A CARROT OR A STICK? PROMOTING WATER CONSERVATION IN ARIZONA AGRICULTURE

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I. Introduction

> Irrigated, government-subsidized farming in the desert is probably the most uneconomical use of water imaginable. It may have made sense a century ago, when Arizona was largely isolated from the rest of the country by a primitive transportation system, and the difficulty of moving commodities here made it vital to be self-sufficient in food production. But it makes no economic sense today.[1]

These words reflect the attitude of many urban Arizonans toward irrigated desert agriculture. At a time when many residents perceive a coming water crisis, Arizona farmers use over eighty-five percent of the state's water resources.[2]

This article examines irrigation in Arizona and explores legal methods for promoting water conservation while maintaining a viable and productive agricultural sector. The analysis focuses primarily on two alternative legal techniques: 1) compelling conservation under the 1980 Groundwater Management Act (GMA)[3] (a "stick") and 2) encouraging conservation through economic incentives by allowing farmers to

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[1] Lessner, *Forget Orme Dam: Find Better Way to Allocate State's Water*, ARIZ. REPUBLIC, June 19, 1989, at A12, col. 1.

[2] Brown, McDonald, Tyselling & Dumars, *Water Reallocation, Market Proficiency, and Conflicting Social Values*, in WATER AND AGRICULTURE IN THE WESTERN U.S.: CONSERVATION, REALLOCATION, AND MARKETS 191 (1982); *see also* Kyl, *The 1980 Arizona Groundwater Management Act: From Inception to Current Constitutional Challenge*, 53 U. COLO. L. REV. 471, 473 (1982).

[3] Act of June 12, 1980, ch. 1, 1980 Ariz. Sess. Laws (4th Spec. Sess.) 1339 (codified as ARIZ. REV. STAT. ANN. §§ 45-401 to 45-637 (1987)).

use or sell the portion of their water right that they save through conservation (a "carrot"). In the final analysis, a combination of these methods works best. The legislature should mandate that all irrigators conserve to some minimum acceptable level, but still provide some incentive to those innovative farmers who conserve beyond that level.

II. The Need for Water Conservation in Arizona Agriculture

Irrigated agriculture began in the Arizona desert in approximately 300 B.C., when the Hohokam Indians began to develop an intricate canal system in the Salt and Gila River valleys.[4] By 1300 A.D., native settlements were scattered along more than 200 miles of canals.[5] Historians believe that the Hohokam disappeared during the fourteenth century and have suggested several possible reasons for their mysterious disappearance: a severe drought, a buildup of alkali in their fields from overuse of water, siltation of canals, or a combination of these factors.[6] As evidenced by the Hohokam's existence and unexplained disappearance, water has played a vital role in human civilization in the Arizona desert for nearly 2300 years.[7]

Arizona is an arid state. Summer temperatures in the state's desert areas rise well over one hundred degrees,[8] with an average annual precipitation below fifteen inches.[9] Although the rainfall is low and the rate of evaporation high, precipitation in the surrounding highlands provides water that maintains some flow in most stream systems and allows limited replenishment of underground aquifers.[10] More than eighty percent of Arizona's population, industry, and agriculture is con-

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[4] L. Gregonis & K. Reinhard, Hohokam Indians of the Tucson Basin 2, 8 (1979).

[5] *See id. See generally* R. Johnson, The Central Arizona Project 1918-1968, (1977).

[6] *See* R. Johnson,*supra* note 5; D. Anderson, The Adoption and Diffusion of Strategic Investments: The Case of Land Leveling in Central Arizona 9 (Jan. 20, 1990) (unpublished M.S. thesis, Univ. of Arizona).

[7] *See* D. Pontius, *Groundwater Management in Arizona: A New Set of Rules*, 16 Ariz. B.J. 28, 28 (1980).

[8] Ariz. Agric. Statistics Serv., 1988 Arizona Agricultural Statistics 92 (1989).

[9] The average annual rainfall is 11.1 inches in Tucson, 7.1 inches in Phoenix, and 2.6 inches in Yuma. *Id.* at 93.

[10] M. Kelso, W. Martin & L. Mack, Water Supplies and Economic Growth in an Arid Environment: An Arizona Case Study 1-12 (1973).

centrated in its arid lowlands.[11]

About 3.4 million people currently live in Arizona. State researchers expect the population to grow to 7.3 million in the next twenty-five years. The United States Census Bureau has issued more conservative predictions, forecasting a state population of 5.32 million in 2010.[12]

Encouraged by seemingly abundant water supplies, Arizona's irrigated agriculture expanded rapidly throughout much of the twentieth century. Irrigated acreage in the state increased from 200,000 acres near the turn of the century to over 1.2 million acres in 1980.[13] The value of crops produced using irrigation increased accordingly. In 1988, irrigated cropland in Arizona generated almost $1.2 billion in cash receipts.[14]

Except for range pasture, virtually all Arizona crops must be irrigated. The state's irrigated acreage is concentrated in Maricopa, Pinal, La Paz, and Yuma counties. Institutional constraints and market forces limit water availability and affect water costs to Arizona agriculture. Over half of all irrigation water is pumped from groundwater; the remainder is supplied as surface water from the Colorado River and reservoirs.[15]

In Arizona, agriculture is both the marginal user of water and the largest user.[16] Arizona farmers use over eighty-five percent of the state's water resources[17] to irrigate crops such as cotton[18] and alfalfa[19]

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[11] *Id.* at 6.

[12] Foster, *Arizona to Attract Millions*, Ariz. Republic, Apr. 17, 1988, at AZ12, col. 1.

[13] D. Anderson, *supra* note 6, at 11, 13.

[14] ARIZ. AGRIC. STATISTICS SERV., *supra* note 8, at 5. Cotton and alfalfa are large contributors to Arizona farmers' income. *See id.* In 1988, cotton produced over $335 million in revenue, and alfalfa hay generated almost $80 million. *Id.*

[15] H. AYER, ARIZONA AGRICULTURE AND FORCES OF CHANGE 2, 5 (1986).

[16] M. KELSO, W. MARTIN & L. MACK, *supra* note 10, at 175.

[17] Brown, McDonald, Tysseling & Dumars, *supra* note 2; *see also* Kyl, *supra* note 2.

[18] Nearly three million acre-feet of water per year is applied to cotton in Arizona. P. WILSON, H. AYER & G. SNIDER, DRIP IRRIGATION FOR COTTON: IMPLICATIONS FOR FARM PROFITS 1 (1982). This is approximately one-third of all water withdrawals in the state. *Id.* An acre-foot of water is the amount of water that would fill an acre to a depth of one foot, or about 325,851 gallons. Shupe, *Waste in Western Water Law: A Blueprint for Change*, 61 OR. L. REV. 483, 484 n.3 (1982). An acre-foot will supply a typical family of four with water for one year. *Id.*

[19] Arizona farmers harvested 155,000 acres of alfalfa hay in 1988. ARIZ. AGRIC. STATISTICS SERV., *supra* note 8, at 30. The Arizona Department of Water Resources (ADWR) estimates the consumptive use of water, the amount that the plant actually utilizes for transpiration and growth, for alfalfa at 4.69 acre-feet per acre. ARIZ. DEP'T

that can be grown in other regions with no irrigation.[20] Other water uses generate a higher dollar value per unit of water used.[21]

