

The National Agricultural
Law Center



University of Arkansas School of Law

NatAgLaw@uark.edu ☎ (479) 575-7646

An Agricultural Law Research Article

**Groundwater Management in GMD4:
Has It Succeeded?**

by

Wayne Bossert

Originally published in KANSAS JOURNAL OF LAW AND PUBLIC POLICY
15 KAN. J. L. & PUB. POL'Y 541 (2006)

www.NationalAgLawCenter.org

GROUNDWATER MANAGEMENT IN GMD4: HAS IT SUCCEEDED?

*Wayne Bossert**

I. INTRODUCTION

This paper has been inspired by a statement that institutional groundwater management has not been successful anywhere in the world.¹ Clearly there are real challenges to groundwater management throughout the world, and also in Kansas. To say groundwater management cannot succeed in Kansas is arguable. To say groundwater management in Kansas has been completely successful is likewise arguable. The question is: To what degree has institutional groundwater management been successful in Kansas?

In this article, I will explore the relevant issues, attempting to identify what has worked well, what has yet to work, and what may never work; as appropriate, I provide some conclusions based upon my experience as manager of the Northwest Kansas Groundwater Management District No. 4 (“GMD4”). It should be stated here that “success” is a subjective term, which must be defined early in any evaluation process. It is always evaluated from many different perspectives and over various time frames. In groundwater management, quite literally, what one considers a success another can see as a failure. Part II provides background, by first defining the parameters which this article will use for determining “success,” and then providing background on the Kansas groundwater management system, as well as a review of the major issues affecting success. Part III provides an analysis of these issue in the context of local groundwater management at the GMD level in Kansas. Finally, Part IV presents my conclusions, and a short discussion of Kansas groundwater management lessons learned.

* Manager, Northwest Kansas Groundwater Management District No. 4, 1977 to Present.

1. Attributed to Dr. Tushaar Shah, International Water Management Institute, January, 2006 in Anand, India, by Professor John Peck.

II. BACKGROUND

A. *Defining Success*

This article defines success as the achievement of stated goals within the duly adopted groundwater management program. This definition does not embody the view of the individual, but rather only the collective view of the district members, as expressed through the publicly developed and adopted management program. This position is consistent with groundwater management law in the state as expressed in the Kansas groundwater management district act: "All powers granted to a groundwater management district under the provisions of this act shall be exercised by an elected board of directors"² And:

Before undertaking active management of the district the board shall prepare a management program When the management program is approved by the chief engineer, the board shall fix a time and place . . . for a public hearing upon the management program After hearing and considering all relevant testimony and information, the board shall . . . adopt, modify, or reject the management program³

The Kansas system appears to empower the locally elected board to represent all district members collectively, while providing each individual member the ability to participate and influence the development of all district activities, the most important of which is the development and implementation of the Management Program. This article thus rejects the notion that just because local Kansas groundwater management activities may not accomplish an individual's particular ideal of success, it is therefore unsuccessful. In other words, what any individual believes only matters when that belief is incorporated into the public management program, and specific goals are established to implement it.

B. *Water Law and Water Management*

The two underlying regulatory acts regarding groundwater in the state are the Kansas Water Appropriation Act (the "Act"), and the Kansas Groundwater Management District Act (the "Groundwater Act"). The Act, effective June 28, 1945, requires among other things that every use of water in the state be exercised under a valid, state-approved water right.⁴ Water rights in Kansas are real property rights:

"Water right" means any vested right or appropriation right under which a person may lawfully divert and use water. It is a real property right appurtenant to and severable from the land on or in

2. KAN. STAT. ANN. § 82a-1027(a) (1997).

3. *Id.* § 82a-1029 (1997).

4. *Id.* § 82a-705 (1997).

connection with which the water is used and such water right passes as an appurtenance with a conveyance of the land by deed, lease, mortgage, will, or other voluntary disposal, or by inheritance.⁵

The Act was designed to manage the state's water resources. It authorizes the chief engineer to halt development whenever deemed necessary or prudent and/or to regulate existing uses whenever the supply becomes short. The way these authorities are granted will become important issues in answering our basic question.

