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Privatization Versus Groundwater Central Management:

Public Policy Choices to Prevent a Water Crisis in the 1990s

By THOMAS H. BRUGGINK*

ABSTRACT. A group of free market *natural resource* economists argue that the current system of limited *property rights* for *groundwater* users should be replaced by a new system of freely transferable property rights. This, they contend, would provide the more efficient allocation of groundwater resources and help alleviate the *water scarcity* problem in the United States. Their case for *privatization* is critically appraised. Groundwater *hydrology*, common property, *contamination*, and other third party effects are examined to determine the set of circumstances under which privatization would work best. The following alternatives to the full privatization plan are also examined: central management, *legal reform*, and "French style" privatized management of *water systems*.

I

Introduction

AQUIFERS are groundwater basins containing enough water to make it economically feasible as a water supply.¹ Water in these basins is viewed as a common property with private ownership initiating upon withdrawal. Most state legal systems have adopted rules over the years that offer only limited property rights to overlying landowners and other water appropriators that have rights to withdrawal. An earlier paper examined the issue of water scarcity and the outdated state laws governing groundwater use.² In this paper several proposed solutions to the ownership and management of this water resource will be critically analyzed.

State laws governing withdrawal have locked water use into historical patterns with limited opportunity to transfer use to new parties. The current laws also do not fully correct the third party effects caused by excessive pumping. As a consequence, the many current uses of water are excessively wasteful or less productive compared to newer alternatives. With limited property rights, water owners lack full incentives to make necessary investments to ensure adequate

[Thomas H. Bruggink, Ph.D., is an associate professor in the Department of Economics and Business, Lafayette College, Easton, PA 18042.] This article completes an examination begun in the last issue of this *Journal* (Jan, Vol 51, No 1) entitled "Third Party Effects of Groundwater Law in the United States: Private Versus Common Property."

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future supply since they will not reap the full benefits of such investments. Under such conditions, emphasis shifts to current consumption, resulting in overpumping. Clearly, significant modifications in state water laws and regulatory rules are necessary at the least, and, according to some economists, a whole new policy should be adopted.

A new group of market oriented natural resource economists³ place little faith in the current limited property rights system that governs groundwater use. Rather than rely on a central management alternative of greater regulation, they argue for a new system of well-defined, exclusive, and freely transferable property rights that will provide greater incentives for the water resource development. The implementation of these ideas (called the New Resource Economics) requires the privatization of aquifers throughout the nation. Individuals or firms holding water rights would be free to use the annual water flow, sell it on the open market, or accumulate it for future transactions, whichever is most profitable to the holder.

Their argument for privatization of aquifers will be examined here, as well as alternatives to privatization. The issues that will be examined include the privatization plan, and three alternatives to a system of complete privatization: 1) central management, 2) legal reform, and 3) "French style" privatized management of water systems.

There are important differences between the privatization of aquifers and the other water use proposals that operate within the existing property rights structure. A privatization plan is far more comprehensive than water marketing, although the latter also offers opportunities for water reallocation. Privatization of aquifers is a new proposal, offering a substantive change in existing property rights. It encompasses a new definition and assignment of water property rights that apply to the entire quantity of water in the aquifer. On the other hand, water marketing results from an easing of certain state restrictions on transfers and storage. It has been adopted within the existing property rights regime, and generally applies only to a portion of the water in an aquifer or surface water source. Furthermore, water marketing is not new, having started with the development of western water in the 19th century.

Water marketing would be more widely practiced if groundwater privatization were adopted. But increased activities in this area can also take place without privatization. Water marketing is not the invention of the New Resource Economists.

Most economists would probably favor privatization of an aquifer if it could be shown that the benefits of privatization outweigh the costs. Because most benefit-cost studies in the water resource area involve the construction of a dam,

a brief review⁴ will illustrate the framework that is needed to evaluate water projects.

Let us consider two potential benefits of a dam, flood control and water supply. The measurement of these benefits employs the probabilities of a flood and a drought combined with the value of the benefits. Having obtained a measure of the expected value of a dam within each year, the standard approach then involves discounting these annual benefits over the life of the dam to obtain a present value. This is then compared to the present value of the construction and maintenance costs. If the present value of the benefits outweigh the costs, the water project has merit.

Although a cost-benefit analysis on the privatization proposal would help policy-makers, it is not possible to estimate the benefits and the costs because, unlike dam construction, there is no historical record to provide the needed information on the benefits and the costs. Nevertheless, the cost-benefit idea will be employed as a method of evaluating the proposal in order to provide a framework for examination.

