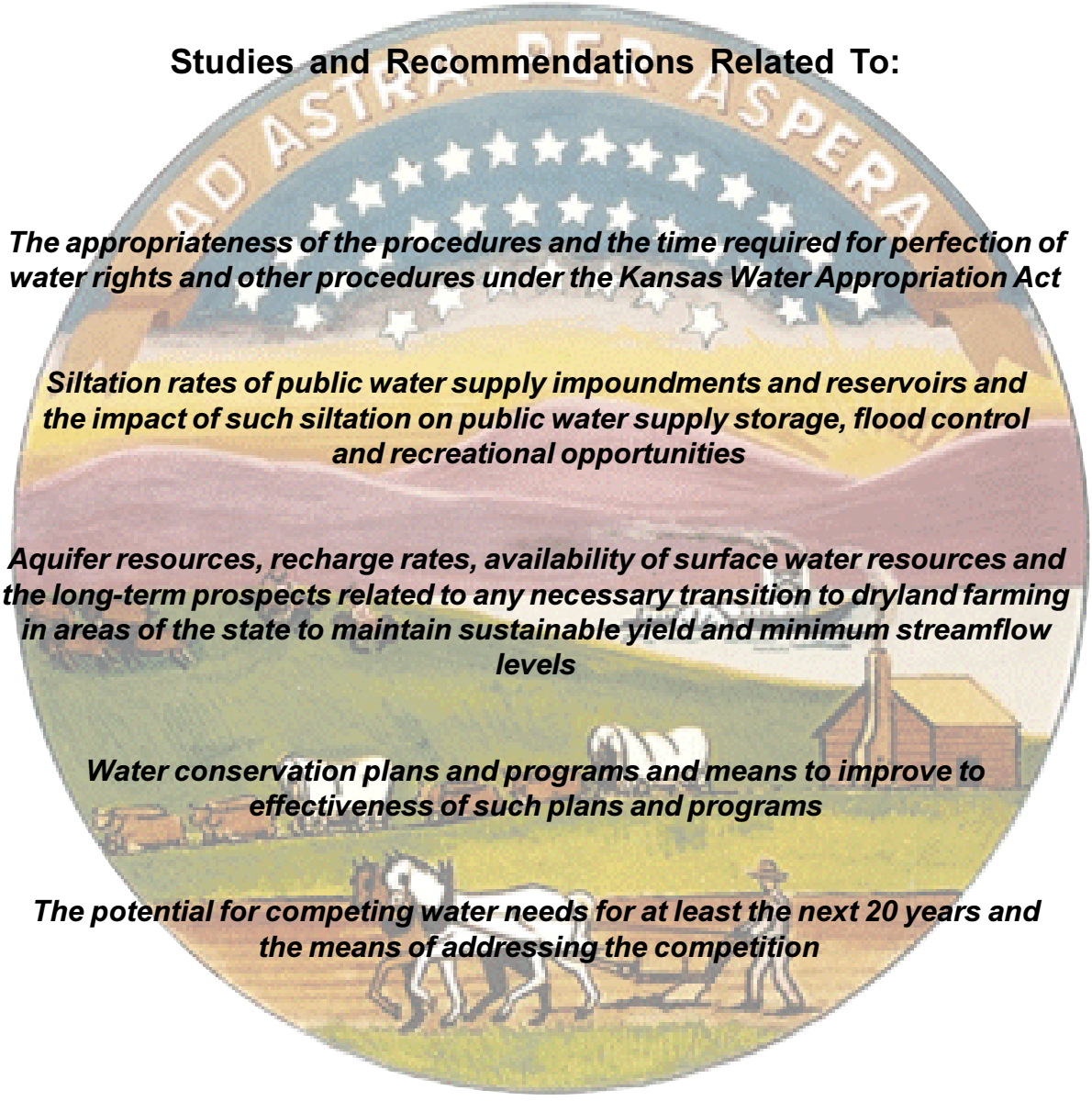
Executive Summary

for

House Substitute for Senate Bill 287 Mandates on

Studies and Recommendations Related To:



The appropriateness of the procedures and the time required for perfection of water rights and other procedures under the Kansas Water Appropriation Act

Siltation rates of public water supply impoundments and reservoirs and the impact of such siltation on public water supply storage, flood control and recreational opportunities

Aquifer resources, recharge rates, availability of surface water resources and the long-term prospects related to any necessary transition to dryland farming in areas of the state to maintain sustainable yield and minimum streamflow levels

Water conservation plans and programs and means to improve to effectiveness of such plans and programs

The potential for competing water needs for at least the next 20 years and the means of addressing the competition

Submitted by the

Kansas Water Authority

January 8, 2001

STATE OF KANSAS

Bill Graves, Governor

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Dear Governor Graves and Members of the 2001 Legislature:

I am pleased to transmit to you the Executive Summary of the studies addressing the issues required under section 15 of House Substitute for Senate Bill 287. Under this 1999 legislation, the Kansas Water Authority was directed to study and develop recommendations regarding the following issues:

The appropriateness of the procedures and the time required for perfection of water rights and other procedures under the Kansas Water Appropriation Act

Siltation rates of public water supply impoundments and reservoirs and the impact of such siltation on public water supply storage, flood control and recreational opportunities

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The potential for competing water needs for at least the next 20 years and the means of addressing the competition

The Kansas Water Authority and its staff have taken a comprehensive approach in dealing with these important issues. This Executive Summary and recommendations were presented to the public through the Kansas water planning process in each of the 12 major river basins.

The Kansas Water Authority is dedicated to achieving proactive solutions for resource issues of the state and to ensure good quality water to meet to the needs of the people and the environment of Kansas. I believe you will find these reports informative, comprehensive, and complete. If you have any questions about this document, please contact the Kansas Water Office at its toll free number at 1-800-KAN-WATER.

Respectively,

Kent Lamb

Kent Lamb
Chairman
Kansas Water Authority

The Appropriateness of the Procedures and the Time for Perfection of Water Rights and other Provisions of and Procedures under the Kansas Water Appropriation Act

The Department of Agriculture reports continuing success and progress in addressing the "certification" backlog through implementation of a strategy know as "Project Zero Out". More than 4000 water right certifications must be addressed during the remainder of the five-year window set out in House Substitute for Senate Bill 287, at a rate of approximately 1180 per year. The agency is close to maintaining this pace. The "application" processing backlog, however, has not fared as well during this time frame. What had been a downward trend in backlogged applications, from a high of more than 825 in the last quarter of 1993 to a low of approximately 425 in the last quarter of 1999, has rebounded to just over 600 in the current quarter. This increase is due, in part, to the priority placed on certification without the benefit of additional resources. Compliance checks for new diversion works are now a low priority in deference to certification. Further, help from field offices on some applications is delayed because of the focus on certification, which causes a delay in processing applications. Other factors influencing the application backlog include loss of experienced personnel and mandatory shrinkage requirements. To help reduce the backlog, overtime has been authorized using Kansas Department of Agriculture year-end savings.

Following are recommendations to address the issues of concern:

- The Kansas Water Authority supports the important work of the Division of Water Resources, Kansas Department of Agriculture, and encourages the Governor and the legislature to provide the resources necessary to carry out the requirements of the statutes in an efficient and timely fashion.

- The Kansas Water Authority supports the Fail Mode Effects Analysis (FMEA) undertaken by the Kansas Department of Agriculture to examine, systematically and objectively, the water appropriation processes of the Division and to identify areas where improvements may be made in Division operations. Initial Fail Mode Effects Analysis findings recommend determining more effective ways to decrease applicant errors and omissions, and using improved office automation to process applications and to allow more efficient access to technical information needed to evaluate applications for approval. The Kansas Water Authority should support the findings of the initial Fail Mode Effects Analysis, and encourage the Governor and the legislature to provide the resources necessary to implement the findings of the Fail Mode Effects Analysis. Further, the Kansas Water Authority encourages Kansas Department of Agriculture to pursue another technical assistance grant with Honeywell/Department of Energy to examine the new application process in more detail.

- The Kansas Department of Agriculture, Division of Water Resources, should consider moving as many of the standard certification processes as possible to the field offices under the purview of the Water Commissioner and have only a final quality control review at headquarters.

- The Kansas Water Authority supports funding to convert archival water right files from outdated microfilm readers to computerized optical imaging systems. This will increase productivity by allowing more efficient access to information necessary to make decisions and allow multiuser access to the same information.

Siltation rates of public water supply impoundments and reservoirs and the impacts of such siltation in public water supply storage, flood control and recreational opportunities.

Introduction

Erosion of the land surface due to rainfall leads to sediment suspended in water flowing in streams. As streamflow enters lakes and reservoirs, the water flow slows, which causes some of the suspended sediment to settle out on the bottom of the lakebed. This siltation, or sedimentation, reduces the available storage space within the lake. Sedimentation in water supply reservoirs has increasingly become an issue of concern to both small and large communities.

During the 1950's, 1960's and 1970's the federal government constructed a number of lakes within the State of Kansas. Under the 1958 Water Supply Act, the State of Kansas gave assurances to the federal government that the State, and ultimately local water purveyors, would repay the cost of construction on a number of those reservoirs. The State's water plan storage act gave the Kansas Water Office, and its predecessor the Kansas Water Resources Board, authority and guidance on purchasing storage space within federal lakes in Kansas. The State has aggressively pursued purchase of this storage for municipal and industrial water supply. Currently the State of Kansas owns and operates storage space in twelve federal lakes.

To manage this storage, the State of Kansas has developed both the water marketing and water assurance programs. These programs make water available to municipal and industrial users on continual basis as well as during times of low streamflow. The water assurance program is nationally recognized and is the only one of its kind in the country. Because of the large investment in federal reservoir storage and the development and dependency of existing programs on that storage, siltation and resulting reduction in water availability within the federal reservoirs is of great concern to the State of Kansas.

To address the needs of cities that are not located close to federal lakes, the State of Kansas also developed the Multiple Purpose Small Lakes (MPSL) Program. This program allows the State to enhance the size of a watershed flood control structure for additional public water supply needs and increased recreational opportunities. To date ten MPSL projects have been authorized and funded. However, these lakes are relatively new and it is difficult at this time to determine the long-term effect of siltation on their operations.

Before the construction of large federal reservoirs or the State MPSL's, a number of cities and rural water districts built lakes of their own. A number of these impoundments are nearing the end of their planned life. The ability of these lakes to provide water during times of drought is becoming more and more questionable. The largest problem however is that the current volume of the lakes has not been estimated for some time. In the past, this has left some communities without water during dry periods and looking for an emergency water sources. In addition, historic information on the original design and construction is often hard to find or non-existent.

During the 1999 session, the Kansas Legislature passed House Substitute for SB 287. This bill requires the Kansas Water Authority to study and make recommendations regarding siltation in public water supply impoundments. This report documents the methodology and results that have been found regarding siltation in selected public water supply reservoirs.

Methodology

The assigned topic of quantifying siltation rates in public water supply impoundments is both broad and varied. An effective method of breaking the task into manageable subtopics was developed. The review of public water supply reservoirs and the effect of siltation on the ability of the reservoir system to meet demands was approached using three different methods. The approached used was based on the program under which the lake was built and operated. Federal reservoirs with public water supply were evaluated based on KWO regulations for 2% drought yield analysis, multipurpose small lakes were reviewed based on original engineering analysis and actively used small lakes had data collected regarding current capacity. Further background and details of each approach are described below.

Federal Lakes

Under the Water Marketing Act, the Director of the Kansas Water Office is required to determine the ability of the reservoir to deliver water with 1950's climatic drought conditions repeated before contracts for the sale of water are made. This yield must be calculated based on hydrologic and capacity conditions projected for the reservoir 40 years into the future (currently using year 2040 conditions).

The effect of siltation on a federal lake can be most clearly seen in the ability of the lake to provide water during times of drought. Therefore, the 2 percent yield analysis was selected as the appropriate measurement for this study.

