies would be needed to develop an effective management plan, the researchers say.

Criteria Developed For Sensitizer Design

A report entitled "Development of Design Criteria for Sensitizer Photooxidation Treatment Systems" has been completed by Richard J. Watts, V. Dean Adams, and T. Joe Middlebrooks.

The reported research succeeded in developing engineering criteria for the design and operation of sensitized photooxidation lagoons to treat toxic and biologically organic wastes.

Through use of these criteria, sensitized photooxidation pilot lagoons may be sized from information on incident radiation, temperature, and spectral quality of water in the influent stream.

With this design information industry will be in a better position to employ sensitized photooxidation waste stabilization ponds as an effective but inexpensive and low-maintenance alternative to traditional waste treatment.

Where these ponds can do the job, they may be able to reduce the cost to the industry of satisfying EPA requirements, provide them with a more effective treatment, and thereby provide a method to industry for more effective pollution control.

Copies of this report are available from UWR Publications. Please request Water Quality Series UWR/Q-85/02. Cost is $5.
20 Years Ago...

Quotes From The Dedication Of UWRL Facility

Dec. 6, 1965

George D. Clyde, former Governor of Utah: "An effective research program must be a balanced research program. First of all, there must be pure, or basic research—which is research not directed at a specific, pre-selected goal but rather aimed at discovering new facts about the laws of nature and their operation. Secondly, we must have a coordinated program of applied research, whose job it is to take the laboratory findings of the basic research and turn them into practical use. And finally, we should follow up with a broad and intensive program of putting the newly developed techniques and procedures to work. Abstract knowledge of what to do accomplishes little good if it is not used."

John C. Calhoun, Jr., Vice President for Programs, Texas A&M University (in 1964 he was responsible for setting up the Office of Water Resources Research in the Department of the Interior): "Just as within the reflections of a water pool one may see a panoramic landscape behind the viewer, so as we dedicate this building and its service, we can see the outlines of broader horizons and deeper commitments. It is not, therefore, solely the importance of water that I would cite to you as this dedication passes into history. This laboratory is set apart to water, but there are deeper commitments that have to do with the husbandry of all resources, with the problems of our environment, with the changing role of the university of which this laboratory is a part, and with the panorama of national-local relationships to which this experiment belongs."

Calvin L. Rampton, Governor of Utah: "As the population of the world doubles and re-doubles itself in the next century, water will become the life-and-death resource. Only with an intelligent and knowledgeable use of our world's limited supply of water will fields continue to produce food for our people, industry be able to produce jobs for our people, and cities be able to provide the convenience of water for their growing populations. To Utah, the Water Research Laboratory holds the promise of continued high availability of her limited water supplies, plus increased efficient usage of that supply for years to come."

Batty Resigns As UWRL

J. Clair Batty, associate director at the UWRL (half time) since November 1, 1982, has resigned this position, effective January 1986.

Batty says that he has "tried to do too many things in too many areas" and would now like to "streamline his focus in the mechanical engineering direction."

Associate Director

Besides his activities at the UWRL, Batty has been active in food engineering in the Nutrition and Food Science Department and teaching in the Mechanical Engineering Department. He joined the USU staff in 1963.

Aquarius sincerely wishes Dr. J. Clair Batty much success and the best of health in this redirection of career focus.

Advisory Council Members Retire

Three members of the 16-member Citizen Advisory Council for Water Resources Research are retiring this year.

Daniel F. Lawrence, director, Division of Water Resources (retired); Donald W. Zillman, director, Energy Law Center, University of Utah; and Reed C. Christensen, supervising, Manti-LaSal National Forest, have completed their terms of service on the Council.

Lawrence served on the council as director of the Division of Water Resources since 1976. The other two each served two 3-year terms.

The retiring members have provided valuable service on updating program objectives and improving research performance while they served on the CAC, which was created to provide guidance on water resources research programs administered on the Utah State University campus.

Aquarius extends a special and well earned "Thank You" to these citizens.

New members being added to the council include D. Larry Anderson, director, Division of Water Resources; Ray J. Davis, J. Reuben Clark Law School, Brigham Young University; Bob Morgan, state Engineer, Division of Water Rights; and J. Kent Taylor, forest supervisor, Fish Lake National Forest.

Aquarius welcomes these new members to the Citizen Advisory Council.
Water Literacy Goal Of Educational Materials

"Water Education," a 166-page activity book designed for use by students from kindergarten through 6th grade, has been developed and produced by the International Office for Water Education at UWRL.

