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Managing the Interconnecting Waters: The Groundwater-Surface Water Dilemma

by Joe Gelt

According to the Bible, on the second day God gathered the waters so that dry land would appear. Before that time all was surface water. Surface water was all. With the appearance of land, the earth's hydrology became complicated. Groundwater thus formed, and a quandary begotten that challenges hydrologists and lawmakers to this day.

The dilemma has to do with the waters of the earth being categorized as either surface water or groundwater. The classifications seem clear enough, surface water occurring above ground, groundwater found below ground. A belief in surface water here and groundwater there simplifies the making of laws and policies. Groundwater and surface water can be regulated separately. And, in fact, in a few states such as Arizona they are.

Nature, however, was not designed for easy, simple regulation. Groundwater and surface water are not isolated phenomena occurring apart and distinct from



Groundwater pumping in certain areas of the state threatens surface water flow. (Photo: Paul Trittenbach)

each other. In nature, groundwater and surface water can intermix or interconnect. A water management strategy that recognizes the interconnection between groundwater and surface water is called coordinated or conjunctive water management.

The University of Arizona's Water Resources Research Center sponsored an October conference, "Managing Connected Groundwater and Surface Water: Problems, Choices, and Opportunities." Conference presentations provide information for this newsletter.

States Adopt Different Plans

States confront a difficult and complex task when defining and managing the hydrological connection between groundwater and surface water. The issue has broad management implications. At stake is the ownership and control of water, a driving issue in western politics.

It should not be surprising, therefore, that states, having different his-

ories and political priorities, should adopt different strategies to deal with the groundwater-surface water issue. Conference participant Ray Jay Davis, Brigham Young University professor of law, described various states' strategies.

Some western states including Nevada and Utah manage all water under a single water code, without distinguishing between types of water. This is the conjunctive management approach. Other western states, such as New Mexico, conjunctively manage their water resources only in specific critical areas, not in the entire state.

States such as Idaho and Wyoming manage groundwater and surface water separately, but applications for permits generally are reviewed to determine effects on all water users, whether of groundwater or surface water. Arizona is among the five western states to manage groundwater and surface water separately, with no mandate to coordinate their management.

Davis described a project co-sponsored by the American Society of Civil Engineers to draft a model code for states to consider when devising a conjunctive management plan. Researchers are identifying a range of management options to provide states the opportunity to choose various alternatives to fit their particular situation. The "model state water code" project is expected to be available in draft form in 1995. Copies will be available from Dr. Davis at the Law College, Brigham Young University.

History of State Water Law

The development of Arizona water law helps explain the state's bifurcated water management policy; i.e., managing groundwater and surface water separately. At the conference Steve Olson of the Arizona Department of Water Resources provided a brief historical review of Arizona water law.

Before statehood, Arizona did not need a formal water code to define water rights. Water was scarce, but population was sparse. Supply therefore exceeded demand. The first official water rules came as provisions within the Howell Code. Enacted in 1864 by the First Legislative Assembly of the Territory of Arizona, the Howell Code embodied the first set of laws to govern Arizona.



Southwest rock art figure.

Underlying the few water provisions within the code is a formal recognition of the prior appropriation doctrine, with its "first in time, first in right" rule. In other words, those who diverted water first have senior rights to those who divert later. Thus began Arizona's commitment to a doctrine that remains in effect today.

A relic from a bygone age, the Howell Code reflects a relatively uncomplicated world, before population and water uses multiplied, and before groundwater was considered a resource to be reckoned with. The Howell Code focused on the appropriation and distribution of surface water, with nothing said about subsurface water. Tapped by digging wells, groundwater at that time was considered relatively inaccessible.

A prevailing notion at that time was that groundwater clearly could be distinguished as either subsurface water which flows in definite underground channels or water which seeps down or percolates into non-tributary permeable soils. Subsurface water flowing in underground channels was subject to the law of prior appropriation. Not thought capable of lateral movement, percolating waters were considered similar to mineral deposits. Landowners obtained title

to them with the land and had the freedom of unregulated withdrawal.

Judicial action in 1933 further defined groundwater in Arizona. In deciding the *Southwest Cotton* case (39 Ariz. 65, 4 P.2d 369 [1931]), the Arizona Supreme Court stated that henceforth all underground water in the state would be considered percolating unless litigants convincingly proved otherwise. This decision in effect left Arizona landowners free to pump as much groundwater as they wanted, providing the water was applied to a "beneficial use."

