RIZONA WATER RESOURCES NEWS BULLETIN

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ARIZONA'S NEW GROUNDWATER LAW AND DEPARTMENT OF WATER RESOURCES

On June 19, Arizona Governor Bruce Babbitt delivered a copy of Arizona's new Groundwater Management Act to Secretary of the Interior Cecil Andrus in Washington, D.C. Andrus indicated that passage of this Act would have a direct bearing on his preliminary allocations of Central Arizona Project (CAP) water. President Carter recommended that "further funding of the project be contingent upon further study of groundwater supplies and institution of groundwater regulation and management by the State of Arizona."

Babbitt is not the first Arizona governor to confront groundwater law reform; nor is Andrus the first federal official to demand it as a condition for approval of the CAP. Notably, former governors Sidney Osborn and Howard Pyle risked their political lives with the issue.

In the 1940s and 1950s control of groundwater was just too big a price to pay for a CAP. Then, CAP was no more than a paper plan with poor prospects of ever being anything more. Only a few water leaders were impressed in 1944 when State Land Commissioner O.C. Williams proposed that groundwater pumping in Central Arizona be reduced by 375,000 acre-feet annually when and if water was imported from the Colorado River.

In 1947 Assistant Commissioner of Reclamation William Warne said, during the first congressional hearing on the CAP, "... without adequate control of the groundwater, the State would probably find itself in a short time, even though the project is constructed, again faced with the situation which now exists."

Seeing a threat to the CAP in this and other statements made in Washington, Governor Osborn began his special calls of the legislature. Governor Pyle set up a committee to revise the groundwater code in 1951 when Secretary of the Interior Chapman stated "Arizona needs a stronger groundwater code than it now has. Put some teeth in it. You will find a much more sympathetic ear from people who want to help you."

But, Arizona then found itself involved in a U.S. Supreme Court suit to prove its right to use Colorado River water, and the CAP was shelved until 1963. The driving force for groundwater law revision was lost. Well drilling and pumping increased.

When the court battle was won and the CAP came to life again in the Congress, the issue of groundwater overdraft also was revived. Nevertheless, the CAP was authorized in 1968 with no language demanding greater control by the state of groundwater pumping. It did set rules for pumping within the CAP service area.

In negotiating the master water delivery and cost repayment contract in 1972 the Secretary of Interior insisted on a provision that irrigators reduce the amount of groundwater pumped by the amount of CAP water delivered to them. The final motivation for action was provided by urban interest pressure for legalizing the transfer of groundwater from irrigation to domestic municipal and industrial use. That has not been possible under Arizona's longstanding, court-decreed principles of groundwater rights. Hence, the Legislature created the Arizona Groundwater Management Study Commission in 1977 to produce legislation.

Interior Secretary Andrus announced that if Arizona did not develop an adequate groundwater control law he would personally stop the CAP. But the Commission, under cochairmen Senator Stan Turley and Representative Burton Barr, and Governor Babbitt, finally produced a bill that the Legislature enacted without amendment in a seven-hour session.

As a result of this bill, Arizona now has a Department of Water Resources. The former Arizona Water Commission, which replaced the older Arizona Interstate Stream Commission, is an advisory board. Wes Steiner, formerly executive director of the Commission, is now Acting Director of the Department of Water Resources.

Just what the effects of the new law will be is something that will unfold with time. One thing remains unchanged: water is and always will be a limiting resource in Arizona; the new law simply is a new method of rationing it.

GEOTHERMAL SPACE HEATING/COOLING

A Direct Use of Naturally Occurring Hot Water in Southern Arizona

In a recent article, James C. Witcher discusses an ingenious use of geothermal energy: hot water pumped from geothermal wells can be used to cool as well as heat homes, schools and factories.*

On wintery days geothermal sources can be used directly to heat homes and buildings that use conventional wall radiators. Such use is limited in Arizona, but given the proper circumstances, naturally occurring hot water can cool space too. Thus, in Arizona, where significant geothermal reserves are believed to exist, geothermal energy is a potentially rich resource.

Absorption refrigeration, a cooling process, uses heat to cool space. Absorption refrigeration units can cool areas and can freeze or preserve food.