Donald R. Daugs, professor of elementary education, and C. Earl Israelsen, professor at UWRL, are authors of this effort to increase water literacy.

"Many future political issues will involve water," Daugs says. "When students get out of high school they should be able to vote intelligently with regard to the issues."

Materials required for the activities outlined in the book are simple and usually available at a school.

For example, a kindergarten activity designed to teach children about the properties of water, involves painting the principal's car with water and large paintbrushes and watching the water evaporate. Activities for older children add an understanding of the Earth's water cycle, the importance of water to all living things, and the principles of water conservation and management.

"We wanted to develop an appropriate curriculum that is scientifically accurate and correct," Daugs said, "in contrast to propaganda or material that may be put out by special interest groups."

Widespread use of these excellent materials requires teacher familiarity. Daugs and Israelsen will coordinate in-service training for teachers. Facilitators have been trained throughout the state. So far, 19 school districts in Utah have contracted for in-service training, and a number of requests have been received from out-of-state.

Funding of $55,000 from the Utah Division of Water Resources and other sources was used last year in developing the materials and field-testing training activities. The Division is also a member of the Utah Water Education Advisory Committee, Daugs said.

Daugs and Israelsen have applied for $150,000 from the states through members of the Western States Water Council to develop curriculum materials for secondary students, and for expanding the training of in-service teams to cover a much larger area.

The book is sold for printing and mailing costs of $2.75 each, and is available from the Publications Office, Utah Water Research Laboratory, Utah State University, Logan, UT 84322-8200.

Landslide Proceedings Now Available

The Proceedings of the Specialty Conference on "Delineation of Landslides, Flash Flood, and Debris Flow Hazards in Utah" edited by David S. Bowles, has now been printed.

The two-day conference was held at Utah State University in June 1984. It included over 50 technical presentations, overview papers by four keynote speakers, and an opening address. Themes covered geological hazards, flood hazards, mitigative measures, emergency preparedness/response and a special session on the Thistle landslide.

The conference was co-sponsored by 11 federal and state government agencies and professional societies, including: U.S. Geological Survey, Federal Emergency Management Agency, U.S. Bureau of Reclamation, National Research Council Committee on Natural Disasters, the Utah Section of the American Society of Civil Engineers, Utah Science and Technology Council, Utah Geological and Mineral Survey, National Weather Service, and U.S. Forest Service, as well as UWRL.

It attracted 226 professionals from all parts of the United States, including leading experts in flooding, landslides, stream hydraulics, protective watershed management and the social, legal, and political aspects of emergency and remedial programs.

A copy may be ordered by writing to Publications: Utah Water Research Laboratory, Utah State University, Logan, UT 84322-8200. Please enclose a check for $30 payable to Utah Water Research Laboratory, or provide invoicing instructions.

NSF Awards Grant To Researchers

The National Science Foundation has awarded a grant of $111,012 to support a study at UWRL entitled "Stochastic Interpolation of Precipitation Data from Multiple Sensors."

The goal of the research is to investigate using stochastic interpolation techniques for merging precipitation data from three sensors: raingages, radars, and satellites.

The project is under the direction of David S. Bowles, Christopher J. Duffy and Witold F. Krajewski, is for the period September 15, 1985, to February 19, 1988.

Dr. Krajewski and others at the National Weather Service headquarters in Silver Springs, Maryland, are working with UWRL in developing fundamental techniques for taking full advantage of modern electronic instrumentation capabilities in improving flash flood forecasting reliability.

The merged analysis of precipitation data coming from more than one type of sensor, hence representing different characteristics of the precipitation process, will provide more accurate space-time representations of rainfall. Since rainfall is the driving input parameter to various hydrologic models, greater estimation accuracy should result in large economic benefits.

Under this project, linear and nonlinear interpolators for stationary and non-stationary spatial processes will be studied. Emphasis will be on comparing new techniques with the methods currently in use using synthetic spatial precipitation data.

AQUARIUS a newsletter for the Utah Center for Water Resources Research
Utah Water Research Laboratory
Utah State University

Utah State University is committed to a policy of equal opportunity in student admissions, student financial assistance, faculty and staff employment and advancement, without regard to race, color, religion, sex, age, national origin, or handicap.
NEWS NOTES


The 3-day conference, sponsored by the U.S. Environmental Protection Agency, The National Science Foundation, The American Academy of Environmental Engineers, and NUS Corporation, provided a worldwide mix of professional delegates from industries, consulting services, research facilities, colleges, universities, and government agencies.