In the 1940s high-powered pumps became available, and hitherto inaccessible groundwater was brought to the surface. Greater amounts therefore were used. The need for some sort of systematic groundwater regulations was becoming apparent. Arizona's regulations consisted of a patchwork of common law and legal decisions of limited effectiveness. The 1980 Groundwater Management Act attempted to remedy this situation by overhauling the system.

The evolution of groundwater regulations is unmatched by any comparable development in the regulation of surface water. Surface water

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Water Resources Research Center
Director, Hanna J. Cortner
Editor, Joe Gelt

remains public water subject to appropriation and beneficial use, with senior right holders having rights superior to all late-comers.

Hydrology and Geology

Early Arizona law often was made without benefit of clearly understood principles of geology and hydrology. With increased knowledge and information came the realization that the interconnection of groundwater and surface water is a complex phenomenon. Herb Dishlip of the Arizona Department of Water Resources described its complexity.

Different types of streams have different potential for interconnecting with groundwater. For example, perennial streams flow year round and generally are connected to the aquifer. Ephemeral streams on the other hand flow only in response to precipitation and do not intersect the aquifer. Intermittent streams flow along some stretches but are dry along others. The stream connects with the aquifer along those stretches with flowing water.

River characteristics may alter in response to changing conditions. A perennial stream could become intermittent, even ephemeral, and an ephemeral stream might once have been intermittent. The diminished flow of a stream might be the result of several factors: excessive pumping, damming or stream diversion. In certain cases, the damage is irreversible.

The above describes certain conditions when a stream likely interconnects with groundwater. A related query addresses what effect groundwater pumping could have on the flow of a stream. This is a complex question, with many variables to consider. For example, the geological conditions underlying the stream greatly determine whether groundwater pumping will draw from the stream. Such conditions include the number and kinds of basin fills that

My Well v Your Surface Water Rights.

A Water Resources Research Center issue paper, "*My Well v. Your Surface Water Rights: How Western States Manage Interconnected Groundwater and Surface Water*" by Barbara Tellman, is available free from the Water Resources Research Center, 350 N. Campbell Ave., University of Arizona, Tucson, AZ 85721; (602) 792-9591.

are present and the occurrence of impermeable rock.

Also stream flow and groundwater might not interconnect if the groundwater is located at a depth greatly below the flow of water. The groundwater may occur at this lower depth because of geological conditions or because excessive groundwater pumping has depleted the aquifer. The stream then flows in response to precipitation, not to an underlying water source.

Various circumstances may cause a well to draw from streamflow. For example, a well may pump from a floodplain aquifer close to a stream. If this pumping causes the water table to sink below the stream level, the stream then loses water to the aquifer, rather than being replenished by it.

A well may draw from stream flow even if pumping occurs at a distance from the stream. For example, a well or several wells located several miles from a flowing stream may be pumping water from a regional aquifer. If excessive pumping occurs from the aquifer and that aquifer is not fully replenished, then a cone of depression develops. Water flows by gravity into the cone of depression, thus lowering the entire water table. This, in turn, eventually affects stream flow. Or the cone of depression may draw directly from the stream or the younger alluvium. It also may

intercept water that otherwise would have recharged the stream. This process might occur over a period of time, with the stream not affected until some time in the future.

This time lapse between the pumping of groundwater in an area and the noticeable reduction of surface flow further complicates the situation. The time lag may be as brief as a single growing season or as long as 30 or 40 years. Because of this time factor, a cause-and-effect relationship between pumping and reduced stream flow may not be readily apparent.

Surface Water Adjudication

The question of the interconnection of groundwater and surface water is itself interconnected with current efforts to resolve other important Arizona water issues; i.e., the adjudication of surface water rights and the preservation of riparian areas. The relatively recent prominence of these latter issues focuses attention on the critical need to resolve the groundwater-surface water question.

The Arizona courts currently are engaged in a vast and complex undertaking to determine the surface water rights for the Gila River and Little Colorado River watersheds. The process is called adjudication. In brief, the adjudication of water rights is a statutory proceeding to determine the relative rights on a stream system.

The labors of adjudication are many and complex. Foremost among them is addressing the groundwater-surface water issue. This involves resolving the primary technical matter of determining the extent to which groundwater and surface water systems are interconnected in any particular situation. The resolution of this matter will determine the court's jurisdiction over groundwater pumpers within the Gila River system.