The primary benefit of privatization is the improved allocation (to its highest valued use) of water resources. As a consequence, there will also be greater pumping efficiency, less waste, and greater efforts to reclaim water. The costs of privatization are the transaction costs needed to make a privatization work. There are costs in obtaining information, reaching agreement, monitoring, and enforcing the contracts for the two parties, as well as the costs to mitigate or compensate third party effects.

Privatization makes sense if its benefits outweigh its costs, but it is optimal only if this net benefit is greater than that of other water reallocation alternatives such as central management or legal reform. Although the measurements of the benefits and costs will not be attempted here, the evaluation of the privatization proposal must be done in the context of viewing alternatives to privatization as well.

II

The Privatization Proposal

ACCORDING TO THE NEW RESOURCE ECONOMISTS, a revision of water laws is needed to create a new set of property rights which would allow the marketplace to put water resources to their highest valued use. Current laws that restrict new uses and transportability, and encourage overpumping and excessive depletion of the basin, and provide little incentive to conserve or reclaim water, need to be revised or abolished.

The new system of property rights would define and guarantee the rights and tenure of ownership, and facilitate the transfer of those rights by allowing them to be sold in the marketplace. In the absence of externalities and with proper safeguards against the drawdown of the groundwater stock below a predetermined level, privatization would maximize the net economic value of the basin.

The New Resource Economists' model for privatization has been most strongly proposed by Terry L. Anderson, Oscar Burt, and David Fractor.⁵ It is based on Vernon Smith's proposed solution to the valuation problem for irrigation water in Arizona.⁶ The central feature of the plan involves a property deed issued to each water user. The deed has two components: 1) a claim to a percentage of basin flow (recharge), and 2) a percentage claim on basin stock. Property rights would be distributed to individuals in proportion to their pumping for some historic base period.

Although the initial assignment of rights is somewhat arbitrary, Anderson notes that alternatives exist such as basing allocations on overlying land areas. Pumps would be metered, and at the end of each year, a water inventory would be taken for all users. The amount pumped would be subtracted from each account, and an appropriate share of the estimated aggregate recharge would be added to each account. Since water that is transported out of the basin area will have no recharge possibilities, such transfers will count against the owner more heavily. Suppose an alfalfa farmer has a diversion right to 10 acre feet of water annually. Assume that 50% of the water is returned after use as recharge, available for other farmers. If the farmer would sell the 10 acre flow to a out-of-the-basin user, other farmers would face a reduction of 5 acre feet that would otherwise be return flow. Therefore, for each acre-foot the farmer sells, he reduces his diversion by more than one acre-foot to avoid damage to third parties.⁷

With this system of property rights, users are free to maximize the economic value of their share of water. The deed can be sold to new owners who will know the nature and certainty of the rights they are receiving. A risk-averse user can conserve his present consumption of water in order to hold more stocks. Under idealized conditions, this protects him from a possible future water shortage.

Implementation of the privatization proposal that will achieve the full benefits of technical and allocative efficiency requires certain idealized conditions to facilitate its functioning: 1) non-interference in pumping among owners' wells, 2) agreement among present users and landowners to determine the initial allocation of aquifer flows and stocks, 3) a low cost, effective system for measuring the recharge attributable to users that return a high volume to the aquifers, 4) low cost, effective system for measuring aquifer interchange with other water sources, 5) uncontaminated water supply, both now and in the future, 6) public

willingness to allow groundwater resources on public lands to become privately owned, 7) public agreement on which basins can be mined and which should be restricted to sustainable yield withdrawals only, 8) resolving disputes concerning political boundaries (between states and between nations), and 9) mitigation or compensation of public interest effects. The optimal operation of a privatization plan will be sensitive to the violation of any of the above-mentioned conditions. Each of these items will be discussed in the next section.

III

Problems with Privatization

PRIVATIZATION brings many problems that must be dealt with.

Spatial Interference. For a successful privatization scheme, one that offers clear efficiency improvements over the present arrangement, the decision to pump today or next year should not be influenced by the pumping circumstances of an adjacent landowner. Yet if the second owner removes his share of the flow and his share of the stock immediately, the lowered water table reduces the ability of the first owner to remove his accumulated share of water, and, in the extreme, his well may be dry. Furthermore, even if the adjacent well is only pumping at annual rates equal to the recharge, the friction of water moving through rock particles causes a drawdown of the water table surrounding the well. Depending on the conductivity of the rock strata, the drawdown can stretch for a long distance, making water less available and interfering with the pumping efficiency of adjacent wells.⁸

The mean and variability of annual natural recharge is generally not known since aquifers lack monitoring devices. Although mean annual recharge is important in determining the rights to flow and stocks in the initial assignment of rights, it is not sufficient to determine the operational viability of a privatization scheme. Property right holders that are risk averse and wish to conserve water for future contingencies may find their rights do not guarantee the flow of water to their wells. For example, a few years of low recharge may leave an owner of a vulnerable well location without access (or access only with very high lift costs) to his entitled amount due to a lowered water table.

