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Currents

A Newsletter of the UC Center for Water Resources

In This Issue

Officials and Scientists Still Seeking Agricultural Drainage Solutions

By John Letey

A plan to provide drainage to the San Luis Unit remains unresolved almost two decades after the observed waterfowl deaths and deformities at Kesterson Reservoir that derailed the originally planned 188-mile San Luis drain to transport the drainage waters into the bay. Since the closure of Kesterson Reservoir, adequate drainage service has not been available for more than 600,000 acres of irrigated farmland served by the federal project. A ninth circuit court of appeals decision in 2000 reaffirmed the United States Bureau of Reclamation's (USBR) obligation to provide drainage service. The court's directive stated "Reclamation... shall without delay, provide drainage to the San Luis Unit, pursuant to the statutory

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EDITORS
Sue McClurg
Rita Schmidt Sudman

WRITER
John Letey

EDITORIAL ASSISTANCE
Pamela Dick

PHOTOS
California Departmentof Water Resources
Rita Sudman
U.S. Bureau of Reclamation

GRAPHICS AND LAYOUT
Curtis Leipold

The UC Center for Water Resources is a multicampus research unit and special program within the University of California's Division of Agriculture and Natural Resources. The Center is charged with stimulating and coordinating research and information dissemination on a wide variety of issues related to California's water resources.

University of California, Riverside
Rubidoux Hall - 094
Riverside, CA 92521
Phone 909-787-4327
Fax 909-787-5295
e-mail cwres@ucrac1.ucr.edu
internet www.waterresources.ucr.edu

Director's Message *by John Letey*

Cooperation Needed to Solve Drainage Problem

Completion of the San Luis Drain to carry agricultural subsurface drainage waters to the Bay was halted by the bird damage at Kesterson Reservoir. The San Joaquin Valley Drainage Program (SJVDP) was established shortly after the Kesterson experience to develop short-range and long-range plans for solving the salinity-toxics-drainage problems of the western San Joaquin Valley. One major constraint placed on the SJVDP was that all alternative plans were to be restricted to in-valley solutions. A National Research Council committee that reviewed developments and provided technical advice expressed strong dissatisfaction with the political influences that directed SJVDP to look for only in-valley solutions. They stated, "This constraint is not scientifically based." The criticism of the constraint was not based on the belief that the out-of-valley discharge was necessarily superior to in-valley disposal, but simply that the option deserved scientific and economic scrutiny.

Today, the U.S. Bureau of Reclamation (USBR) is under court order to provide drainage to the San Luis Unit without delay. In essence, the USBR is in the same position that the SJVDP was more than 15 years ago. There have been essentially no scientific or economic studies devoted to the out-of-valley disposal option during the intervening period. Political opposition remains strong.

I firmly believe that the time has come to absolutely eliminate discharge to the ocean or the Bay as options. This position is not taken on scientific and economic merits (that information is lacking) but because even under the best of circumstances it will take decades to provide the discharge. During this period of time, there would be irreparable damage to many agricultural lands without facilitating alternative options. Furthermore, it does not comply with the court order to provide drainage "without delay." Complete attention should now be focused on the in-valley plan. Except for deep well injection (an option that I believe has very limited utility) the USBR in-valley disposal option requires evaporation basins of some

