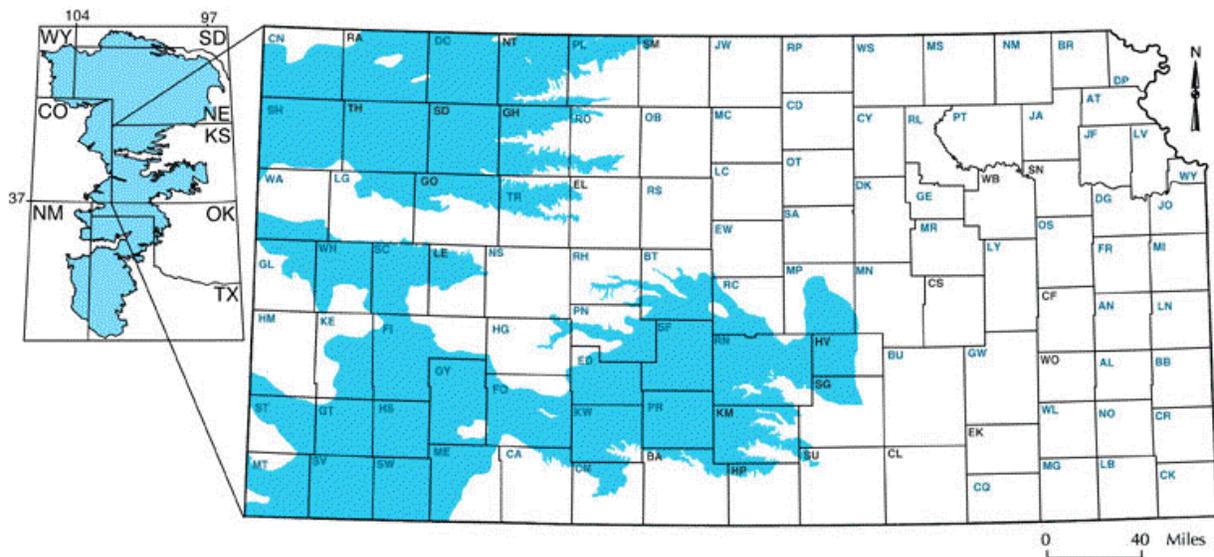


Ogallala Aquifer Management Advisory Committee

Discussion and Recommendations for long-term management of the Ogallala Aquifer in Kansas



OCTOBER 16, 2001

**T. Bogner Farms
10055 Eagle Road
Dodge City, KS 67801**

Oct. 16, 2001

Mr. Al LeDoux, Director
Kansas Water Office
901 S. Kansas Ave.
Topeka, KS 66612-1249

Dear Al:

Agriculture is changing faster than the Ogallala Aquifer.

Fully aware of the dynamic nature of water management in the Ogallala, I submit for your consideration the Ogallala Aquifer Management Advisory Committee report. It's the product of six months of deliberation of my committee members and members of the Ogallala Aquifer Management Technical Advisory Committee. Without their dedication and commitment to this valuable resource, this report would not have been possible.

Aquifer usage is based on economics. As with any phase of today's society, volume is the key to survival. This is also true in crop production with our current farm policies. LDP (Loan Deficiency Payments) are based on volume

I would ask that everyone acquaint themselves with producers who are and will not only stay in business, but will prosper. You will find that we all are continuing to examine our own operations and seeking the best production practices (and even inventing a few of our own) for our economic viability and that of our great state of Kansas. We all are tenants of our Lord God, accepting the privilege of farming His ground.

We are very fortunate to have in the leadership of Kansas the Kansas Water Office, the Division of Water Resources of the Kansas Department of Agriculture and the Groundwater Management Districts. The scientists and policymakers of these groups, along with the farmers they serve, keep Kansas in the forefront of the High Plains Aquifer management.

Our management committee is backing the Mayo Commission report, "High Plains Aquifer Conservation and Environmental Preservation Act." We felt portions of the report (Water rights retirement program) could initiate federal action to help reduce demand on the Aquifer. We are pleased to be working with Cliff Mayo, chairman of the Mayo Commission, Garden City; Sen. Sam Brownback and Rep. Jerry Moran and their staffs.

I believe our report will begin a unified effort of all parties affected, from irrigators to state agencies and the general public. This will help preserve our precious commodities, agriculture producers, communities, the great State of Kansas and the High Plains Aquifer.

Respectfully,

Tom Bogner
Chairman, Ogallala Aquifer Management Advisory Committee

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Ogallala Aquifer Advisory Committee Members and Staff

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Kansas Water Authority, Garden City

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First National Bank President, Goodland

Steve Morris

State Senator, Hugoton

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Kansas Water Authority, Penokee

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Senator Brownback's Staff, Garden City

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Larry Meschke

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Bill Hargrove, KSU, Manhattan

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SW KS Irrigators Association, Hugoton

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Kansas Water Office, Topeka

Discussion and Recommendations for long-term management of the Ogallala Aquifer in Kansas

Section I.

Introduction

On April 12th, 2001, the Kansas Water Authority unanimously approved the continued development of a management concept for the Ogallala aquifer through the water planning process. This action included the creation of two advisory committees to further evaluate management ideas for the Ogallala. The Authority directed Al LeDoux, Director, Kansas Water Office, to appoint a citizen-based management advisory committee and a technical advisory committee. The management advisory committee was to evaluate ideas for the long-term management of the Ogallala aquifer to meet water needs as an area transitions to less water availability. The technical advisory committee was to work on methodologies related to technical issues, such as criteria to delineate aquifer subunits. The technical committee would work under the direction of the management committee. The technical committee's report is included as appendix B of this report.