The relative importance of irrigated agriculture in Arizona's economy has decreased. With increased urbanization and the accompanying rise in industrial production, manufacturing and service industries have surpassed agriculture in income generated.[22] Agriculture produced seventeen percent of Arizona's personal income in 1954. By 1959, however, this share had declined to seven percent. In 1987, farm and agricultural services employment comprised about two percent of the state's personal income.[23]

If the state allocated its water through a pure market mechanism, irrigators would be least able to compete for scarce supplies. Therefore, the increased demand and resulting increased cost of water affect irrigation most acutely. The prospect of sharply higher water costs not only acts to halt expansion of irrigated acreage, but also endangers the viability of many present agricultural operations.[24]

While the demand for water in all uses has risen, the opportunities for developing additional supplies have declined.[25] With most prime reservoir sites already developed, construction costs high, and little unclaimed water left, the possibility of importing significant quantities of additional surface water is negligible.[26]

Rising power costs to pump groundwater from increasing depths has been one factor leading to the recent decline in the profitability of irri-

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OF WATER RESOURCES, DRAFT MANAGEMENT PLAN FOR THE SECOND MANAGEMENT PERIOD, PHOENIX ACTIVE MANAGEMENT AREA 357 (1988). Assuming a statewide average irrigation efficiency of 70%, over one million acre-feet of water was used to irrigate alfalfa hay in Arizona in 1988.

20 Arizona ranks fourth among all states in cotton production and first in the production of American-Pima cotton, a valuable variety highly favored for finer textiles. ARIZ. AGRIC. STATISTICS SERV., *supra* note 8, at 7. American-Pima cotton is grown almost exclusively in Arizona; Texas, New Mexico, and California produce only small quantities of this variety. *Id.* Irrigated cotton is an important crop in Arizona, California, New Mexico, Oklahoma, and Texas. These five states produce 60% of all United States cotton; nearly 80% of the cotton acreage in these states is irrigated. P. WILSON, H. AYER & G. SNIDER, *supra* note 18, at 1. Arizona ranked 21st in alfalfa hay production in 1988. ARIZ. AGRIC. STATISTICS SERV., *supra* note 8, at 7.

21 Municipal, industrial, and mining are the primary higher-value water users. *See* M. KELSO, W. MARTIN & L. MACK, *supra* note 10, at 175.

22 M. KELSO, W. MARTIN & L. MACK, *supra* note 10, at 13.

23 Rex, *History Lends Perspective to Current Economy*, ARIZ. BUS., Aug. 1989, at 8.

24 K. FREDERICK, SCARCE WATER AND INSTITUTIONAL CHANGE 7 (1986).

25 K. FREDERICK, *supra* note 24, at 110.

26 *See generally* M. REISNER, CADILLAC DESERT (1986).

gated agriculture.[27] Pumping costs are a large part of the production costs for all irrigated crops.[28] Once a well is installed, farmers maximize profits by pumping until the marginal cost of pumping equals the marginal revenue attributed to the water use.[29] Although other expenses vary with pumping rate, the largest component of the marginal cost of pumping is the energy cost to operate the pump. The increase in depths from which groundwater is pumped, coupled with dramatic increases in energy costs during the 1970's and early 1980's, has resulted in decreased profitability for farmers who have not adapted.[30]

The increased pumping costs also provide incentive for groundwater irrigators to begin experimenting with a variety of water-saving innovations. New irrigation technologies can increase efficiency and reduce production costs.[31] They can also increase crop yields by distributing water more uniformly.[32] Available water-saving technologies and irrigation practices include laser leveling,[33] sprinkler or drip irrigation,[34] tailwater recovery systems,[35] irrigation scheduling,[36] eliminating exces-

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[27] M. KELSO, W. MARTIN & L. MACK, *supra* note 10, at 109-10.

[28] P. WILSON, H. AYER & G. SNIDER, *supra* note 18, at 2. For example, water costs comprise 22-49% of the total variable costs of producing cotton in the major agricultural areas of Arizona. *Id.*

[29] Marginal cost is the change in total cost resulting from a one-unit increase in output. J. DOLL & F. ORAZEN, PRODUCTION ECONOMICS: THEORY WITH APPLICATIONS 33 (1978). Marginal revenue is the incremental increase in gross returns derived from producing that same unit. *Id.* at 72. An operator maximizes his total profit at the point at which marginal revenue equals marginal cost. *See id.* at 55-60.

[30] *See* P. WILSON, H. AYER & G. SNIDER, *supra* note 18, at 2.

[31] J. DAUBERT & H. AYER, LASER LEVELING AND FARM PROFITS 1 (1982); D. Anderson, *supra* note 6, at 28. Not all advancements in technology and practices can be applied to each type of irrigation system. For example, laser leveling and tailwater recovery systems are used almost exclusively with flood or furrow irrigation. *See* J. DAUBERT & H. AYER, *supra*, at 28. Alternative management techniques such as irrigation scheduling and a change in cropping patterns can be implemented with any system. *See* D. Anderson, *supra* note 6, at 28.

[32] D. Anderson, *supra* note 6, at 28.

[33] Laser leveling allows farmers to level most fields to a zero percent slope more efficiently and without the uneven spots commonly associated with conventional methods. *See* D. Anderson, *supra* note 6, at 29. Laser leveling can increase the irrigation efficiency for an average parcel from the current 50-65% to 85%. *See* J. DAUBERT & H. AYER, *supra* note 31, at 3.

[34] A change from flood or furrow irrigation to a sprinkler or drip system can decrease significantly the amount of water applied. *See infra* notes 44 and 45.

[35] A large portion of irrigation water applied by flood or furrow systems ends up as runoff at the end of the field. A tailwater recovery system can greatly reduce the water lost through runoff. Such a system captures runoff water at the end of the field and stores it in a pit or pond. Small pumps convey the recovered water back to the fields.

sive conveyance losses,[37] and changing cropping patterns.[38]

As in other western states, recent public concern in Arizona has changed from developing new water supplies to a greater emphasis on protecting and conserving existing supplies.[39] Waste occurs in industry

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Because tailwater recovery systems require only about one-seventh the energy necessary to pump the same amount of water from a depth of 200 feet, the energy savings to the farmer can be substantial. Farmers can also realize significant water savings because "lost" water is being recycled for further use. *See* P. Wilson, H. Ayer & G. Snider, *supra* note 18, at 169.

Even without a recovery system, some portion of the runoff would eventually return to the stream or percolate into the groundwater aquifer. The advantage of the tailwater recovery system is that it makes this process more efficient by reducing evaporation and percolation losses, and by reducing the costs associated with pumping the water again. *See* Shupe, *supra* note 18, at 502-03.

[36] By scheduling water deliveries using irrigation management programming, a farmer can meet crop water needs more accurately and increase irrigation efficiency. *See* Weatherford, Mann, Riley, Birch & Marsh, *Factors Underlying Irrigation Efficiency in the Tulare Basin of California*, in WATER AND AGRICULTURE IN THE WESTERN U.S.: CONSERVATION, REALLOCATION, AND MARKETS 53, at 61, 62 (1982); Aiken, *The National Water Policy Review and Western Water Rights Law Reform: An Overview*, 59 NEB. L. REV. 327, 327 (1980).

Modern irrigation scheduling combines soil, climate, and crop data in calculations to limit water applications to the precise amount needed at particular times. Increased efficiency not only results in water conservation, but also increases profitability through higher crop yields and lower operating costs. *See* Shupe, *supra* note 18, at 506-07.