If owners of adjacent land decide to withdraw their portion of the stock of water, they may also leave a landowner who has a vulnerable well location without access to water (or access only with very high lift costs) due to a permanently lowered water table. In order to anticipate this occurrence, the vulnerable landowner may wish to invest in several test wells to determine his water availability status.

Complete resolution of this problem can only be achieved by operating all wells in an aquifer as a single pumping system. This would involve a unitization plan similar to ones promoted in the Texas oil fields. A brief discussion of unitization for water systems is covered in the next section of this paper.

Monitoring Costs. Annual recharge needs to be measured so that the percent flows can be allocated properly from year to year. Incorrect measurement can result in an unintentional overdraft. Also, some high water users return a large portion through recharge (e.g., irrigation). This needs to be measured accurately so credit can be given accordingly. Without proper credit those high recharge users will lack incentives to maximize their return flow.

Assignment of Rights. Assignment of rights on the basis of historical use patterns presupposes that accurate historical records exist. Since most water withdrawals are not currently metered, assignment instead must be based on estimates of past use, estimates of current flow, or the maximum permitted flow (even though the maximum may never have been approached). In addition, dormant rights will undoubtedly be exercised. The total allocation may exceed supply for some aquifers, especially if base levels are established. However, foreknowledge of an upcoming prorationing assignment of rights will encourage waste and overcapitalization as current water users try to maximize their once-and-for-all share.

An alternative method of assigning property rights is based on the relative share of overlying land. However, this would lead to problems in those states where water use rights are not tied to land ownership. Because the government cannot disenfranchise water rights holders without due process, it seems that extensive negotiation among all current users (not only those owning overlying land) would be required.

Contamination Protection. Since contamination poses serious health risks to humans and can cause long term, or even permanent, damage to the ecosystem, careful monitoring of the aquifer is necessary to warn users of potential danger and to determine the guilty party or parties. Of course, this activity should be undertaken regardless of whether the aquifer is privatized or owned by the public. The assignment of liability to guilty parties is necessary to properly compensate innocent water right holders and victims. Redress in court may be ineffective without strict monitoring of each right holder, since liability is otherwise extremely difficult to assign.

With privatization, agreements must be reached for responsibility for as yet undetected contamination episodes, undetected pollution that escapes the monitoring devices, and water usage contingencies during cleanup (e.g., prevention of excessive pumping from a portion of the aquifer not yet affected by

the pollution plume). Liability and cleanup rules under current laws may not be sufficient to protect one's additional investment with privatization.

Public Willingness. Major consideration must be given to the 700 million acres of land owned by the federal government. Most of the public land is forests, grasslands and wilderness, and is used for national parks, national forests, preservation areas, wildlife refuges, and public rangelands. The national parks and congressionally protected wilderness areas are, for the most part, off limits to resource projects.

The federal land agencies, the Interior Department, and the Agricultural Department's Forest Service are in charge of granting private access to the natural resources both on and under the land. Development must occur without degrading the land in a way that would take centuries to erase. Dramatic increase in resource development on this land, as attempted by Interior Secretary James Watt in 1981–83, has been met with resistance by Congress, and has created a great deal of conflict and tension among interested parties. Given this background, water resource development on public land, if it occurs at all, would most likely receive agency approval if it was publicly, not privately, owned.

Public concern also arises because in many communities groundwater is the sole source of municipal water. Under these circumstances the aquifer is likely to be considered "critical," and any proposal to change from public to private ownership is likely to face considerable opposition. Government ownership of municipal water utilities is the dominant ownership type in the United States (90% of all water utilities),⁹ and privatization of water utilities seems to be an unlikely prospect where groundwater is the sole water source, despite potential efficiency advantages.

Political Boundaries. Hydrogeologic maps of the U.S. show the extent to which aquifers underlie the nation. Many basins encompass more than one state, which would cause jurisdictional problems whenever disputes would arise. A 1987 survey of groundwater specialists revealed 23 U.S. locations of current and potential interstate competition for groundwater resources:

It is clear that there is significant competition for groundwater all over the contiguous 48 states and along the U.S.-Mexico border. Also there are many areas where competition may be expected to develop in the future. States advantaged by this competition (*i.e.*, states that are pumping water that flows to them across state lines) have few incentives to curtail their groundwater pumping.¹⁰

Because privatization requires certainty of ownership, interstate disputes would need to be resolved before complete privatization can occur.