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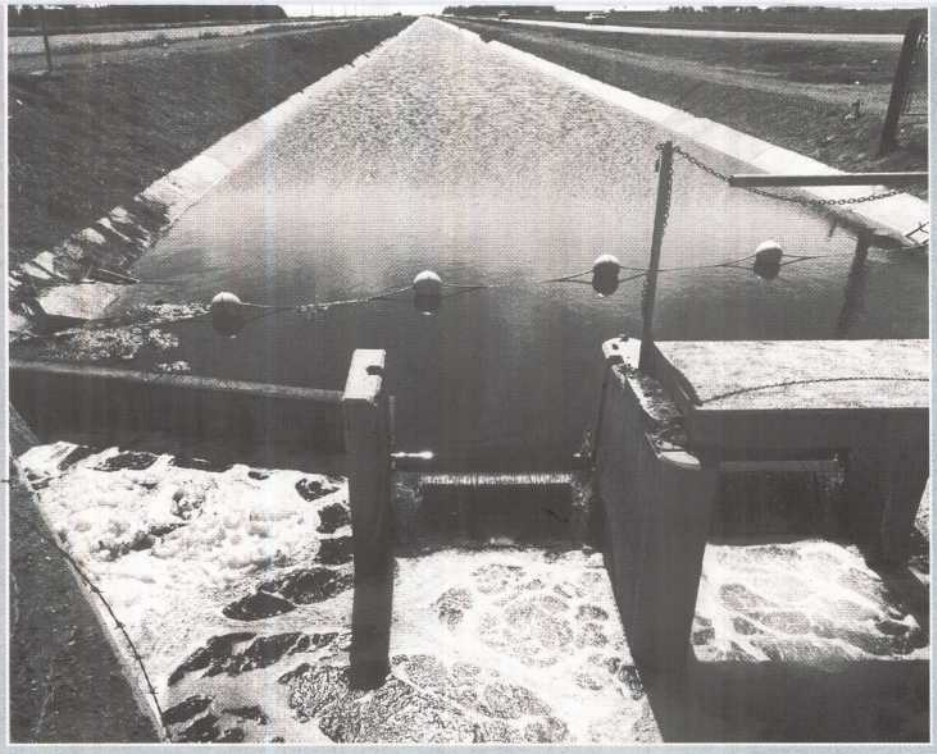
duty imposed by Section 1(a) of the San Luis Act."

In response to the court order, the USBR is working to formulate and implement a plan that supports sustainable agriculture by providing agricultural drainage service that achieves long-term, sustainable salt and water balance in the root zone in irrigated lands.

At the March 26-27 annual UC Salinity Drainage Program and Department of Water Resources Meeting held in Sacramento, speakers the first day addressed this charge.

Jason Phillips (USBR) summarized the progress being made toward meeting the court order. Within the process of developing alternatives and options, the USBR considered it necessary to estimate the amount of drainage service needed, i.e. the volume and quality of drain water that would be discharged if drainage service were provided. Gaining this information, however, is complicated by the fact that the answer can vary over a large range of values depending upon the irrigation, drainage, and drain water reuse management that the farmer may adopt. Management can dictate the amount of drainage service, but cannot negate the need.

The identified ultimate salt disposal options by USBR are the Pacific Ocean or Delta (out-of-valley disposal options) or landfills (in-valley disposal). The in-valley disposal option, however, requires evaporation basins as a component of the system prior to disposal in landfills. The re-evaluation is on schedule to publish an alternatives report, identifying a preliminary preferred alternative, by December 2002 and to complete environmental documentation in 2005.



Construction of San Luis Drain, above, began in 1968, but was halted in 1975.

Reusing drainage water for irrigation is one means of reducing the volume for ultimate disposal. The sequential use of drainage waters on crops reduces the volume but increases the salt concentration. Dr. Bill Jury (UC Riverside) reported that developing management plans for drain water concentrations cannot be based on steady state considerations. Because of large travel times, the concentration of water collected in the drainage system would be different than the concentration of water leaving the crop root zone for several years. He provided a theoretical basis for estimating the transient time drainage water concentration.

Using Dr. Jury's analyses on travel times, Dr. John Letey (UC Riverside) simulated the long-term consequences of a farm system that included irrigating salt-sensitive crops with good water followed by irrigating salt-tolerant crops with a combination of drainage and good waters and eventually disposing the drainage in evaporation basins. The imposed conditions consistent with common farmer goals included planting only economic crops and restricting yield reductions to less than 10 percent. This system was found to be physically sustainable for centuries. The economic sustainability will be largely predicated on the costs for the evaporation basins and these costs will be greatly dictated by regulations.

Drain water management strategies include source control, reuse, treatment and evaporation ponds. Questions of interest addressed by Dr. Keith Knapp (UC Riverside) were efficient management, policy instruments, and sustainability. A high level of source control is indicated without reuse due to the relatively high cost of evaporation ponds; this is accomplished largely through high uniformity/high cost irrigation systems. With reuse, the

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primary form of source control is reduction in land area devoted to freshwater production; the released land goes to reuse production.

Reuse appears as an economically promising solution to the drainage problem. Positive net returns are achieved while maintaining overall hydrologic balance in the system. Economic efficiency and hydrologic balance may be attained through pricing or market schemes. With pricing, growers are charged for deep percolations flows, while reuse and evaporation pond operators are paid for extractions. With markets, permit supply is generated by extractions from the water table, while permit demand is generated by deep percolation. Competitive equilibrium exists, is efficient, and implies hydrologic balance. The analysis suggests that agricultural production may be possible for some period of time while still maintaining environmental quality.