J. Paul Riley is visiting China and Hong Kong as leader of the Riley Delegation for the U.S.-China Scientific Exchange through the American Water Resources Association. Dr. Riley is presenting papers on solar ponds at the various exchange meetings.

Trevor C. Hughes, Robert Hill, Lyman Willardson, and Wynne Walker were at Rabat, Morocco, during September, on an AID sponsored program for improving the staff and curriculum at the Institute of Agronomy there.

Personnel Changes

Edward C. Waymire has joined the USU staff as a visiting associate professor with a joint appointment in the Mathematics Department and at UWRL. His one-third time UWRL assignment will involve work with Dr. V.J. Gupta on building a stronger program for advancing theoretical hydrology for practical water resources management applications.

Dr. Waymire is on leave from Oregon State University at Corvallis. He received his degrees in mathematics, the BS from Southern Illinois University, and the MS and PhD from the University of Arizona.

Philip DeGroot, UWRL research scientist working on a joint project between UWRL and the Agricultural Research Service Northwest Watershed Research Center at Boise, Idaho, has accepted a position on the faculty of Drexel Institute of Technology, Philadelphia, PA.

Mountainside processes that originate landslides such as this one in Ward Canyon near Bountiful, are the subject of a joint study between UWRL and the Utah Geological and Mineral Survey.

Landslide Processes Topic Of Joint Study

A joint study of landslide processes in Utah is monitoring hillside stability and landslides and debris flows. The Utah Water Research Laboratory and the Utah Geological and Mineral Survey are cooperating in event mapping, field monitoring, and modeling.

This project will identify, define, and classify conditions that initiate shallow landslides in steep mountain depressions and propagate continued soil movement down the slopes and onto developed lands below. The resulting risk analysis will provide better hazard definition and faster more effective hazard mitigation procedures, the researchers say.

The importance of this research was brought to light in the spring of 1983 when many landslides occurred along the Wasatch Front.

The research will provide better measurement of the quantity and processes that 1) originate mass wasting and extend debris runout downslope, 2) transport loosened material to the base of the mountains, and 3) spread the hazards in the urban areas below. This process quantification will be combined with inventory to catalog valid information on slope, stream, and alluvial fan conditions.

The concentrated effort will be on the mountainside processes that originate slides and debris flows. The transport modeling and hazard mapping effort will use models now in the final stages of development at UWRL for identifying hazard areas and mapping risk levels within them.

Participating on the USU phase of the study are Loren Anderson and L. Douglas James as principal investigators, with Jeffrey R. Keaton, Roland W. Jensen and David S. Bowles.

Jan Surface, research aide in water quality, has left UWRL to return to school, and Susan Knight, lab technician in water quality, has accepted a position as a post graduate at Skidmore College in Saratoga, NY.

Aquarius wishes them success in their new career developments!

Don L. Brakensiek, Agricultural Research Service, Northwest Watershed Research Center, Boise, who has had an adjunct faculty appointment at UWRL, has announced his retirement for the end of December. Aquarius extends warm wishes for a productive retirement.
USU Grads Win Awards For Water Research

Two graduates of Utah State University, Robert E. Hinchee and Kenneth H. Solomon, have been recognized for their outstanding doctoral research by the Universities Council on Water Resources (UCOWR).

"USU has won far more of these awards over the last several years than any other university nationwide," said L. Douglas James, UWRL director.

Dr. Hinchee, an environmental engineer, was cited for his dissertation on "Groundwater Movement of Mutagenic Compounds in Spent Oil Shale," completed under the guidance of W. Dean Adams. He also received a bachelor's degree from USU and a master's degree from Louisiana State University. He is employed at EA Engineering Science and Technology, Inc., Sparks, MD, where he evaluates groundwater contamination from petroleum fuels and designs cleanup programs.

Dr. Solomon's research project in agricultural and irrigation engineering was titled "Irrigation Uniformity and Yield Theory," and provides a way to relate the uniformity of irrigation to crop yield.

Dr. Solomon is acting director of the U.S. Department of Agriculture Salinity Laboratory in Riverside, CA. His bachelor's and master's degrees, from Harvey Mudd College and Claremont Graduate School in Claremont, CA, are in mathematics. His major professor at USU was Jack Keller.

UCOWR, with headquarters at the University of Nebraska, Lincoln, is an organization of universities devoted to encouragement of education and research in water resources.