Public Interest. If a water transfer has a high probability of adversely affecting the wildlife in an ecosystem, or the cultural heritage of a community, or the ability of a region to sustain agricultural activity, legitimate objections can be

raised in court. As water transfers increase in popularity, this issue has received greater public attention.¹¹

Objectors to a transfer believe the transfer adversely affects their private interests or violates their perception of public interests. Current law encompasses concepts of injury that are comprehensive enough to protect a broad range of private and public interests, and many water transfers can be reformed to satisfy all parties.¹²

The costs of the legal and engineering expenses in the Rocky Ford Ditch Transfer case was \$1 million. This suggests that transaction costs can be quite high whenever the parties to the transfer try to mitigate the harm to third parties or to compensate them.

IV

Unitization

THE OWNERS OF RIGHTS must agree to *unitize* the production of water in the basin if full pumping efficiency and elimination of pumping externalities is to be attained. This operation of the aquifer as a single system will overcome the spatial distribution problem and provide assurance of future supply to those that wish to conserve. The common property problem cannot be completely resolved without such assurance. Anderson discussed the advantages of unitization in his most recent water marketing and privatization proposal.¹³ However, agreement on allocation rights must be worked out completely before unitization begins. Since the decision on unitization must be a voluntary, once-and-for-all agreement among current owners, the transactions cost of negotiations may be high. In the oil fields in Texas, voluntary agreements for oil field unitization were not only permitted but were encouraged by the state to reduce oil recovery losses stemming from overpumping. Unfortunately, high transactions costs of negotiations sometimes precluded agreement even though all parties stood to gain.¹⁴

With an aquifer unitization agreement, certain wells would be closed down and others operated to eliminate pumping interference. This means that the division of water outflows among owners must be a once-and-for-all settlement at the time of unitization. Division of water flows based on size of overlying land and historical output favors large firms and results in a different set of incentives to reach agreement between large and small owners.

Small landowners will be reluctant to join agreements that might worsen their expected future profits unless some concessions were made. This will result in high bargaining costs, and it may prevent agreement. This reluctance to reach an agreement on coordinated pumping can be understood in the context of an individual owner decision on whether or not to join. The objective is to maximize

the expected present value of the property rights. If he joins the unit formation, he has an expected revenue flow based on the use of his percentages of the basin stock and flow; if he delays in joining, concessions may alter the allocation rule in his favor since his holding out causes aggregate losses in pumping efficiency (rent dissipation). Since the stock and flow of an aquifer is not known with certainty, the value of joining the consolidation is not known with certainty. Aquifers with less information on stock and flow will find landowners less likely to join in the early stages of negotiation. Major information problems include lack of data and subjective interpretation of what will be available. As a consequence, firms will rely on the private data of their own surveys and pumping histories. This will result in information asymmetries and contribute to the failure to unitize. This is what occurred in the Texas and Oklahoma oil fields.¹⁵

V

Can Privatization Work?

IN THE ABSENCE of a unitization plan, there are serious problems with the spatial distribution of wells that must be resolved to avoid third party externalities. Dense pumping is inefficient, and may cause vulnerable wells to go dry. Agreements as to the location and pumping rates of wells are necessary to minimize interference. Uncertainty of future recharge and demand levels, incomplete information, and opposing desires among landowners (each will want a well of his own) will undoubtedly make such agreements difficult to achieve.

For aquifers that have interchange with rivers or lakes, the external effects of pumping can involve surface water users as well. Agreements must be reached and monitoring devices must be installed to measure the flow between the two systems. Alternatively, aquifers that have a substantive physical connection to another water source could be excluded from any privatization plan.

The water contamination issue cannot be excluded from a privatization proposal. Pollution can affect the whole basin, seriously damaging the asset value of the resource, perhaps irreversibly. Liability and cleanup rules under current laws may not be sufficient to protect one's investment in water property. The threat of future damage to an asset encourages overuse in the present, which is the type of behavior that privatization hopes to avoid.

In view of the transactions costs that are suggested, it seems unlikely that there are very many aquifers in which an agreement among the owners of new property rights will result in a privatization plan that significantly reduces the third party effects that trouble common property resources. The proposal will only work if it is applied to aquifers that currently 1) do not face problems with spatial distribution of wells, 2) have well-behaved recharge and demand behavior,

3) have only a few water users, with historical use patterns that roughly correspond to the relative shares of the overlying land, 4) have no contamination problems on the horizon, 5) have no significant interchange with a river, lake, or ocean, 6) have no boundary problems with other states or nations, or with public lands, 7) are not a major source of supply for municipal water, and 8) have minimal impact on the third party public interest issues. Undoubtedly there are a few, a very few, privatization candidates which conform to these conditions, but they will hardly solve our nation's water shortage.