Declines in the Ogallala aquifer continue to be addressed. Activities at the federal, state legislative, administrative, and agency levels directly influenced the creation and charge of the Ogallala Aquifer Management Advisory Committee by the Kansas Water Authority.

State Legislation. The 1999 Legislature, through House Substitute for Senate Bill 287, directed the Kansas Water Authority to study and make recommendations on aquifer resources, long-term prospects related to any necessary transition to dryland farming in areas of the state to maintain sustainable yield and minimum streamflow levels, the potential for competing water needs for at least the next 20 years, and the means to address the competition. The Kansas Water Authority report made the following recommendation specifically for managing the Ogallala aquifer: "Use the water planning process with its integration between local Basin Advisory Committees, the Groundwater Management Districts, the Conservation Districts, local government, and the general public to assist in the development of a) State policy for water usage and management strategies that serve to sustain the replenishable portions of the State's ground water resources to ensure healthy regional communities; b) State policy for water usage and management strategies that serve to efficiently administer and provide transitional guidance when the amount of water in excess of the replenishable portions of the State ground water resources start to become exhausted; and c) Regional aquifer subunit delineations based on aquifer characteristics that quantify the replenishable portion of the aquifer." (KWA, Executive Summary, January 8, 2001, page 42).

Federal Activities. The *Kansas Water Plan* (July, 2000) directed the Kansas Water Office, in coordination with other state agencies, to work with the Kansas federal legislative delegation on changing federal farm policy to reduce irrigation water usage. To accomplish this, the Director of the Kansas Water Office appointed, and the Kansas Water Authority approved, an *ad hoc* committee to make recommendations on possible federal assistance to help conserve the High Plains Aquifer. That committee, chaired by Cliff Mayo, produced the report "Federal Actions Necessary for the Conservation and Environmental Preservation of the High Plains Aquifer" (October 27, 2000). The Mayo Committee strongly urged that the use of incentives to promote conservation be utilized versus a legislative or regulatory approach. Governor Graves endorsed this report, and Kansas Concurrent Resolution #5009 urged the U.S. Congress to take actions consistent with those recommendations. The Ogallala Aquifer Management Advisory Committee has also supported federal assistance (see appendix D).

Governor's Guidance. Governor Graves, in his 2001 State of the State address, noted he wanted to assure

that the people who rely on this resource [the Ogallala aquifer] have access to it for decades to come.

Background

The High Plains Aquifer is the primary source of water for all reported uses in western Kansas. In the 1960's/70's, too many wells were authorized and constructed, and as a result, in many parts of the aquifer in Kansas, mining has occurred. Ongoing technological and management improvements have raised efficiency and decreased pumpage.

The High Plains aquifer is a regional aquifer system composed of several smaller units that are geologically similar and hydrologically connected—that is, water can move from one aquifer to the other. The High Plains aquifer system lies beneath parts of eight states in the Great Plains, including about 33,500 square miles of western and central Kansas. The most important component of the High Plains aquifer is the Ogallala aquifer. The eastern extension of the High Plains aquifer is composed of younger sediments that are similar to the Ogallala. These younger sediments include the “Equus beds” aquifer and the “Great Bend Prairie aquifer.” Also lying above the Ogallala Formation are other Pleistocene deposits and other younger deposits in the valleys of modern streams. Where these stream deposits are connected to the Ogallala or Pleistocene aquifers, the alluvial aquifers are considered part of the High Plains aquifer.

Large-volume pumping (mostly for irrigation) eventually led to declines in the water table, and people realized that the amount of water in the aquifer was finite and could be exhausted. In the 1960's/70's, ground water rights were authorized because Kansas wanted irrigation development.

A considerable amount of water remains in much of the aquifer. For example, declines of 100 feet or more may have occurred in parts of southwestern Kansas, but that represents less than half of the original saturated thickness, and 100 to 200 feet of saturated thickness remains. In other areas, though, the original saturated thickness was much less, often less than 100 feet. (For more information see *An Atlas of the High Plains Aquifer: Kansas Geological Survey, 2000*)

Most of the High Plains Aquifer has been under intense management by the Groundwater Management Districts (GMDs) #1, 3, and 4 for nearly three decades. The Groundwater Management District Act of 1972 (K.S.A. 82a-1020) indicated that effective ground water management could best be carried out by local water users. Each GMD is a political subdivision of the state, and shares authority for managing the ground water resources with the Division of Water Resources, Kansas Department of Agriculture (K.S.A. 82a-730). The GMDs formed in the early 1970's to comprehensively manage the water resources, which had already been heavily developed. To a large extent, the GMDs thus far have focused primarily on conservation issues and education, but their authority is broad enough to support much more specific and sophisticated management approaches. Although all of GMD #1, and most of GMD #3 and #4, are closed to new well development, numerous permitted, legal wells are putting water to beneficial use resulting in a declining aquifer.

The state water planning process is used to prepare the *Kansas Water Plan*. The *Kansas Water Plan*, which the Kansas Water Office is statutorily required to formulate, is the guide for the state's water policies and programs. The planning process is coordinated, comprehensive, and continuous. All recommendations in a draft plan go through reviews by Basin Advisory

Committees, state agencies, district authorities (including GMDs, conservation districts, and watershed districts), and the general public. Revisions are made to the draft water plan and it goes through a second round of comments and revision. The Kansas Water Authority, comprised of thirteen appointed members and ten heads of agencies, has final approval of the plan. The approved plan is submitted to the Governor and

Legislature, as are recommendations to implement the *Kansas Water Plan*.