The Corps of Engineers periodically conducts sediment surveys on lakes in which they own storage. The most recently collected information was compared to the original construction surveys to evaluate the amount of storage that has been lost due to siltation both over the life of the lake and on an annual basis. This comparison was used to project the sedimentation and estimated storage of the lakes at ten year intervals of 2000, 2010, 2020, 2030 and 2040. These estimates were then used within the 2 percent yield analysis to determine the effect of that sediment on the reservoir's ability to provide water supply.

Information on siltation in the flood pools of each of the federal lakes has also been collected by the appropriate federal agency. The current capacity was compared to the designed flood control capacity. In most cases, the original intent of the flood pool was to manage a 100 year flood event. Since there did not appear to be a single case where the sediment was entering the flood control pool faster than expected and the projects have not reached the end of their design life, no further analysis was completed.

The recreation component of federal lakes and the affect of siltation is the most difficult to evaluate. Because of this only colloquial information was gathered and presented in this report.

Multiple Purpose Small Lakes

Ten lakes with public water supply pools have been constructed under the Multipurpose Small Lakes Program. The first such lake, received funding in State Fiscal Year 1987. Since the lakes are relatively new in terms of total reservoir life, original engineering projections of sedimentation and reservoir yield were used in this study. This applies to both the water supply and flood control portions of the lakes.

Municipal Lakes

Information on siltation in small public water supply lakes did not exist in most cases, or was extremely outdated. The Kansas Water Office contracted with the Corps of Engineers to conduct sediment surveys on actively used city lakes. Due to the limited time and budget, lakes that were not part of a municipality's current water supply were not studied or included within this report.

Original survey data was collected from a number of sources. Information was received from the Kansas Department of Agriculture Division of Water Resources, Kansas Department of Health and Environment, Natural Resources Conservation Service and from information within the Kansas Water Office records. Each of the municipalities was also contacted for any additional information that was not available through other sources. Unfortunately, this search did not always result in complete or accurate information. Where original information was not collected, it was believed to be important to have current data and identify potential problems not previously exposed.

Field data collected by the Corps of Engineers was compared with original data where available. The comparison evaluated the loss of storage below the normal pool and the relative amount compared to the watershed. A serious limitation turned out to be the "as-designed" versus "as-built" capacities. Material to build the dam is often taken from the upstream side of the reservoir to create additional storage. However, unless the plans are updated after construction to reflect this removal of material, the actual original storage of the lakes is often under estimated. Therefore, the loss of storage and the rate of loss becomes very difficult and in some cases impossible to determine.

Results

Discussion of results will be broken out into the three categories as identified in the methodology section.

Federal Lakes

Review of information regarding siltation in the flood control pool of each of the lakes indicates that sediment is entering these pools more slowly than originally projected. Therefore, it does not appear that siltation is an impediment to flood control within federal lakes in Kansas at this time.

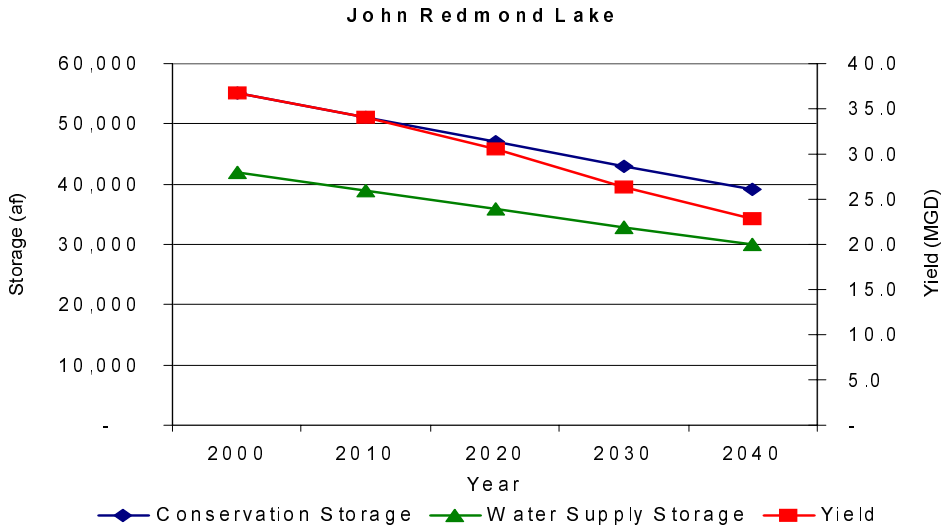
John Redmond Lake

The Kansas Water Office completed a yield analysis in 1997 which indicated that the long term yield of the reservoir would not support all of the current uses. Currently the Wolf Creek Nuclear Generating Station has a water marketing contract from John Redmond Lake. In addition, the Cottonwood and Neosho Basin Water Assurance District has contracted for water storage for low flow augmentation for municipal and industrial use.

The current estimated rate of siltation is 725 acre feet loss per year in the conservation pool. This is not much different than the original projection for the entire lake. However, very little sediment is being deposited in the flood pool which means the sediment allocation for the conservation pool is filling more quickly than designed for. The Kansas Water Office has requested the Corps of Engineers study the possibility of permanently raising the conservation pool by two feet to offset the sediment entering the conservation pool. Initial work is being completed on this study at this time. If this is not accomplished, the existing contracts will have to be cut back within 15 years. Figure 1 shows the conservation and water supply storage and projected yield for John Redmond Lake

In addition to the reduction in water supply capability, recreation for fishery, waterfowl and boating are being impacted at this time. This will continue to deteriorate with additional siltation.

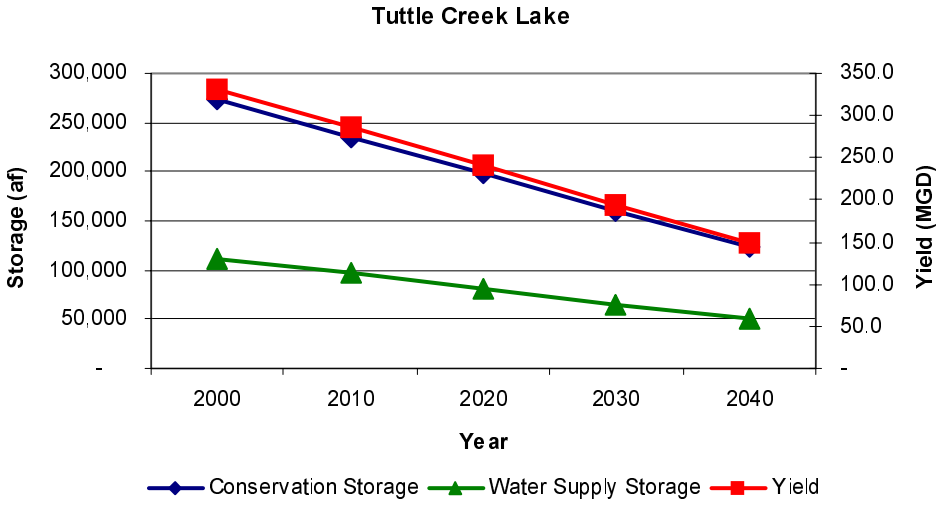
Figure 1



Tuttle Creek Lake

Figure 2 shows the conservation and water supply storage and projected yield for Tuttle Creek Lake. The current estimated rate of siltation is 3,753 acre feet loss per year in the conservation pool.

Figure 2



Tuttle Creek Lake has lost large areas of water surface to siltation in the upper end of the reservoir. The view upstream from the bridge crossing the lake near Randolph, Kansas is now that of a mudflat rather than water during times of normal or low water. A small marina once operated just upstream from this bridge. However, siltation caused the marina to close permanently. This lake has seen the greatest level of adverse recreational impact compared to other federal lakes in Kansas from sediment.

At the present time the only contract holder is the Kansas River Water Assurance District which has contracted for water storage for low flow augmentation for municipal and industrial purposes. The State of Kansas is still able to meet the needs of the Assurance District and is expected to be able to do so for many years to come.

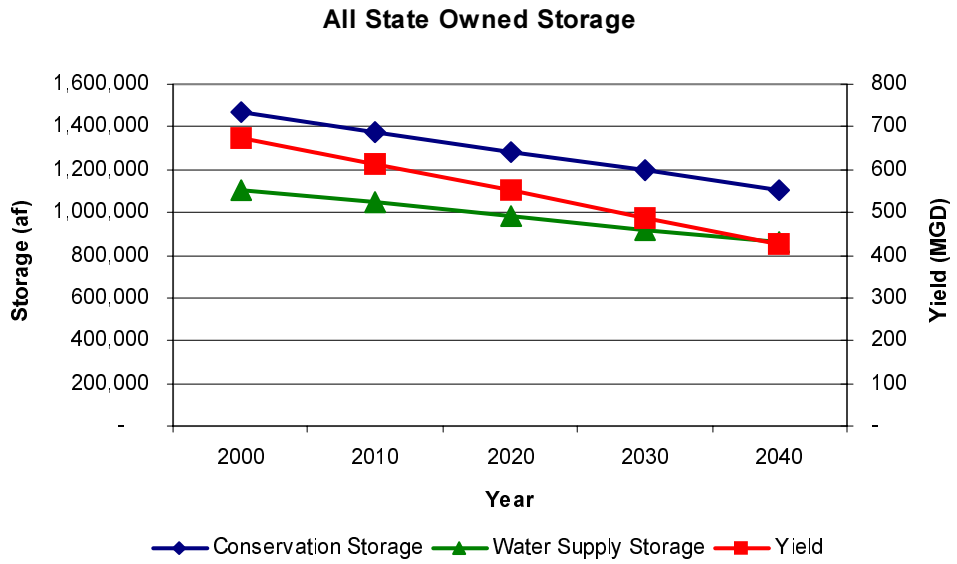
All Lakes in Which the State Owns Storage

The above discussion covered two examples of lakes in which the State of Kansas owns water storage space that is actively used. In total, the water supply storage space that the State currently has under contract with the Corps of Engineers is slightly more than 1.1 million acre feet. By the year 2040, siltation will have reduced this amount to roughly 857,000 acre feet at a rate of loss of 6,260 acre feet per year.

The entire conservation storage space in these twelve lakes will decrease from the current estimated capacity of 1.47 million acre feet to 1.1 million acre feet. Storage will be lost at a total rate of 9,260 acre feet per year. Figure 3 shows the total conservation storage and water supply storage space in these reservoirs as well as the estimated yield from the water supply space.

While the numbers appear to be rather serious, the State will be able to meet all of its contractual obligations through the year 2040. The only cases where contract obligations were reduced or are in jeopardy are at Clinton Lake and John Redmond Lake respectively.

Figure 3



Multiple Purpose Small Lakes

As each of the MPSL's that have been constructed in Kansas are relatively new, this section represents information that was gathered from the original engineering projections on siltation. The amount of yield available from the water supply portion is also provided as a comparative measure of each lake's ability to provide water. Table 1 is a summary of this information.

Table 1

MPSL	Year Constructed	Design Life (years)	Water Supply Pool (af)	Sediment Allocation (af)	Reservoir Yield (mgd)	Projected Sediment Loss (af/yr)
Banner Creek	1996	50	2250	537	1.5	10.74
Bone Creek	1996	100	9284	666	2.95	6.66
Centralia	1989	100	4700	1181	0.75	11.81
Jetmore	1990	50	585	354		7.08
Little Sugar Creek	Not Yet	100	8400	900	1.75	9
Mill Creek	1994	100	880	107	0.262	1.07
Pony Creek	1993	50	2367	263	0.65	5.26
Wellington	1997	50	5300	1200	6	24
Xenia	1997	100	1142	210	0.55	2.1
Yates Center	1990	100	2485	215	0.6	2.15

As can be seen from Table 1, the oldest MPSL, Centralia Lake, was constructed in 1989. The design life as shown in Table 1 represents the length of time it is estimated that it will take to fill in the sediment reserve. This is also the projected timeframe the lake can be expected to provide the stated yield. Each of these lakes can be expected to provide water supply to the local area for at least the next 46 years. It will become important to complete sedimentation studies on these lakes at regular intervals starting in 5 or 10 years. The State, and local entities in many cases, have invested a significant amount of money in these structures. It is important that every effort be made to extend the life of the lake and spread the benefit and relative cost.