One could argue in favor of privatization even though third party effects of dense pumping are not greatly reduced (assuming the obstacles to agreement can be overcome). As long as the remaining benefits of improved resource allocation and technical efficiency outweigh the costs, limited privatization will be worthwhile. Also, with pricing in private hands, the market outcome for the tradeable property rights to water will undoubtedly result in higher prices for water use. This will help eliminate uneconomic uses, reduce waste, and encourage conservation. But marginal improvements in water allocation can be gained by other measures than full privatization, and since many of these schemes will seem less radical to the public, they are more likely candidates for adoption. These alternatives are the subject of the next section.

VI

Alternatives to Full Privatization

THE FULL PRIVATIZATION BENEFITS of allocative and technical efficiency may not be available for most watersheds, but there are several alternatives that may improve the current situation. These alternatives are: 1) legal reform of state water laws, 2) increased reliance on central management, or regulation, by the government, and 3) increased reliance on private sector management of water systems. Each of these alternatives will be discussed below.

Legal Reform. A 1982 U.S. Supreme Court declared water to be an article of commerce; states cannot unreasonably restrict its transfer across state lines (*Sporbase v. Nebraska*, 1982). This decision, along with other reforms in various states, has opened the door to an increase in water markets and created an environment for flexible arrangements for water transfers between and within states. Weatherford and Shupe¹⁶ have identified five reallocation methods (in addition to the sale of the land to which the water rights are attached) that are receiving renewed interest. These are indicated below.

1) Leasing of water rights. This method provides great flexibility while retaining ownership with the original right holder.

2) Option to lease water rights during emergencies. This allows for alternative sources of supply during a drought or other water emergency. For example, a municipality (junior right holder) might have such an arrangement for irrigation water from a farmer (senior right holder), and the payment will cover the loss of crops.

3) Consent not-to-sue agreements. These occur between junior and senior right holders, and allow junior right holders to obtain their allotment during shortages. Senior right holders will receive payment or, if the junior party is the government, participation in the benefits of a new water project (e.g., irrigation).

4) Conservation offset agreements. Junior right holders will invest in conservation efforts in a senior use, thus creating a water "surplus" available for junior use.

5) Transfer rights to "salvage" water. This is similar to the offset agreement, except the owner of water will reap the benefit of conserving the water.

These, despite their economic desirability, are in limited use only. Organized, competitive markets for water do not exist in this scheme, although some are beginning to form in the West. Most water right transfers occur incidentally to a land transfer or as an isolated transaction. In addition, most major water purchases are made by municipal water utilities that are securing additional supplies for their growing populations. "Ironically, much of the water marketing is not facilitating privatization but demonstrates increasing public control over western water by local governments."¹⁷

Greater use of water reallocation methods would require specific legal reforms of water transfer laws that would provide the incentive to use them. For example, only California recognizes salvage rights. It is also necessary to revise the legal definition of water rights and clarify the nature of enforcement activities (such as the "use it or lose it" provisions of the appropriation rights doctrine).

A great advantage of legal reform is that much can take place within the structure of the existing laws through changes in interpretation and implementation. A state with a more pressing water scarcity (a "pre-crisis" situation) will operate in a climate favoring quick action, while other states will modify their laws more gradually.

The disadvantages of the legal reform alternative are that it is very slow, the reforms may selectively favor those interest groups with the greater political clout, and the piece-by-piece process doesn't look at the whole water supply and demand picture (thereby overlooking side effects and precluding coordination). Another problem is that the allocation of water over time is not specifically confronted.

Central Management. Another approach, which can be considered as an opposing solution compared to privatization, would provide an increased role for

government decision-making. The state and local government would own and manage the aquifer. Two recent examples of this approach are Spokane County's Spokane-Rathdrum Aquifer, which focuses on water quality, and Arizona's new groundwater code.

In Spokane, the increased government role was in response to public concern over potential health problems from the water quality degradation associated with economic development.¹⁸ In particular the problems were caused by greater amounts of wastewater, reduction in the amount of undeveloped land to handle stormwater runoff, and landfill contamination of the 350 square mile aquifer. The creation of a aquifer protection district has the goal of no further degradation. The County Utilities Department formed a Satellite System Management Agency to provide management services to the eighty water utilities that service the Spokane area. The preventative measures that have been adopted and are being implemented are:

- 1) Impose minimum design standards on wastewater treatment facilities.
- 2) Compatibility of interconnections among the utilities.
- 3) Water quality monitoring.
- 4) Sharing of facilities for reservoirs and sources of water supply.
- 5) Monitoring of dry wells.
- 6) Stormwater management.
- 7) Regulation of the use of critical materials by industry to prevent improper disposal and minimize the chance of accidental spillage.
- 8) Regulation of existing landfill operations within aquifer area.
- 9) Prohibition of new landfills over the aquifer area.