The Ogallala Management and Technical Advisory Committees recommendations will be considered by the Kansas Water Authority for inclusion into a preliminary draft *Kansas Water Plan*. If included, these recommendations will be reviewed through the state water planning process.

Section II.

Recommendations

The Ogallala Aquifer Management Advisory Committee recommends setting incremental milestones to extend and conserve the life of the Ogallala aquifer. The committee also decided, after discussion with the Kansas Water Authority Chairman, to abandon the “two pools” proposal. The committee strongly believes that incentive based programs, improvements in technology and education are the best way to conserve and extend the life of the aquifer. The committee makes the following recommendations:

1. **Delineate the Ogallala Aquifer into aquifer subunits to allow management decisions in areas of similar aquifer characteristics.** Each Groundwater Management District, and the Division of Water Resources for areas outside of GMD’s, should delineate these subunits. The Kansas Geological Survey, Division of Water Resources, Kansas State University, and Kansas Water Office should cooperate and assist through the water planning process.
2. **The GMDs and DWR should identify each aquifer subunit in decline or suspected decline and establish water-use goals to extend and conserve the life of the Ogallala Aquifer.** Setting water-use goals in aquifer subunits helps define the enormous challenge of managing this large, extremely valuable resource today and into the future. In areas where ample supplies remain either no reductions will be necessary or modest reductions may be recommended to help extend and conserve the life of the aquifer and reduce stress on nearby subunits. In a subunit with a rapid decline and a short estimated usable lifetime, a more aggressive goal should be set. Assistance programs would be targeted to those areas to help reach the water-use goals. Variables to consider in setting the water-use goal include the estimated volume of water available, recharge, amount of annual water use, estimated usable life of the aquifer, public input and others should be determined by the GMD’s and DWR.
3. **Identify aquifer subunit priorities to extend the life of the aquifer and sustain the vitality of western Kansas.** Base priority on rate of decline, the estimated time before an area must transition to less water use due to declines and the potential socio-economic impact of the decline and other factors. High priority aquifer subunits should be candidates for acquiring additional information necessary to implement plans, assistance programs and/or other actions deemed necessary by the GMDs and DWR. If incentive and voluntary plans are unsuccessful, then strict administration of existing water law should be applied.
4. **Support and expand programs and activities to extend and conserve the life of the Ogallala Aquifer.** Provide a menu of options to extend and conserve the life of the aquifer that are consistent with the prior appropriation doctrine, including the guiding principles that are listed in Appendices A and C. In subunits where irrigation is no longer economically feasible GMDs and DWR should identify and implement management strategies to sustain the life of the aquifer in that subunit.
5. **Support and expand research and education on the Ogallala to extend and conserve the life**

of the aquifer. Enhance understanding of effectiveness of various options and promote voluntary actions for less water use. Develop tools needed to better manage Ogallala, especially for areas that must transition to less water use. Identify innovative management strategies to be tested in pilot studies that are consistent with the following guiding principles. (See appendices A & B).

Section III.

Guiding Principles

The following principles are to be used in guiding development of future management of the Ogallala aquifer.

1. **Actively use the current legal framework to manage and administer aquifer decline:**
 - a. **Kansas Water Appropriation Act (K.S.A. 82a-730)**

The Kansas water appropriation act, passed in 1945, provides the tool to determine who gets water when there isn't enough to meet all water rights. Priority is based upon the prior appropriation doctrine "first in time, first in right".
 - b. **Groundwater Management Act (K.S.A. 82a-1020)**

The Groundwater Management Act establishes the right of local water users to determine their destiny with respect to the use of the ground water insofar as it does not conflict with the basic laws of the state of Kansas. The districts were created, in part, to address the need to conserve the ground water resources and prevent economic deterioration. There are numerous management opportunities available as a result of the statutorily granted authorities of the districts.
2. **IGUCAs (K.S.A. 82a-1036) provide water management tools.**

Although administration of existing rights is based on priority, there may be cases, as determined by the GMDs and/or DWR, where some flexibility is merited. For example, through statutorily authorized corrective control procedures, an Intensive Groundwater Use Control Area (IGUCA) allows more flexibility in possible solutions to managing water shortages than strict water right administration. The management requirements within an IGUCA, once approved by the Chief Engineer, have the effect and force of law and as such, are strictly enforced. An enhanced management plan outside an IGUCA relies on current regulations, programs, and voluntary, incentive-based approaches.
3. **Use the current organizational structure to manage ground water:**
 - a. **Groundwater Management Districts**
 - b. **Kansas Department of Agriculture, Division of Water Resources**

Retain the current governmental structure with responsibility for managing the ground water resource shared between the GMDs and DWR. Allow GMDs the opportunity for first response in addressing ground water-decline transition.
4. **Use the State Water Planning Process to obtain public input on new proposed management strategies for the Ogallala Aquifer.**

The State Water Resource Planning Act (K.S.A. 82a-901a) provides the authority and mechanism for comprehensive planning of the state's water resources. Use this existing planning structure to help evaluate and recommend the actions necessary to carry out the recommendations of this report, consistent with guiding principle #1, above.
5. **Utilize voluntary, incentive-based approach over regulations where possible.**

Voluntary, incentive-based approaches are an important strategy to extend and conserve the life of the

aquifer. Voluntary approaches would include education, cost sharing, and retirement of water rights.

6. **Enforce current state law and regulations over new management plans.**

There are many compelling legal, technical and socio-economic reasons for actively managing and administering future Ogallala aquifer pumping in the context of the Kansas Water Appropriation Act and the Kansas Groundwater Management Act as opposed to developing new aquifer management plans.