The court has expended great effort in establishing a formula to

define when groundwater pumping draws on surface water reserves. Maricopa Superior Court Judge Stanley Goodfarb at first adopted a 50%/90-day rule. In effect, this rule determined that groundwater is appropriate if, over a 90 day period, its removal from the underlying aquifer reduces the flow of any nearby surface supply by 50 percent or more of the total volume pumped. Appropriate water is to be included in the adjudication of surface water rights.

The Arizona Supreme Court subsequently overturned Judge Goodfarb's 50%/90-day ruling as arbitrary. Goodfarb then offered a definition determining subflow as the saturated floodplain alluvium. He stated that wells that pump subflow or whose cones of depression reach the subflow zone and affect a stream are to be included in the Gila River adjudication. This opinion is under review by the State Supreme Court.

Federal Reserve Rights

The federal government is a major player in the adjudication, with water rights on vast federal holdings within the state. These include Indian lands, military installations, national forests, public lands managed by the U.S. Forest Service and the Bureau of Land Management, national parks and monuments, and fish and wildlife refuges.

Bill Swan, an attorney with the U.S. Department of the Interior, described the federal interest in the adjudication proceedings as protecting instream flow on federal lands in Arizona. Federal officials thus are concerned about groundwater pumping that may threaten federal surface water interests in the state.

To protect those interests, federal officials claim a legal precedent that gives the U.S. government the authority to limit groundwater pumping within the states. This precedent applies in situations where pumping

threatens surface water resources needed to fulfill the purpose for which a specific piece of federal land was set aside.

The case cited empowering the federal government to regulate groundwater pumping is *Cappaert v. United States*. In 1952 President Truman designated 40 acres of federal land in Nevada as a national monument. The tract included a pool, the only remaining habitat of the Devil's Hole pupfish.

An adjacent landowner's wells caused the water in the pool to drop below the level required for the spawning of the pupfish. Even though the landowner was in compliance with Nevada law, the federal government contested the pumping claiming that it had reserved rights to sufficient water to protect the pupfish.

The U.S. Supreme Court enjoined the pumping. The Court claimed the water in the pool was set aside for a federal purpose, and therefore was protected "from subsequent diversion, whether the diversion is of surface or groundwater," regardless of state law.

Cappaert provides the federal government a major power of enforcement and enables it to be more aggressive than the state in regulating groundwater pumping. In fact, some officials claim that federal *Cappaert* powers will override Arizona's eventual definition of subflow. If this is true, the federal government could adopt a well-by-well strategy, rather than being bound by an overriding state ruling. The federal government could then pursue pumpers the state would not.

Legislature Responds to the Adjudication

The adjudication proceedings have now continued for about 15 years, and some legislators are concerned about its progress, or rather, its lack thereof. In February

1994, the state Legislature established the Joint Select Committee on the Arizona General Stream Adjudication to review the state's adjudication process and to recommend strategies to encourage or facilitate progress. The WRRC conference included a panel of legislators who serve on the committee: Senators Gus Arzberger and Carol Springer and Representative Jack Brown.



Southwest rock art figure.

The Joint Select Committee has approved, in concept, statutory changes to hasten settlement of water rights for the majority of claimants. The changes mainly would affect "de minimis" water users. (De minimis water users use a quantity of water considered to have a cumulative impact too small to harm other water users on a stream.) Such a classification includes 47,000 claimants or about 60 percent of the total.

The committee called for legislation to define de minimis users as domestic or other small users of three acre-feet of water or less per year, and as stockponds with a capacity of 15 acre-feet or less. Included among the committee's recommendations is a provision that the court summarily adjudicate de minimis claimants without requiring them to take any further action.

Senator Arzberger acknowledged the need for the state to reclassify groundwater, surface water and subflow. He noted that the Arizona Supreme Court, when ruling on Judge Goodfarb's definition of subflow, said the Legislature is responsible for determining definitions of groundwater and surface water.

Although deemed essential by many water experts, the adjudication

does not enjoy universal support. At the conference, Representative Jack Brown was critical, if not hostile, toward the proceedings. Brown questioned the purpose of the adjudications and criticized the lengthy and detailed studies involved.

Riparian Protection

Along with the adjudication, another water issue to focus attention on the groundwater-surface water question is riparian protection. Riparian areas are endangered ecosystems in Arizona, many having been altered or destroyed by land use activities such as urban construction, or diversion, grazing, and/or groundwater pumping. Riparian protection strategies include careful appraisal of the effects of groundwater pumping on rivers and surface water.