[37] Many Arizona farms still use unlined earthen ditches to convey irrigation water. Unlined ditches can lose up to 25-40% of the flow before reaching the field boundaries. Seepage generally accounts for most of this conveyance loss. Therefore, irrigators could significantly curtail conveyance loss by lining ditches to reduce seepage. Also, lining ditches would improve water quality by reducing subsurface salt uptake by the seepage. *See* Shupe, *supra* note 18, at 506-07.

[38] Crops vary in their water requirements. Irrigated acreage in Arizona continues to be dominated by the production of cotton and alfalfa, two relatively high water use crops. *See supra* notes 19-20 and accompanying text. A change to crops that use less water per acre would result in significant water savings, without requiring a net decline in irrigated acres. *See* K. FREDERICK, *supra* note 24, at 175.

Crop water use is influenced by several factors and varies by region. The Arizona Department of Water Resources (ADWR) has adopted estimates of the consumptive use for individual crops in the Phoenix area. *See* ARIZ. DEP'T OF WATER RESOURCES, *supra* note 19. Cotton (3.43 acre-feet per acre) and alfalfa (4.69) are relatively high water use crops. Crops such as durum wheat (2.15), green onions (1.45), and lettuce (0.71) use less water per acre. Some crops using less water (i.e. durum wheat) produce less economic return per acre and may result in a decrease in net returns to the farmer. *See* P. WILSON, H. AYER & G. SNIDER, *supra* note 18, at 12. Other low water use crops (i.e. lettuce and other fresh vegetable products) are subject to volatile market conditions and may increase the grower's overall enterprise risk. *See id.*

[39] "Management of irrigation water continues to be a very important feature of Ari-

and in municipal systems, but inefficient water use by irrigators holds special significance because so much water in the West is devoted to irrigation.[40] The United States Soil Conservation Service estimates that almost twenty-four million acre-feet of water are irretrievably lost in agricultural irrigation each year.[41]

Arizona farmers have employed various irrigation systems through the years, each with its own advantages and disadvantages. Those most commonly utilized are flood irrigation,[42] furrow irrigation,[43] sprinkler irrigation,[44] and drip irrigation.[45]

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zona agriculture. The situation intensifies in several regions of the state due to limitations on water availability in many districts and its rapidly increasing costs." Silvertooth, *Comments on Cotton: Water Management Tools*, 69 ARIZ. FARMER-STOCKMAN, #3, March 1990, at 3; *see also* Aiken, *supra* note 36, at 327.

[40] Wilkinson, *Western Water Law in Transition*, AM. WATER WORKS A. J., Oct. 1986, at 34, 40.

[41] U.S. SOIL CONSERVATION SERV., *Crop Consumptive Irrigation Requirements and Irrigation Efficiency Coefficients for the U.S.* 17, NATIONAL ANALYSIS, SECOND NATIONAL WATER ASSESSMENT app. (1976), *cited in* Shupe, *supra* note 18, at 484 n.3. Most of the water physically wasted on a typical farm eventually returns to the system as either surface water runoff or percolating groundwater. Therefore, not all water that is lost to the irrigator vanishes entirely from the hydrologic cycle. Shupe, *supra*, at 490.

[42] The oldest and most common means of distributing water to crops is flood irrigation. It is most effective when it is used on relatively flat or level grades, those with less than one percent slope. The water distribution uniformity throughout an individual field rarely approaches 70%, even when the land is well graded. Weatherford, Mann, Riley, Birch & Marsh, *supra* note 36, at 62.

An overall irrigation efficiency of no more than 50-65% can be expected from a flood irrigation system. *See* D. Anderson, *supra* note 6, at 28.

[43] Under the furrow irrigation method, 50-80% less of the field's surface area receives water than with flood irrigation. *See* Shupe, *supra* note 18, at 502-03. Because the furrowing process helps distribute water evenly to the areas where the plants are located, furrow irrigation can be used on fields with one to two percent slopes. Also, a furrow irrigation system generally is more economical to construct than a flood system because there is less land grading. Weatherford, Mann, Riley, Birch & Marsh, *supra* note 36, at 62.

The most serious disadvantage of furrow irrigation is inefficiency. Due to losses from deep percolation and excessive tailwater, the overall efficiency of furrow irrigation is only 40-70%. Tailwater return systems provide higher efficiency. In areas of high water cost, high salinity, or soils subject to high water tables, furrow irrigation has certain severe limitations. *Id.*

[44] "Sprinkler irrigation has proven an effective means of reducing the problems associated with nonuniform water application. . . .[W]ith their increased control and uniformity of water application, sprinkler systems can reduce by ninety percent the percolation losses typically associated with flood [or furrow] irrigation." *See* Shupe, *supra* note 18 at 503.

Waste in irrigation consists of any water that would be unnecessary if available modern irrigation practices were employed.[46] "Waste [in irrigation] is of two principal types: [1] transmission losses through leaky ditches or by evapo-transpiration; or [2] excessive application of water to crops."[47] Water is "lost" to the irrigator through seepage, leakage, operational spills, runoff, and deep percolation if it is not put to immediate use in the growing of crops.[48]

Farmers also can eliminate surface runoff by reducing the flow through the sprinklers to allow the soil sufficient time to absorb the water. Farmers also may use sprinklers on land with rough and irregular features, where surface methods would require expensive land grading and preparation. The primary limitations of sprinklers are the initial cost and annual energy costs. Sprinklers require appropriate water pressure to operate, and a dependable power or fuel source must be available. Also, substantial evaporation losses may be associated with sprinkler systems, especially when used under windy or extremely arid conditions. *See id.* at 503-04; Weatherford, Mann, Riley, Birch & Marsh, *supra* note 36, at 63.

[45] Drip irrigation is "the precise, slow application of water in the form of discrete drops, continuous drops, tiny streams, or miniature sprays." P. WILSON, H. AYER & G. SNIDER, *supra* note 18, at 1. Arizona farmers first utilized drip technology in 1979. Drip irrigation has gained moderate acceptance throughout the agricultural areas of the United States, with approximately 500,000 acres of farmland using some form of drip irrigation. *1982 Irrigation Survey*, 32 IRRIGATION J. (1982), *quoted in* P. WILSON, H. AYER & G. SNIDER, *supra* note 18, at 28.

One advantage of drip systems is the potential to solve problems such as water shortage, water cost, poor or excessive soil permeability, and steep land slope. When properly designed, the drip system's lower application rate enables water to penetrate the soil with minimum runoff. The increased penetration reduces the losses from deep percolation. Drip systems can reduce water use by 30-50% and increase crop yields by up to 29% as compared to conventional flood or furrow systems. A well-managed drip system also will improve air exchange in the roots' environment, resulting in healthy roots and improved growth. Frequent water application also dilutes the salts in the soil. This dilution makes possible the use of higher salinity water than could be used with other irrigation methods. Despite the possible benefits, drip irrigation does have certain disadvantages for the adapting farmer. A typical drip irrigation system costs $900 to $1200 per acre to install. Furthermore, a change to drip irrigation often requires changes in tillage, planting, fertilizer application, pesticide treatment, and crop rotation. Finally, while researchers have documented substantial yield increases from this conversion, the resulting yield effect over a widespread geographic area remains speculative. *See* P. WILSON, H. AYER & G. SNIDER, *supra* note 18, at 2, 3; D. Anderson, *supra* note 6, at 34; Weatherford, Mann, Riley, Birch & Marsh, *supra* note 36, at 64, 65.