Conventional units use a gas flame or an electric heating coil to heat the boiler or generator within. By contrast, a geothermal

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system substitutes hot water for the heat produced by gas or electricity. For absorption refrigeration purposes, geothermal hot water must be from 80 C (175 F) to 150 C (300 F).

These refrigeration units use heat to cool space by making use of several well-known physical phenomena: 1) the boiling temperature of a liquid depends on pressure; 2) heat is "robbed" from the environment when a liquid boils; and 3) heat travels from a hotter to a colder material, not vice versa (imagine coldness as the absence of heat).

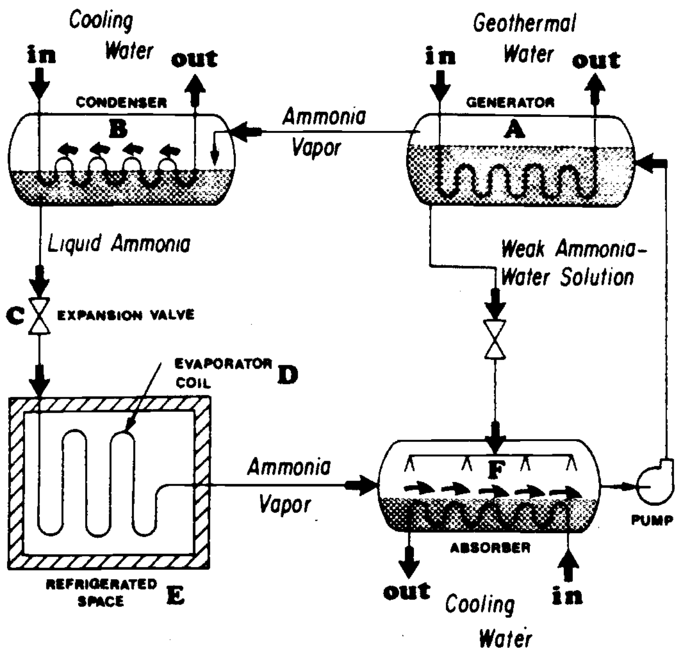

Figure 1. Geothermal absorption refrigeration process. Adapted from B. Briendel, R.L. Harris and G.K. Olsen. 1978. Geothermal absorption refrigeration for food processing industries, in direct utilization of geothermal energy: A symposium. Geothermal Resources Council and U.S. Department of Energy.

Figure 1 illustrates how the geothermal process works. Hot water is pumped from a geothermal well to the generator (A). There, geothermal heat causes the ammonia, which has been dissolved in water, to boil. The water remains a liquid because its boiling temperature is much higher than that of ammonia. The evolved ammonia gas is then funneled over a condenser (B). It cools the gas. An evaporative cooler can be used to provide water to cool the condenser. As the gas cools, it condenses into pure liquid ammonia. Liquid ammonia then leaves the condenser and travels through the expansion valve (C).

The valve reduces liquid ammonia pressure. Thus, its boiling temperature drops **drastically.** Because of its decreased boiling temperature, the ammonia begins to boil vigorously as it enters the evaporator coil (D). The vapor from the boiling ammonia is **colder** than the temperature of the refrigerated space (E) that envelops it. The space then is robbed of its heat, Remember, heat travels from a hotter to a colder material. Thus, the refrigerated space is cooled.

The evolved ammonia gas contains the heat it took from the space and continues its journey into the absorber (F). In the absorber, the ammonia gas releases its heat and dissolves in the ammonia-water solution. An evaporative cooler can be used to provide water to cool the absorber also. As the ammonia dissolves in the weak solution, the ammonia in solution becomes very concentrated.

Finally, a small electric motor-driven pump pumps the solution to the generator (A) to begin the process anew.

Water and lithium bromide can be substituted for ammonia and water in this process, Instead of ammonia, the refrigerant is water; and instead of water, the absorbing medium is lithium bromide. However, a lithium bromide system cannot be used to cool below 0 C (32 F) because water, the refrigerant, would freeze in the evaporative coils. Such a system cools the 100-room Rotorua International Hotel, Rotorua, New Zealand. This air-conditioning system, operating since the late 1960s, uses 170 gallons per minute of 117 C (243 F) hot water; using geothermal water, it conserves gas and oil.