The WRRRC conference included several speakers representing interests in two Arizona rivers: the Verde and the San Pedro. A review of occurrences in those areas demonstrates that successfully preserving riparian areas often depends upon resolving the groundwater-surface water question. Dick Thompson, chairman of the Verde Watershed Association (VWA), and Andy Groseta, rancher and president of the Cottonwood Ditch Association, presented information on the Verde River. Judy Gignac, a community leader and water company owner in Sierra Vista, and Karlene Burris of the Nature Conservancy, discussed the San Pedro River.

The Verde River

The Verde River is a perennial river that flows from the high mountains in northern Arizona to the central valley. Members of the VWA are concerned that groundwater pumping threatens the flow of the river, especially the segment ex-

tending south of the town of Paulden to below Camp Verde at Beasley Flat. Water is being pumped in the upriver area of Chino Valley for agriculture and development.

Also groundwater is being pumped in the Verde Valley. Although presently limited, this pumping could develop into a problem with increased growth in the area. Evidence suggests that the base flow of the Verde River is groundwater-supported.

A recent U.S. Bureau of Reclamation study suggested that the Chino Valley and the Verde River are hydrologically connected. An important question yet to resolve is how much pumping can occur in the Chino Valley and Prescott areas before the flow of the Verde River is seriously affected.

In an effort to gather more information about the issue, the VWA, assisted by the U.S. Natural Resource Conservation Service, is conducting a cooperative river basin study. Its purpose is to collect all existing data related to the groundwater and surface water resources of the basin. Areas of further study will be identified.

Many interests are anxious that the flow of the Verde River continue unabated. Federal officials are concerned that a diminished Verde River flow might threaten an important riparian habitat and an endangered fish species. Agricultural users in the area depend upon Verde River flow for irrigation. The river also is a centerpiece for Verde Valley's plans to create a greenbelt in the valley.

The VWA represents a cooperative effort among all interests, to better work out a mutually acceptable solution to preserve the river flow. The eventual goal is to develop a water management plan for the basin. Such a plan could include self-imposed water use limitations, if necessary. Various options are to be considered including, but not limited to, legislative action.

The San Pedro River and Sierra Vista

Residents of the Sierra Vista sub-basin of the Upper San Pedro River also are confronting groundwater-surface water problems. Pumping in the area threatens the flow of the San Pedro River. The underlying issue is hydrology, but in the public arena the discussion is about protecting the riparian area while allowing for economic development.

The Upper San Pedro Basin includes the Riparian National Conservation Area, the greater Sierra Vista area with about 55,000 people, and Fort Huachuca, the largest employer in the area. These entities represent the players in what has become a major water use controversy.

Concern about the effects of pumping on the San Pedro River surfaced in the late seventies when residents of the agricultural area of Hereford/Palominas requested well monitoring because river flows appeared to be diminishing. Since the San Pedro is tributary to the Gila River, the Gila River Adjudication proceedings added another note of uncertainty about San Pedro River rights and water use in the Sierra Vista area.

Meanwhile, critical attention focused on Sierra Vista's growth and its possible effect on the San Pedro. Some feared that increased pumping would adversely affect, possibly even destroy the river's riparian system. Also, critics complained that the proposed expansion of Fort Huachuca, although a boon to the Sierra Vista community, would further deplete water resources.

Momentum was building to work out a water use strategy among all interests. Progress clearly depended upon a cluster of interests — local, public, private, state and federal — sitting down and working out a mutually acceptable strategy to preserve riparian resources and support

economic growth. The various interests initially were distrustful of each other. Progress, however, was made and a Water Interests Group (WIG) was formed, co-chaired by Judy Gignac and Karlene Burris.

WIG has developed a concept paper calling for legislation establishing an appropriate form of water management for the Sierra Vista sub-basin. Local involvement is central to the proposed management plan. Management goals for ensuring a reliable water supply are stated. Management strategies to achieve the goals are to be decided locally, yet subject to the concurrence of the Director of the Arizona Department of Water Resources. A component of the plan includes "coordinated management of groundwater and surface water resources as may be appropriate to achieve the management goals."

Riparian Studies Commissioned

Along with work being done along the Verde and San Pedro rivers, other riparian studies are underway in the state. The Arizona Legislature initiated a study when confronted with riparian protection legislation in 1992. Before adopting any measures, the lawmakers wanted more information about the groundwater-surface relationship and its effect on riparian areas. The Legislature assigned various state agencies the task of gathering the information.