The Groundwater Act, effective July 1, 1972, establishes self-determination as a matter of state policy:

It is the policy of this act to preserve basic water use doctrine and to establish the right of local water users to determine their destiny with respect to the use of the groundwater insofar as it does not conflict with the basic laws and policies of the state of Kansas.⁶

The Groundwater Act sets forth the specific process of forming a district, spells out all district authorities, and defines the relationship between the Groundwater Management District ("GMD") and the Division of Water Resources ("DWR"). It is also clear that all management activities must first be included in a publicly approved management program before those activities are undertaken.⁷ The management program is to be the public expression of the GMD's public interest, and guides all of its goals and management activities. The GMD4 management program is basically a description of the perceived problems, a set of goals to be achieved, and a listing of the programs desired to achieve the goals.

C. Groundwater Management Problems in GMD4

There are six principal management problems. The first problem concerns depletion. One of the most visible groundwater problems in Kansas is the decline in the High Plains Aquifer. The western Kansas decline problem first showed up in the mid-1950's, when a few specific areas were identified based upon study of collected groundwater level data by DWR and others. The earliest state-measured groundwater level data in Northwest Kansas was collected in 1942⁸. The observation well network grew more or less haphazardly in areas as the decline problem grew more serious.⁹ Today, the network in Northwest Kansas includes approximately 285 wells (out of 1,300 wells statewide) which have been specifically chosen to cost-effectively achieve a pre-determined level of useful data. In GMD4, the water table decline rate has varied over time and by area of the district.

5. *Id.* § 82a-701(g) (1997).

6. *Id.* § 82a-1020 (1997).

7. *Id.* § 82a-1029 (1997).

8. GMD4 Observation Well Data (1942) (on file with the author).

9. Ricardo Olea, *Optimization of the High Plains Aquifer Observation Network, Kansas*, KANSAS GEOLOGICAL SURVEY, GROUNDWATER SERIES 7, 2 (1982).

The second problem concerns how to locally determine what constitutes the public interest: since local groundwater management must be done in a consistent manner with state law and policy, it is important that either the local public interest coincides with the state's public interest, or, that the state can accommodate local public interest that conflicts with the state's. Determining the public interest is an important concept throughout water law in Kansas, and many of the authorities provided by the Legislature involve the consideration of the public interest.

The third problem concerns educating the public about groundwater management. A well-informed constituency is vital to the success of almost any governmental endeavor. In matters of water and water law, more often than not the public is under-educated. Areas that need better public education involve understanding the water agency hierarchy, the divisions of responsibility, and basic water law doctrine.

The fourth problem concerns enforcement: Local enforcement of programs and regulations most often provides the quickest, most efficient, and least expensive form of enforcement. Slow and inefficient enforcement impedes the water regulatory process and redirects funding that would be better used for programs.

The fifth problem concerns water quality: without good water quality the quantity of water is not of much use. Since the two are inextricably linked, both are therefore equally important.

The final problem concerns the availability of energy: economical energy is critical to the availability and use of groundwater within the district. Should energy become too costly, the resulting immediate decline in the area-wide economy would be undesirable at best. It is in the best interest of the district to support and/or assist private efforts aimed at assuring an adequate supply of energy at a reasonable cost for the pumping and diversion of valid water rights within the district.

III. ANALYSIS

The goals of GMD4 must be compared against the activities of the district for each of these six problems. If these activities are consistent with the district direction and are meeting the goals, then the public groundwater management process must, by definition, be considered a success.