The UCOWR recognition carries a $200 cash award for each recipient.

Erosion Handbook Now Available

A handbook on "Erosion and Sedimentation in Utah, a Guide for Control" has been completed by C. Earl Israelson, J. L. Fletcher, F. W. Haws, and E. K. Israelson, and is now available for distribution.

The handbook, which contains rainfall erosion maps, was prepared for use in predicting runoff and erosion from disturbed sites, evaluating the effectiveness of possible erosion control measures and commercially available products, and selecting an appropriate control program for a given site.

It describes the factors influencing erosion and sedimentation, and presents a procedure for predicting sheet erosion. Several kinds of erosion are discussed, along with methods for control, and essentials of erosion control planning are listed.

To obtain a copy, please request Hydraulics and Hydrology Series, UWRL/H-84/03. Cost is $12.00. Address requests to Publications, Utah Water Research Laboratory, Utah State University, Logan, UT 84322-8200.

Subsurface Structures Baseflow Runoff Relationships Studied

A theoretical approach is being used to study the complex relationships between basin subsurface structure and baseflow runoff generation. The subject is currently receiving a great deal of attention in the research community.

The Agricultural Research Service Northwest Watershed Research Center, Boise, and UWRL researchers, are jointly launching a long-term study with two main objectives. The first is to characterize the multidimensional hydrologic processes, building from measurements on the Upper Sheep Creek Watershed near Boise, and the relation of these processes to the physical characteristics of existing landforms. The second is to implement a physically based saturated-unsaturated three-dimensional flow model for the simulation of the hydrologic response at the experimental site.

Project leader is Christopher Duffy. Working with him at the Boise site has been Philip DeGroot who recently completed his doctoral program, and Jim Walters, a PhD candidate. Participating from the Northwest Watershed Research Center are D. L. Brakensiek, T. Springer, and G. Stephenson.

USU researchers are working closely with ARS personnel and collaborate with various experts in the rainfall, snowmelt aspects of this study as well.
CAC Members Meet At UWRL

The Citizen Advisory Council to the Utah Center for Water Resources and the Utah Water Research Laboratory and the Campus Water Resources Research Council met at the UWRL December 16 for their annual fall meeting.

Using the successful meeting format introduced last year, L. O. James, UWRL director, reports that "the sessions were not just 'show and tell' but provided meaningful interaction between council members and faculty in identifying water problems and research directions."

A. Bruce Bishop, dean of the College of Engineering, welcomed the council, "You are the experts, the people who know Utah's water problems best," he said. "We have a strong faculty in water science and engineering to work with you on solving these problems."

Joe Melling, chairman of the CAC, and manager, Cedar City Corporation, said, "This council has a responsibility to coordinate research with action, to facilitate (Continued on page 2)

USGS Research Projects Selected

Five studies have been selected for funding through the cooperative program jointly supported by the USGS and UWRL. They include three continuing projects and two new ones.

"Management issues related to the Great Salt Lake continue as a major water problem for Utah," says L. Douglas James, UWRL director. "It is becoming increasingly clear that successful lake level control is going to require better understanding of the climatologic and hydrologic ties between the lake and the basin as a whole," he said.

Two of the five studies address the relationship between the lake and the large desert basin to its west.

One builds a base of scientific data and develops analytic methodology for using it in examining the hydrogeologic feasibility of controlling lake level by pumping water from the lake into the desert to evaporate upward of the present lake. This project, "A Comprehensive Study of Water Cycling in the Great Salt Lake Basin: Hydrogeology of the West Desert Region," is headed by Gail E. Bingham, associate professor in the Soil Science and Biomechatronics Department at USU. Working with him are Lawrence E. Hipp, assistant professor of the same department, J. Clair Batty, professor, Mechanical Engineering Department, Eugene K. Israelson, senior research engineer, and J. Paul Riley, professor, Utah Water Research Laboratory.

The evaporation from water ponded in the desert potentially adds humidity to the air mass moving across the lake and precipitation on the Wasatch Mountains whose snowmelt runoff is the major source of the runoff to the lake. Both factors contribute to rapid lake rise, and the relationships causing them need to be quantified for the design and assessment of the pumping scheme and other control options for the Great Salt Lake.

A major source of added flow into the lake in the last few years has been the desert basins to the west. Should the lake expand into that area, major changes will be made to a geohydrologic regime that is presently poorly understood. The second "lake" proposal is "A Conceptual Model of the Hydrogeology of Closed Desert Basins." Principal investigators are Christopher J. Duffy, assistant professor, UWRL; James Mcelhaney, assistant professor, Geology Department; and J. Paul Riley, professor, UWRL.