Drainage ponds' hazard to birds is their biggest drawback as an ag drainage solution.

Because in-valley disposal options entail the use of evaporation basins, the afternoon session was devoted to presentations on the scientific and regulatory factors associated with evaporation basins.

Dr. Ken Tanji (UC Davis) reported on the scientific knowledge concerning selenium in water, sediments and evaporites in evaporation basins. Although selenium should become concentrated by evaporation, much of the selenium is tied up in the organic detrital layer in the pond bottoms and its underlying mineral sediments, as well as in evaporite salts formed in the mature basins. Much of the selenium at the pond bottoms is in the reduced form. Research is needed to determine how much of this tied up organic selenium and elemental selenium may become bioavailable to aquatic food chain.

Selenium ecotoxic risk reduction in evaporation basins was the topic of Dr. Teresa Fan's (UC Davis) presentation. She and her colleague, Dr. Rick Hagashi, found that selenium is volatilized by microalgae isolated from the Tulare Lake Drainage District basins and that selenium volatilization is most significant in the hyper-saline basin cells. They are exploring the approach of coupling selenium volatilization with foodchain disruption by exhaustive microinvertebrate harvest. The harvested material, such as brine shrimp, already has good market value and is exported out of the San Joaquin Valley. The preliminary results are encouraging.

Hazard to birds is the greatest deterrent to the utilization of evaporation basins for drainage water disposal. Joe Skorupa (US Fish & Wildlife Service) presented extensive information gained through years of study on the effects of selenium on birds and then summarized the Fish and Wildlife Service perspective on evaporation ponds. He pointed out that evaporation basins are attractive nuisances for birds. Birds are attracted to the water and do not recognize the potential damaging effects of the selenium in the water on reproductive impairment including teratogenesis and other chronic effects. The USFWS policy is that evaporation basins are to be "bird free or bird safe."

The results of actions to reduce bird impacts on evaporation basins and to create compensation habitat at Tulare Lake Drainage District were reported by Dr. Charles Hanson (Hanson Environmental Inc.). Actions, such as increasing interior levee slopes, removing windbreak islands and other shallow-water areas, management to increase water depth, removal of tires used for levee stabilization, levee vegetation control, and increased bird hazing have had a combined effect on reducing the bird usage on the South and Hacienda Evaporation Basins. The

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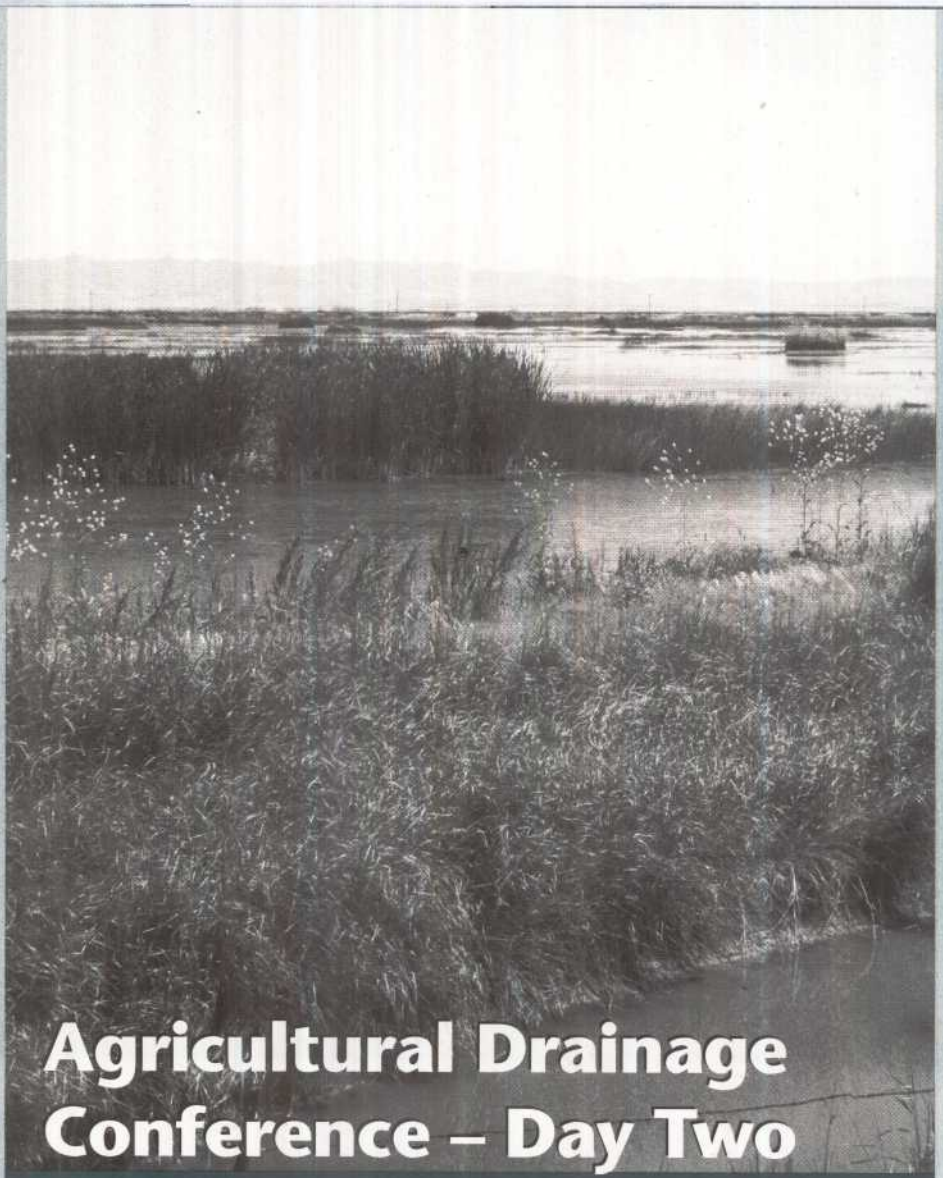