[46] Wilkinson, *supra* note 40, at 40; *see also* Mann, *Institutional Framework for Agricultural Water Conservation and Reallocation in the West: A Policy Analysis*, in WATER AND AGRICULTURE IN THE WESTERN U.S.: CONSERVATION, REALLOCATION, AND MARKETS 9, 20 (1982).

[47] J. SAX & R. ABRAMS, LEGAL CONTROL OF WATER RESOURCES 333 (1986).

[48] *Id.*

III. Mandated Conservation Under the Groundwater Code

Arizona's perceived water shortage has spurred a rise in public opinion favoring conservation. Given the large percentage of the state's water resources that are consumed by irrigation, the burden of any conservation measures will fall most heavily on the agricultural sector. In the Groundwater Management Act, Arizona legislatively mandated that Arizona farmers adopt conservation measures.

A. *The Groundwater Management Act*

The Arizona Legislature passed the Groundwater Management Act (GMA or Act) in 1980.[49] The Act sets forth a program designed to achieve "safe yield," a level of groundwater withdrawal equal to that of recharge, by the year 2025.[50] Conservation is a cornerstone of the GMA.[51] The Act contains provisions that mandate reduced water use by municipalities, industry, and agriculture.[52]

The GMA's conservation provisions apply most strictly in designated Active Management Areas (AMAs). AMAs are areas in which the Director of the Arizona Department of Water Resources (ADWR or Department) has deemed groundwater overdraft, i.e., withdrawals in excess of recharge, most severe. The four initial AMAs, Phoenix, Tucson, Prescott, and Pinal, encompass approximately eighty percent of Arizona's population, much of the irrigated farmland, and sixty-nine percent of the state's groundwater overdraft.[53] The Act also provides a procedure for designating additional AMAs in the future.[54]

The Act provides for a series of ten-year management plans to implement measures designed to achieve the management goals in each

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[49] Act of June 12, 1980, ch. 1, 1980 Ariz. Sess. Laws (4th Spec. Sess.) 1339 (codified as Ariz. Rev. Stat. Ann. §§ 45-401 to -637 and scattered other sections (1987)).

[50] Ariz. Rev. Stat. Ann. § 45-562.A (1987) (establishing safe yield as the management goal for the Phoenix, Tucson, and Prescott Active Management Areas (AMAs)); *see also* Ariz. Rev. Stat. Ann. § 45-562.B (1987) (establishing a less stringent management goal for the Pinal AMA).

[51] Ariz. Rev. Stat. Ann. § 45-401.B (1987) ("It is therefore declared to be the public policy of this state that in the interest of protecting and stabilizing the general economy and welfare of this state and its citizens it is necessary to conserve, protect and allocate the use of groundwater resources of the state . . . .").

[52] *See* Kyl, *supra* note 2, at 471. Kyl notes that in passing the GMA, Arizona made a fundamental decision to choose public regulation rather than a free-market solution to its water shortage. *Id.*

[53] Kyl, *supra* note 2, at 482.

[54] Ariz. Rev. Stat. Ann. §§ 45-412 to -415 (1987 & Supp. 1988).

AMA.[55] Each plan will mandate progressively greater conservation requirements.[56] The maximum groundwater allotments for irrigation are reduced under each successive management plan.[57]

Regulation is less pervasive outside of the AMAs. The Act created Irrigation Non-expansion Areas (INAs) in which no new irrigated acreage is permitted.[58] In areas not included in an AMA or an INA, the rule of "reasonable and beneficial use" governs groundwater withdrawals and uses.[59]

The GMA also created ADWR, which is responsible for the administration of both groundwater and surface water law.[60] ADWR consolidated the administrative responsibilities previously vested in the Arizona Water Commission, the office of the State Water Engineer, and the State Land Department. The Arizona Water Commission now functions as an advisory board to the ADWR Director. The Director is appointed by the Governor with Senate approval.[61]

B. *Overview of GMA Agricultural Provisions*

The GMA establishes legal limits on groundwater use for crop irrigation through maximum groundwater allotments. The agricultural conservation provisions are designed to continue to reduce groundwater use for irrigation throughout the series of management plans. The groundwater use allotments are enforced through a complex set of per-

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[55] ARIZ. REV. STAT. ANN. §§ 45-563 to -568 (1987 & Supp. 1988).

[56] *Compare* ARIZ. REV. STAT. ANN. § 45-564 (1987 & Supp. 1988) (statutory requirements for the First Management Plans, 1980-1990) *with* ARIZ. REV. STAT. ANN. § 45-568 (1987 & Supp. 1988) (the Fifth Management Plans, 2020-25).

[57] *Compare* ARIZ. REV. STAT. ANN. § 45-564.A(1) (1987 & Supp. 1988) *with* ARIZ. REV. STAT. ANN. §§ 45-565.A(1) to -568.A(1) (1987 & Supp. 1988).

[58] ARIZ. REV. STAT. ANN. §§ 45-431 to -439 (1987).

[59] ARIZ. REV. STAT. ANN. § 45-453(1) (1987). The legislature's intent as to adoption of the common law reasonable use doctrine for groundwater rights outside the AMAs is unclear. Leshy & Belanger, *Arizona Law Where Ground and Surface Water Meet*, 20 ARIZ. ST. L.J. 657, 714-15 (1988). Prior to the GMA, all groundwater use in Arizona was governed by the reasonable use doctrine. *See, e.g.*, Bristor v. Cheatham, 75 Ariz. 227, 255 P.2d 173 (1953). The GMA substantially modified the reasonable use doctrine. Leshy & Belanger, *supra*, at 715. The Act eliminated the doctrine inside the AMAs. The groundwater transportation provisions also drastically altered application of the doctrine outside the AMAs. *Id.*; *see* ARIZ. REV. STAT. ANN. §§ 45-541 to -545 (1987). The addition of the beneficial use requirement, traditionally a surface water law doctrine, raises further doubt as to the legislature's intent to adopt the common law treatment of groundwater outside the AMAs. Leshy & Belanger, *supra*, at 716.

[60] ARIZ. REV. STAT. ANN. §§ 45-102 to -107 (1987).

[61] Pontius, *supra* note 7, at 30.

mits and limitations.[62]

An irrigation grandfathered right (IGFR) is the right to use groundwater to irrigate land irrigated in whole or in part with groundwater at any time between 1975 and 1980.[63] IGFRs give landowners the right to the use of water, but not necessarily in the same quantity that existed during the 1975-80 statutory period.[64]

A certificate of irrigation grandfathered rights delineates the specific acres, known as irrigation acres, that may be irrigated with groundwater.[65] The certificate does not, however, specify the quantity of groundwater that the certificate holder may use to irrigate those acres. ADWR uses a statutorily prescribed formula to establish the maximum quantity of groundwater that may be used.[66]

The Groundwater Code defines the irrigation water duty, the primary component of the agricultural conservation program, as "the amount of water in acre-feet per acre that is reasonable to apply to irrigated land in a farm unit during the accounting period."[67] In the first management period, the irrigation water duty was calculated as "the quantity of water reasonably required to irrigate crops historically grown in a farm unit and [assumed] conservation being used in the state which would be reasonable for the farm unit including lined ditches, pump-back systems, land leveling and efficient application practices, but not including a change from flood irrigation to drip or sprinkler irrigation."[68]

The Director has calculated a new irrigation water duty for the second management period, 1990 to 2000, by considering the "quantity of water reasonably required to irrigate the crops historically grown in the farm unit and . . . assum[ing] the maximum conservation consistent with prudent long term farm management practices within areas of similar farming conditions, considering the time required to amortize conservation investments and financing costs."[69] In the third management period, 2000 to 2010, the highest twenty-five percent of irrigation water duties within a sub-basin may be adjusted "to more clearly re-

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[62] Groundwater allotments include grandfathered rights, service area rights, groundwater withdrawal permits, and exempt withdrawals. This article discusses only the irrigation grandfathered rights.