A. The Problem of Depletion

The GMD4 management program lists the declining water table as a problem, and divides that problem into three sub-problems:

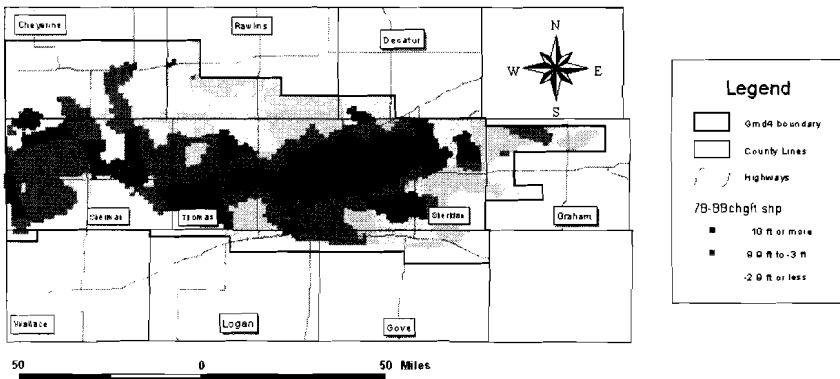
Stopping or controlling groundwater depletion is a complex problem. A pure resource approach toward a solution will necessitate focusing equally on the control of new development, the ability to direct or influence the use of existing development as necessary, and the

design and implementation of programs for augmenting water supplies where possible. Other factors such as social, economic and legal impacts will also require attention, but are at this time actually non-resource components of the problem that will likely require State or Federal cooperation when resource solutions are being designed.¹⁰

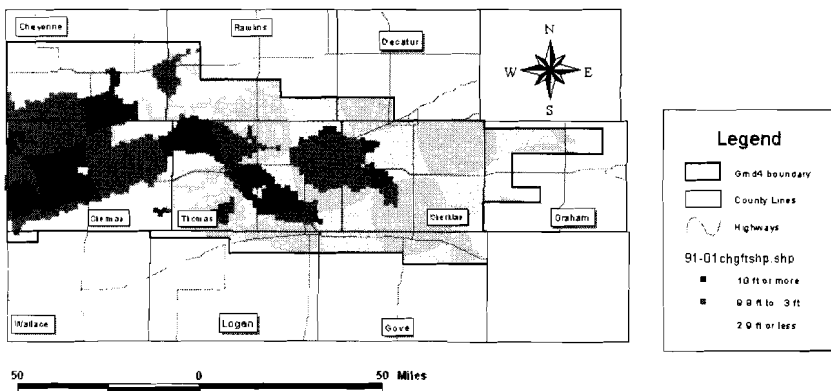
District declines have varied over space and time (see maps 1 and 2). Between 1978 and 1988, the major declines (of ten feet or more, shown in black on the maps) were taking place in eastern Thomas and western Sheridan Counties. Between 1991 and 2001, the major declines were taking place in Southwest Sherman County.

Map 1: Kansas Groundwater Depletion, 1978-1988

Water Level Change in Feet: 1978-1988



Map 2: Kansas Groundwater Depletion, 1991-2001



10. Northwest Groundwater Management District No. 4: Revised Management Program, (March 9, 2006) available at <http://www.gmd4.org/mp.html>, at IV-3.

1. GMD4 Goals for Controlling New Groundwater Development

The current revised management program for GMD4 sets forth three goals for each of the depletion sub-problems. First, it prohibits new development that exceeds the long-term annual recharge in the local area of a proposed new water right. Second, it prohibits any new water right from directly impairing any existing water right to an unreasonable degree. Finally, it allows only limited access to new water rights for small requests for legitimate uses in specified circumstances.¹¹

2. GMD4 Actions to Control New Development

Since August 19, 1991, the only new development allowed in GMD4, with the exception of small use applications of twenty-five acre-feet or less, has been that which does not exceed the long-term recharge of the two-mile radial circle surrounding the proposed well location (335 acrefeet). On January 31, 2004, GMD4 further restricted small use applications to no more than fifteen acre-feet in any one-mile radial area.¹²

Since February 20, 1980, GMD4 has had a secondary well-spacing regulation designed to prohibit direct interference between wells. The spacing distances are variable, depending upon the quantity of water authorized to be pumped: the more water requested, the greater the spacing distance required. The minimum spacing distances for each quantity of requested water were set to allow a maximum of six inches of drawdown (interference) on any existing well. Any more direct impact to an adjacent well was considered unreasonable.