7. **The federal government has a role in conserving the High Plains Aquifer.**

The High Plains Aquifer, which consists primarily of Ogallala water, underlies eight states and is the source of ground water for about a third of all irrigation in the United States. The problems associated with the decline of the aquifer should be addressed at the federal, state, local, and individual levels. Federal assistance should be for research, education, and voluntary, incentive-based programs only. Federal assistance is not to be tied to federal pre-emption of States, GMDs, and other local authority.

8. **The future economy of western Kansas will remain agriculturally based.**

Agriculture will remain the dominant economy of western Kansas, even in areas where water use must decrease. Supplemental or marginal irrigation will have an increasingly important role in areas that become water short; it could serve as crop insurance for a primarily dryland operation. Shifting from full irrigation to supplemental irrigation or dryland takes time and planning.

9. **Management should be through the use of aquifer subunits.**

GMDs #1, 3 and 4, and DWR should define aquifer subunits (smaller, more homogenous areas of the Ogallala) for water management purposes, and define high priority subunits based on aquifer conditions. Set water-use goals to conserve and extend the life of the aquifer for each subunit in decline. Because there must be a solid technical understanding of each of these subunits before specific water use goals can be established, sufficient time must be provided to gather and interpret the relevant technical data.

10. **Management decisions should be based on hydrologic conditions, with consideration given to socio-economic and related issues.**

Identify management strategies when and if an aquifer subunit becomes depleted beyond an identified, renewable level, and economics or voluntary incentives have not reduced withdrawals sufficiently to extend the life of the aquifer. These strategies should be based on hydrologic conditions, with consideration given to the socio-economic issues and related factors. Through careful evaluation, the GMDs and/or DWR may determine that an alternative management plan is better suited for a given aquifer subunit, but an explanation (justification) for this decision must be provided to well owners within the subunit.

11. **Provide information so water users have a workable timeframe to adjust to reduced water use.**

Providing information on the status and projected usable life of the aquifer will help water users plan for their future and when they might need to make adjustments to reduced water use. The State and GMDs have a responsibility to share the best available information on aquifer resources in storage, trends, and projections.

12. **Continued research and education on the Ogallala Aquifer are critical.**

Strongly support additional research on the aquifer, the potential economic impacts of declining water supplies, and evaluation of alternative management strategies to extend aquifer life, which are important to making best management decisions. Of particular importance are the specific pilot programs, and the gathering of comprehensive field data, as described in the Technical Advisory Committee Summary Report. Enhanced and continued education on the Ogallala is also essential to help communities and individuals plan their water use into the future.

13. **Maintain Ogallala Advisory Committee for future needs.**
Maintain an Ogallala Aquifer Advisory Committee to be on call to the Kansas Water Office and the Kansas Water Authority to make recommendations that would be pursued through the water planning process.
14. **Establish a timeline for the coordinated development of a policy to extend the life of the Ogallala Aquifer.**
Establish a timeline for development and achievement of policy goals to extend the life of the Ogallala aquifer. The work is to be a coordinated effort between the GMDs #1, 3, and 4, and the State water agencies. The timeline is for planning to meet the five recommendations made in this report. Appendix A, Part II. "Management of Aquifer Subunits" presents key dates regarding subunit assessment, definition and management. For example, by the summer of 2003, the GMDs should have defined the protocols they will follow to establish subunit boundaries.
15. **Support aquifer recharge where local conditions are appropriate.**
16. **Recognize that free market economic forces can be very useful at reducing the rate of aquifer decline, and allow such forces to develop.**
17. **Inquire and document what current and planned action other states are taking to manage the use of the High Plains Aquifer.**