In addition to saving other fuels, geothermal systems can be used to help cut consumer energy costs. Human desire for comfort on hot summer days makes the cooling of homes and buildings necessary. But peak power loads experienced by Arizona utilities during the summer push consumer costs up. By using geothermal energy to cool shopping centers, office buildings, factories and schools, the load stress on utilities could be relieved partially, thus reducing costs.

How to use geothermal cooling best in Arizona will depend upon the location, temperature, production (flow) rates and chemical quality of hot water in the potential geothermal reservoirs in Arizona. Absorption units vary in size, efficiency and cost.

Cost depends upon well depth, well head temperature, area to be cooled, retrofitting (if any) and financing. For example, constructing systems for individual homes is not practical. But constructing them for neighborhood use or for city use might be economically practical. The disadvantage of these systems is the high initial cost.

Nevertheless, potential long-term advantages resulting from large-scale use might compensate for the high initial monetary outlay. In addition to the potential for conserving oil and gas and cutting consumer energy costs, these units recycle water. Used geothermal water retains heat. So it can be reused in industrial, agricultural and domestic processes that require low grade heat. Furthermore, if geothermal water quality is good, used water can be added to domestic and agricultural water supplies; if not, the water can be returned to the earth to be heated again.

Thus, the availability and suitability of the resource must be weighed against the cost of constructing and maintaining the system.

The Arizona Bureau of Geology and Mineral Technology Geothermal Branch staff is studying geothermal potential in Arizona. The studies are part of an effort by the U.S. Department of Energy to evaluate geothermal resources in Arizona. For further information contact Richard Hahman, 2045 N. Forbes Blvd., Tucson, Arizona, or call 626-4391.

*Published in *Fieldnotes* 9(4):1-2 and paraphrased herein. James C. Witcher is a geologist for the Arizona Bureau of Geology and Mineral Technology Geothermal Branch.

OWRT SURVEYS INSTITUTE ACTIVITIES

In FY 1979, the 54 state water resources research institutes, on an equal basis, shared $5.93 million awarded under the Office of Water Research and Technology (OWRT) Annual Cooperative Program (ACP). While research funded under this program is a vital part of institute activities, research conducted with these funds is only one part of a broad range of activities and funding sources coordinated by the institutes.

With the cooperation of the institutes, OWRT has just completed a survey of all relevant funding sources and program activities. Table 1 shows the results of the survey and documents the relative proportions of federal, state and other commitments dealing with water resources. The table permits a comparison of dollar amounts and sources and activities of the nationwide program and individual institutes. Horizontal lines on the table show amounts spent in the various activity categories mandated by Public Law 95-467, *e.g.*, research and development, technology transfer. Vertical columns show amounts provided by various sources from which institute programs are funded.

Results of the survey show that the institute program is a genuinely cooperative one; OWRT funds in the ACP and Matching Grants programs are supplemented by almost $20 million in state and private funds. The survey also revealed that when professional time and costs are properly allocated among the activity categories, overall administrative costs, an area of concern for Congress, OWRT and the institutes, consume only about

5 percent of the total program effort of the average institute.

TABLE I

Office of Water Research and Technology
Allocation and Sources of Institute Funds - 1979

(Thousands of Dollars)

All Institutes

ACTIVITY	OWRT Funds		Non-OWRT Funds			
	Allotment	Other	Federal	State	Private	Total
Research and Development Program						
1. Allotment Projects	3.972	0	185	3.239	73	7.469
2. OWRT Matching Grant Projects	0	4.620	0	4.978	75	9.673
3. OWRT Focused Research Projects	0	577	3	130	0	710
4. Non-OWRT Projects	0	0	9.892	6.207	1.729	17.828
Subtotal	3.972	5.197	10.080	14.554	1.877	35.680
Five-Year Water Research Priorities Development	139	0	0	117	0	256
State Research Program Development and Coordination	775	0	17	1.010	50	1.852
Technology Transfer and Information Dissemination	531	509	264	1.292	8	2.604
Administration	513	0	33	1.096	19	1.661
Total	5.930	5.706	10.394	18.069	1.954	42.053

CONDENSATION

STATE WATER RIGHTS AFFIRMED

The Synthetic Fuels Bill, which was agreed to by U.S. House and Senate conferees on June 16. creates a federal synthetic fuels corporation as its major feature.