Agricultural Drainage Conference – Day Two

Reports on DWR Projects

The second day of the UC Salinity/Drainage Annual Meeting featured update reports on research projects funded either fully or partially by DWR through Proposition 204 (Drainage Sub-account) or by the Agricultural Drainage Program. The Proposition 204 Program was authorized by Section 78645 of the Safe, Clean, Reliable Supply Act of 1996 (Proposition 204, Drainage Reuse Sub-account). Proposition 204 finances research proposals submitted by qualified public agencies interested in developing methods to reuse subsurface agricultural drainage water. Projects are selected for funding through a competitive review process.

Jose Faria, manager of DWR's Agricultural Drainage Program, moderated the program that featured 18 speakers covering a wide array of topics. All provided valuable information for developing management plans to cope with the salinity-toxics-drainage issues in the western San Joaquin Valley.

Speakers summarized drainage water treatment technology projects (1) a desalinization pilot demonstration project, (2) update on the algae-bacterial selenium removal facility and (3) the use of granulated activated carbon for selenium removal. The conclusion from the granulated active carbon research is that it did not work.

Recovery, purification and utilization of salts from agricultural drainage waters have been studied. Most attention has been given to the utility of sodium sulfate, which is a predominant salt in the drainage waters. Sodium sulfate samples recovered from agricultural drainage water collected from different sites were tested for utility in the reactive dye process with cotton fabrics. Sodium sulfate extracted from different drainage waters varied in their effectiveness in producing a good dye, with salts from the Mendota site proving to be the most suitable.

Integrated On-Farm Drainage Management system (IFDM) has been established at the Red Rock and Rainbow Ranches. The system has been practiced at the Red Rock Ranch for several years and a progress report was received (see page 8). The Rainbow Ranches originally had an evaporation pond that they closed and after a two-year fallow period, have converted to IFDM system. Positive results were reported for the first year of operation.

Reusing drainage waters for irrigating crops, particularly in the IFDM system, requires the availability of salt tolerant crops. Bermuda grass has been successfully grown and used as forage for grazing cows in one project. Another report summarized the evaluation of halophytes and salt tolerant forages

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UC Committee Examining Technical Issues for Dairy Waste Management

California's 2,000 dairies are home to more than 1 million cows – a figure only expected to increase as the dairy industry continues to expand throughout the state. With each cow capable of excreting 35 to 40 pounds dry weight of wastes a day, environmental impacts can be severe when these wastes are not properly handled and disposed. In a dairy, on the average, 75 to 100 gallons of water are needed per animal in cleaning the milking parlor and flushing waste. During the rainy season, uncontrolled surface runoff from dairies can carry waste to downstream surface water bodies. Also, ammonia in stored wastes may be volatilized to become airborne pollutants.