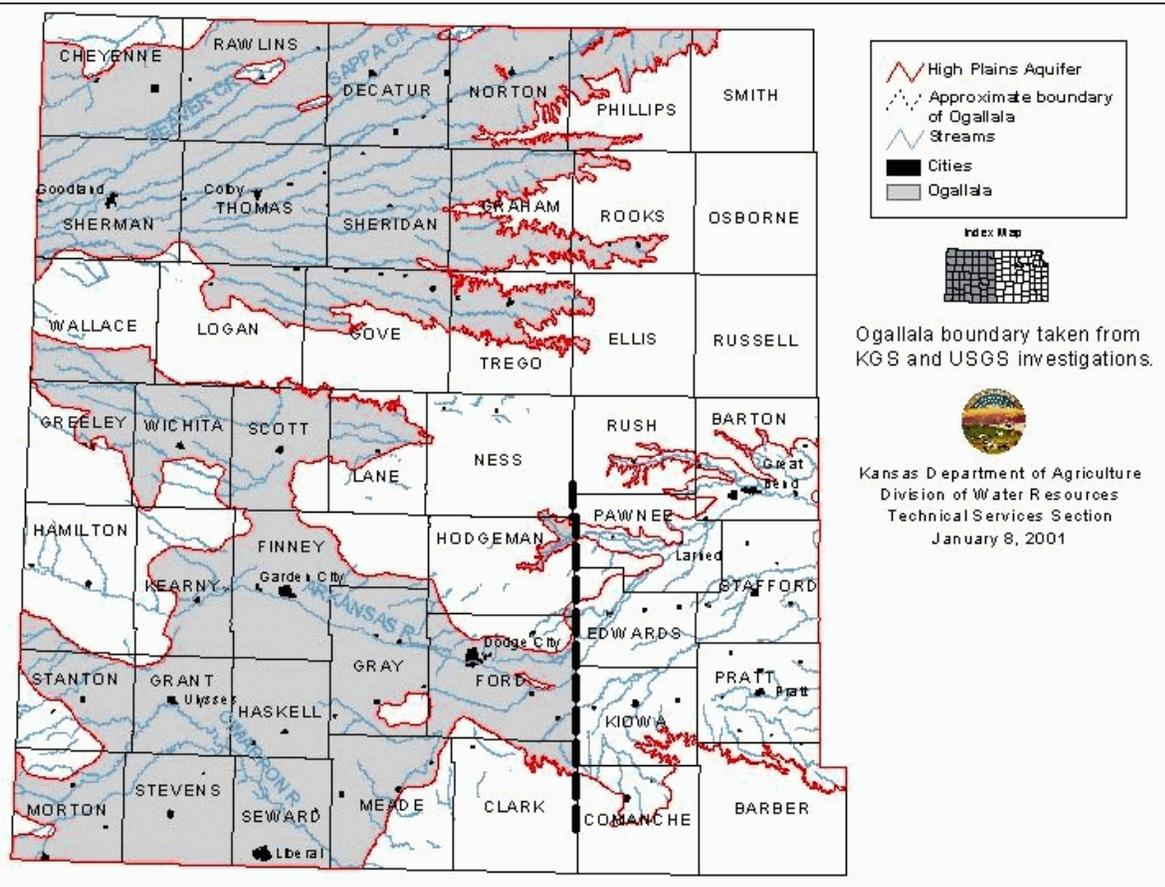


Figure 1: Area of the Ogallala, with connected alluvial aquifer, within the High Plains Aquifer

Appendix A: Menu of Options

I. Conserve and Extend the life of the aquifer

A. Conservation

1. Increase irrigation efficiencies that result in actual water savings, and maintain or increase agricultural output. Improve water use efficiency through technical assistance and/or funding water saving practices and devices to allow better management by individual water users. Support, and enhance where possible, the Water Resource Cost Share program, and other state conservation programs identified in the *Kansas Water Plan*.
2. Provide financial assistance for subsurface drip irrigation (SDI) and other highly efficient irrigation systems, which justify the high initial capital costs and result in actual water savings.
3. Set criteria for minimum water savings to be met as a condition of the cost share assistance for more efficient irrigation systems.
4. Develop other conservation measures that would contribute to water savings.

B. Seek to Reduce number of authorized water rights.

1. Seek federal funding for voluntary water right purchases to retire water rights from the Ogallala aquifer in areas that are closed to new water rights.
2. Federal support for water right retirement should be administered through the State Conservation Commission.
3. The Groundwater Management Districts, as the local sponsor, should identify and recommend areas for possible water right purchase in accordance with K.S.A. 2-1915 and 2-1919, and in cooperation with the Division of Water Resources.
4. Encourage development of state incentives for water right retirements, including but not limited to, state funding of water right purchases.

C. Support the Groundwater Management Districts' and the Division of Water Resources' capability to enforce current regulations on water usage, including providing adequate staff. It is unreasonable to expect enforcement to be the sole motivation for compliance. Successful enforcement relies on a general willingness to comply with the rules by most users in response to a strong and consistent enforcement presence that will not allow violations to persist. State and local compliance-monitoring and enforcement entities should be given the resources to ensure a consistent and rapid response to compliance violations.

1. Enforce requirement of accurate water use reports from individual water right owners. This would include monitoring meter compliance.
2. Respond to all reported overpumping, and provide aggressive enforcement against blatant and recurring overpumpers, and all other illegal acts, particularly those that result in

excessive water use.

3. Clearly define the authority and responsibilities for compliance monitoring and enforcement of each Groundwater Management District and the Division of Water Resources. Rules and regulations, district management plans, and memorandums of understanding should express the areas of responsibility of each entity.

II. Management of Aquifer Subunits

A. Develop a protocol to define criteria to a) identify preliminary aquifer subunits, b) establish preliminary water use goals for each subunit, and c) classify aquifer subunits as high, medium, or low priority, using existing data and tools recommended by the Technical Advisory Committee. The GMDs and DWR, with assistance and cooperation from the KWO, KGS, and KSU, are to establish the protocols and report them to the Kansas Water Authority by July 2003. The GMDs, and DWR for Ogallala aquifer areas outside the GMDs, are to identify preliminary aquifer subunits and preliminary water use goals.

B. The GMDs and DWR should set timelines to achieve sections C through H of the management proposal by July 2003. The progress made towards the aquifer subunit goals is to be reported to the Kansas Water Authority every 2 years, beginning in 2004.

C. The GMDs and DWR are to establish criteria to identify aquifer subunits as high, medium, or low priority, and then assign priority to each subunit in their areas. Consider factors such as rate of decline, the estimated time before an area must transition to less water use due to declines, legal (water right) criteria in each subunit, the economics, and potential socio-economic impact of the declines. High priority aquifer subunits would be targeted for additional data if needed, assistance, and possibly enhanced management.

D. Identify aquifer subunits based on aquifer characteristics and other key parameters that can be used in water resource management. Each GMD is to identify the aquifer subunits within their district, and DWR is to identify the Ogallala aquifer subunits outside of the districts. The KGS, DWR, KWO and KSU should cooperate and assist. The Technical Advisory Committee has recommended several tools for delineating aquifer subunits. An aquifer subunit can later be redefined, based on new data or management needs.

E. For high priority aquifer subunits, enhanced water management plans should be considered by the GMDs. These enhancements can be developed with input from water users in the subunit about management approaches outside of strict water administration. The Chief Engineer must determine that these approaches are not in conflict with the water appropriation act and are in the public interest. If GMDs choose not to implement enhanced management plans the Chief Engineer may initiate them in response to the public interest to protect the resource.

F. Analyze additional data as needed to verify high priority aquifer subunit conditions, and as needed for proposed management strategies.