In a section of the bill on water rights the report declares. "Nothing in this part shall affect the jurisdiction of States or the Federal Government over water. affect any interstate compact. or confer on any non-Federal entity the ability to exercise any Federal right to water. No project constructed pursuant to the authorities of this part shall be considered to be a Federal project for purposes of the application for an assignment of water rights."

RIVER FLOOD FLOWS RE-EVALUATED

The Water and Power Resources Service (WPRS) and the Army Corps of Engineers are re-evaluating flood flows that could occur on the Salt and Verde rivers. The re-evaluation, scheduled for completion by summer 1981. is associated with WPRS responsibilities under the Safety of Dams Act and the ongoing Central Arizona Water Control Study. Eugene Hinds. Regional Director. said "If re-evaluation results in a substantial increase in the Inflow Design Flood. some modification of CAP features might be required. as well as of existing dams on the Salt and Verde rivers."

PROPOSALS SOLICITED FOR REGION VI AND IX WATER QUALITY CENTERS

Proposals for area water quality centers are being solicited by Battelle's Columbus Laboratories. The centers will be established in educational institutions in Region VI (Arkansas, Louisiana, New Mexico, Oklahoma and Texas) and Region IX (California, Nevada and Arizona). The centers, modeled after a pilot center established at the University of Massachusetts, Amherst. will offer state-of-the-art courses to public and private-sector employees engaged in studying the causes, prevention, reduction and elimination of water pollution.

Examples of courses that will be offered include: identifying and analyzing chemical and bacteriological contaminants in drinking water; operating wastewater treatment plants; and conducting bioassays for toxic and hazardous materials. The Environmental Protection Agency will select the educational sites based on criteria developed by Battelle. *i.e.*, location. available skills and facilities and institution commitment. A plan for managing the centers has been developed by Battelle and will be used at the new water quality centers.

Universities in Regions VI and IX interested in obtaining the Request for Proposal package should contact Lawrence Welling, Battelle's Columbus Laboratories. 505 King Avenue. Columbus. Ohio 43201.

ALTERNATIVE AND INNOVATIVE TECHNOLOGIES PROGRAM

Ways to break down bureaucratic barriers that discourage new ideas for alternative and innovative technologies should be found. Eckardt C. Beck. Environmental Protection Agency (EPA) water programs chief. recently told the Science Advisory Board's newly-established subcommittee on alternative and innovative technologies. The subcommittee's program. he said. should proceed on the premise that the EPA is willing to risk failure of some projects in order to get new technologies moving.

The alternative and innovative technologies program was established in 1977 to provide alternatives to large conventional wastewater treatment plants that often are not cost-effective for small or rural communities. Under the program. 85 percent. rather than 75 percent. of the capital costs of a qualified plant will be funded as will all replacement costs of an unsuccessful program.

The subcommittee recently was formed with state. local and engineering representatives: to advise EPA of technologies it should be supporting: to recommend ways to stimulate new technologies in the grant process: and to work with the EPA on the place these projects should take in the upcoming construction grants strategy for the 1990s.

CONFERENCES

WATER QUALITY MONITORING AND MANAGEMENT SYMPOSIUM

The Arizona Section—American Water Resources Asssociation will sponsor a Water Quality Monitoring and Management Symposium October 23-24. 1980. at the Sheraton-Pueblo Inn. Tucson, Arizona. A program and registration information will be distributed soon. For information contact Ken Foster (626-1955) or Jim DeCook (626-1009) in Tucson. or Don Young (255-3500) in Phoenix.

Tentative titles of papers to be presented and authors are listed below.