Current guidelines governing such disposal used by state and regional water quality officials were derived from technical data obtained in the 1970s and are no longer adequate to protect groundwater from nitrate pollution and excessive salt loading. Because a UC Water Quality Task developed these guidelines, the State Water Resources Control Board (SWRCB) last year asked the university to establish a committee to review them.

Dr. Reg Gomes, Vice President of the UC Division of Natural and Agricultural Resources, has since convened a Dairy Waste Management Committee of Consultants to address technical questions posted by the staff of SWRCB and Regional Water Quality Control Boards (RWQCBs). The committee determined that it was necessary to update the following information:

- Amounts of nitrogen excreted by dairy cows
- Distribution of wastes and waste-borne nitrogen in dairies
- Loss of nitrogen during storage
- Fate and transport of waste-borne nitrogen and salts following application on cropland

The Committee's preliminary findings:

1. **Nitrogen Excretion by Dairy Cows in California** – The Committee projected that lactating cows in California excrete 392–565 g N cow^{-1} day^{-1} representing a 50 to 70 percent increase of N excretion in the past 25 years. The new estimates are also considerably higher than the national average of 263–372 g N cow^{-1} day^{-1} as reported in a white paper published by the National Center for Manure and Animal Waste Management.

2. **Waste Distribution and Nitrogen Losses in Dairies** – Wastes excreted by the cows can be deposited on the surface of the dirt lots where they are held and fed in between milking or flushed into waste storage ponds. The ratio of the two depends on the type of dairy operation. In free stall dairies, a significant amount of material is

used as bedding that will increase the wastes and nitrogen loads of the dairies.

Ammonia volatilization is the primary route of nitrogen losses in dairies. For wastes deposited on ground surface, the ammonia volatilization is immediate and as much as 30 percent of the nitrogen might be volatilized in first seven days of its deposition. The ammonia volatilization from the storage ponds is highly variable. The Committee estimated that, for climatic conditions of Fresno, the ammonia volatilization from storage ponds might vary from 3 to 62 kg cow^{-1} yr^{-1} depending on the depth, pH, and ammonia concentration of the pond.

3. **Crop Nitrogen Requirements** – Dairy wastes are customarily applied on cropland as fertilizers for forage production. Current dairy waste application practices do not appear to result in over application of phosphorus and potassium. However, the nitrogen inputs through dairy waste applications were generally twice the amount of N removed by crop harvests. Repeated applications over the long run will result in the buildup of soil nitrogen and nitrate leaching.

The quality and the timing of the waste applications are critical for effective N utilization by plants. To minimize nitrate leaching, the application of dairy wastewater must be properly metered and synchronized with the crop nitrogen and irrigation requirements.

The Committee is working to:

- Develop computation algorithm that estimates the wastes and pollutant excretion of dairy cows based on the feed ration and milk production records.
- Develop a mass transfer based computer model to estimate the ammonia volatilization from dairies and obtain field data for model validation.
- Estimate the mineralization of dairy waste-borne nitrogen and denitrification of soil nitrogen when the dairy wastes are land applied.
- Evaluate the strategies of applying dairy wastes on land for forage crop production using a nitrogen uptake and transport model.

Members of the Committee include Andrew Chang (Chair), Rob Atwill, Marsha Campbell-Mathews, John Letey, Deanne Meyer, Roland Meyer, Thomas Harter, Peter Robinson, Frank Mitloehner and Ruihong Zhang. The UC Center for Water Resources has been given the responsibility to coordinate activities of the Committee members and prepare the University's responses. Dennis Westcot of the Central Valley RWQCB Board is the liaison for the state agency. Information generated from activities will help to formulate the new generation of guidelines for protection of water quality from dairy wastes.

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form as a component of the system prior to salt disposal in landfills. Utilization of evaporation basins is constrained by bird hazard and the legalities associated with the Toxic Pits Act if the selenium concentration is too high. Both of these issues must be resolved.

Actually, the Toxic Pits Act is not the problem and does not need to be amended or modified. Classifying water containing 1mg/L concentration of selenium as a toxic waste creates the problem. This concentration was derived by multiplying the California drinking water standard by an environmental accumulation factor of 100. The reason for selecting 100 rather than a smaller or larger number is not obvious. The California drinking water standard was 10 mg/L in the 1980's when the hazardous waste limits were adopted. The drinking water standard has since changed to 50 mg/L. However, the criterion for being a toxic has not been adjusted.