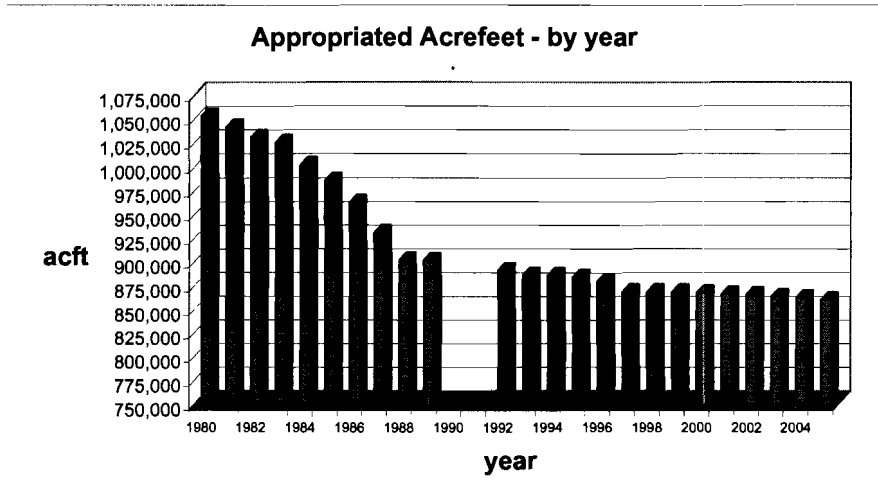
The GMD4 Board has always sought to allow limited, small-use groundwater applications, so that no area would be completely closed to any new appropriation. The fifteen acre-feet limit per radial mile is the most restrictive such policy which GMD4 has ever implemented. In 2005, seven small use applications were approved for a total of 58.6 acrefeet.¹³ Even with this level of new development, the net annual change in appropriated water rights in GMD 4 is decreasing. In 2005, the total appropriated water within GMD4 was 860,449 acre-feet. This is down 192,848 acrefeet from a high of 1,053,297 appropriated acre-feet in 1980.¹⁴

11. *Id.* at IV-1.

12. GMD4 Rules and Regulations, (Jan. 31, 2004) available at <http://www.gmd4.org/mp.html>.

13. GMD4 Water Rights Tracking Database (on file with author).

14. GMD4 Assessment Data By Year (on file with author).



3. GMD4 Goals for Controlling existing Groundwater Development

GMD4 has generated nine distinct goals for controlling existing groundwater development. First, it seeks to reduce diversions from the aquifer from existing water rights according to the Enhanced Management Program process of the GMD4 management program. Second, it seeks to eliminate irrigation on unauthorized places of use. Third, it seeks to eliminate overpumping—the pumping of unauthorized quantities of water. Fourth, it seeks to promote the enrollment of water rights into conservation programs. Fifth, it supports the creation and the proper operation of water banks. Sixth, it seeks to assist in the development of state and federal programs designed to reduce water use. Seventh, it seeks to cooperate with other state and local entities to evaluate other ideas for the reduction of overall groundwater diversions; this effort includes the local development and implementation of sub-aquifer management areas designed to identify and address the decline problems in the highest-priority areas of the district. Eighth, it seeks to cooperate with DWR to ensure that water use does not increase as a result of changes made to existing water rights. And finally, it seeks to ensure that all water use within GMD4 abides by the Kansas Water Appropriation Act.

4. GMD4 Actions to Control Existing Groundwater Development

Since the new management program was only adopted on March 9, 2006, this program is still under development. No reductions in aquifer diversions can yet be attributed to this effort.

In 1999, GMD4 staff used current aerial photographs to make an inventory of all center pivot irrigation systems in the district, matching these systems to authorized water rights. The staff reconciled all found discrepancies, so that no unauthorized acres are being irrigated with center pivot systems. While other irrigated lands were not inventoried, approximately

eighty percent of the irrigated land in GMD4 at that time was under pivot irrigation, and has been reconciled.

In 1994, GMD4 staff began evaluating all water use reports against the authorized acre-feet for the well, and against the amount of water that should have been reasonably pumped during that report's year, based on the crop irrigated, the effective rainfall received at that location, and the local crop evapotranspiration values. GMD4 then notified all water users who had reported pumping in excess of either value, and urged them to contact the district to discuss its findings. While there was (and still is) no legal consequence for exceeding either of these values, these notifications have increased public awareness of depletion, and GMD4's education of each of its respondents has been well received. Moreover, DWR has implemented a program designed to address blatant and recurring overpumpers, which has often required such overpumpers to meter their wells and produce state-approved conservation plans.