G. Further develop and implement an enhanced management plan for high priority aquifer subunits, after additional data verifies conditions. Each enhanced management plan should have a date to indicate a defined level of progress in reducing the rate of Ogallala aquifer decline, and a course of

action if that level of progress is not achieved.

H. Transition to Dryland. Develop assistance programs for farmers that transition to dryland farming. Different programs will be needed for farmers who choose to transition before supplies are exhausted, as opposed to those who do so after supplies are exhausted. Provide education on no-till farming that maximizes infiltration of rainfall.

III. Research and Education Needs

A. Determine a basis to prioritize the need for information in the subunits, and develop a monitoring program that is consistent with the level of certainty necessary for the proposed management strategy.

B. Recommend development of a model using coupled hydrologic-economic tool with GIS support.

C. Develop a partnership between Western Kansas Irrigation Research Project and Kansas State University, GMDs #1, 3, and 4, Kansas Water Office, Division of Water Resources, and Kansas Geological Survey. The partnership is to design and test innovative strategies to conserve and extend the life of the Ogallala aquifer in one or more pilot areas.

D. Increase efforts to educate and assist current irrigators on most efficient use of systems in ways that save water and maintain or increase farm profitability. Continue support for hands-on assistance provided by Kansas State University's Mobile Lab.

E. Support development of a website that links various databases, maps, tools, references, reports, and agencies involved with the High Plains Aquifer. Develop "web master" position to keep site current, and to provide educational outreach.

F. Refine estimates of recharge (precipitation and irrigation recharge), examine long-term climatic variation, and the relationship between pumping amounts and change in aquifer storage.

IV. Future Role of Ogallala Advisory Committee

A. Maintain committee on call to continue to advise the Kansas Water Office and Kansas Water Authority, and give recommendations to be pursued through the water planning process.

B. Give recommendations for future actions on managing the Ogallala aquifer that would be considered through the water planning process, approved by the Kansas Water Authority, and identified in the *Kansas Water Plan*.

Appendix B: Ogallala Aquifer Technical Advisory Committee Final Report
Approved 10/3/2001

Recommendations on Issues

The Ogallala Aquifer Technical Advisory Committee (TAC) of the Kansas Water Authority was charged to review and consider technical issues associated with the development of management concepts focused on the Ogallala aquifer in Kansas. Working under the direction of the Ogallala Aquifer Management Advisory Committee, the TAC provides recommendations on the following issues presented for review and comment.

Issue 1: *Establish a protocol that will allow parties to agree on data that will or can be used in management strategies prior to the development of the strategy. This may include quality assurances and control measures, recommendations of use and scale for that data.*

- 1) Data are simply a representation of or provide the bases for a model of natural conditions and/or phenomena. As such, data will always have some level of uncertainty and accuracy in their representation.
 - a) Where possible and practical, the quality of existing data should be improved. In some cases, quality control programs from the moment of capture to incorporation into a database can document levels of uncertainty well enough to preclude the need for additional data. In no cases can a quality control program improve the accuracy of data once captured in time, but enhancements to other characteristics of the data may be conducted, (e.g. improved ground elevations for monitoring wells).
 - b) There is sufficient existing information and established water-level networks to obtain future data for planning and monitoring regional trends. Depending on the scope of enhanced management plans, additional data may be necessary to provide a higher level of confidence for a given portion of the aquifer.
 - c) Selection of appropriate data is dependent upon management goals and whether the current levels of uncertainties in existing data sets are low enough to implement those management objectives.
- 2) Any management plan or strategy that involves State programs, activities or funds should be outlined and described in appropriate sections of the Kansas Water Plan.
 - a) Describe analysis methodologies and data sources used in that process and an iteration of the purpose and scope of the management strategy.
 - b) The Kansas Water Plan is not the primary controlling factor in deployment or operation of a management strategy, but is one method to convey and illustrate management activities and goals to a broad range of interested parties.
 - c) The principle advantage of using the Kansas Water Plan is its development process, which is open to review and feedback from other state, local, and public entities.
 - i) All parties are presented with management goals, selected data sources, and chosen analysis

procedures to evaluate proposed plans and strategies and implement those accepted.

- ii) This information can then be reviewed by and is open to consideration and comment from the public, including those affected by the management strategy.
 - d) The Kansas Water Plan can be the vehicle to coordinate and partner management objectives with other entities for project development, analysis needs, and data collection. Establishing an expanded consortium of partners would assist in the acceptance of management plans, data collection, and analysis methods.
- 3) Where appropriate and practical, all data that is used in any management policy or strategy should have complete and appropriate “Metadata” developed. Metadata is often described as “data about data.” Metadata provides additional information about databases, spatial GIS files, and other sources that are normally not contained within the data files themselves. For example, information within metadata files would list who created the data set, how it was captured, what are the limitations, who do you contact for more information, and how often will be updated.
- a) It is recommended that all data files used in management considerations have fully developed metadata files that are modeled after the Federal Geographic Data Committee (FGDC) Standards. This is not to imply that data will be limited to those sources that have fully developed FGDC standard metadata files, rather a recommendation to have the files developed when possible in order to provide background information.
 - b) The metadata files should include, but is not limited to the following parameters; documentation and methodology on capture procedures, listings of appropriate scales of use, access or use constraints, data or attribute quality, data structure, field definitions, and contact and originator information.
- 4) Management plans or strategies should be supplemented with additional data sources if needed and when practical.
- a) The need for additional data is dependant upon the current accuracy of existing data and what is considered an acceptable level of uncertainty in relation to the management scope and what it is trying to address.
 - b) Consideration of how much detail is necessary to manage the aquifer and the costs/benefit ratio of that additional information.
- 5) Establish smaller, more homogenous aquifer subunits and create a basis for prioritizing need for information (such as estimates in the usable life of the aquifer). Then move towards a monitoring program for high priority subunits that combines the existing observation network with other statistically based measurement designs.
- a) Monitoring by subarea would permit more efficient use of information and resources in achieving desired objectives. In most cases, existing data and networks are probably adequate to develop a cost-effective and process-based monitoring strategy with the addition of new wells, as information is needed.