The advantage of Spokane's central management program is that it recognizes the link between land use patterns and water quality. Because water supply cannot be separated from water quality, and the most certain activity to ensure quality is prevention of degradation. It is a small comfort to know that a private firm is liable for the cleanup of a contamination incident when the entire aquifer is at risk. Mutual interdependence between utilities is also recognized, and coordination of their services is part of the management plan.

Although the whole water system is considered as a single unit, the individual parties are not provided with economic incentives to maximize the utility of the water basin. Water reallocation and property rights are not addressed. However, the coordination of utility services should improve the spatial distribution of wells and the land use management plan should reduce third party effects. Nonetheless, new economic activities that need permits from the aquifer protection district may not be the ones that yield the highest net benefits to society since government bureaucratic decision-making opens the door for undue in-

fluence by special interest groups. Thus we cannot conclude that total water benefits will be maximized.

Another problem with economic incentives concerns the aquifer protection fees on users. In Spokane, a fixed charge of \$1.25 per month, regardless of total use, is levied on each water user and an additional \$1.25 per month, regardless of the amount, for those who discharge waste through a drainage field. Supplemental funds for sewage facilities and aquifer protection are provided by a \$.0025 county sales tax.¹⁹ A better fee system would tie the levy to the actual amount of use. This sends the appropriate signal to the marketplace. Could such a fee system be adopted? This certainly should be no problem for metered water consumption, although measuring use of a drainage field may require an arbitrary relationship to water intake.

In Arizona, there is a new groundwater code. It is a response to continual annual overdrafting of the state's groundwater, due to water intensive agricultural practices and rapid population growth. In addition to depletion, there were problems with land subsidence and quality degradation.²⁰ The goals of the new code are to control overdraft and increase flexibility of reallocation. The state created a Department of Water Resources to administer all state water laws (except those relating to quality). The new code set up four geographical areas defined by hydrology, in which intensive water management is practiced. These Active Management Areas (AMAs) encompass eighty percent of the state's population and seventy percent of its water consumption. There is a User Advisory Council in each AMA to advise area directors and make recommendations on groundwater management. The governor appoints the state water director and the Council, and the state director appoints the area directors. A series of five management plans, extending to the year 2025, are scheduled to gradually create a balance between withdrawal and recharge.

The primary force for reduction in water use among existing users is a series of increasingly stringent conservation requirements. Agricultural users must reduce consumption to a level consistent with a historical measure of water required for crop growth. Industrial users must use the latest commercially available conservation technology. Municipal officials must limit use of water in private swimming pools and golf courses, public parks, and roadways.

New uses associated with economic growth can obtain water in one of three ways:

- 1) purchase of existing (grandfathered) rights in private hands
- 2) application for state groundwater withdrawal permit
- 3) application for service from the local utility.

Successful application for a permit will depend on the availability of private purchase of grandfathered rights and an assessment of the availability of sufficient supply for the life of the permit. Local service availability is constrained by limited area extensions and restrictions on new wells.

A very desirable feature of the Arizona central management approach is the priority placed on the purchase of private rights for water reallocation. Whether new water users see it as to their advantage to avoid this avenue in favor of the other Action Management Area options remains to be seen. Unfortunately, this is the extent of the reliance on economic forces to provide incentives for efficiency. Conservation efforts (changes in technology and practices) are mandated rather than market driven. By requiring industrial users to adopt an existing conservation technology, the code does not reward innovative alternatives to achieving the same goal at a lower cost. In addition there are no salvage rights to the conserved water. Clearly, mandated controls are less than optimal. Finally, the new pump tax is used merely to cover the AMA administrative expenses, and is not used to conserve water by pricing what is viewed essentially as a free good.

Privatized Municipal Water Systems. Although not widely practiced in the U.S., private water system management is common in Europe, particularly in France.²¹ In France there are five private water supply and distribution groups that operate nationwide and in competition with the public sector. They handle both drinking water and sewage treatment, and offer services in the fields of project development and civil engineering. While the responsibility for water provision ultimately rests with the municipalities that retain ownership of the water utility, they have the option of delegating their authority to private enterprise through fixed-year lease contracts. Faced with aging facilities and new contamination problems that require new expertise, municipalities have responded by privatizing their operations, and now over 4300 out of 15,000 municipal systems (including groups of small rural municipal systems) are run by private firms. They serve 60% of the total population.