GMD4 has continually informed all of the set-aside programs developed at the state level, and has publicized these programs to its members. In a review of newsletter articles since January 2000, the Water Rights Conservation Program (WRCP), the Environmental Quality Initiative Program (EQIP), the Kansas Irrigation transition program (WTAP), the Northwest Kansas Groundwater Conservation Foundation (NWKGCF), the SCC Water Resources Cost Share Program, and the Multi-year Flex Account (MFA) programs have been reported on thirty-one times. These reports have helped to educate GMD4 members of the conservation opportunities available to them within the district.

GMD4 staff participated in the select water-banking task force appointed by DWR, which in 1999 issued a suite of recommendations to the Kansas Secretary of Agriculture regarding proposed legislation. GMD4 fully supported the local ability to create and operate water banks. A water banking bill was passed by the Legislature in 2001 but was restricted to a few pilot banks within the state.¹⁵

5. GMD4 Goals for Augmenting Water Supplies

GMD4 has generated three goals for the augmentation of water supplies within the district. First, it seeks to promote new water-importation projects, so far as they are practical. Second, it seeks to design and to operate artificial recharge structures, when funding outside the district is available. Finally, it seeks to promote efficient water use to the maximum practical extent.

6. GMD4 Actions to Augment Water Supplies

GMD4 has not yet had the opportunity to promote water importation projects. These projects are beyond the administrative and engineering scope of the district at this time. As for recharge, between 1979 and 1983, GMD4 helped to design and subsidize forty recharge projects, which principally

15. KAN. STAT. ANN. §§ 82a-761 - 773 (Supp. 2005).

involved level terraces and small retention dams. Since then, no outside funding has been provided.

B. The Problem of Locally Determining Public Interest

So many water-management decisions must be made in consideration of the public interest—a term used no fewer than seven times in the KWAA and five times in the GMD Act¹⁶—that the district feels it is necessary to articulate a local definition of this term, and to give that local definition a legitimate standing at the state level.

1. GMD4 Goals in Defining “Public Interest”

GMD4 has generated two goals in defining the term “public interest.” First, it seeks to convey through its management program a clear expression of what the local public interest is within GMD4, so far as it relates to groundwater management. Second, it seeks to insure that the district will continue to be able to act according to the local public interest, within the authorities expressed in the GMD Act.

2. GMD4 Actions to Achieve a “Local Public Interest”

The fact that developing a local concept of public interest and having it recognized on the state level is listed as a problem in the management program, and the fact that this concept has been approved by the chief engineer and the district members, is evidence enough that both goals have been achieved.

C. The Problem of Public Education

The entire concept of local control hinges on public awareness and public involvement in the affairs of the GMD. This is particularly true in the formulation of management policy and in other planning activities. Encouraging public interest and involvement has remained a problem from the start of the district and will require continuing attention from the board. The importance of a well-informed and active membership cannot be over-emphasized.

Areas where a lack of public education has been identified include water rights administration; general water doctrine in Kansas; the role of local districts in managing water, and awareness of the different responsibilities of various water-related agencies and authorities in Kansas, including the Kansas Geological Survey, the United States Geological Survey, DWR, the Kansas Water Office, the Kansas Water Authority, the Kansas Department of Health & Environment, the Kansas Corporation Commission, the Kansas Department of Wildlife and Parks, and GMD4 itself. Without an acceptable knowledge of the

16. The term “public interest” is used in the following KWAA sections: KAN. STAT. ANN. §§ 82a-711-712, 726-727, & -733 (Supp. 2005). The term “public interest” is used in the following Groundwater Management District Act sections: KAN. STAT. ANN. §§ 82a-1020, 1024, 1036, & 1038 (Supp. 2005).

areas just mentioned, the effectiveness of public input into district planning and policies will be restricted.