- b) By prioritizing aquifer subunits, resources can be better targeted without over or under management. A second advantage of using aquifer subunits for management purposes is the facilitation of adding data sources as needed.

Issue 2: *Develop procedures to conduct a literature and data search on all existing information from databases and aquifer studies. Establish a procedure for this information to be made available to interested parties and a recommendation on the appropriate federal, state, or local organizations that should conduct this exercise.*

- 1) Establish and maintain an electronic data warehouse / internet site focused solely towards knowledge and information about the Ogallala aquifer. This site would contain a variety of data that is available to a broad group of users ranging from the general public, to GMD and agency personnel, to system modelers and researchers.
 - a) The data warehouse would contain information related to:
 - i) Hydrogeologic conditions (water level information, bedrock elevations)
 - ii) General water uses (crop production, municipal demands)
 - iii) Economic and social issues (jobs, supported industries)
 - iv) Energy issues (sources and availability, energy uses in crop production)
 - v) Interested agencies and contact information (GMDs, KDA-DWR, KWO)
 - vi) Water rights (legal and enforcement issues, technical assistance)
 - vii) Others.
 - b) In order for this data warehouse to be viable and a current source of information, a “web master” position should be designated.
 - i) In addition to creating and maintaining the site, this work would also be focused to general data support for recognized management entities and researchers.
 - ii) This work would also be involved in educational outreach programs throughout the state.
 - iii) This work would also work with the eight state, High Plains Aquifer coalition of geologic surveys in disseminating information about the Ogallala.
 - iv) It is recommended that funding for this work be made available to provide these services. Funding sources could include the State Water Plan Fund, GMD Support, Kansas Water Research Institute, or federal sources or grants. The exact number of positions and amount of funding would be controlled by the level of responsibility and work load.
 - v) This site and program should be evaluated after a set number of years to evaluate its use and

future expansion or continuation.

- 2) The Ogallala data warehouse would work in conjunction with the newly formed Ogallala Aquifer Institute at Garden City, Kansas.
 - a) Where the data warehouse provides electronic media and access, the Ogallala Institute would serve as an educational and demonstration site for work products and other material related to the Ogallala aquifer in Kansas and its extent in the country.
 - b) The Institute could contain display cases, interactive and informative CDs, and simple fact sheets and pamphlets about the Ogallala. Computer terminals could be setup to provide real time access to data from the data warehouse plus other interactive and analysis software programs orientated to water issues in the Ogallala.

Issue 3: *Establish a protocol to identify aquifer subunits that can be used for any management concept. This may include identification of key parameters and political considerations.*

- 1) It is recommended that the Ogallala aquifer be managed at a subunit or sub-regional level to be designated by local Groundwater Management Districts where represented. Given the heterogeneity of the aquifer across the state, aquifer subunits are appropriate for both targeting management policies and decision-making.
- 2) Subdividing the aquifer into management units does not necessarily require that every unit have a special management policy. Many areas of the Ogallala appear to have reduced their rate of decline and managing the aquifer by subunits should be viewed as a process of prioritizing resources and management efforts.
- 3) Initially delineate preliminary aquifer subunits by focusing on the current conditions of the aquifer rather than on past, historical trends. The complexity and method of determination of the aquifer subunits can change based on scope and purpose of the management plan or if additional data sources are acquired.
- 4) There are several methods to determine aquifer subunits and management entities are encouraged to choose one that best fits its needs. The delineation of aquifer subunits should be based on a variety of methods and the different results should be compared. Some of possible methodologies for aquifer subunit delineations are as follows:
 - a) Geo-statistical clustering routines (example provided in attachment). A minimal number of aquifer characteristics are suggested for use in assisting the determination of subunits so that the relationships between the parameters can be better understood.
 - b) Hydrogeologic analysis.
 - c) Local knowledge and experience.
 - d) Results from past studies and research activities.
 - e) Resource trends and current conditions.

- f) Other techniques.
- 5) It is further recommended that all results be presented for public review and comment. Within the boundaries of the Groundwater Management Districts, this shall specifically include the appropriate GMD management plan process as defined in the GMD Act and the State Water Plan.

Issue 4: Review, report, and develop where necessary technology tools that would be available to planners and decision makers in developing and implementing management concepts. Ensure that these tools are capable of the flexibility to be used across the aquifer region.

- 1) Expand or develop software, and in particular, internet tools that would provide local entities and other agencies the ability to process and analyze particular data sets relevant to the State of Kansas. Many of these types of tools exist in some fashion but often require specific knowledge about the data and software and how it is modeled or the use of specific software tools. Migrating these capabilities to internet-based tools would greatly increase their use and facilitate the decision making process without the limitations of capital and staffing. An example of tool development would be an internet-based mapping program that allows users to select a point in the state and then extract data and graphs showing the ground water trends from the three closest monitoring wells. Other type of tools could include:
 - a) The ability to process water right summaries of past reported usage and current authorized amounts,
 - b) Display of regional ground water trends and saturated thickness maps
 - c) Review of water quality and its relationship to different use standards
 - d) Run farm level cost/benefit evaluations on water use, energy costs, and crop production.
- 2) It is recommended that a regional hydrologic/economic model be developed that integrates water usage, aquifer response, agricultural production and economics.
 - a) The focus of this model is to answer “what if” questions based on a variety of water use scenarios and the resulting economic factors.
 - b) The model would be used to generate regional economic forecasts in response to various water use options and water availability.
 - c) The model would allow exploration of the regional economic impacts resulting from any changes in agricultural production, changes in water use, changes in saturated thickness, well yield, water quality, and crop yield.
 - d) Ideally, this model would contain the flexibility for operation across the aquifer and provide for a range of data selection or input parameters at differing levels of resolution.