The goal is to develop a conceptual characterization and a mathematical model of groundwater circulation in a desert basin where relatively fresh water drains out of the mountains, infiltrates into porous basin margin materials, flows above and interacts across a steep density gradient with highly saline groundwater, and emerges in springs or seeps that flow into the desert playa, mix with the brines there, and eventually evaporate.

The water forced to the surface produces high humidity above the shallow water table areas and adds to downwind evaporation sup-

(Continued on page 3)
CAC Members

(Continued from page 1)

the implementation of research results to solve problems and to make wise use of water resources. In doing so, the experiences gained will lead to more effective water policies at federal, state, and local levels."

Council members actively participated in the research review. They presented research needs that they felt important and then interacted in discussions on current programs to express ideas and offer suggestions on research directions and dissemination of the results.

The emphasis on the Great Salt Lake in the research need presentations led to USU President Stanford Cazier opening the general discussion with comments on the effort really needed in controlling the level of the Great Salt Lake. After this, the group separated into reporting and discussion sessions.

Sessions were Cloud Seeding (presented by Geoffrey Hill), Instream Flow (L. D. James), Lessons from History (Jay M. Bagley), Hydrologic Hazards (David S. Bowles), Salinity (Christopher Duffy), Environmental Hazards (Ronald Sima), Water Education in Public Schools (C. Earl Israelsen), and Water Systems Operation (Glen Stringham and Trevor Hughes).

After the concurrent sessions concluded, the group reassembled to report and discuss the eight session deliberations. A demonstration debate by teams from Logan and Mountain Crest high schools, of this year's national debate topic, "That the federal government should establish a comprehensive national policy to protect the quality of water in the United States," concluded the day's activities.

CAC members are: Kenneth L. Alkena, director, State Division of Environmental Health; D. Larry Anderson, director, Division of Water Resources; Genevieve Atwood, director, Utah Geological and Mineral Survey; Ted Arrow, district chief, Water Resources Division, USGS; Sheldon H. Barker, Ch 2M Hill; Grace G. (Gigi) Brandt, League of Women Voters; Wayne D. Criddle, Clyde-Criddle-Woodward, Inc. (retired); Ray J. Davis, J. Reuben Clark Law School, Brigham Young University; Dee C. Hansen, executive director, Department of Natural Resources; Leonard H. Johnson, NRC Consultants; Lynn S. Ludlow, general manager, Central Utah Water Conservancy District (retired); Gayle F.

Jay M. Bagley discusses lessons from water history with CAC members.

Students from Logan and Mountain Crest high school debate teams debate the national debate topic of water quality for CAC members.

Annual Reports Now Available

The 1985 Annual Report of the Utah Water Research Laboratory and Center for Water Resources Research, combined with the Agricultural and Irrigation Engineering and the Cooperative Fisheries Research Unit, is now available for distribution.

The report contains the director's report, a sentence outline of each project in the total research program, a one or two page description of each of the research projects active during fiscal 1985, and a listing of publications for the year.

A Summary Annual Report is also available. It contains only the sentence descriptions of the active research projects along with the director's report, publications list, and staff.

Both Summary Annual Report and Annual Report are available from Publications, Utah Water Research Laboratory, Utah State University, Logan, Utah 84322-8200. There is no charge.
USU Scientists Measure Snowpack Using Satellites, Artificial Intelligence

Using satellite information, computers, and skis, Utah State University scientists are creating models for measuring snowpack within northern Utah snow basins, with the aim of generating more accurate runoff forecasts.

Snowmelt is the major source of water supply for many regions of the western United States, according to Robert W. Gunderson, USU mathematician.

If basinwide snowpack amounts, and distributions, can be measured accurately, runoff can be better predicted. Better water management decisions can be made to protect the public from floods or consequences of drought.

Gunderson and USU hydrologist David S. Bowles are using artificial intelligence to create snowpack models that take into account many factors in the extremely varied conditions in mountain snow basins. Landsat satellite data are processed to create a television screen image of the Cache Valley area.

Brightness differences tell the researchers soil types, plant types and plant densities, all factors that influence snowpack accumulation and melt.

Elevation, slope steepness, and the direction the slope is facing are added to the models by superimposing the satellite maps onto topographic maps.