The expected annual loss to siltation varies by more than an order of magnitude. Wellington Lake is expected to lose 24 acre feet of storage each year while the loss at Mill Creek is only 1.07 acre feet per year. These values are a direct result of the lake's watershed size, upstream soil type and watershed land use. In general, predictions are higher for watersheds with a higher percentage of cropland than pasture or grassland. Soil is taken into account as the relative ability of the soil to resist movement by rainfall. Soils with high clay content generally hold together better and resist erosion and siltation.

Municipal Lakes

Table 2 below shows the basic information for each of the municipal lakes that were reviewed under this study.

The size of the lakes varied greatly from Timber Creek Lake, in Cowley County, which has a capacity of more than 19,000 acre feet to Crystal Lake, in Anderson County, with a year 2000 capacity of 104 acre feet. Comparison of lakes with this large a range in size becomes difficult. Additionally, in most cases information on the amount of water that could actually be withdrawn from the lake by the water utility could not be determined. To reach that level of information would require significantly more work and detailed engineering analysis of each lake.

Information gathered from both the municipality that owns the lake and other sources indicate that a number of the smaller lakes are losing viability. While siltation is a cause for this concern in some cases, the ability of the public water supplier to meet increasingly stringent water quality regulations is often more of a deciding factor.

With the limited amount of information that could be gathered under this study, it is really not possible to determine if the lakes listed in Table 2 will be unable to provide support to the public water supplier during times of drought. However, we are aware of at least one case where the City has already made that determination. The City of Horton learned prior to this study that the average depth of Mission Lake had dropped to roughly 6 feet. The location of their water supply intake within the lake further limited their ability to draw water from the lake. Because of this the City of Horton has been actively looking for an additional water source this past year.

The Kansas Water Office will be providing the information gathered to each of the municipalities that own one of the lakes that has been studied. Each City will also be advised to provide the information to their engineers for further evaluation of the condition of the lake to supply water during a drought.

The information gathered will also be folded into other studies and work that is ongoing. The Kansas Water Authority has established three objectives that this information is applicable to. Those objectives basically state that all public water suppliers will have adequate surface water storage where available, have technical, financial and managerial capacity and that less than 5 percent of suppliers will be drought vulnerable. These objectives are expected to be met by the year 2010. In addition, the Environmental Protection Agency has required the Kansas Department of Health and Environment to complete a source water assessment for each public water supplier in the State. KDHE is working with public water suppliers to complete this task. Information on current capacity and siltation rates will be of direct benefit in each of these efforts.

Although it is impossible to identify exactly which water supplier will be impacted first, as we do not have all of details necessary, it is possible to say that some will be impacted. We can further say that the impact will become obvious during the next extended drought if not before. It is important that the State continue this work in order to better identify the potential problems before it occurs.

One measure that may give an indication of the potential problems is the final column of Table 2 which indicates the number of years it will take before the lake is completely full at the estimated rate. While each lake will become impaired for water supply before that point, it does provide some insight into the relative time frame for each lake. Under this evaluation, Westphalia Lake appears to be most at risk with an expected total life remaining of less than 40 years. Crystal Lake also appears to be somewhat at risk. According to the projected information contained in the table, the lake will be completely filled in 50 years.

Very few of the lakes built for municipal water supply have a flood control component. Flood control as defined for this report requires that some type of gate or valve regulate the release from the flood pool. The Cities of Augusta, Herrington and Eskridge (Lake Wabaunsee) reported having flood pools. Of these only Augusta indicated trouble with siltation in the flood pool. This siltation was removed from the flood pool in the 1970's and apparently is not a major issue at this time.

Most of the city lakes had a recreation component. Nearly all of the lakes with recreation indicated fishing as the primary activity. A few of the larger city lakes allowed boating on the lake. Only the City of Eureka reported siltation impact to recreation. In that case, a boat ramp was replace due to sediment accumulation.

Table 2

Municipal Lake	Serves	Date Built	Original Capacity (af)	2000 Capacity (af)	Watershed Area (acres)	Yearly Loss (af)	Remaining Life
Alma City Lake	Alma	Jan-66	1013	383		18.52	20.68
Augusta City Lake	Augusta	Jan-40	2358	2100		4.30	488.71
Blue Mound City Lake	Blue Mound	Jan-57		165	391		
Buffalo City Reservoir	Buffalo	Jan-60		1631			
Council Grove City Lake	Council Grove	Jan-42	8416	7346	5,017	18.44	398.46
Crystal lake	Garnett	Jan-40	229	104	1,352	2.08	49.95
Eureka Reservoir	Eureka	Jan-39	3690	3125	9,720	9.26	337.62
Fort Scott City Lake	Fort Scott	Oct-59		7200	6,337		
Gardner City Lake	Gardner	Mar-40	2301	2020	3,398	4.69	430.33
Harveyville City Lake	Harveyville	Jan-60	235	222	333	0.32	683.54
Herington Reservoir	Herington	Mar-82	5759	5750	11,022	0.50	11,389.73
Lake Kahola	Emporia	Jan-36	6600	5500	10,131	17.18	320.22
Lake Miola	Paola	Jan-57	2960	2760	3,541	4.65	593.78
Louisburg City Lake	Louisburg	Aug-84		3750	384		
Lyndon City Lake	Lyndon	Dec-66	948	930	875	0.54	1,709.81
Madison City Lake	Madison	Feb-70	1445	1333	2,481	3.74	355.98
Mission Lake	Horton	Jan-24	1866	940	5,440	12.18	77.20
Moline Reservoir	Moline	Jan-37		1590	297		
Mound City Lake	Mound City		1773	1525		2.48	615.36
Olathe City Lake	Olathe	Jan-57	3330	3300	10,507	0.70	4,733.01
Parsons Lake	Parsons	Sep-38	10050	8500	23,647	25.26	336.51
Pleasanton Reservoir	Pleasanton	Jan-68		1180	1,198		
Polk Daniels Lake	Howard	Jan-35	777	640		2.11	303.85
Prairie Lake	Holton	Jan-48		495	863		
Prescott City Lake	Prescott	Jan-64	138		391		
Richmond City Lake	Richmond	Jan-55		220	538		
Sedan City South Lake	Sedan	Feb-65	780	770	4,470	0.29	2,687.19
Severy City Lake	Severy	Jan-38		115	814		
Strombridge Reservoir	Carbondale	Jan-66	3371	2902	3,156	13.79	210.52
Thayer New City Lake	Thayer	Jan-60		560	413		
Timber Creek Lake	Winfield	Aug-70	19800	19500	40,960	10.20	1,912.25
Wabaunsee County Lake	Eskridge	Jun-45	4175	3600	7,163	10.53	341.96
Wellington New City Lake	Wellington	Aug-96	3250	3250			
Westphalia Lake	Anderson RWD	Jan-63	278.39	130	1,654	4.01	32.44
Yates Center City Lakes	Yates Center	Jan-90	2720	2241	2,850	48.20	46.49

Summary and Conclusions

The Kansas Water Authority has long recognized the concern often held by many citizens that public water supply impoundments are filling with sediment. In many cases those concerns were justified, in others the concern was more perception than fact. In all cases the Kansas Water Authority and Kansas Water Office have responded whenever possible.

The Kansas Water Authority has for many years funded from the Kansas Water Plan Fund conservation measures upstream from public water supply lakes to help reduce the amount of sediment entering the lake.

The State has also helped a number of communities find or develop an additional water source when concerns about siltation proved to be founded. Solutions such as sale of water from federal reservoirs, connection with another public water supplier or development of an MPSL have been implemented. In additions to direct financial assistance, the State also funds technical assistance to public water suppliers to address siltation issues.

However, there is much more work to be done.

The federal reservoirs in general are in good shape and not filling with sediment at an alarming rate. In a number of cases sediment is entering the conservation pools faster than predicted. None of the federal reservoirs that were evaluated had sediment accumulating in the flood pool faster than expected.

Of note and concern with the federal reservoirs is John Redmond Lake discussed above. While the overall sediment rate is not greater than expected, the sediment is settling almost entirely within the conservation pool. The Kansas Water Office has requested a reallocation of storage from the flood pool to the conservation pool to rebalance the lake to the original design proportions. Some initial funding was made available in the current year federal budget. This work needs to continue in order for the State owned storage to continue to function as needed.

The remaining federal lakes are all able to support current contracts without modification or reallocation through the year 2040. However, some of these lakes will begin to see significant reductions in yield after that point.

Although it may appear that siltation at Tuttle Creek Lake is occurring at a high rate compared to other lakes in Kansas, deposition of sediment is actually occurring at the estimated rate. This means that with the current users, water supply will not be impacted for 60 to 70 years.

It can be expected that additional demands will be placed on each of the federal lakes

as populations served continue to expand. This population expansion will have the greatest effect on the lakes in the Kansas River Basin and on Hillsdale Lake in the Marais des Cygnes Basin. This effect will need to be continually re-evaluated at regular intervals to insure that adequate storage is being made available, protected and/or developed.

The Multiple Purpose Small Lakes Program has experienced many successes. Wellington, Yates Center, Sabetha and Holton have all replaced lakes that were becoming inadequate with MPSL's. At this point, however, it is too early to evaluate whether or not the siltation estimates in the original design are accurate.

Municipal lakes have been of special concern for a number of years. Many of these lakes were built decades ago and have been the sole source of water for the municipality that they serve since that time. As these lakes age, they become more vulnerable to drought because of a decrease in storage space due to siltation. During the drought of the late 1980's and early 1990's this fact became apparent at a number of lakes

In general terms, each of the lakes that have been studied, and are relatively old are becoming more drought vulnerable due to sedimentation. The State should work with the local municipality to identify potential water sources to offset this effect.

Another option to deal with siltation in small municipal lakes is through dredging or restoration of the existing lake. This option should be evaluated carefully however, as it can prove to be quite costly. A 1998 Kansas Water Office evaluation of a similar program in South Dakota indicates that the cost of dredging is approximately $5,600 per acre foot of sediment. This cost is nine times higher than the cost per acre foot to develop water supply under the MPSL program.

The basic conclusion that can be reached from this study is that siltation in public water supply impoundments will continue to become more of an issue and problem with each passing year. The State has taken a proactive role and tried to reduce the sediment load entering the lakes and deal with problems when the lakes become drought vulnerable. These efforts should be expanded however as the cost to deal with problems after the fact continues to rise.

Recommendations

The basic recommendation of the Kansas Water Authority for this issue is that existing programs should be continued and enhanced. An additional State sponsored activity is also being recommended. The high, medium and low indicators represent the Kansas Water Authority prioritization of the need to implement each of these recommendations.

<u>Federal Lakes</u>

1. (High priority) -The legislature should pass a resolution indicating State support for federal funding of the study to reallocate storage in John Redmond Lake from the

flood pool to the conservation pool. If approved, this reallocation study would rebalance the capacity of the conservation and flood control storages as originally designed.

2. (Medium) - The Kansas Water Office should pursue reallocation studies on lakes in which sediment is entering the conservation storage space faster than anticipated and slower than designed in the flood pool. These reallocation studies should be pursued once that it is determined that water supply will be impaired in the future.
3. (Low) - The State should work with the Corps of Engineers to evaluate the possibility of removal of sediment from the upper ends of federal lakes that most impact water supply.