[63] ARIZ. REV. STAT. ANN. § 45-465.A (1987).

[64] Kyl, *supra* note 2, at 485.

[65] ARIZ. REV. STAT. ANN. § 45-465.B(4) (1987).

[66] *See* ARIZ. REV. STAT. ANN. § 45-465.B (1987).

[67] ARIZ. REV. STAT. ANN. § 45-402(21) (Supp. 1988).

[68] ARIZ. REV. STAT. ANN. § 45-564.A(1) (1990).

[69] ARIZ. REV. STAT. ANN. § 45-565.A(1) (1990).

flect the average of the middle fifty percent of the water duties within the sub-basin."[70] In calculating the irrigation water duties, the ADWR considers historic water requirements which reflect variations in soil type (due to the quantity of water required to leach salts from the root zone with certain soil types), historic cropping patterns (based on the specific consumptive use requirement of certain crops), and cultural practices.[71]

ADWR's calculation of irrigation water duties includes factors for interpreting irrigation efficiency by measuring the general effectiveness of water application through a crop season and indicating the portion of total water applied that is used beneficially by the crops. The effectiveness of water application is a function of many variables including evaporation loss, soil intake rate, land slope, water application technologies, and irrigation management practices. ADWR also has considered reasonable on-farm water losses for typical irrigation distribution systems.[72]

Water duty acres are "the highest number of acres in the farm, taking land rotation into account, which were legally irrigated during any one year in the five years preceding January 1, 1980 . . . . "[73] The number of water duty acres may be less than the number of irrigation acres in a farm unit. The Department calculates the maximum annual groundwater allotment by multiplying the irrigation water duty by the water duty acres.[74] The maximum groundwater allotment may be used to irrigate all or any portion of the irrigation acres.[75] If a farmer does not decrease his per-acre water use with his current crop mix, he has two choices: 1) reduce irrigated acreage (use the full irrigation water allotment on fewer acres) or 2) switch to different crops that require less water per acre.[76]

C. *Ramifications of GMA Provisions*

The GMA agricultural provisions have several significant ramifications for the future of Arizona agriculture. Because desert agriculture is

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[70] ARIZ. REV. STAT. ANN. § 45-566.A(1) (1990).

[71] ARIZ. REV. STAT. ANN. § 45-465 (1987); *see also* Pontius, *supra* note 7, at 33.

[72] ARIZ. DEP'T OF WATER RESOURCES, DRAFT MANAGEMENT PLAN FOR THE SECOND MANAGEMENT PERIOD, PINAL ACTIVE MANAGEMENT AREA 105-09 (1988).

[73] ARIZ. REV. STAT. ANN. § 45-465.B(3) (1987).

[74] *See* ARIZ. REV. STAT. ANN. § 45-465.B(5) (1987); *see also* Pontius, *supra* note 7, at 36 (a sample calculation of the maximum groundwater allotment).

[75] ARIZ. REV. STAT. ANN. § 45-465.D (1987).

[76] Pontius, *supra* note 7, at 33.

so controlled by water use, allocation of the state's groundwater resources has a substantial impact on the continued prosperity of this sector of the state's economy.

1. Retirement of Agricultural Land Near Urban Areas

Urban encroachment threatens much of the prime farmland in Arizona, especially in the Phoenix metropolitan area. ADWR projects that land with irrigation rights in the Phoenix AMA will be converted to urban uses at an average rate of 3900 acres per year through the year 2025, a total of over 130,000 acres. The Department estimates that urbanization in the Tucson and Pinal AMAs will displace an additional 60,000 irrigable acres by that time.[77]

The GMA agricultural provisions have spurred this conversion from agricultural to municipal use. The Act requires that a purchaser buy a farmer's land in order to obtain his water right.[78] Commentators have criticized the conservation disincentives which this restriction creates:

> Another troubling aspect of the agricultural plan from an economist's point of view is the continued linkage between land and water. In order to purchase a farmer's water rights, one must purchase the farmer's land as well. This "tying" together of the two products is inefficient in that it reduces incentives to conserve water. Any farmer who invests in conservation to the point that his water use efficiency exceeds that required by law is wasting money — the excess water saved can neither be applied to additional farmland nor sold. It is not clear who gains from this arrangement.[79]

Spurred by the GMA provisions, urban developers have been acquiring agricultural land and water rights at a frantic pace.[80] Given the nature of these provisions and the continued increase in population in the state's metropolitan areas, the conversion of agricultural land to residential use is likely to continue in the future.

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[77] Webster, *Farmers Facing Cuts in Water Use May Benefit from Population Boom*, Ariz. Republic, Apr. 17, 1988, at AZ16-17, col. 1.

[78] ARIZ. REV. STAT. ANN. § 45-465.C (1987); *see also* Pontius, *supra* note 7, at 37.

[79] McNulty & Woodard, *Arizona Water Issues: Contrasting Legal and Economic Perspectives*, 32 ARIZ. REV., Fall 1984, at 6.

[80] G. WOODARD, E. CHECCHIO, G. THACKER & B. COLBY, THE WATER TRANSFER PROCESS IN ARIZONA: ANALYSIS OF IMPACTS AND LEGISLATIVE OPTIONS 28-38 (1988). The author's recent conversations with local real estate brokers suggest that the purchase of agricultural land by developers has declined substantially since 1988.

2. Water Ranches

A similar phenomenon has arisen as municipalities have purchased outlying agricultural land for the appurtenant water rights. This is known as "water farming" or "water ranching" because land that was formerly used to grow crops or cows is being purchased solely for its underlying water rights.[81]

The water farming rush was touched off by provisions of the GMA requiring that urban areas demonstrate a hundred-year assured water supply as a prerequisite to new development after the year 2000.[82] The GMA also created an attractive source of water by easing restrictions on pumping and transporting ground water in areas outside the AMAs.[83] Municipalities, corporations, and private individuals involved in water marketing have viewed the Central Arizona Project (CAP)[84] aqueduct as a potential vehicle to transport this water from rural to urban areas at a reasonable cost.[85]

3. GMA Fund to Purchase and Retire Farmland

The GMA also provides a mechanism for purchasing and retiring agricultural land. Under the statute, ADWR may collect a withdrawal fee of up to five dollars per acre-foot of groundwater pumped within an AMA. The withdrawal fee has three components: 1) an administrative fee of between fifty cents and a dollar; 2) an augmentation fee of not more than two dollars; and 3) a purchase and retirement fee of not more than two dollars.[86] The creation of a purchase and retirement fund, in conjunction with the conservation and supply enhancement provisions, is designed to aid in meeting the safe yield goal.[87]

Collection of the purchase and retirement portion of the fee begins when the ADWR Director implements a plan for retiring

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[81] *Id.* at 2.

[82] ARIZ. REV. STAT. ANN. § 45-576.A (1987).

[83] ARIZ. REV. STAT. ANN. § 45-544 (1987).