1. GMD4 Goals to Educate its Public

Generally speaking, GMD4 has sought to develop a public education program that informs and educates people about district actions, important non-district activities, water rights, and anything else that may affect or assist them. In support of that general goal, GMD4 strives to achieve six related goals. First, it seeks to support schools, service clubs, and local groups with information about GMD4. Second, it seeks to periodically notify schools of its readiness to provide presentations on water issues within the district. Third, it seeks to produce a newsletter of general circulation, at least quarterly. Fourth, it seeks to use public service announcement and television interviews whenever possible. Fifth, it seeks to periodically conduct a district-wide listening tour to improve communication between the GMD4 Board and the district members. Finally, it seeks to work with all applicable agencies, authorities, and the legislature on water-related issues, both ours and theirs.

2. GMD4 Actions to Educate its Public

GMD4 has generally succeeded in achieving its stated goals to improve public knowledge and awareness of groundwater management. District staff and board members, when asked, have never failed to make a presentation at any service club, school or other group event. While the district is asked for such presentations perhaps only ten to fifteen times a year, each request has been accommodated. Providing notification to schools about GMD4's presentation capabilities has not been a routine activity of the district, although it has been done twice in the past. The GMD4 newsletter has been produced at least quarterly since 1978. Beginning in 1984 the publication went to bi-monthly, or 6 times per year. The current mailing list is 5299 subscribers,¹⁷ which includes district members, legislators, agency personnel, agribusinesses, and other interested people. All editions since January/February, 2004 are currently posted on the district's web page at www.gmd4.org/nl.html. The use of public service announcements has not been as aggressive as it might be. At least once or twice a year staff conducts radio or TV interviews, mostly upon the request of the local media station. Public listening tours have been used from time to time for specific issues, but of late, they have not been scheduled annually. They have in the past been poorly attended and do not yet warrant the time and costs involved. With ready access to the district via e-mail and the web, fewer face-to-face meetings are being held.

GMD4 has always and continues to work with all water-related agencies and the Legislature. The district began its involvement in June, 1977 by participating in Governor Bennett's Blue Ribbon Task Force. This was an interesting process with many parallels to the present. Our 1977 invitation read:

17. GMD4 Newsletter Database (2006) (on file with author).

The Governor's Task Force on Water Resources would like for you to make a presentation, June 23, 1977, Room 514, State Capitol Building at 1:30 p.m., on the functions and effectiveness of your Groundwater Management District in providing for the conservation of groundwater in your area.

It would be appreciated if you would comment on the adequacies and inadequacies of your basic authority, your financing and planning capabilities, and the administrative control and reporting systems for water users in your district.¹⁸

GMD4 has been involved in most major groundwater issues in Kansas ever since, and is currently and actively involved in the following five statewide groundwater management efforts: (1) the NRCS State Technical Committee and EQIP sub-committee; (2) the KWO Upper Republican Basin Advisory Committee; (3) the KWO Water Issues Strategic Plan for the Ogallala; (4) DWR's Solomon Subbasin Water Resources Management Program; and (5) the U.S. Department of Energy (DOE) Energy-Water Nexus.

D. The Problem of Enforcement

The enforcement of locally-developed policies could pose problems in the effective management of remaining groundwater reserves. Usually, local enforcement is more effective, more efficient, and less expensive than state enforcement. However, anticipating a certain percentage of cases whereby local enforcement is not going to be effective, the district has identified this as a potential problem. Moreover, the district recognizes potential problems concerning the consistency of enforcement when there is not proper coordination between federal, state, and local concerns.

1. GMD4 Goals regarding Enforcement

GMD4 has generated three goals regarding enforcement. First, it seeks to work on local enforcement as a primary endeavor, yet to remain able to quickly coordinate and to implement a cooperative enforcement program with the appropriate state agency when the board deems it necessary. Second, it seeks to monitor federal and state enforcement activities and, whenever such activities are inadequate, to develop its own enforcement capabilities. Finally, it seeks to promote the responsive state enforcement of local policies and regulations when requested.