The Arizona Department of Water Resources was directed to study the interrelationship between groundwater and surface water and to investigate management options. Arizona Game and Fish was directed to map Arizona's perennial and intermittent streams, and the Arizona Department of Environmental Quality was to evaluate human impacts on riparian areas. A Riparian Area Advisory Committee (RAAC) was formed to review the agencies' work as well as

conduct its own study. RAAC performed its task and developed recommendations for the 1995 legislature.

RAAC members agreed that riparian areas are best protected if local communities are empowered to develop plans appropriate to their areas. RAAC deemed this strategy more effective than broad changes to state water law mandating conjunctive management. Agreement was not reached, however, on ways to protect areas in the absence of local initiative, although state incentives to develop protection plans was endorsed.

Impacts of Management Options

What will be the effects of adopting some form of conjunctive water management policy or continuing with a bifurcated system? Four conference speakers addressed this topic: Bonnie Colby, University of Arizona, described economic impacts; John Keane, Salt River Project, discussed impacts on urban areas; Doug Nelson, Arizona Rural Water Association, addressed impacts on rural areas; and Duncan Patten, Arizona State University, described ecological impacts.

Economic impacts. If the groundwater-surface water connection is not recognized, surface water flow in certain areas will diminish, with resulting economic impacts. For one, some surface water right holders will face uncertain future supplies. To compensate for water lost to groundwater pumping, they may face additional expenses to sink wells or purchase CAP water.

Recreational revenues also might be reduced. Diminished lakes and streams might cause communities that profit from visitors who fish, birdwatch or engage in other water-related activities to lose revenues. Such areas may no longer support the plentiful and varied plant and animal life that attracts visitors.

Economic impacts also will result if groundwater pumping is limited per a conjunctive management plan. Groundwater users likely will need to turn to higher-cost sources of water—CAP or effluent—or they may purchase surface water rights. A limit on groundwater pumping could adversely affect business activities within certain communities.

Disputes likely will arise regarding payment of the resulting costs. Will groundwater users or surface water users need to absorb the additional costs, or will the taxpayer be expected to compensate water users for losses?

Impacts on Urban Areas. The interconnection of groundwater and surface water is not a critical issue in large urban areas, such as Tucson and Phoenix. The hydrological connection that once existed between the two types of water in such areas has generally been severed due to excessive groundwater pumping.

This does not mean that urban areas are uninvolved in conjunctive management, just that their involvement takes different forms. For example, the Salt River Project jointly manages groundwater and surface water in artificial recharge projects.

SRP also is involved in conjunctive management by blending surface water and groundwater to ensure suitable water supplies. SRP has 258 wells to provide groundwater to augment its surface water resources.

Keane observed that groundwater pumping is regulated within high water use Active Management Areas where virtually no groundwater-surface water connections still exist. In areas outside AMAs, where the groundwater-surface water connections remain intact, groundwater pumping is not regulated. Clearly this unregulated pumping upstream may in the future reduce the Phoenix area's surface water supplies.

Impacts on Rural Areas. Most rural areas rely, at least partly, on groundwater for drinking. Further,

their economies often are based on operations such as farms and ranches that consume groundwater. As a result, rural water users are concerned about pumping rights in the adjudication proceedings. Depending upon how subflow is defined, some rural water users may be pumping water subject to the adjudication.

Rural communities are concerned with having sufficient water supplies for future growth. If groundwater pumping is restricted because of its effect on adjudicated surface water, growth and development in certain areas could be curtailed.

Rural areas often are not well situated to import water. For example, they are likely too high or too far to benefit from the CAP aqueduct. For such rural communities groundwater is the most accessible and secure water source.

Preserving surface water also is a rural concern. Some rural communities along the Colorado River depend solely on surface water for drinking supplies. Also, various rural communities have riparian areas that attract visitors, thus boosting the local economy. Unregulated groundwater pumping could threaten these important surface water resources.

Ecological Impacts. A riparian ecosystem includes the broad vegetated area on both sides of the floodplain. Studies of the San Pedro River and the Tanque Verde Wash in Tucson have determined that excessive groundwater pumping adversely affects riparian vegetation. If the water table drops a few feet below the stream level, older, more mature trees may survive but young trees may die and seedlings might not take root.

Even mature vegetation may not survive if the water table drops below the root zone for a long period of time. The dry Santa Cruz River near Tucson is a prime example of loss of riparian vegetation largely due to extreme lowering of the water table.