Small Lakes

4. (Medium) - Existing sites on which a watershed structures have been proposed and have potential for water supply storage should be identified. A list of these sites should be compiled and maintained so that the State will better be able to provide technical assistance and recommendations to local municipalities with siltation problems.
5. (High) - The Multipurpose Small Lakes Act should be amended to allow for restoration of lakes being impaired by siltation.
6. (High) - Additional funding should made available to cost share with local entities for source water restoration and infrastructure development. An additional funding source should be identified and developed to provide the State's portion of the cost share.

Conservation

7. (High) - Additional funding should be made available to continue installation of conservation measures upstream from public water supply lakes. This activity has been targeted to public water supply impoundments watersheds and generally has been viewed favorably by all parties.

Research

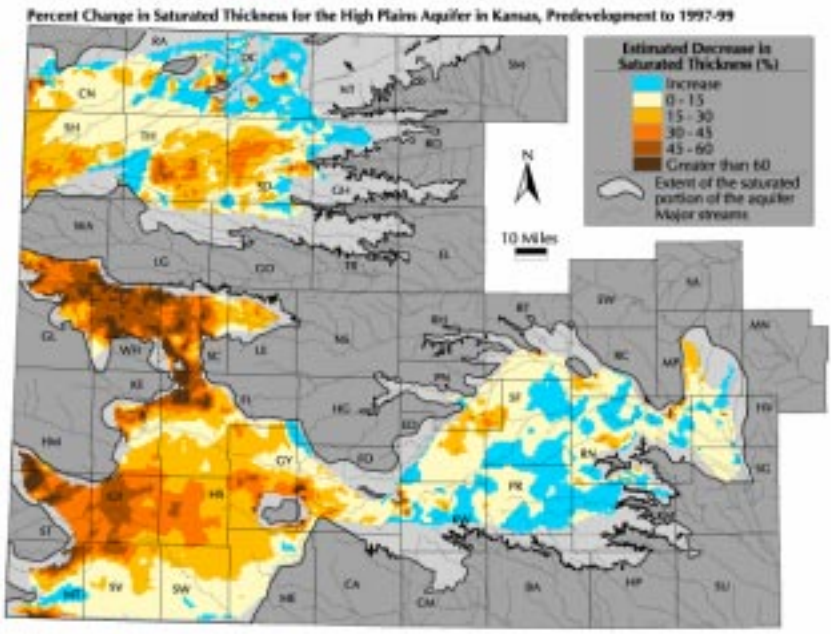
8. (High) - The sediment data collection network that was reactivated in 1999 should continue at least through the third year of the proposed study. The information gathered from this study should be compiled and presented to the Kansas Water Authority. A portion of the report should evaluate the relative effect of upstream conservation measures on siltation in public water supply lakes.
9. (Medium) - The State should periodically complete additional sediment surveys on both municipal and multiple purpose small lakes to insure that potential problems are identified before siltation leaves the municipality without a viable source.

Aquifer Resources, Recharge Rates, the Availability of Surface Water and the Long-term Prospect Related to any Necessary Transition to Dryland Farming in Areas of the State to Maintain Sustainable Yield and Minimum Streamflow

This report on the High Plains Aquifer addresses issues arising from the legislative mandate to the Kansas Water Authority under SB287. It is based on an updated and expanded version of the High Plains Aquifer Atlas; phrases in *italic* type are the titles of individual sections and appendices. The report focuses primarily on the western Kansas groundwater-related conditions and trends. However, groundwater and surface water resources are inseparable, even where one is the dominant water supply. Following a general *Introduction* to the report and the subject, a section on *Surface Water in Kansas and its Interactions With Groundwater* places the High Plains aquifer in perspective - both in terms of statewide water resources, and in relation to its interactions with surface water. Above the High Plains aquifers, stream channels and river valleys are locations of both preferential recharge and of groundwater discharge to the surface. This means that both the potential for and the effects of groundwater use vary across the land surface in ways that are not directly accounted for in most present water laws and management practices. A particularly troublesome effect is the shifting and reduction of stream baseflow as aquifer water levels are reduced.

Understanding groundwater requires some familiarity with the terms and concepts of geohydrology. A report section describing the *Aquifers of the High Plains Region* explains the geography and interactions of western groundwater resources, and a technical appendix on *Aquifer Types and Terminology* provides background on the concepts and nomenclature. A major tool being used in modern resource studies, including this report, is GIS - Geographic Information Systems applications. Some of the approaches by which geologic and hydrologic data are generalized and transformed for mapping, modeling, and visualization are presented in the technical appendix on *Bedrock/Mapping Methods*.

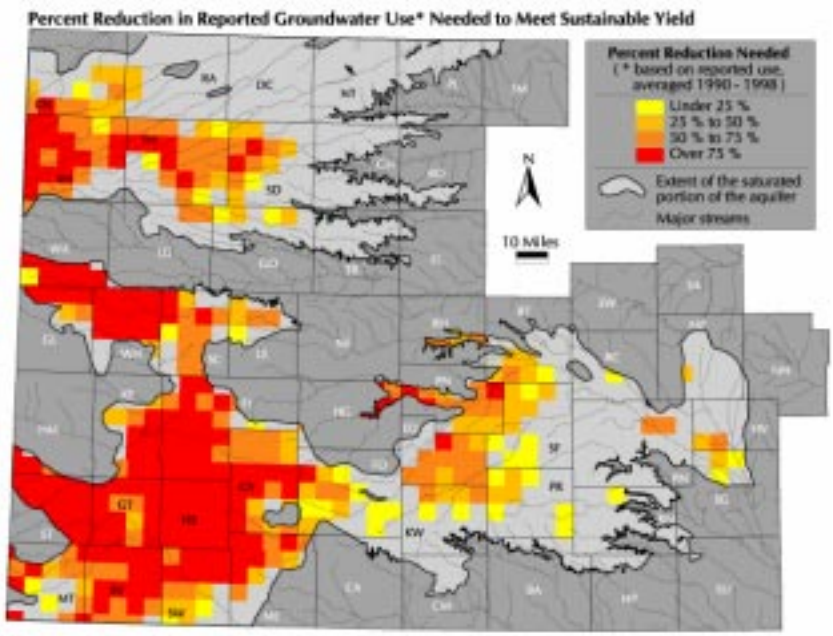
The High Plains Aquifer in Kansas is often regarded as a single feature - a major resource that is the primary source of water for people, agriculture, and industry in a large area of the state where precipitation and surface water resources are in short supply. This view is not inaccurate, but it is seriously incomplete. The groundwater resource is far from uniform - different regions have a wide range of characteristics. Before the intervention of man, the amount of water in the aquifer varied from place to place; groundwater pumping has



modified and is some cases intensified the patterns of distribution. These patterns, and their change with water use, are shown in the sections on *Saturated Thickness (Predevelopment, Current, and Change)* and *Water Storage (Predevelopment and Change).*

Technical appendices provide background information on the *Concepts of Saturated Thickness* and the processes of *Groundwater Storage and Flow*. The systematic differences in groundwater distribution influence *Availability and Accessibility*, and interact with variations in the amount and nature of water use, water quality, recharge and sustainability, groundwater-surface water interactions, and a variety of other factors. Understanding how the aquifer system varies across time and space is a key factor in analyzing, preparing for, and responding to socioeconomic issues such as resource depletion, the transition to dryland farming, competition for water resources, and so on.

In broad outline, the Ogallala aquifer portion of the High Plains (located in the extreme western third of the state) is located in a region where the *Estimated Annual Groundwater Recharge* is low and variable, and therefore difficult to measure or predict. However, there is no doubt that the *Current Maximum Authorized Quantity* of groundwater withdrawal is significantly in excess of the average recharge. Evidence of this is seen in the change in saturated thickness and water in storage, in the findings presented in the appendix on Decline Rates, and especially in the maps of *Estimated Useable Lifetime for Large Volume Pumping* of the aquifer which are based on present water amounts and historic pumping rates. *Water Usage* in these areas is strongly climate-dependent (as is recharge), and even though the *Percentage of Authorized Quantity Used* is typically less than 100%, the *Total Reduction in Authorized Quantity Used* - and the *Average Reported Use Needed to Meet Sustainable Yield* is at or above the 75% level. However, even in this overall region, major differences exist.

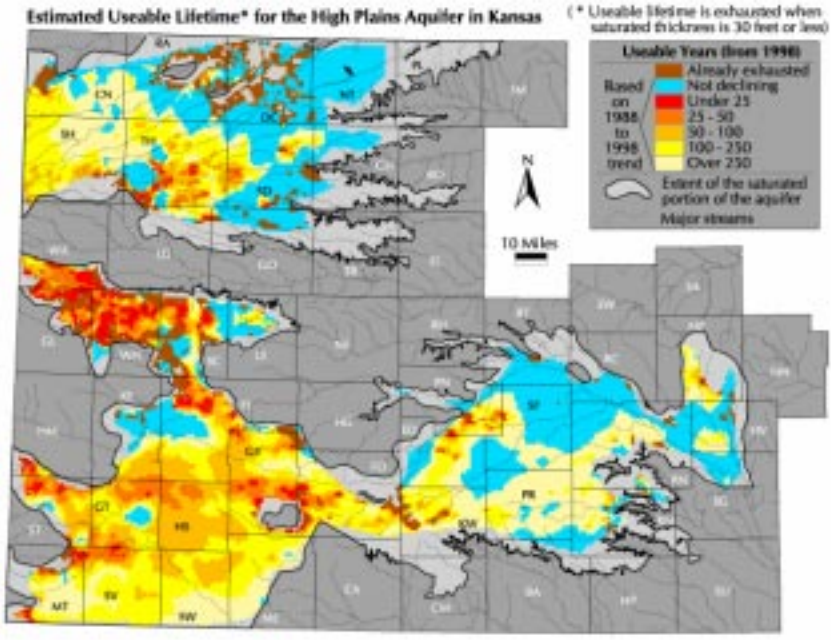


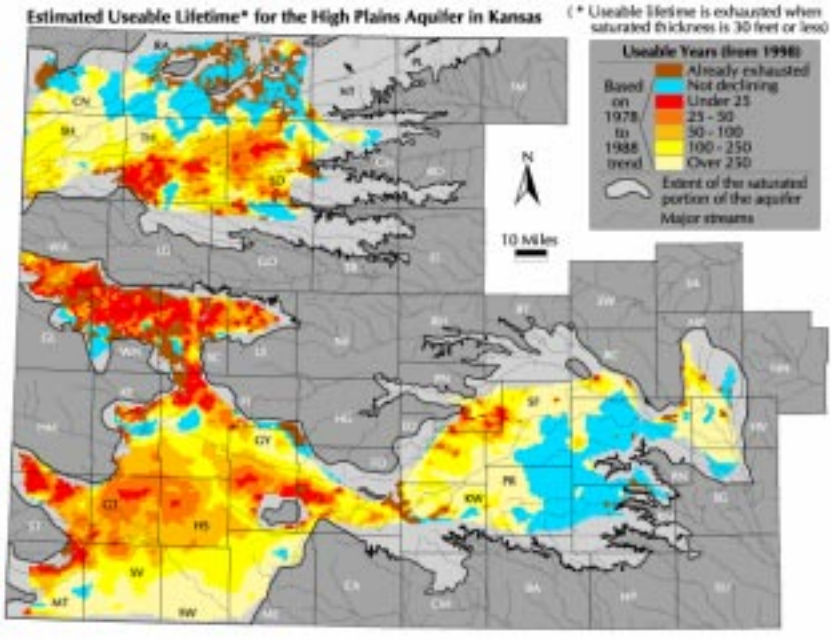
Some high-use, high-decline areas have large reserves of groundwater remaining, which means that the measures needed to forestall resource exhaustion are not yet urgent. Other areas are at or very close to effective groundwater depletion, and relatively prompt action will be needed to insure that a sustainable reserve of water is kept to support essential basic needs, such as domestic and community water supplies. Within both of these classes, different sub-areas have significant local differences in recharge and discharge of surface water, as well as in water quality concerns and present or potential demand or conflicting needs.