2. GMD4 Actions regarding Enforcement

GMD4 first attempts to locally enforce its regulations. The district has created a streamlined local enforcement process using a district order, and then seeking injunctions if district orders are not complied with.¹⁹ This process has been used successfully many times in dealing with the non-control of irrigation tailwater and abandoned wells, and can potentially be used for virtually any

18. Letter from Governor Shelby Smith to Wayne Bossert, GMD4 Manager (June 6, 1977) (on file with author).

19. See KAN. ADMIN. REGS. § 5-24-11 (2005).

district violation.

The district began its abandoned well program by monitoring wells and turning them over to the Kansas Department of Health and Environment ("KDHE"). When state enforcement results were deemed insufficient, the board developed the district's own monitoring and enforcement program. This effort eventually caused the proper plugging of over 2,000 abandoned wells in GMD4 within three years. GMD staff also monitored oil and gas well activity closely, working with the Kansas Corporation Commission ("KCC") and KDHE personnel to correct deficiencies in regional oil drilling operations. In this case, the state agency reactions were deemed adequate, so no local enforcement action has been necessary. GMD4 files contain numerous letters to state officials reporting deficient operations, including inadequate well cementing, insufficient surface/production pipe setting, inadequate well pluggings and abandoned oil and gas wells. The district also worked with the former Division of Plant Health, Kansas Department of Agriculture, to develop a joint enforcement capability for chemigation systems, providing the district's enforcement authority to the state agency at the agency's discretion.²⁰

E. The Problem of Water Quality

1. GMD4 Goals for Water Quality

The district board chose water quality as a problem, recognizing that water quantity meant very little if the water quality was not sufficient. This problem was divided into two sub-problems: unplugged, poorly constructed, and improperly maintained wells; and surface activities that can degrade groundwater quality.

GMD4 set forth two goals in regards to these sub-problems. First, within six months of learning of a deficient well, GMD4 sought to plug, cap, or reconstruct that well. Second, GMD4 sought to monitor both federal and state policy and regulation of all listed surface activities, and consider the development of local regulation, if the district found the federal and state standards inadequate to protect water quality within GMD4.

2. GMD4 Actions to improve Water Quality

Beginning in 1985, the district started field-checking abandoned wells and turning them over to KDHE for disposition. When KDHE's efforts proved too cumbersome, the board developed its own authority in 1986, and started addressing these wells in-house. By 1991 the district had identified and handled 2,260 wells. While the district does not currently seek out abandoned wells, the procedure to do so remains in place and can cause the proper disposition of all wells brought to our attention.

District staff have not sufficiently monitored other activities which

20. Memorandum of Understanding, Kan. Dept. of Agriculture, Division of Plant Health and GMD4 (Nov. 1988) (on file with author) (regarding chemigation systems in GMD4).

degrade water quality. These would include primarily feedlots, landfills and other waste dumps, underground fuel storage facilities, oilfield tank-batteries and distribution systems, and all the agricultural-related storage, handling and usage of chemicals, including elevators, chemical plants, and chemigation systems. The district did design and implement a two-year water quality monitoring network that sampled representative facilities for most of the identified potential contaminants, but failed to continue funding beyond the two years.

F. The Problem of Energy Costs

The availability of economical energy is critical to the availability and use of groundwater within the district. Should energy become too costly, the resulting immediate decline in the area-wide economy would be undesirable at best. It is in the best interest of the district to support and/or assist private efforts aimed at assuring an adequate supply of energy at a reasonable cost for the pumping and diversion of valid water rights within the district.

1. GMD4 Goals for Economical Energy

GMD4 set forth two main goals to secure, as far as it could, an economical energy supply. First, it seeks to support and/or assist private efforts aimed at assuring an adequate supply of energy at a reasonable cost for the pumping and diversion of valid water rights within the district. Second, GMD4 seeks to work on behalf of the energy consumers of the district in maintaining a cost-effective and reliable source of energy for the production of crops and all other water uses within the district.

GMD4 has made no efforts to date regarding either of these two goals.