"We can estimate critical snowpack properties from existing Landsat multispectral measurements, providing that data are properly combined with non-satellite information," Gunderson said.

They are creating computer models that "learn" from a set of "training data" how to estimate snowpack properties, such as snow depth and water content with the satellite information.

Gunderson and Bowles are identifying optimal sites for making land-based measurements of snow. Existing measuring stations, often located for convenience, may not be the best sites for gathering predictive data, Gunderson said.

Soon the researchers will be skiing to selected sites where they will take snow measurements to compare with the satellite data.

"We hope to follow this initial investigation with one designed to provide estimates over a much larger area than our current study basin in the Kellowsville Mountains," Gunderson said. "Instead of skiing to measurement sites, we plan to locate remote sensing units at a small number of previously determined optimal locations, and have the data transmitted back to the USU satellite downlink."

Ultimately, our goal is to be able to obtain reliable estimates of these critical snowpack measurements over the entire region of large mountain snow basins, from the information transmitted from only a very few optimally placed remote measuring stations."}

USGS Research Projects Selected

(Continued from page 1)
Grad. Studies Secondary Wastewater Disinfection By Ultraviolet Light

Secondary disinfection of wastewater by ultraviolet (UV) light can be cheaper, safer, and as effective as chlorination if certain guidelines are followed, says USU graduate student Eva Czarnecka-Nieminska, who recently completed a PhD degree in civil and environmental engineering.

Eva studied the effectiveness of different UV light dosages in inactivating bacteria in wastewater.

Chlorination, although a popular disinfection method, has its disadvantages. Chlorine forms suspected cancer-causing compounds and is toxic to aquatic life. Taking into account the costs of dechlorinating water with sulfur dioxide, UV treatment can be cheaper, Czarnecka-Nieminska said.

Ultraviolet light is high-energy radiation capable of breaking molecules in living things. The lower energy of light in the visible spectrum, on the other hand, can be captured and used by living things—in plants for photosynthesis, and in animals for vision.

"UV has been used for years to disinfect water, but people don't know enough about how it might be used. I was looking at the factors that control its efficiency as a disinfectant."

The most important factors, Czarnecka-Nieminska found, were the sizes and amounts of suspended solids in the water, and the ability of the bacteria to reactivate when exposed to sunlight, a process known as photoreactivation.

If many large particles are suspended in the wastewater, bacteria cling to them and are protected from the UV light. Elimination of the larger particles by filtration makes subsequent UV treatment more effective, she said.

Initially, exposure to UV inactivates 99 percent of the bacteria in the water, but not all die. About 20 percent of the bacteria will re-activate, both in dark conditions and under exposure to long light wavelengths.

Ultraviolet light causes the production of molecules known as dimers in the genetic material, tying it up so that the bacteria cannot grow or divide. Under dark conditions or long light waves, repair enzymes are activated that break down the dimers.

The bacteria most often used as indicators of wastewater quality, coliform bacteria and streptococci, are quite susceptible to UV light, she said.

However, bacteria such as Micrococcus luteus are extremely UV-resistant. "If UV is applied," Czarnecka-Nieminska recommends, "we shouldn't use the normal indicators. We should use Micrococcus."

Czarnecka-Nieminska, 33, is a native of Warsaw, Poland. She holds master's degrees in environmental engineering from the Warsaw Technical University and the University of Notre Dame, and has done research at the Polish Academy of Science and the Warsaw Institute of Meteorology and Water Management. Her PhD work at USU was under the direction of R. Ryan Dupont.

Telemetry Options Report Topic

"Remote Control of Hydrometeorological Devices" is the title of a report recently completed by Geoffrey E. Hill, Wayne Lofthouse, Hans Leinemebner, and Hans Rodrigues de Miranda.

Collecting data from remotely located sensors and controlling remotely located devices poses practical problems in communication that must be solved for more efficient water management. This report examines various options for data acquisition and remote control as illustrated by hydrometeorological applications.

These options include telemetry by radio or telephone using various communication modes. These include one and two way RF links, line-of-sight systems, repeaters, telephone, meter scatter and satellite systems. Each of these approaches is examined according to availability of equipement, frequency allocations, costs, and other factors.

A detailed description of a communication system for data acquisition for remotely located sensors is given. This low cost system combines RF and telephone. Another system for controlling remotely located devices is also described. Both systems may be operated effectively in mountainous terrain and other remote areas.

To obtain a copy of the report request Atmospheric Water Resources Series UWRL/A-85/01. Cost is $3.00