In the eastern High Plains, Groundwater Management Districts 2 and 5 operate under

safe yield policies, and issues are different from the western regions. Because of higher populations, higher municipal uses, shallow water tables, and natural and artificial contamination, water quality is an issue that is at least as important as water quantity. Both quantity and quality, however, are influenced by groundwater extraction, and the spatial variations in quality and use point to differential classification of aquifer regions in ways similar to the depletion and sustainability issues in western Kansas.

The hydrogeologic characteristics of the aquifer provide a natural basis for classifying aquifer subunits in terms of their potential for use. An example of one possible approach to classification is presented in the section on *Groundwater Availability and Accessibility Provinces*. However, water use is influenced not only by physical availability, but also by water quality. Both natural geochemistry and human influences have shaped the *Groundwater Quality Provinces* of the High Plains aquifer. In order to preserve the greatest possible social and economic benefits of the groundwater resource and to minimize the negative effects of competition for a diminishing resource, the natural aquifer subunits must be evaluated in the light of the trends and changes in the resource over the past three to four decades of intensive groundwater development. This combined approach provides a basis for identifying and prioritizing aquifer regions where specific management activities are most needed in order to preserve a sustainable reserve of water to support the basic social structure of the region.





Approaches to identification of aquifer subunits and the urgency of their conditions have been developed, and can be compelling; a good example is provided by the *Estimated Useable Lifetime for Large Volume Pumping* projections,

which show a consistent picture of the regions most likely to exhaust the groundwater resources. However, variations in detail depend on the exact depletion trend adopted, and the appendices on *Decline Rates* and *Drawdown and Pumping* illustrate some of the issues involved in determining the appropriate time and space scales (i.e., size of the subunit considered and the timing of measurements). The technical concepts and tools are available to support the development and implementation of improved resource conservation and management approaches; the most urgent need is policy consensus on the relative priorities of the potentially competing socially beneficial uses of High Plains groundwater.

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Water conservation plans and programs and means to improve the effective ness of such plans and programs.

During the 1999 Legislative Session, the Kansas Legislature enacted House Substitute for Senate Bill 287. Among the provisions of this Bill is that the Kansas Water Authority (KWA) is to study and develop recommendations related to five specific issues and submit its findings on or before January 8, 2001. **The purpose of this report is to discuss the issue of water conservation plans and programs and the means to improve the effectiveness of such plans and programs.** The Kansas Water Office (KWO) has prepared water conservation plan guidelines for three categories of water use. The three categories are municipal, irrigation and industrial water use.

Municipal Water Conservation

This section of the report includes: a) introductory comments on the development of municipal water conservation plan guidelines, b) survey results on the **perceived** effectiveness of water conservation plans and KWO assistance, c) evaluation of the **actual** effectiveness of water conservation plans, d) national recognition of the Kansas Municipal Water Conservation Program and e) recommendations for improving the effectiveness of the plans and Program.

Introduction

The Initial Municipal Water Conservation Plan Guidelines were prepared by the KWO and approved by the KWA in 1986. These guidelines were revised in 1990. As of August 16, 2000, the KWO and the Kansas Department of Agriculture, Division of Water Resources (KDA-DWR) have approved 435 municipal water conservation plans. 330 plans were based on the 1990 guidelines. The remaining 105 plans were based upon the 1986 guidelines and have not been revised.

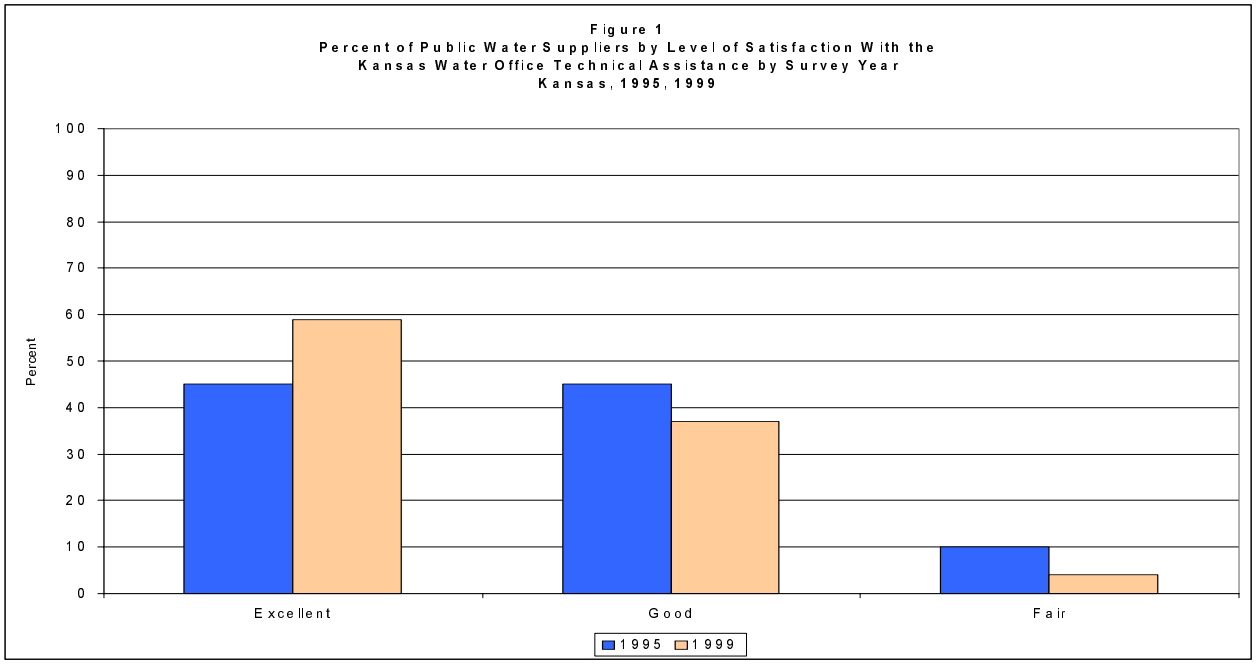
K.S.A. 82a- 733 charges the KWO with the responsibility to provide or arrange to provide technical assistance for water users required to adopt and implement water conservation plans and practices. Since 1994, the Kansas Water Office has made extensive use of two part-time, temporary positions to assist public water suppliers in preparing municipal water conservation plans.

Perceived Effectiveness of Municipal Water Conservation Plans and KWO Assistance

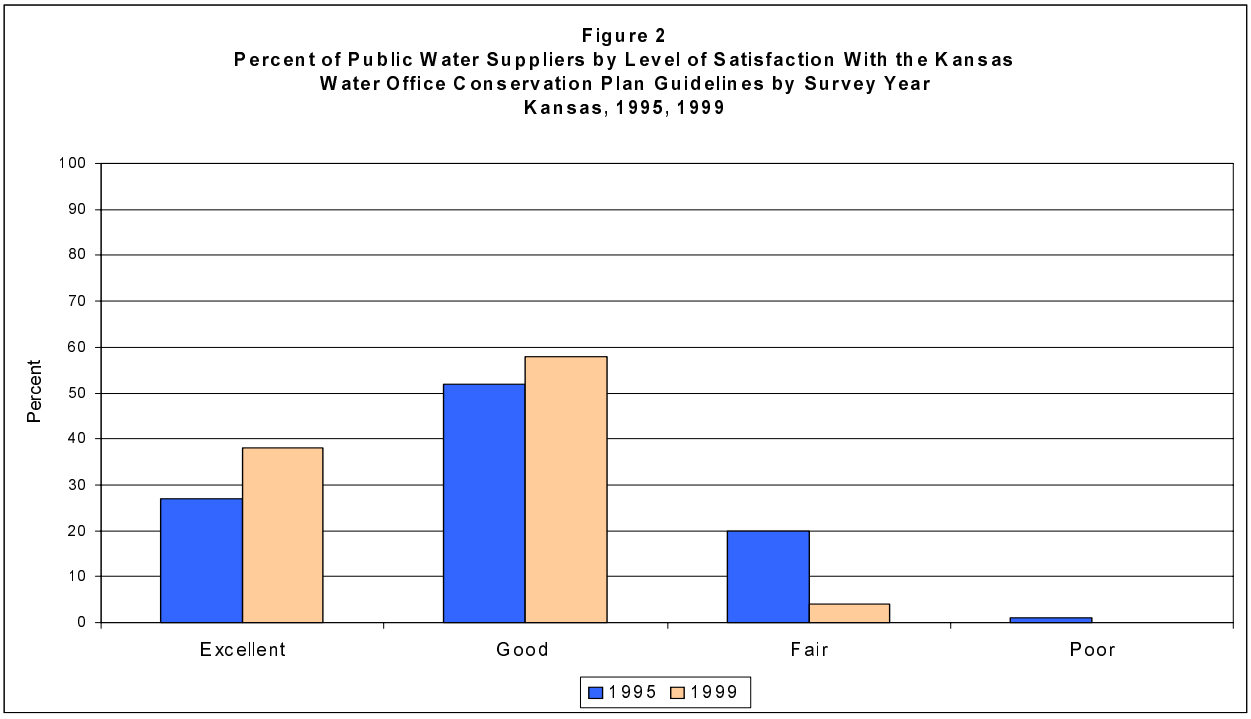
In 1995, the KWO sent a letter and a brief survey form to the 114 public water suppliers (pws) who had state-approved municipal water conservation plans, based on the 1990 guidelines. On August 12, 1999 the KWO sent this same survey to the 275 pws who had state approved water conservation plans based on the 1990 guidelines. The purpose of the letter and survey form was to determine the public water suppliers' perception of the quality of the water conservation planning assistance provided by the KWO and the effectiveness of their plans. On September 3, 1999, the KWO sent a follow-up letter and another copy of the survey form to each pws that did not respond to the first letter. A total of 232 survey forms or

84 percent of the 275 forms mailed were returned in 1999 compared to 77 percent in 1995. The key survey results are shown below.

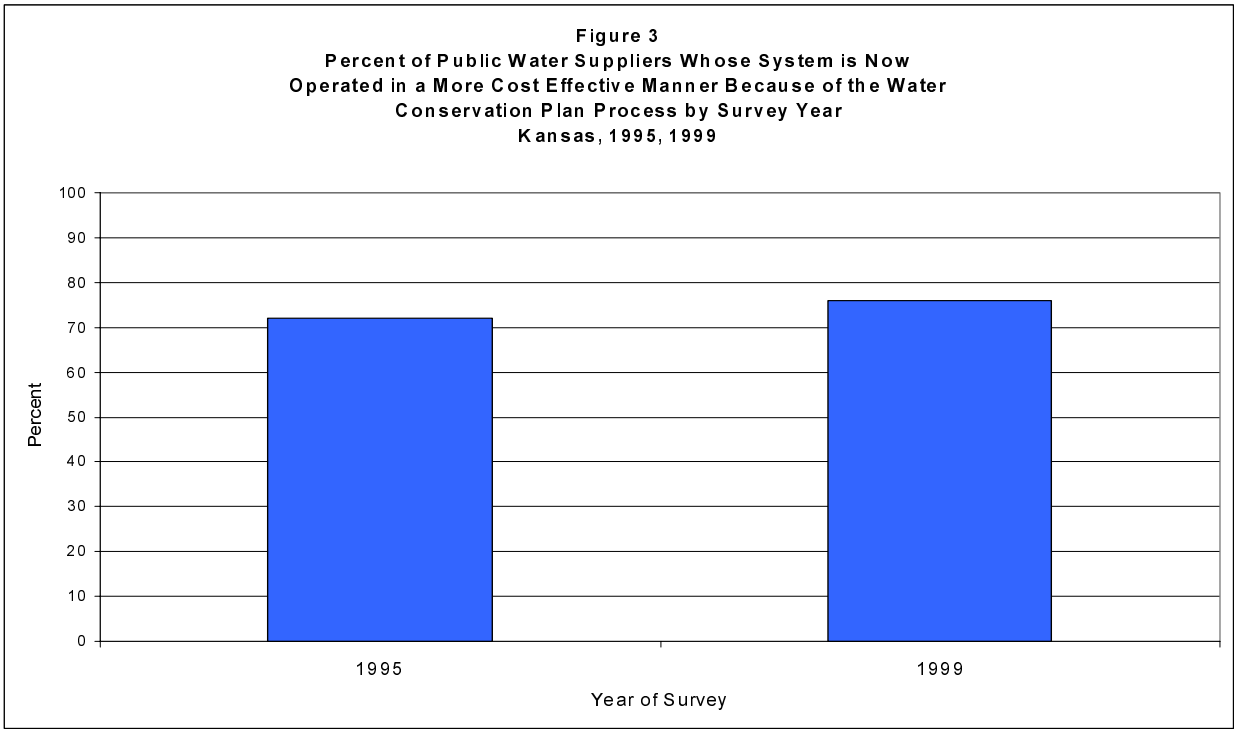
- The percent of respondents that thought the technical assistance received from the KWO was good or excellent increased from 90 percent in 1995 to 96 percent in 1999, as shown in Figure 1.