There are three types of fixed-year lease contracts:

- 1) Concession. The private firm finances, builds, and manages the utility installation.
- 2) Farm lease. The municipality finances and builds the utility, but a private firm manages it.
- 3) Management contract. The municipality retains direct control and shares responsibility of management and operations with a private firm.

Municipalities favor privatization to be relieved of day-to-day management, to utilize technological advances that increasingly rely on specialists and econ-

omies of scale, and to draw on the ability of specialists in handling modern water quality problems. Although private firms do not have a monopoly on specialists or state of the art technology, many municipalities do not have the technical staff to match the private firms, nor can they take advantages of available economies of scale in operation and in research and development.

Since the reimbursement for expenses under the concession contract is entirely through customer rates, full cost pricing (no subsidies) is ensured. Although the rates are still regulated on the basis of cost-plus pricing, the possibility of nonrenewal will undoubtedly temper yearly requests for rate increases and provide incentives to lower costs. Potential and actual competition during contract renewals will also encourage long term efficiency as firms position themselves as being better equipped than their rivals to apply advanced technology or solve water emergencies in a cost effective manner.

Although it incorporates privatization, the French system is not complete because it only includes the delivery of water, not the ownership. While the third party effects of pollution are mitigated, the central issue of water reallocation among users is not addressed.

The prospects for French-style privatization of water utilities in the U.S. are more limited,²² with the most likely location of conversions being small towns that have a limited ability to raise funds and retain specialists needed to satisfy more stringent water quality standards required in the 1986 amendments to the Clean Water Act. In the Eastern states, where contamination concerns are at least equal to concern for water quantity, privatized management might be particularly attractive to these small municipalities. Most large municipalities, on the other hand, have a strong tradition favoring government ownership and management.

VII

Conclusion

DESPITE ITS INHERENT APPEAL of efficiency and conservation, the enormous transaction costs of implementing and operating a privatization plan for an aquifer make it a poor candidate as a policy alternative for any water crisis that appears. It would seem to work best in a few regions with low population density where the water transfer impact on third parties is minimal (in some of the Western states). It is unrealistic or unacceptable as a nationwide policy. Due to the problems discussed in this paper, the benefits of privatization would undoubtedly be outweighed by the costs.

As a second best solution, the avenue of legal reform to allow more water marketing seems very promising. While this reform does not optimize the use

of water for an aquifer the way the privatization promised, it will improve the allocative efficiency of resource use.

It seems likely that the New Resource Economists will declare that the battle for groundwater privatization has been won as they seize the center stage of the trend toward water marketing. In reality they will abandon privatization as originally conceived because it is unworkable.

This paper also looked at the new central management alternatives (*i.e.*, government ownership and/or regulation) formed in response to an increasing water scarcity. These lack the private incentives that encourage efficiency and invite special interest groups to seek favored treatment. Among the alternatives to groundwater privatization, the only complete system is found in the Arizona central management plan. Similar action may be taken in other southwestern states that face a severe and threatening overdraft problem. However, in most states the problems in water quantity and quality will be on a smaller scale, or will occur with a longer time horizon, and the less dramatic remedy of legal reform will be chosen.

In the eastern states, where contamination of groundwater assumes greater importance, the French style of privatized management for regional water systems might be the appropriate second best alternative to privatization. In this region conditions are most closely aligned to those found in France, where this practice has achieved success.

It is interesting to note that the legal reforms move the nation closer to privatization of groundwater (although not necessarily the model proposed by the New Resource Economists), whereas the states and counties facing emergency situations favor an increased role for government regulation. It is an American tradition to respond to economic and military crises by having the government play a more active role in the marketplace,²³ and a forthcoming water crisis should be no exception. Yet the gradual response of limited privatization through legal reform may offer a more economically efficient solution in the long run than the central management alternative.

Notes

1. Aquifers are underground layers of porous rock and rock particles holding vast amounts of water. They are usually bounded from below by impermeable rock strata, forming a large basin. They underlie most of United States and supply drinking water to at least some populations in every state. Rainfall, snowmelts, river flows, lakes and other impoundments, and man-made discharge are part of the hydrologic cycle that continuously provides the water that percolates through the layers of rock surfaces to recharge the basin. Withdrawals from an aquifer occur through a pumping well or natural connection to a stream, lake, underground stream, or another aquifer.

2. Thomas H. Bruggink, "Third Party Effects of Groundwater Law in the United States: Private versus Common Property" *American Journal of Economics and Sociology*, Vol. 51 (Jan. 1992): 1-17.