[84] The CAP is a federally-funded project designed to transport water from the Colorado River to Phoenix, Tucson, and the surrounding agricultural areas. *See generally* D. BUSH & W. MARTIN, POTENTIAL COSTS AND BENEFITS TO ARIZONA AGRICULTURE OF THE CENTRAL ARIZONA PROJECT (1986); W. MARTIN, H. INGRAM, N. LANEY & A. GRIFFIN, SAVING WATER IN A DESERT CITY (1984).

[85] Woodard, *Pumping a County Till It's Dry*, Ariz. Republic, May 7, 1989, at C1, col. 4, C6, col. 1.

[86] ARIZ. REV. STAT. ANN. § 45-611 (Supp. 1988).

[87] Kyl, *supra* note 2, at 492; *see* ARIZ. REV. STAT. ANN. § 45-562.A (1987) (discussed *supra* note 50 and accompanying text).

grandfathered rights. The statute specifies that the retirement plan cannot be implemented earlier than January 1, 2006.[88]

D. *Analysis of GMA Agricultural Provisions*

With certain limitations, the agricultural conservation provisions of the GMA are sound public policy for Arizona. On their face, these requirements provide little economic incentive for farmers to conserve. When further examined, however, these provisions are a conservation incentive for the average farmer. If a farmer does not increase his efficiency to comply with the minimum GMA requirements, the viability of his operation will be impaired by the significant sanctions available under the Act.

The primary weakness of the mandated conservation program is that it gives farmers no further incentive to reduce water use in excess of the GMA-mandated requirements.[89] A farmer whose irrigation efficiency is already above average has nothing to gain from adopting additional conservation practices. The GMA agricultural provisions, on the whole, do not "force technology."[90] They coerce the average farmer into adopting available technologies, but provide innovative operators with little incentive to develop even more progressive methods of water conservation.

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[88] ARIZ. REV. STAT. ANN. § 45-611(3) (Supp. 1988).

[89] Some innovations, however, may be profitable for the farmer to adopt even absent further statutory requirements. For example, Wilson, Ayer, and Snider have documented specific scenarios in which it would be profitable for the farmer to install a drip irrigation system. P. WILSON, H. AYER & G. SNIDER, *supra* note 18, at 16-21. Increased profitability in these situations is based solely on the economics of production and is not the result of any incentive created by the GMA. *See id.* Absent a legal incentive or subsidy, however, situations in which a farmer may profitably invest his own capital in a drip irrigation system are limited. *Id.* at 27-28.

[90] "Forcing technology" generally refers to statutes drafted to require actions that are not technologically achievable or economically feasible at the time the statute is enacted. By requiring compliance with an ambitious standard, the legislature forces the regulated entities to develop innovative practices. *See generally* La Pierre, *Technology Forcing and Federal Environmental Statutes*, 62 IOWA L. REV. 771 (1976). The statutory definition of "irrigation water duty" refers to "the amount of water that is *reasonable* to apply to irrigated land in a farm unit during the accounting period, as determined by the director pursuant to §§ 45-463, 45-464, 45-469 or 45-472." ARIZ. REV. STAT. ANN. § 45-402(21) (1987) (emphasis added). The reasonableness requirement is evidence that irrigators are not forced to adopt irrigation practices that are not technologically and economically achievable. *See* Pontius, *supra* note 7, at 33.

IV. Transferring Conserved Surface Water

The Groundwater Management Act, as its title indicates, primarily regulates the use of groundwater.[91] The use of surface water,[92] on the other hand, is governed by the prior appropriation doctrine,[93] and by surface water statutes.[94] Prior appropriation, in turn, is based upon beneficial use.[95]

Beneficial use has two basic requirements: 1) the purpose for which the water is used must be one that the state has deemed permissible and 2) the use must not be wasteful in amount.[96] Although the beneficial use doctrine generally has worked well as the basis for surface water law, it can have undesirable consequences in certain instances.[97]

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[91] Groundwater is "water under the surface of the earth regardless of the geologic structure in which it is standing or moving. Groundwater does not include water flowing in underground streams with ascertainable beds and banks." ARIZ. REV. STAT. ANN. § 45-101(4) (1987). Certain provisions of the GMA have had substantial impact on the regulation of surface water. *See, e.g.*, ARIZ. REV. STAT. ANN. § 45-452.A (prohibiting irrigation of new land inside an AMA with *any* water) (emphasis added), § 45-467 (1987) (requiring complex accounting and management for farms irrigated with a combination of surface water and groundwater). The primary focus of the Act, however, is on groundwater regulation. *See* ARIZ. REV. STAT. ANN. § 45-401 (1987).

[92] Surface water is "waters of all sources, flowing in streams, canyons, ravines or other natural channels, or in definite underground channels, whether perennial or intermittent, flood, waste or surplus water, and of lakes, ponds, and springs on the surface." ARIZ. REV. STAT. ANN. § 45-101(6) (1987).

[93] The Arizona Constitution explicitly rejected the common law riparian doctrine, ARIZ. CONST. art. XVII, § 1; *see also* Leshy, *The Making of the Arizona Constitution*, 20 ARIZ. ST. L.J. 1, 53 (1988), which defines water rights based on ownership of parcels of land. J. SAX & R. ABRAMS, *supra* note 47, at 154. Under the prior appropriation doctrine, "[o]ne's priority is determined by the date at which he or she first applied the water to beneficial use, or the date on which the first work leading to application was begun." *Id.* at 279. The mere ownership of land does not confer the rights to water use. *Id.* at 278. Nine western states currently follow the prior appropriation system: Alaska, Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming. Comment, *Liability Rules as a Solution to the Problem of Waste in Western Water Law: An Economic Analysis*, 76 CALIF. L. REV. 671, 675 (1988). Eight other states in the West have mixed systems of prior appropriation and riparianism. *Id.*

[94] ARIZ. REV. STAT. ANN. §§ 45-141 to -180 (1987 & Supp. 1988).

[95] ARIZ. REV. STAT. ANN. § 45-141.B (1987) states, "Beneficial use shall be the basis, measure and limit to the use of water."

[96] J. SAX & R. ABRAMS, *supra* note 47, at 221.

[97] *See generally* Comment, *supra* note 93, at 693.

A. *Allowing Use or Transfer of Conserved Water*

The prior appropriation doctrine assumes that water that is not consumed by an appropriator will be returned to the common source for appropriation by downstream users.[98] This creates a disincentive to conserve when it denies a farmer the benefits of more efficient irrigation practices.[99] Under a strict application of the beneficial use doctrine, water saved as a result of on-farm improvements does not necessarily accrue to the farmer who made the improvements. Increased water use efficiency can actually result in the loss of the conserved portion of the farmer's water rights. If a farmer adopts water-saving technology, the appurtenance rule provides that the water he saves may not be used on his other lands or sold to other users. The water he saves is subject to forfeiture for the use of later appropriators.[100] Thus, in order to preserve an existing water right, a farmer might apply it to uses from which he derives little or no return.[101] Likewise, he might inflate his current use as a hedge against his own increased needs in the future.[102]

One proposed solution to this problem is to allow irrigation water rights, in whole or in part, to be severed and transferred separately from land. If the value in an alternative use exceeded that in irrigation, a farmer could sell a portion of his underlying water right to other users,[103] or use the surplus water on other land that he owned. A system that required the farmer to consider the opportunity costs of his water use would promote conservation and redirect water to its highest and best uses.[104]

Proposals to create such a system have been criticized for failing to protect downstream appropriators. In theory, water that is neither used by crops nor lost to evaporation either returns to its source as return flow or percolates into the aquifer as groundwater. Irrigation of more land with the same amount of water would reduce returns to the system, and downstream users would suffer.[105]

Opponents also argue that the improved efficiency is an indication

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[98] *See* J. Sax & R. Abrams, *supra* note 47, at 283.