- The percent of respondents that thought the 1990 KWO guidelines were good or excellent, increased from 78 percent in 1995 to 96 percent in 1999, as shown in Figure 2.



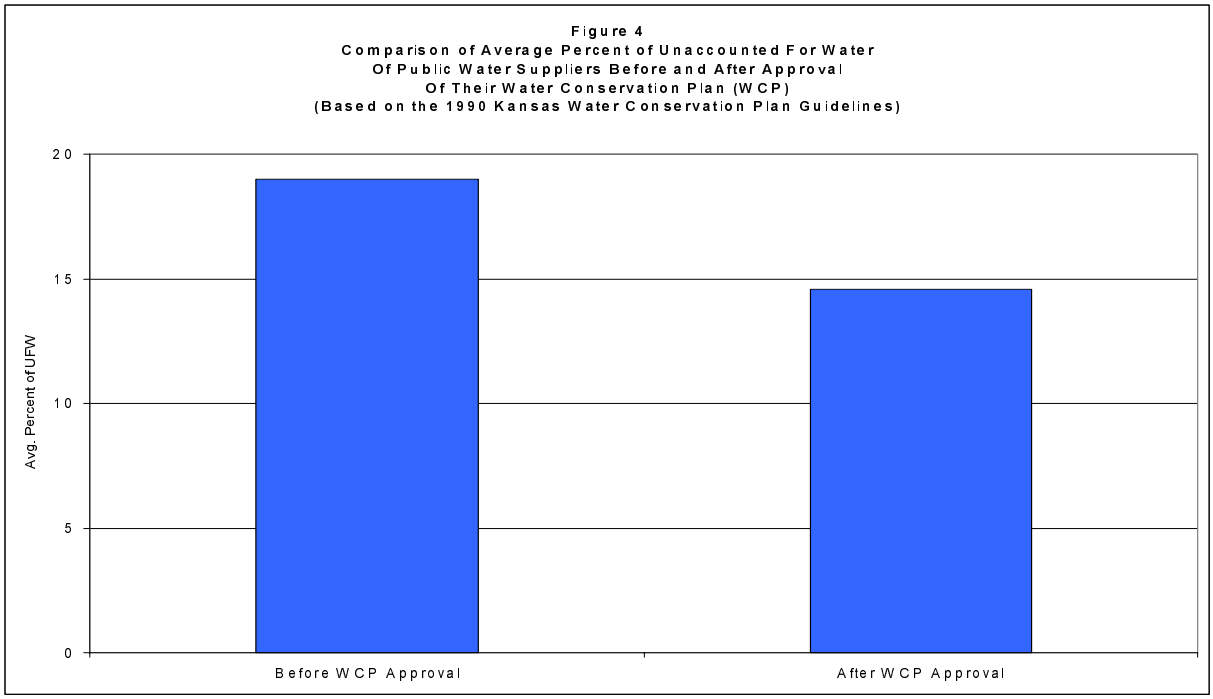
- 76 percent of the respondents thought their water supply systems operated in a more cost-effective manner in 1999, compared to 72 percent in 1995, as shown in Figure 3.



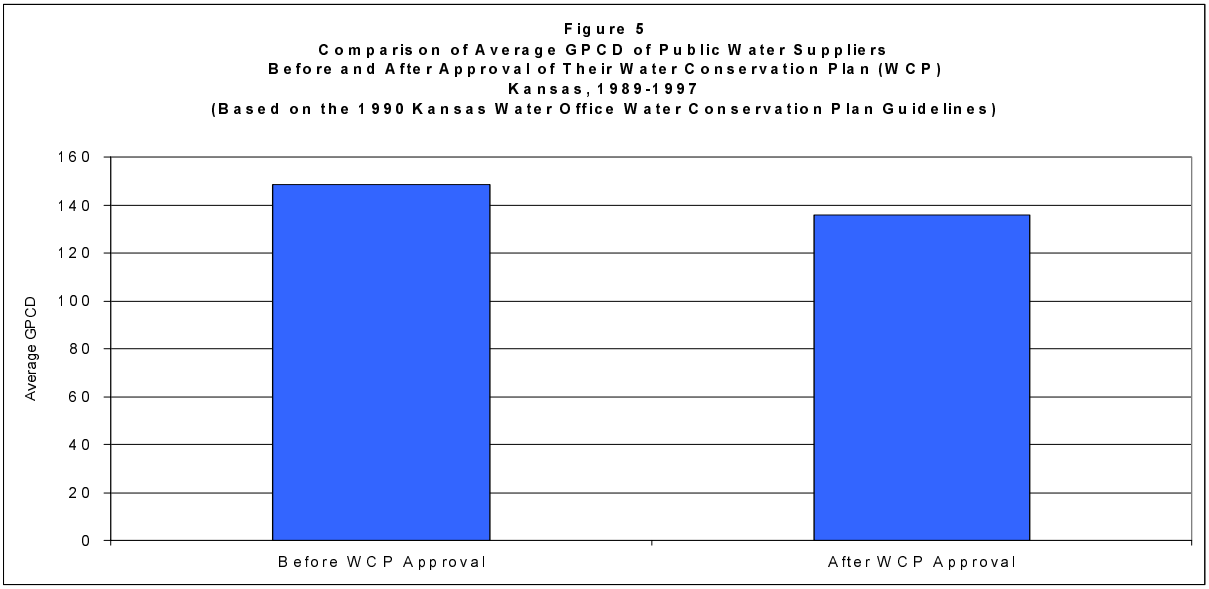
Actual Effectiveness of Municipal Water Conservation Plans

Two statistical analyses were used to determine if public water suppliers, who prepared water conservation plans using the *1990 Water Conservation Plan Guidelines*, used water more efficiently after their water conservation plans were approved, than they did before they were approved.

The **first analysis** used the percent of "unaccounted for water" (ufw) as the evaluation parameter. The average percent of ufw was 14.60 for pws after their plans were approved, compared to 19.00 before their plans were approved, as shown in Figure 4. This decrease in the percent of ufw is a good indication that their plans have been effective in aiding them to achieve a more efficient use of water. However, a statistical test of hypothesis was conducted to determine if the average change in percent of –4.40 was statistically significant or if this result was within the realm of normal chance occurrences. The statistical test (a paired t-test) did show that the average percent change of –4.40 was statistically significant. Hence, after preparation and implementation of a water conservation plan by pws, their percent of ufw decreased.



The **second analysis** used the gallons per capita per day (gpcd) as the evaluation parameter. The average gpcd was 135.68 for pws after their plans were approved, compared to 148.53 before their plans were approved, as shown in Figure 5. The average change in gpcd usage of -12.86 is a good indication that their plans have been effective in aiding the pws to achieve a more efficient use of water. A statistical test of hypothesis was conducted to determine if the average change of -12.86 gpcd, achieved by the pws was statistically significant or if this result was within the realm of normal chance occurrences. The statistical test (a paired t-test) did show that the average change in gpcd usage of -12.86 was statistically significant. Hence, after preparation and implementation of a water conservation plan the average gpcd of the pws decreased.



National Recognition of Kansas Municipal Water Conservation

- An evaluation of the best municipal water conservation guidelines currently in use by states included the Kansas Municipal Water Conservation Plan Guidelines (Maddaus Water Management 1997).

- In September 1997, a representative of the KWO was chosen by the Environmental Protection Agency (EPA) to serve on their Water Conservation Plan Guidelines Subcommittee (Hansen 1997).

- The American Water Works Association (AWWA) selected a representative of the KWO as one of a three-person panel, identified as the key participants in the development of EPA's Municipal Water Conservation Plan Guidelines, to discuss the EPA Subcommittee's work at the June 1998 Annual AWWA Conference.

- Kansas was cited as being in the top echelon of States that are the most active in water conservation in a paper presented at the AWWA'S CONSERV 99 Conference (Miri 1999).

Recommendations for Improving the Effectiveness of Kansas Municipal Water Conservation Plans and Program

Although the survey results, the actual reductions in water use and the national perception of Kansas are all very positive, there is always room for further improvement. Specific recommendations are listed below:

- Target technical assistance in preparing water conservation plans to public water suppliers with a high percentage of unaccounted for water or high gallons per capita per day use.

- Target technical assistance to public water suppliers to revise plans based on the 1986 KWO Guidelines to the 1990 Guidelines.

- Conduct on-site reviews of water conservation plans and measures for public water suppliers with existing water conservation plans which don't appear to be effective.

- In the FY 2003 Kansas Water Plan, prepare a recommendation to provide cost-share funds for small public water suppliers to repair and/or replace inaccurate water meters at raw water intakes.

Irrigation Water Conservation

This section includes: a) introductory comments on the development of irrigation water conservation plan guidelines, b) survey results on the **perceived** effectiveness of water conservation plans and KWO assistance, c) evaluation of the **actual** effectiveness of water conservation plans and d) recommendations for improving the effectiveness of the plans and program.

Introduction

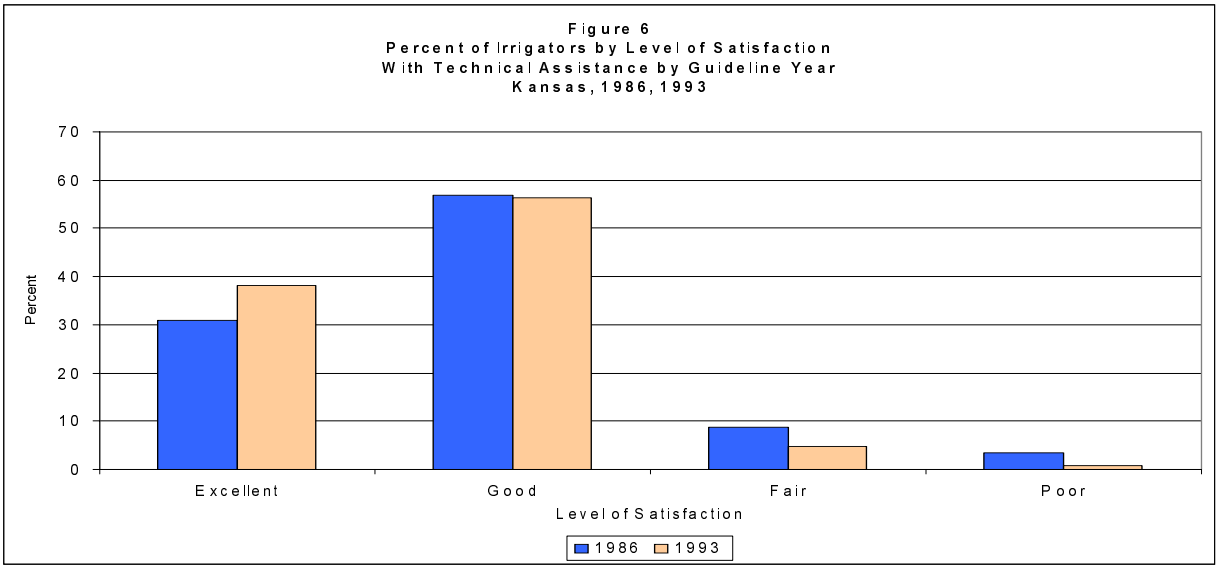
The initial Irrigation Water Conservation Plan Guidelines were prepared by the KWO and approved by the KWA in 1986. These guidelines were revised in 1993, after considerable input from the groundwater management districts. The KDA-DWR has required and approved more than one thousand irrigation water conservation plans (plans), primarily in the early 1990's.