The legislation was passed to protect the environment. The key question is: Would raising the selenium concentration before it is classified as a toxic waste materially increase the environmental hazard? My answer to that question is no. There would be zero impact on wildlife. Wildlife must be protected from these waters at concentrations that are orders of magnitude less than 1mg/L. There would be very little impact on groundwater. Most of the selenium in evaporation

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Red Rock Ranch: An Agricultural Drainage Case Study

by Joseph Skorupa

Monitoring of avian exposure to selenium and consequent avian reproductive performance at the Red Rock Ranch Integrated On-Farm Drainage Management (IFDM) demonstration site initially revealed a grave risk to breeding water birds. In 1996 the eggs of black-necked stilts (a large shorebird) averaged 58 ppm (parts per million) selenium and 56.7 percent of 30 embryos that were assessed had overt deformities such as missing eyes or malformed beaks. However, in 1996 the demonstration site was being operated without following any management practices designed to avoid or minimize environmental risks to wildlife.

With implementation of various management practices to better control the extent, duration, and timing of standing irrigation water, by the year 2000 the eggs of black-necked stilts averaged only 19 ppm selenium and only 5.6 percent of 36 embryos that were assessed had overt deformities. By 2001, the percent of deformed embryos had declined to 0 percent. The selenium content of the eggs has not yet been analyzed for 2001 samples.

Overall, through implementation of adaptive management specifically guided to address potential selenium-induced wildlife hazards at the Red Rock Ranch IFDM demonstration site, such hazards have been substantively minimized. Currently, birds nesting at Red Rock Ranch are less likely to be adversely affected by selenium exposure than by other operational conflicts, such as physical destruction of nests. Compared to an evaporation basin alternative for management of drainage water, the Red Rock Ranch IFDM system with wildlife BMPs is far less hazardous to wildlife.

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number of stilt and avocet nests has decreased from a high of 2,266 in 1994 to a low of 2 in 2000. In contrast, the number of stilt and avocet nests in a 307-acre compensation habitat exceeded 4,000 in 1998. The compensation habitat was designed using the best scientific knowledge on what constitutes a productive habitat.

The Toxic Pits Act is a major regulatory deterrent to using evaporation ponds to collect drainage waters quite high in selenium concentration. The Toxic Pits Act requires expensive liners and other practices to contain toxic liquids. Water with a concentration of 1mg/L of selenium has been classified as being toxic for the provisions of the Act. Corey Yep (Department of Toxic Substances Control) presented a comprehensive report on the Toxic Pits Act and how it applies to evaporation ponds. Significantly, water deposited in an evaporation pond is classified as a waste and therefore falls under the provisions of the Act if (1) the selenium water concentration exceeds 1mg/L; (2) the sediments in the evaporation ponds exceed 100 mg/kg; or (3) the sediments in the evaporation ponds exceed 1 mg/L using the California Waste Extraction Test. In addition to the provisions of the Act, the evaporation pond may also be subject to the hazardous waste permitting provisions if these selenium levels are reached in the water or sediments of the evaporation ponds.

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for use in the IFDM system. Initial steps have been taken to determine the forage quality, as well as yield potential for various crops.

Two reports were presented on activities related to the Grasslands area's effort to meet the discharge requirements for the San Joaquin River. Various practices have been adopted that have allowed farmers to meet the selenium discharge requirements that became progressively more restrictive each year. One of the reports explained the use of an economic model to estimate costs for combining the multiple alternative options evaluated at each planning stage.

Reports were made on three studies designed to evaluate time trends of (1) irrigation technology adopted on drainage impaired areas, (2) long-term salinity concentration trends in subsurface agricultural drainage, and (3) the amount of area classified as saline-sodic soils. There has been some shift from surface to pressurized irrigation systems in recent years. The number of acres classified as saline-sodic have increased significantly. In 1998, 350,000 acres of soils were classified as saline-sodic in the draft Fresno County, western part soil survey. This acreage represented 45 percent of the irrigated land in the soil survey and is a 30 percent increase over the amount reported in 1985 or an increase of approximately 121,000 acres in the 13 years without drainage service, the saline-sodic area is expected to increase further. (The soil survey project was funded through the Natural Resources Conservation Service rather than Proposition 204.)

L to R: Iddo Kan and John Letey at the UC Salinity/Drainage Annual Meeting.