IV. CONCLUSION

Institutional groundwater management in GMD4 has succeeded in implementing around eighty percent of its management plans over the years. GMD4 has successfully managed its groundwater in twelve different ways. (1) It has stopped new development, and stopped the decline in water levels from getting worse. (2) It has raised public awareness of the problems facing the district. (3) It has improved its public education of groundwater issues. (4) It has virtually eliminated irrigation tailwater. (5) It has stopped the increase in consumptive use of water caused by water-right changes. (6) It has eliminated all illegal wells within the district. (7) It has plugged all visible abandoned wells. (8) It has assisted district members to facilitate their transition away from irrigation, in order to address the decline problem. (9) It has provided convenient and accurate water rights assistance to its membership. (10) It has cooperated with state agencies to reduce consumptive use. (11) It has cooperated with DWR to meter all GMD4 wells by 2010. Finally, (12) it has reduced appropriated water rights by twenty percent.

Despite these successes, there are three areas which need more attention.

First, The GMD4 management program has had a minimal affect on reducing decline rates. District activities have certainly not increased these rates, but they have not significantly slowed them either. This issue should be addressed by the new Enhanced Management Program section of the March 9, 2006 Revised Management Program. The essence of this shortcoming has been the inability to set a specific and meaningful management goal for declines. Under the new management program, landowners and water users in all high-priority aquifer subunit areas are slated to discuss and recommend specific goals to the GMD4 board for implementation within their individual subunit area. The passage of the new management program, including the new Enhanced Management Program, shows great promise in dealing with this most significant issue, which has yet to be resolved.

The second area needing more attention is that of energy costs. Goals regarding energy costs may be at cross-purposes to those concerning declines in groundwater levels. The goals of GMD4 are to work toward adequate energy for irrigation at reasonable prices, and to reduce declines by reducing water use. The more successfully energy prices are held down, the more difficult it will be to reduce water use.

Third, the district needs to reinstate a water quality monitoring network designed to discover trends of deteriorating water quality. Such a program requires technical personnel and a sufficient budget to either collect and run the many water quality samples required, or to establish an in-house lab for such work.

In closing, it might be helpful to list some of the lessons learned—or the fundamental groundwater management truths discovered—during my twenty-seven years of experience. In that experience, I can identify four such lessons. First, classic problem-solving processes break down too easily in the face of complex problems, when those problems involve critically important issues such as water. The existence of too many positions over too wide a range of possibilities makes it difficult to reach the consensus sufficient to reach public solutions.

Second, the issues surrounding groundwater overdraft are more social, economic, legal, and political than they are hydrological. Solving the decline problem from a hydrological standpoint is fairly straightforward: reduce annual consumptive use by the level of annual recharge. Yet trying to do so in way that does not disrupt the economy and society of Western Kansas, while staying within its political and legal framework, is most challenging.

Third, success in groundwater management in Kansas is almost exclusively a function of funding. Increased funding for district and state programs can mitigate the economic and social impacts of potential solutions, and thus accelerate the attainment of goals. With no funding, the economic and social impacts cannot be adequately considered.

Finally, we have so far addressed the decline problem either hydrologically, with little regard for economic and social ramifications, or, we

have addressed the problem from an economic standpoint, with little regard for how these efforts affect consumptive use. "Value-added" and cost-sharing support for more efficient irrigation systems are examples of economic solutions which tend to increase consumptive water use, while the establishment of an Intensive Groundwater Use Control Area is a hydrological solution which will most likely hurt the economy and social fabric of the targeted area. Perhaps it is time to explore water uses that reduce consumptive water use and return higher economic payoffs. Yet before such conversions can be made, there must be regulations in place that insure reduced consumptive water use, prohibit new water rights, and prevent changed water rights from increasing consumptive water use. We have been fairly successful at developing management tools for hydrological solutions or for economic solutions, but we have not been successful at developing hydro-economic management tools.

Only in the past two years has anyone suggested the coupling of multiple computer models for such complex problems as water. The GroWE (Consortium for Global Research on Water-Based Economies) effort is an interdisciplinary approach to finding practical solutions for the water problems we are facing, by using social, economic, and hydrological models coupled together and serviced by global information systems data-sets. This may be one of the new tools needed for finding new solutions.