K.S.A. 82a-733 charges the KWO to provide, or arrange to provide, technical assistance to water users who must prepare plans. Following adoption of the 1993 irrigation plan guidelines, the KWO began using Kansas Water Plan Funds to provide irrigators with free on-site technical assistance in preparing irrigation plans. This was done by contracting with groundwater management districts and by using one of the part-time temporary positions identified in the municipal water conservation narrative.

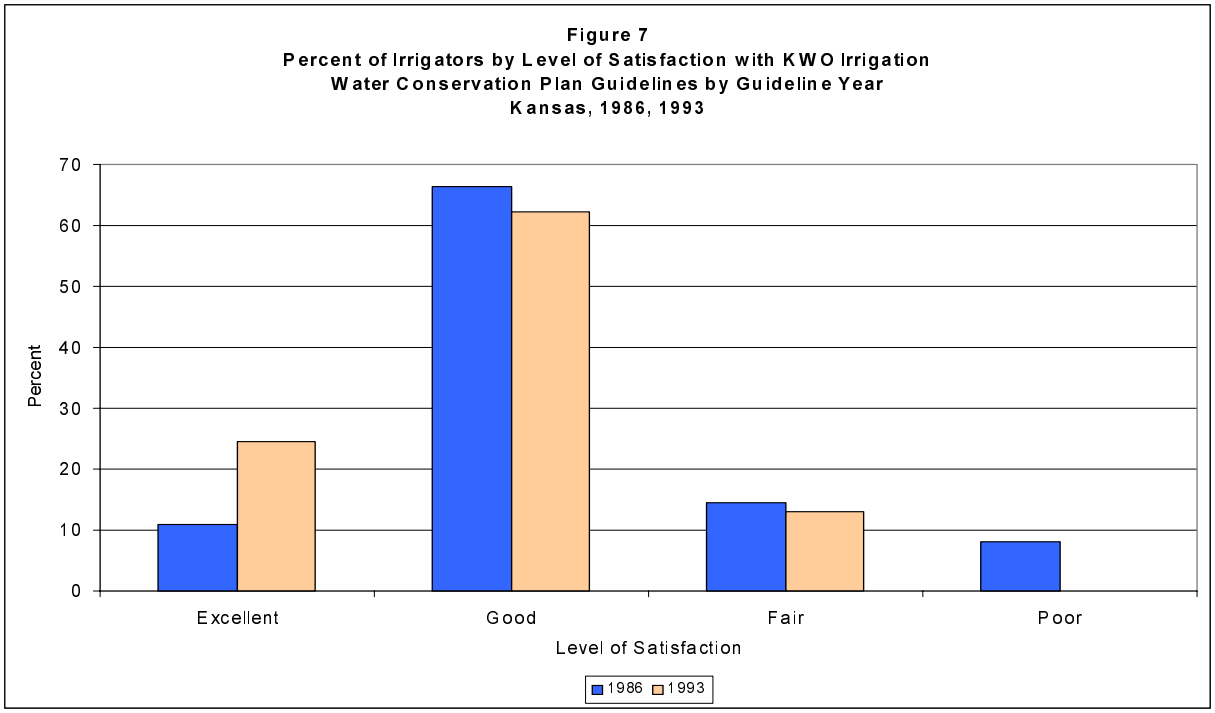
Perceived Effectiveness of Irrigation Water Conservation Plans and KWO Assistance

The KWO sent a letter and a brief survey form to irrigators for each irrigation water right that had an irrigation plan that had been approved on or before December 31, 1997. For analysis purposes, the data were summarized on the basis of the responses received from irrigators regarding the 743 irrigation water rights with plans for which only a single point of diversion was utilized. The survey letter and form was mailed on February 24, 2000 and a follow-up survey letter and form was mailed to all nonrespondents on March 28, 2000. A total of 570 survey forms or 77 percent of the 743 forms mailed to irrigators, for water rights with only a single point of diversion, were returned. Of the 743 irrigators surveyed, 543 had plans prepared using the 1986 guidelines and 200 used the 1993 guidelines. They key survey results are shown below:

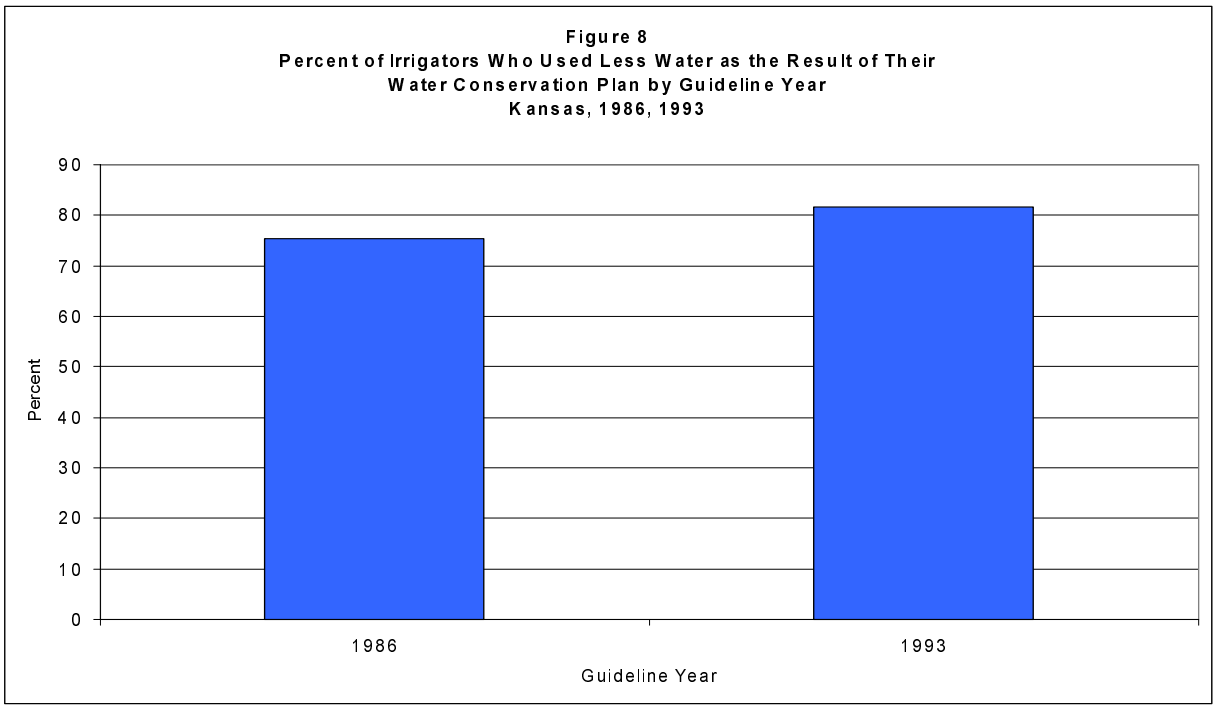
- The percent of irrigators that rated the technical assistance provided in preparing their plan as good or excellent increased from 88 percent for the 1986 guidelines to 94 percent for the 1993 guidelines, as shown in Figure 6.



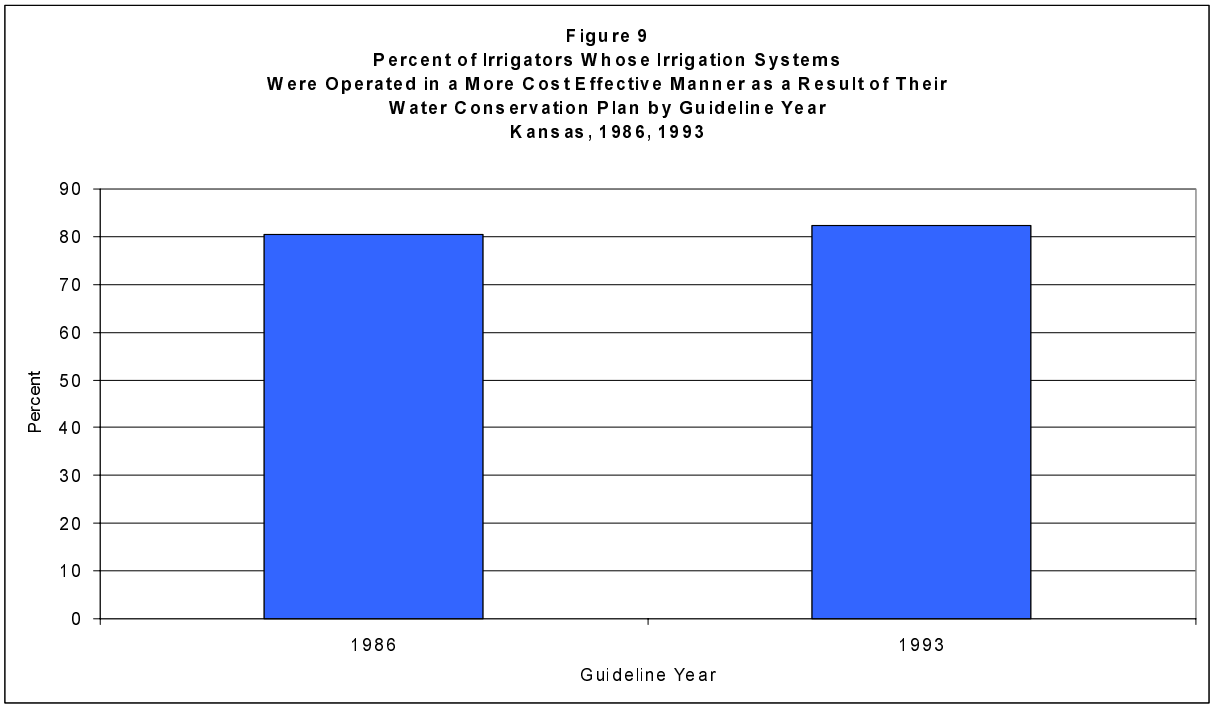
- The percent of irrigators that rated the KWO Irrigation Conservation Plan Guidelines as good or excellent increased from 77 percent for the 1986 guidelines to 87 percent for the 1993 guidelines, as shown in Figure 7.



- The percent of irrigators that indicated they used less water as a result of their plan increased from 75 percent for the 1986 guidelines to 82 percent for the 1993 guidelines, as may be seen in Figure 8.



- The percent of irrigators that indicated they operated their irrigation system in a more cost-effective manner as a result of their plan increased from 80 percent for the 1986 guidelines to 82 percent for the 1993 guidelines, as shown in Figure 9.



The KWO, using Kansas Water Plan Funds, contracted with the Kansas State University Statistical Laboratory (KSU) to conduct a large number of statistical tests to determine if there was a statistically significant association between commonly used irrigation water conservation practices and the irrigators perceived effectiveness of their irrigation plan. One of the most important implications for water conservation policy is that some irrigation water conservation practices may not be as beneficial as was once thought. For example, the statistical analysis showed that there was no statistical or practical relationship between the use of low pressure drop nozzles and the irrigators' perception of whether: a) less water was used, b) water was used more efficiently or c) their irrigation system was operated in a more cost effective manner.