[99] *See* Shupe, *supra* note 18, at 483.

[100] Aiken, *supra* note 36, at 330-32.

[101] M. Kelso, W. Martin & L. Mack, *supra* note 10, at 60.

[102] Comment, *supra* note 93, at 693; *see also* Williams, *The Requirement of Beneficial Use as a Case of Waste in Water Resource Development*, 23 Nat. Resources J. 7, 7-10 (1983).

[103] R. Smith, Trading Water: An Economic and Legal Framework for Water Marketing 22, 23 (1988).

[104] Aiken, *supra* note 36, at 331.

[105] *Id.*

that a farmer's prior use was wasteful.[106] Because no one has a right to waste water, some state courts have held that an irrigator who now conserves water never acquired a valid right to the excess in the first place.[107] Although superficially appealing, the argument ignores the impact of advances in technology which make it possible to use less water. The success of such technology does not indicate that water was being wasted before the technology was available.

A call for measures that allow for the transfer of conserved water is not new. In 1973, the National Water Commission recommended that:

> States in water-short areas should adopt doctrines and procedures to encourage voluntary actions to improve efficiency of water use. Specifically, rights should be created in salvaged water, and the rights should be freely transferable to other uses and users, subject only to the limitation that rights of others should not be injured.[108]

The time has come to reconsider transfers of conserved irrigation water. Several academic and government research groups are now investigating various aspects of this policy alternative.[109]

B. The Arizona Scenario

1. *Salt River Valley Water Users' Association v. Kovacovich*

Only one Arizona case has considered whether a farmer may use or sell conserved water. In *Salt River Valley Water Users' Association v.*

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[106] Comment, *supra* note 93, at 692.

[107] *See, e.g.*, Giffen v. State, 690 P.2d 1244 (Colo. 1984); Tudor v. Jaca, 178 Or. 126, 164 P.2d 680 (1945), *reh'g denied*, 178 Or. 156, 165 P.2d 770 (1946); Fuss v. Franks, 610 P.2d 17 (Wyo. 1980); *see also* Salt River Valley Water Users' Ass'n v. Kovacovich, 3 Ariz. App. 28, 411 P.2d 209 (1966). *Contra* Pomona Land & Water Co. v. San Antonio Water Co., 152 Cal. 618, 93 P. 881 (1908); Basinger v. Taylor, 36 Idaho 591, 211 P. 1085 (1922); East Bench Irr. Co. v. Deseret Irr. Co., 2 Utah 2d 170, 271 P.2d 449 (1954); CAL. WATER CODE §§ 1010(b), 1011(b) (West Supp. 1985).

[108] NATIONAL WATER COMM'N, WATER POLICIES FOR THE FUTURE: FINAL REPORT TO THE PRESIDENT AND TO THE CONGRESS OF THE UNITED STATES 305 (1973).

[109] For example, the United States Geological Survey (USGS) has recently funded a project to examine the economic and financial aspects of agricultural water conservation in New Mexico. The USGS also has funded a study of transactions costs in water transfers and exchanges to be performed at the Natural Resources Law Center in Boulder, Colorado. The Western Governors' Association, in conjunction with the United States Department of Interior and the Western States Water Council, recently issued two reports discussing the legal and administrative policies designed to facilitate the transfer of salvaged water. Western Governors' Ass'n, Western Water: Tuning the System (1988); Water Efficiency Opportunities for Action (1988).

Kovacovich,[110] the defendant landowner irrigated non-appurtenant lands with water conserved by lining his ditches.[111] The Arizona Court of Appeals held that he was limited by the beneficial use doctrine to using his water rights only on appurtenant lands.[112] The court stated:

> Any practice, whether through water-saving procedures or otherwise, whereby appellees may in fact reduce the quantity of water actually taken inures to the benefit of other water users and neither creates a right to use the waters saved as a marketable commodity nor the right to apply same to adjacent property having no appurtenant water rights. It is believed that any other decision would result in commencement of return to the very area of confusion and chaos which gave rise to the development and application of the concept of beneficial use.[113]

Therefore, the court limited a landowner to the amount of water he can beneficially use upon the land to which the water right is appurtenant.[114] Water left over after such use must be allowed to return to the public supply in order to be available for other appropriators.

Kovacovich, however, does not necessarily suggest that a water right can never be transferred from the land to which the original appropriation attached.[115] If the decision is limited to its specific facts, the court held only that an appropriator who had failed to obtain the applicable permit from the state agency was not entitled to use the conserved water. Arizona statutes provide a detailed mechanism for applying for permission through ADWR for either: 1) a new appropriation[116] or 2) a severance and transfer of all or part of the original right to other lands to which it was not previously appurtenant.[117] The court in *Kovacovich* noted that the defendant appropriator had neither applied for nor obtained any such permit.[118]

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[110] 3 Ariz. App. 28, 411 P.2d 201 (1966).

[111] *Id.* at 29, 411 P.2d at 202.

[112] *Id.* at 30, 411 P.2d at 203.

[113] *Id.* at 31, 411 P.2d at 204.

[114] *Id.* at 30, 31, 411 P.2d at 203, 204.

[115] *See* Address by Professor John D. Leshy, Annual Conference of the Arizona Section of the American Water Resources Association (Oct. 27, 1989) (text available at Law Review offices).

[116] ARIZ. REV. STAT. ANN. §§ 45-151 to -159 (1987).

[117] ARIZ. REV. STAT. ANN. § 45-172 (1987).

[118] 3 Ariz. App. at 29, 411 P.2d at 202. The court also referred to the Arizona statutes for change of purpose or place of use:

> This [beneficial use] doctrine was further implemented by enactment of a series of statutes . . . wherein matters pertaining to application of waters to new lands or changes in use of water previously appropriated was placed under the jurisdiction of the State Land Department [subsequently transferred to ADWR]. In addition, these statutes prescribe certain stan-

2. The Effect of *Long* on *Kovacovich*

The Arizona Supreme Court's recent decision in *Arizona Public Service Co. v. Long*[119] now casts some doubt upon the continued validity of *Kovacovich*. Although *Long* has been strongly criticized by some commentators,[120] its general policy rationale suggests an argument against the *Kovacovich* rule.

The *Long* dispute concerned the disposition of sewage effluent discharged from municipal treatment plants. Several cities had previously discharged effluent into the Salt River from where it was subsequently taken by the plaintiffs and other downstream appropriators. In 1973, the cities contracted to sell the effluent to a group of utilities for use at the Palo Verde Nuclear Generating Station. The plaintiffs sought to enjoin the sale, arguing on appeal that it violated Arizona surface water law. They contended that the cities only had the right to use the water, not the right to sell the unconsumed portion of their appropriation.

The Arizona Supreme Court held that the cities were not required to continue discharging effluent into the river, even though the plaintiffs had appropriative rights.[121] The court reasoned that the definition of effluent under the GMA[122] is persuasive evidence that it is not subject to regulation under surface water or groundwater law.[123] It also reasoned that the statutory section regulating the appropriation of surface water[124] does not explicitly include effluent.[125]

Long gives municipalities almost unlimited discretion to dispose of their effluent. It also provides some basis to argue that irrigation return

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> dards to be followed by the State Land Department [ADWR] with respect to applications for acquisition of change in the use of water.