Keynote Address. Kenneth D. Schmidt.
Highlights of the State Water Quality Management Program. W.D. Moss and L.K. Stephenson.
Colorado River Basin Salinity Control Project. Dana Hill.
Industrial Application of Water Use and Recycling. E.A. Eggers.
New Organic Tracers for Waste Monitoring. Glenn M. Thompson.
Water Quality Management in Grand Canyon. Stanley K. Brickler.
Impact of Recreation on the Water Quality of the East Verde River. Arizona. M.R. Sommerfeld. P.V. Athey and B.C. Mueller.
Water Quality Considerations for Landfill Siting in Arizona. L.G. Wilson.
Water Quality Problems in the Globe/Miami Copper Mining District, Arizona: An Institutional Approach. R.J. Cinq-Mars. Ed Mayercek and E.K. Swanson.
Radio-chemical Problems in the Puerco River, Arizona. E.K. Swanson.
Preliminary Development of a Water Quality Monitoring and Management System for the Zarga River Jordan. M.E. Norvelle, D.J. Percious and J.D. Johnson.
Water Quality Monitoring Program of the Colorado River Grand Canyon. Stanley K. Brickler and Brock M. Tunnicliff.

PIXE and Electron Probe Techniques for Multi-element Trace Analysis of Ground and Surface Waters. Harold W. Bentley.
DBCP in Ground Water of San Joaquin Valley. Kenneth D. Schmidt.
Use of Complex Resistivity to Monitor Ground Water Contamination from a Brine Injection Well Near Hobbs, New Mexico. Richard Tinlin.
Poster Session: Drums Along the Salt. James Lemmon.

PUBLICATIONS

SALT RIVER INDIAN RESERVATION GROUNDWATER SYSTEMS SIMULATED BY DIGITAL MODEL

U.S. Geological Survey (USGS), in cooperation with the U.S. Bureau of Indian Affairs, has published Open-File Report No. 80-503W, *Simulated Effects of a Proposed Well Field on the Ground-water System in the Salt River Indian Reservation, Maricopa County, Arizona.*

The report, prepared by R.P. Ross, discusses a digital model that has been developed to simulate the effects of a proposed well field on the water levels in existing wells on the Salt River Indian Reservation. The model can be used to predict future water level declines based on projected amounts of pumpage. Additional water level declines, indicated by the model, would be about 2 to 6 feet per year in existing wells after 20 years of pumping in the proposed well field.

Copies of the report are available for inspection at USGS offices: in Tucson, Room 5-A Federal Building, 301 West Congress Street; in Phoenix, Suite 1880, Valley Center; and in Flagstaff, 225 North Gemini Drive, Building 3. Also, the report may be purchased from USGS, Open-File Services Section, Branch of Distribution, Box 25425, Federal Center, Denver, Colorado 80225.

COPPER AND OTHER TRACE METALS IN THE ENVIRONMENT

John Wiley & Sons recently has published Jerome O. Nriagu's *Copper in the Environment: Part 1, Ecological Cycling;* and *Part 2, Health Effects.* These two volumes contain articles on the biological, chemical, geological and clinical studies on copper and other trace metals in the environment.

Part 1 covers copper in the atmosphere and precipitation; copper in natural waters; the aqueous environmental chemistry of copper; removing copper from wastewaters, soils and sediments; copper in agricultural crops; and accumulations in freshwater, coastal and marine biota.

Part 2 discusses environmental and occupational exposure to copper; teratogenic effects of copper; toxicity to aquatic biota; effects on embryonic and juvenile aquatic animals; and using copper as a molluscicide.

Copies are available from John Wiley & Sons Inc., One Wiley Drive, Somerset, New Jersey 08873. Cost: Part 1 (520 pages), $45.95; Part 2 (489 pages), $44.95.

FLOODPLAIN MANAGEMENT MANNUAL

The Office of Water Research and Technology has published *A Process for Community Flood Plain Management.* The manual presents a process for developing and installing a floodplain management program at the community level by translating floodplain management concepts into practical applications. This document, No. PB 80-135296, is available from National Technical Information Service, Springfield, Virginia 22161.

Please address your news items or comments on the News Bulletin to any of the four editors:

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