3. The advocates of the privatization proposal are associated with the New Resource Economics (NRE) school, lead by Terry Anderson, John Baden, and research associates at the Political Economy Research Center based in Bozeman, MT. See Michael D. Copeland, "The New Resource Economics," in *The Yellowstone Primer*, eds., John A. Baden and Donald Leal (San Francisco: Pacific Research Institute for Public Policy, 1990).

4. Daniel A. Graham, "Cost-Benefit Analysis under Uncertainty," *American Economic Review* Vol. 71 (Sept. 1981): 715-25.

5. Terry L. Anderson, Oscar R. Burt, and David T. Fractor, "Privatizing Groundwater Basins: A Model and Its Applications," in *Water Rights: Scarce Resource Allocation, Bureaucracy, and the Environment* (Cambridge, MA: Ballinger Publishing Co., 1983); Terry Anderson, *Water Crisis: Ending the Policy Drought* (Washington, DC: Cato Institute, 1983); David T. Fractor, "Privatizing the Groundwater Resource: Individual Use and Alternative Specifications," *Water Resources Bulletin* Vol. 24 (Apr. 1988): 405-412; Terry L. Anderson and Donald Leah, *Free Market Environmentalism* (Boulder, CO: Westview Press, 1991).

6. Vernon L. Smith, "Water Deeds: A Proposed Solution to the Water Valuation Problem," *Arizona Review* Vol. 26: 7-10.

7. This example is adapted from Rodney T. Smith, *Trading Water: An Economic and Legal Framework for Water Marketing* (Washington DC: Council of State Policy and Planning Agencies, 1988): 18.

8. See Warren Viesman, Jr., and Clair Welty, *Water Management and Institutions* (New York: Harper, 1985); G. F. Briggs, "Developing Groundwater Resources," in *Handbook of Water Resources and Pollution Control*, eds., Harry W. Gehm and Jacob I. Bregman (New York: Van Nostrand Reinhold, 1976); Warren Viessman, Jr., W. Knaff, Gary L. Lewis, and Teremce E. Harbaugh, *Introduction to Hydrology* (New York: Harper, 1977).

9. Patrick Mann and John Mikesell, "Ownership and Water System Operation," *Water Resources Bulletin* Vol. 12 (Oct. 1976): 995-1004.

10. Zachary A. Smith, "Interstate and International Competition for Water Resources," *Water Resources Bulletin* Vol. 23 (Oct. 1987): 873-77.

11. Victor Brajer and Wade E. Martin, "Water Rights Markets: Social and Legal Considerations," *American Journal of Economics and Sociology* Vol. 49 (Jan. 1990): 35-44.

12. Kevin B. Pratt, "Mitigating Third-Party Effects," *Journal of American Water Works Association* (Mar. 1988): 55.

13. Anderson and Leah, 1991.

14. The material that follows is adapted from three related articles by the same authors: Gary D. Libecap and Steven N. Wiggins, "Contractual Responses to the Common Pool: Prorating of Crude Oil Production," *American Economic Review* Vol. 74 (Mar. 1984): 87-98; "Oil Field Unitization: Contractual Failure in the Presences of Imperfect Information," *American Economic Review* Vol. 75 (June 1985): 368-87; "The Influence of Private Contractual Failure on Regulation: The Case Oil Field Unitization," *Journal of Political Economy* Vol. 93 (Fall 1985): 690-714.

15. Libecap and Wiggins, 90.

16. See Gary D. Weatherford and Steven J. Shupe, "Reallocating Water in the West," *Journal of American Water Works Association* (Oct. 1986): 63-67.

17. *Ibid.*, 70.

18. See William R. Dobratz, Robert L. Wubena and John M. Maxwell, "Protection and Management of Spokane's Sole Source Aquifer," *Journal of American Water Works* (Sept. 1986): 62-69.

19. *Ibid.*, 69.

20. See Kathleen Ferris, "Arizona's Groundwater Code: Strength in Compromise," *Journal of American Water Works* (Oct. 1986): 79-84.

21. See Jean-Dominique Deschamps, "Privatization of Water Systems in France," *Journal of American Water Works* (Sept. 1986): 34-40.

22. See Michael M. Stump, "Private Operation of U.S. Water," *Journal of American Waterworks Association* (Feb. 1986): 49-51.

23. Robert Higgs, *Crisis and Leviathan: Critical Episodes in the Growth of American Government* (New York: Oxford UP, 1987).

Economics and Philosophy

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There is only one reference (p. 167) to Jeremy Bentham, the father of us all! His view is quoted and rejected that "The community is a fictitious *body*, composed of the individual persons who are considered as constituting as it were its *members*."

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F.C.G.