Id. at 30, 411 P.2d at 203 (citation omitted).

[119] 160 Ariz. 429, 773 P.2d 988 (1989).

[120] *See e.g.*, Leshy, *supra* note 115:

> The *Long* decision is muddled and confusing. It makes a questionable interpretation of Arizona statutes to reach a result seemingly inconsistent with some fundamental principles of water law. The upshot is to threaten the security of most water rights, tear the fabric of the Arizona Groundwater Management Act, and generally undermine expert administrative regulation of water use in the public interest.

[121] *Long*, 160 Ariz. at 437, 773 P.2d at 996.

[122] Effluent is "water which, after being withdrawn as groundwater or diverted as surface water, has been used for domestic, municipal or industrial purposes and which is available for reuse for any purpose, whether or not the water has been treated to improve its quality." ARIZ. REV. STAT. ANN. § 45-402(6) (Supp. 1988).

[123] *Long*, 160 Ariz. at 435, 773 P.2d at 994.

[124] ARIZ. REV. STAT. ANN. § 45-141.A (1987).

[125] *Long*, 160 Ariz. at 435, 773 P.2d at 994.

flow is effluent, and that an irrigator therefore has broad discretion to dispose of it. In its amicus brief in *Long*, ADWR noted the similarities between the issue in *Kovacovich* and the sale of municipal effluent.[126] Surprisingly, however, the supreme court in *Long* did not discuss *Kovacovich*.

Several conceptual difficulties exist in using *Long* to argue that irrigation return flow is effluent. First, although the court in *Long* found that the definition of surface water in Arizona Revised Statutes § 45-101(6) does not include effluent, a court would likely hold that irrigation return flows are included in the "waste or surplus waters" provision of that statutory definition. Second, the court in *Long* relied heavily on the characterization of effluent as a "nuisance."[127] This public policy argument might not be as compelling when applied to irrigation return flows. Third, the court looked to the statutory definition of effluent in the GMA, which refers only to the water left over after use "for domestic, municipal or industrial purposes,"[128] and thus would exclude agricultural return flows.[129] Furthermore, although agricultural return flows are arguably similar to municipal effluent in that both are essentially wastewater that has been degraded by use, the analogy is somewhat less apt with respect to conserved water, which has not been used or even withdrawn from the water system in some cases.

Despite the difficulties in using *Long* as the sole basis for overturning *Kovacovich*, the public policy ramifications that flow from the *Long*/*Kovacovich* distinctions are significant. An important basis upon which to distinguish these cases is the court's reliance in *Long* on the GMA's definition of effluent. Such a distinction would strictly limit the *Long* holding to municipal sewage effluent and reserve the *Kovacovich* rule for agricultural return flows.[130]

Public policy considerations do not justify such a limitation. As Professor Leshy has stated, "Municipal effluent and agricultural return flows arguably legally should be treated the same — both are leftover water after the initial appropriation and use."[131] No sound policy reason exists to differentiate these two sources of "leftover water." Both

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[126] Amicus Curiae Brief for ADWR on the Nature of Effluent as Surface and Groundwater at 10-12, Arizona Pub. Serv. Co. v. Long, 160 Ariz. 429, 773 P.2d 988 (1989) (Nos. C-433718 & C-505023) (consolidated).

[127] *See Long*, 160 Ariz. at 434, 435, 773 P.2d at 993 (*citing* Wyoming Hereford Ranch v. Hammond Packing Co., 33 Wyo. 14, 22, 236 P. 764, 772 (1925)).

[128] ARIZ. REV. STAT. ANN. § 45-402(6) (Supp. 1988) (quoted *supra* note 122).

[129] *See* Leshy, *supra* note 115.

[130] *See id.*

[131] *Id.*

municipal effluent and irrigation tailwater are water that remains after an initial valid beneficial use. The common law prior appropriation doctrine would treat municipal effluent and irrigation tailwater similarly. Likewise, logic concludes that both should be treated similarly under Arizona law.[132]

C. *Will Farmers "Adopt" without a Mandate?*

Most available water-saving technologies require a large initial investment by the farmer. Each requires intensive day-to-day management to maximize its potential benefits. Economists have suggested that, even with the possible savings in operating costs, yields would have to be increased to make the technologies profitable for the average farmer.[133] The cost savings alone, although substantial in some instances, do not compensate for the investment required for large-scale irrigation improvements such as drip irrigation and laser leveling.[134]

No farmer is likely to undertake water-saving measures unless he believes that both the short-term and long-term economic benefits are readily attainable.[135] In the short term, an irrigator may not have the financial resources required for the extensive capital investment that is required; in the long term, he may not perceive that significant benefits will be forthcoming.[136] These other factors might discourage the adoption of new water conservation technology, even if the legal system allowed the farmer to use or market the water he saved.

Additional barriers may impair the transfer of conserved water in Arizona. A farmer wishing to change either the purpose or the place of use of his water right must comply with administrative procedures which may, in certain circumstances, add significantly to his costs.[137] The expense of the procedure should be considered when examining

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[132] For a detailed discussion of the *Long* decision, see generally Note, *Creating a 'New' Class of Water—Regulation of Municipal Effluent, Arizona Public Service Co. v. Long, 160 Ariz. 429, 773 P.2d 988 (1989)*, 22 ARIZ. ST. L.J. 987 (1991) (written by this author).

[133] D. Anderson, *supra* note 6, at 28; *see, e.g.*, P. WILSON, H. AYER & G. SNIDER, *supra* note 18, at 27-28; J. DAUBERT & H. AYER, *supra* note 31, at 10, 11.

[134] P. WILSON, H. AYER & G. SNIDER, *supra* note 18, at 27-28; J. DAUBERT & H. AYER, *supra* note 31, at 10, 11.

[135] Weatherford, Mann, Riley, Birch & Marsh, *supra* note 36, at 97.

[136] Mann, *Institutional Framework For Agricultural Water Conservation And Reallocation In The West: A Policy Analysis*, in WATER AND AGRICULTURE IN THE WESTERN U.S.: CONSERVATION, REALLOCATION, AND MARKETS 9, at 28-30 (1982).

[137] *See* Colby, McGinnis & Rait, *Procedural Aspects of State Water Law: Transferring Water Rights in the Western States*, 31 ARIZ. L. REV. 697, 697-98 (1989).

the feasibility of transferring conserved irrigation water.

V. Conclusion and Policy Recommendations

Arizonans continue to struggle over how best to meet the ever-increasing demands being placed on the state's water supply. The rapid urbanization and industrialization of the past few decades have shifted the balance of political and economic power. Agriculture, as both the largest water user and lowest-value user, will be required to bear the brunt of the conservation measures necessary to meet future conservation goals.

The basic policy question is: "What mechanism is best used to promote water conservation in Arizona agriculture? A 'carrot' or a 'stick'?" The reasoned answer is "both a carrot AND a stick." Although a system allowing the use or transfer of conserved water may provide additional economic incentives to conserve, it is not without its flaws. Likewise, the mandated conservation program under the GMA is effective, but has practical difficulties. The most effective way to promote agricultural water conservation is to combine these two alternatives. While mandating a minimum acceptable level of conservation, some mechanism must be developed to permit those users who conserve water beyond that minimum level to benefit from their innovation.

The Department of Water Resources, together with the Arizona Legislature, must take further steps to promote water conservation in Arizona agriculture. A concerted system of mandates and incentives is the best policy tool with which to achieve this goal.