By preserving the surface water-

groundwater connection, conjunctive management is the preferred strategy for maintaining riparian ecosystems. Other methods, however, are available. For example, effluent supports a healthy riparian ecosystem along the Santa Cruz River, downstream of the Nogales International wastewater treatment plant.

Along this segment of river, young trees are becoming established and wildlife flourishes. Studies indicate, however, that even an apparently thriving effluent-dominated ecosystem may not do well in the long run if excess nitrification occurs, and toxic substances build up.



Southwest rock art figure.

Recharge projects also can help sustain riparian ecosystems. For example, CAP water can be recharged into an aquifer that otherwise would draw surface water. Introducing water with very different characteristics than the natural water source, however, may affect what types of vegetation will grow.

Suggested Approaches

The conference concluded with several participants reflecting on courses of action to consider when implementing a conjunctive management policy. The participants were Jim Johnson, an attorney with Fennemore Craig; John MacKinnon, deputy county attorney in Cochise County; Hugh Holub, attorney representing the City of Nogales; and Dale Pontius, director of the Southwest Field Office of American Rivers.

Jim Johnson is not convinced that conjunctive management will fulfill what its proponents promise: better adherence to scientific principles,

preservation of riparian areas, and the protection of surface water rights.

Johnson suggests that the goal of preserving stream flows and riparian areas might better be served by curbing surface water uses rather than groundwater uses. Surface water users could be encouraged to shift to CAP water and wells as an alternative to surface water diversion.

He questions the assumption that surface water rights are superior to and firmer than groundwater rights. Possibly groundwater is a more dependable water source than surface water in Arizona. Further, the prior appropriation doctrine may be outdated and impractical for arid Arizona. Johnson suggests that surface water might be managed under the groundwater code.

The state's economic development has taken place mostly since 1935, usually based on groundwater resources. A significant change in state water law doctrine could harm Arizona's economy without accomplishing the desired objectives.

John MacKinnon said the task of implementing conjunctive management at a global or state level is overwhelming. A more effective approach is to work locally. This is the strategy of choice in the Sierra Vista area and in Santa Cruz County.

Major local interest groups in Sierra Vista have joined in a cooperative effort to devise a management plan to protect both the riparian area and community water supplies. The Sierra Vista plan differs from an AMA strategy in several important respects.

The Sierra Vista plan stresses local management and control, with less reliance on DWR administration. Thus the plan goes beyond the AMA goal of maintaining safe yield, to take on an issue of local importance; i.e., the protection of both riparian areas and community water supplies. The task involves conjunctively managing groundwater and surface water.

Hugh Holub described the back-

ground and purpose of the new Santa Cruz Active Management Area. He said an active and involved community supported legislation establishing the new AMA. Along with sharing a common cultural heritage, the community was united in its belief that unique hydrological conditions in the Santa Cruz area justified an AMA apart from the Tucson AMA.

A distinctive feature of the Santa Cruz AMA is its inclusion of conjunctive management principles. Its goal is to maintain safe-yield and to prevent local water tables from experiencing long-term declines. In effect, this mandates preserving shallow water levels currently existing in certain areas of the AMA including along the Upper Santa Cruz River. Riparian habitat thus would be afforded some degree of protection from overpumpage.

Further, the legislation establishes that all "water withdrawn from wells" is subject to management plan provisions. As a result, if either groundwater, surface water or sub-flow is withdrawn from a well, it is subject to conservation requirements or other DWR regulatory provisions.

Dale Pontius said it has become ob-

vious that some form of conjunctive management is long overdue. The commitment to adjudicate water rights helped prompt this awareness. Also, the passage of the 1980 Groundwater Management Act increased awareness that surface water management also needed to be addressed. Without some form of conjunctive management critical surface water flow will be lost in Arizona.

Conclusion

Historical precedent and vested interests often have as much, and perhaps more to do with determining what groundwater-sur-

face water laws are on the books than do geology and hydrology. This observation is borne out by developments in the early history of Arizona's bifurcated water laws.

As the WRRC conference demonstrated, however, times have changed. Over the years water uses have become more diverse. A greater diversity of water use means a greater range of water interests, from environmental to agricultural to urban uses. Thus a public policy is needed that is tailored to varied interests and recognizes hydrological complexities. Many observers believe it is not a question of whether Arizona adopts a policy of conjunctive management but what form it will take.

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