The final presentation was an invited report by Scott Irvine (USBR) and Huanmin Lu (University of Texas, El Paso) on a conceptual application and feasibility of salinity gradient solar pond technology. They described the technology and reported some of the results of a salt gradient pond in El Paso, Texas. They investigated the technical feasibility for ponds at five sites in the San Joaquin Valley. The solar ponds are constructed by having dense, high salt concentration waters at the bottom of the pond with decreasing salinity moving to the surface. The density gradient prevents a water column overturn as the temperature in the bottom part of the pond increases due to solar radiation that is transmitted through the water to the bottom of the pond. The ponds have the potential for creating low-grade generated heat from the hot water at the bottom of the pond.

In summary, a wide range of projects have been funded through Proposition 204. DWR is preparing a CD with all of the information that was presented at the meeting by PowerPoint.

Researchers Provide Updates on Ag Drainage Projects

During the first day of the March 26-27 Annual Salinity/Drainage Meeting, principal investigators of 17 projects funded by the UC Salinity/Drainage Program and the Prosser Trust Fund provided progress reports. Five-minute oral presentations highlighted the most significant accomplishments. Posters with detailed information were available for viewing and discussion with the scientists during breaks and lunch throughout the day.

WRC Funded Research Projects

Each year, the Water Resources Center reviews research proposals to determine which to award. These projects provide critical information on issues related to some of California's most difficult water issues. A total of 16 new projects for 2002–2004 in the amount of $892,000 are funded effective July 1, 2002. They are listed as follows:

TITLE	PRINCIPAL INVESTIGATOR	CAMPUS
Cryptosporidium in Bivalves as Indicators of Fecal Pollution in the California Coastal Ecosystem	*P. A. Conrad*	*UC Davis*
Development of an Autonomous O_2 Delivery System for In-Situ Aerobic Bioremediation	*M. A. Deshusses*	*UC Riverside*
DNA Aptamers-Based Detection of Atrazine in Water	*A. Mulchandani*	*UC Riverside*
Evaluating the Effectiveness of Vegetated Buffers to Remove Nutrients, Pathogens, and Sediment Transported in Runoff from Grazed, Irrigated Pastures	*K. W. Tate*	*UC Davis*
Experimental Determinations of Henry's Law Constants of Polybrominated Diphenyl Ethers (PBDEs) to Evaluate Exposure to Aquatic Biota	*M. J. Charles*	*UC Davis*
Influence of Nutrient Loading on the Invasion of an Alien Plant Species, Giant Reed (*Arundo donax*), in Southern California Riparian Ecosystems	*R. F. Ambrose*	*UC Los Angeles*
Linking Upland Landcover Change with Wetland Structure in Elkhorn Slough, CA	*N. M. Kelly*	*UC Berkeley*
Mount Shasta's Glaciers: An Endangered Resource?	*S. Tulaczyk*	*UC Santa Cruz*
Nature of Flow and Gas Dynamics below Spreading Ponds	*J. F. Clark*	*UC Santa Barbara*
Predicting Flow and Sediment Transport in Steep Channels: Field Study and Flume Experiments to Develop and Test Models	*W. E. Dietrich*	*UC Berkeley*
Pyrethroid Insecticides in Nursery Runoff: Transport and Impact on Aquatic Invertebrates	*J. Gan*	*UC Riverside*
Structure and Seasonal Changes of Nematode Communities form Vernal Pools (Santa Rosa Plateau)	*P. DeLey*	*UC Riverside*
The Catalysis of Perchlorate Ion Electroreduction at Transition Metal Electrodes	*W. R. Fawcett*	*UC Davis*
The Speciation and Reactivity of Wastewater-Derived Organic Nitrogen	*D. Sedlak*	*UC Berkeley*
Upstream and Upslope Translocation of River-Borne Materials by Aquatic and Riparian Organisms: Contrasts in Spatial Fluxes along Mainstems and at Tributary Confluences	*M. E. Power*	*UC Berkeley*
Use of Bioassays to Assess the Water Quality of Wastewater Treatment Plants for the Occurrence of Estrogens and Androgens	*D. Schlenk*	*UC Riverside*

Director's Message

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basins is volatilized, reduced to elemental form, adsorbed, or otherwise confined in the detrital layer beneath the pond. Water that percolates from the evaporation basins would be relatively low in selenium but highly concentrated in other salts that would prohibit its use for drinking water wells.

The net result is that having a selenium concentration at 1mg/L classified as a toxic waste imposes tremendous costs for its containment with essentially no compensating benefit. This is an issue where urban, agriculture, and wildlife proponents should all agree and work collectively to eliminate it as a deterrent to achieving economically viable drainage disposal.