Issue 5: Recommendations on Future Research Needs

- a) A continued commitment to research and analysis of the High Plains Aquifer should be recognized.

There are many characteristics of the aquifer that are generally unknown or roughly estimated. In this light, future research should have continued commitment to hydrogeology, irrigation, cropping systems, policy, and economics.

Appendix C: Water Management Programs in the Ogallala Aquifer Region

Programs	GMD #1	GMD #3	GMD #4	KDA/DWR
Number of Irrigation Wells	2,586 wells	9,883 wells	3,473 wells	799 wells
Number of Municipal wells	37 wells	235 wells	76 wells	115 wells
Number of other water wells	178 wells	751 wells	139 wells	242 wells
Population Base ¹	9,431	133,572	26,141	18,742
1. # Irrigation acres in district or Ogallala area outside district	246,789 acres	1,593,329 acres	378,577 acres	33,241 acres
2. Wells metered (%) Based on water use meter reading reports	45% flow meters; 41% hour meters	95%	20%; all new and redrilled wells since 1980	All wells in IGUCA, and all new or changed point of diversion wells
3. Township Closure	All GMD Closed	Yes, majority closed. All 250 townships re-evaluated yearly	Majority of GMD Closed	Prairie Dog Creek basin, Hodgeman & Ness Co., Bluff Creek basin (Clark Co.)
4. Contracts w/ KWO	Yes; to correct water use reports	Not currently, but have past 10+ years.	No, but does water use editing	No, but old MOU on water use program, and cooperate on blatant and recurring over-pumpers.
5. Cooperate w/ KGS on various projects	Yes; on data maps	Yes; data maps, evaluation of sat. thickness, and other.	Yes	Yes. Annual well measurements, monitoring well installations, review of research activities.
6. Data Collection	Yes	Yes; water quality & level.	Yes	Yes, well measurements.
7. Education	Yes	Yes; water rt. & water use rept assist, website	Yes	Water use reports, subbasin working groups, websites, conferences.
8. Irrigation Efficiency Plans	Yes	Yes; provided assistance over 10 years	Yes; require on new wells, changes, and isolated cases	Upper Ark basin irrigation survey
9. Metering Policy	Yes, all	Yes, all	Yes, on new and redrilled wells since May 1980	Yes, all new or changed wells and those in an IGUCA.
10. Pilot Recharge Program	Yes- earth dam pilot project	Studies ongoing. Past pilot project.	No; cost shared in past	No; proposed Upper Ark basin working group project
11. Plugging of Abandoned Wells	Yes; inventory and assistance	Yes, technical assistance	Yes- require owner to address	No
12. Rainfall Observation Network	Yes	No; weather stations in past	Yes	No
13. Safe Yield	Yes, new wells.	No; planned depletion	Yes; new wells only	Yes, safe yield analysis using USGS recharge values in 2 mile circles.
14. Soil Moisture Measurements	Yes; provides equipment	No; in past was not used much	No	No

¹ Kansas Census Population data, April 1, 2000, certified to Secretary of State by Division of Budget on July 1, 2001, and revised on August 16, 2001.

15. Tailwater Control	Yes; prevent waste	Yes, waste of water policy & regulation	Yes, forbid loss off land; require reuse if sufficient quantity.	Addressed through no waste of water and must be kept on authorized place of use.
16. Water Conservation Plan	Yes	Yes; provide assistance	Yes	Requirement on some water rights, and Water Right Conservation Program
17. Water Level Measurements	Yes special request	Yes, by special request, and a monitoring system & database	No	Yes, wells >100 g.p.m. must have water level measurement tube. KGS/DWR measure 1,000+ wells annually. DWR measures 300+ quarterly, 100+ monthly in focus areas.
18. Water Quality Program	supply kits and	Yes, provide kits, info & tech assistance; have sampling network of >500 wells for monitoring & by special request	Inactive, rely on Local Environmental Protection Group efforts now	Yes, when contamination effects quantity or use made of water.
19. Water Right Administration	Yes; assist district members	Yes, assist district members, monitor MOUs, Board Reviews on request 2 mile radius studies	Yes; track 5 year allocations, assist district members	Yes, in response to calls of impairment.
20. Water Use Reporting	Yes	Yes, provides assistance to public on filling out state WUR	Yes	Yes, annual on all water rights.
21. Weather Modification	Yes	No, but supports w/ \$2,500 per participating co. in the district	No, not since 2000	No
22. Well Battery Policy	Yes	Yes	Yes	Yes, limit of 4 wells in a 300 ft radius not to exceed 800 g.p.m. to a common distribution system.
23. Well Construction Requirements	Adopted Article 30: Water well construction & abandonment	Defer to Article 30; also have K.A.R. 5-23-5	Yes	Yes; complete in < 24 months, water flowmeter and measurement tube may be required.
24. Well Spacing	Yes; 2640 feet	Yes	Yes, 1400' – 2800'; distance varies with acre feet	Yes; spacing sufficient to prevent direct impairment between wells.
25. Work with DWR	Yes; compliance checks	Yes, monitor wells, have M.O.U.	Yes	