The bird hazard is a far more complex and difficult issue to resolve. In this regard, the USBR and the U.S. Fish and Wildlife Service (USFWS) appear to have conflicting roles. However, both are federal agencies established to serve a societal need and are publicly supported. The USBR is under court order to provide drainage service. I believe that it is incumbent on USFWS to cooperatively work with the USBR to help them comply with their court order.

The USFWS appears to place much higher emphasis on having no unhealthy or dead birds than on increasing the number of healthy, living birds. Compensation habitat constructed at the Tulare Lake Drainage District clearly demonstrates the opportunity to produce a large number of healthy birds. Indeed, the number of bird nests at the 307-acre compensation habitat exceeded the number of bird nests on more than 3,000 acres of evaporation basins. The opportunity to provide economic drainage would be greatly enhanced if USFWS adopted a policy of allowing some damage on evaporation basins, which is offset by constructed productive habitats, rather than their present absolute "bird free or bird safe" policy.

The relaxation of the "bird free or bird safe" policy would not be inconsistent with policy elsewhere. For example, the Salton Sea is the largest evaporation basin in California. About 85 percent of the water discharged to the Salton Sea originates from agriculture. The importance of the sea to the Pacific flyway has been emphasized by USFWS. Millions of birds are annually using the sea and the variety of bird species exceeds 400. Yet the sea is not bird safe. Since 1992, hundreds of thousands of birds have died at the Salton Sea. In the first four months of 1998, approximately 17,000, representing about 70 species, died from a variety of diseases. Although these bird deaths are undesirable, there is no effort to eliminate the sea to prevent these deaths because of the sea's value to the very high population of birds that do not die. Indeed, farmers are encouraged to continue wasteful water management so that the evaporation basin (sea) can be maintained. My statements should not be interpreted as suggesting wholesale bird damage on evaporation basins. I am merely urging the relaxation of the "bird free or bird safe" policy to one of allowing some damage with appropriate compensation.

The bottom line is that USBR is under court order to provide drainage service. This places a tremendous, complex burden on USBR that they should not be expected to carry alone. It is incumbent on every individual and institution that has involvement with the issue to share the responsibility with USBR to achieve a suitable plan to provide drainage service. No individual or organization should be critical of any USBR proposal unless they are prepared to submit a viable alternative.

New Water Resources Center Archives Donors

The following generous contributions were received since the last publication of Currents. This support is gratefully acknowledged by the Water Resources Center Archives, as well as the Center for Water Resources.

Contributors (contributions of less than $1,000):

- Philip Williams & Associates

Joe W. Johnson Memorial Funds

Two memorial funds have been established at UC Berkeley in memory of Professor Emeritus Joseph William Johnson (1908-2002). Joe, as he was always known, was a professor of hydraulics in the Civil and Environmental Engineering Department and a pioneer in the field of coastal engineering. In addition to establishing an outstanding research and teaching record, he served as Director of the Hydraulic Engineering Laboratory (1959-1968) and Chairman of the Division of Hydraulics and Sanitary Engineering (1963-1967).

Joe Johnson was instrumental in getting the Water Resources Center established in the University of California and he particularly recognized the importance of establishing the Archives within the Center. He was very actively involved between 1963 and 1973 in the development of the Archives at Berkeley. Because of his interest in both the Archives and the Engineering College, his family has established a memorial fund in each. Contributions can be made to either the Professor Joe Johnson Memorial Fund, Water Resources Center Archive; or Professor Joe Johnson Memorial Scholarship Fund, College of Engineering. Checks should be made payable to UC Regents and reference the intended memorial fund.

The addresses are:
Professor Joe W. Johnson
Memorial Fund
Water Resources Center Archives
c/o Linda Vida, Librarian
410 O'Brien Hall, MC 1718
University of California
Berkeley, CA 94720-1718

Professor Joe W. Johnson
Memorial Scholarship Fund
College Relations Office
(c/o Dan Estropia)
College of Engineering
201 McLaughlin Hall, MC 1722
University of California
Berkeley, CA 94720-1722

University of California, Riverside
Rubidoux Hall - 094
Riverside, CA 92521
Phone 909-787-4327
Fax 909-787-5295
e-mail cwres@ucrac1.ucr.edu
internet www.waterresources.ucr.edu

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REDLANDS CA 92373

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