Actual Effectiveness of Irrigation Water Conservation Plans

The acre-feet per acre (af/a) water use is the data parameter chosen to use for evaluating the effectiveness of irrigation plans. Since seasonal precipitation has a major effect on af/a water use, the statistical analyses conducted by KSU removed the effect of seasonal precipitation on af/a water use. The analyses involved a comparison of the difference in af/a water use before and after approval of plans for each of the five groundwater management districts and for the balance of the State. The results shown below represent all regional locations for which the difference in af/a water use before the plans were approved and after they were approved was statistically significant.

For plans prepared and approved under the 1986 guidelines:

- The estimated average af/a was reduced from 1.30 before plans were approved to 1.20 after plans were approved for water rights located within the boundaries of Southwest Kansas GMD No. 3.

- The estimated average af/a was reduced from 0.97 before plans were approved to 0.76 after plans were approved for water rights located within the boundaries of Northwest Kansas GMD No. 4.

For plans prepared and approved under the 1993 guidelines:

- The estimated average af/a was reduced from 1.64 before plans were approved to 1.36 after plans were approved for water rights located within the boundaries of Northwest Kansas GMD No. 1.

- The estimated average af/a was reduced from 1.01 before plans were approved to 0.67 after plans were approved for water rights located within the boundaries of Northwest Kansas GMD No. 4.

- The estimated average af/a was reduced from 1.03 before plans were approved to 0.85 after plans were approved for water rights located outside of any groundwater management district boundaries.

From a statewide perspective it is important to note that in 1998, the estimated average af/a of water saved by using plans was 0.18 for plans prepared under the 1986 guidelines and 0.38 for plans prepared under the 1993 guidelines.

The estimated reduction in af/a water use due to plans and the improved benefit from the 1993 guidelines is in agreement with the perception of irrigators from the 1999 irrigation survey. This survey showed that 82 percent of irrigators, with plans based on the 1993 guidelines, believed that they used less water as a result of their plan, compared to 75 percent for irrigators with plans based on the 1986 guidelines. Also from the 1999 survey, it was noted that 82 percent of irrigators, with plans based on the 1993 guidelines, believed that they operated their irrigation system in a more cost-effective manner as a result of their plan, compared to 80 percent for the 1986 guidelines. Both sets of guidelines were effective in reducing water use and increasing the cost-effectiveness of irrigation systems.

<u>Recommendations for Improving the Effectiveness of Kansas Irrigation Water Conservation Plan Program</u>

- Due to the estimated savings in af/a water use and the irrigators' perceptions that the plans are cost effective and save water, there should be a significant increase in the number of plans prepared annually.

- In cooperation with the groundwater management districts and the KDA-DWR, the KWO should offer free assistance to irrigators in the voluntary preparation of irrigation plans and focus on irrigators with high af/a water use in comparison to their peers in the same geographical area.

- If a significant response to the offer of free assistance is not received, then the KDA-DWR should use the priorities outlined in K.S.A. 82a-733 to trigger additional irrigation plans.

- The portion of the 1993 Irrigation Water Conservation Planning Guidelines that focus on monitoring of plans has never been implemented. This portion of the guidelines should be reviewed by the KWO, KDA-DWR and the groundwater management districts to reach a consensus on whether it should be implemented or revised.

Industrial Water Conservation

This section includes: a) introductory comments on the development of industrial water conservation guidelines and the complexities of industrial water use, b) a discussion of the information needed to evaluate industrial water conservation plan effectiveness, and c) recommendations for improving the effectiveness of the plans.

Introduction

The KWO, with approval of the KWA, published Industrial Water Conservation Plan Guidelines in December 1986. Currently, there are approximately 15 industrial water users in Kansas that have industrial water conservation plans that have been approved by the KDA-DWR.

The complexity of industrial water use is many times greater than that of irrigation or municipal water use. There are five major industry groups that account for most industrial water use in the United States (Hadley 1995). The five groups may be described as: a) food and kindred products, b) paper and allied products, c) chemicals and allied products, d) petroleum refining and related industries and e) primary metals industries. It is possible to gain a better understanding of the complexities of industrial water use by briefly discussing the primary uses made of water by the first major industry group.

Food and kindred products include establishments manufacturing or processing foods and beverages for human consumption. The major subcategories include meat products, dairy products, fruits and vegetables, grain mill products, bakery products, sugar products, fats and oils, and beverages. An overview of water conservation measures for the food and kindred products industry, prepared by California Department of Water Resources and the Metropolitan Water District of Southern Californita 1989 includes:

- Eliminating water waste during cleanup.
- Monitoring of plant-wide water use to detect processes using more water than required.

- Leaving as much extraneous food product in the fields as possible.
- Using settling ponds as surge reservoirs to remove field soil.
- Using water-filled flotation tanks to remove debris.
- Eliminating overflow from water supply tanks.
- Using low-volume, high-pressure cleanup operations.
- Having automatic shut-off valves on water lines.
- Cleaning with air instead of water.
- Employing water-efficient peeling and pitting equipment.
- Separating waste process streams at their source for by-product recovery.
- Grouping wastewater by both heat and purity to facilitate water reuse.
- Increasing dry handling of solid wastes.
- Changing from water to steam blanching.

Additional Information Needed to Evaluate Industrial Water Conservation Plan Effectiveness

In order to revise the KWO Industrial Water Conservation Plan Guidelines or to evaluate the effectiveness of the 15 industrial water conservation plans that have been approved, it would be necessary to become much more knowledgeable about water use by the various categories of industrial water users in Kansas. In evaluating the effectiveness of municipal water conservation plans, the existing Municipal Water Use database was used and the data parameters used for the evaluation were gallons per capita per day (gpcd) and the percent of "unaccounted for water". The data parameter used for the evaluation of the effectiveness of the irrigation water conservation plans was acre-feet of water use per acre irrigated (af/a). In order to evaluate the effectiveness of industrial water conservation plans, it would be necessary to look at data parameters such as gallons per employee per day or gallons per specified product. This information is not available to the KWO and would need to be collected, probably as a cooperative effort with the KDA-DWR, similar to the same way it has been done with irrigation and municipal water use data for the past 10 to 15 years.

In summary, the KWO Industrial Water Conservation Planning Guidelines have not been evaluated or revised because: a) water users with industrial water rights use only about three percent of the total water use in Kansas, b) industrial water use is complex and c) there is a lack of sufficient resources to devote to such evaluation or revision.

Recommendations for Improving the Effectiveness of Kansas Industrial Water Conservation Plans and Guidelines

- The KWO should develop and implement an Industrial Water Use Program, which would be similar to the ongoing KWO Irrigation and Municipal Water Use Programs that are a cooperative effort with the KDA-DWR.

- The Industrial Water Use Report Form, required by the KDA-DWR, should be revised to collect the type of data needed to revise the industrial plan guidelines and to use in evaluating industrial plans.

- The 1986 KWO Industrial Water Conservation Plan Guidelines should be revised following two years of data collection efforts in cooperation with the KDA-DWR.

Water Conservation Staff Considerations

Full implementation of the above recommendations would require an additional 2.0 FTE for the KWO. The KWO has never had a full-time staff member assigned to the Water Conservation Program. The current responsibilities for water conservation within the KWO are divided among five different staff members. The combined total amount of time per year that is devoted to the Water Conservation Program is approximately 1.2 FTE. A recent national survey of state water conservation programs found that 41 percent of the states have an Office of Water Conservation or its equivalent (Miri 1999). The study found that the states of Arizona and California had the most FTE's with 50 and 20 respectively and that the average number of FTE staff per state was 7.6.

Kansas Department of Agriculture, Division of Water Resources also may require additional staff if large numbers of irrigation water conservation plans were to be processed and recorded as part of the appropriation process.

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The Potential for Competing Needs in Kansas for the Next 20 Years and the Means to Address the Competition

Conflicts over water resources in Kansas have occurred throughout the history of the state and are well represented today. The availability and usability of the State's water resources are under pressure of increasing demands that will dictate a continued progression in both stressed resource conditions and disputes over the usage of that water. Kansas is a transitional state in terms of its cultural settings and the variability in climatic and physiographic environments. In this light, when competition over water develops, its occurrence has differing levels of intensity and magnitude that can arise at broad spatial scales. This often necessitates the involvement of federal, state, local, public, and/or private interests to develop management plans and strategies to maintain the vitality of the resource for future generations.

This report attempts to illustrate where and how future water competition may develop under the premise of Supply vs Demand. Under this characterization, competition over water only occurs when that resource becomes impaired in terms of its availability or usability. When water supplies are physically and locally available to fulfill all desired uses, there is no competition. Likewise, there will be no competing interest in water supplies if there is no resource available to use. The competition arises when the current or desired uses of a water resource become injured or the supply starts to become unattainable.

The concept of addressing competing water needs in the context of supply and demand is fully attuned to the structure and definitions of existing state water law. In 1945, the Kansas Legislature passed the Water Appropriation Act (WAA) which bases Kansas water law on the Prior Appropriation Doctrine for both ground and surface water resources. The Prior Appropriation Doctrine is often referred to as the doctrine of "First in Time, First in Right" and is based on the first person or organization to put water to a beneficial use has the complete and exclusive (i.e. senior) right to use that water over all subsequent (i.e. junior) water rights. Under the WAA, it is illegal to use water, expect for domestic uses, without first obtaining a water right. A water right is considered a property right, although it does not constitute ownership of water itself- only the right to use it for beneficial purposes if and when water is physically available.

Water Management in the Western United States

All of the western states in the country (those directly north, south, and west of Kansas) use the prior appropriation doctrine although the targeted resource of ground or surface water varies. The doctrine is used predominantly for surface water resources, while the management of ground water resources is generally less defined. Historically, ground water has been addressed as a separate resource from surface water and any management efforts have been primarily designated to some form of local control and regulation. Although the focus of the appropriation doctrine in the western states may not be addressed directly to both ground and surface water resources as in Kansas, this report does provide a terse overview on several unique management approaches and strategies used by western states that may have some applicability.

Just about every western state has some type of program or cost-share fund established that allows for the conversion of existing water distribution systems to be more efficient in the

delivery and application of water. This focus on the conservation of existing water supplies is based on the foundation of doing more with existing resources as opposed to developing additional supply sources. In the State of Washington, there is existing legislation that mandates water conservation techniques be employed, if effective, over impacting other water sources to increase supply and availability. Conservation efforts are targeted to both municipal and agricultural uses and all center of doing more with the water resources currently available. In several states, these conservation efforts are dynamic and become more stringent as the water resources become more strained. Other states have clauses in their state laws that have expanded the definitions of "beneficial use" to better represent current day practices. In some states, the non-use of water for conservation is itself considered a beneficial use.

Another common approach for meeting increased demands for water supply in the western states is to physically develop additional water storage projects or to transfer water from water rich areas to more arid regions. Given that the era of developing large dams in the west is over, many states are looking towards developing smaller, multi-purpose storage projects to augment water supplies. This can include converting or enhancing existing water impoundments that have traditionally been used for flood control. In some states, the physical transfer of water over very long distances is being explored or expanded.

A relatively new management strategy among many of the western states is water banking. The term water banking can lead to confusion since it is used interchangeably to represent two fundamentally different concepts. This reports uses the term "physical water bank" to represent the capture, transfer, and storage of water into naturally occurring, underground aquifer systems where the water can be used at a future date. The term "water right banking" is used to characterize the concept where water right allocations are "deposited" into a water bank and is then available to be "leased" by other users. Many western states use both of these concepts to deal with increasing water demands.

Previous Approaches to Addressing Competing Water Needs in Kansas

The underlying water law in the western states for all of these management strategies is still the Prior Appropriation Doctrine, which in itself does not guarantee a supply of water, only the right to use it when available. The Kansas Water Appropriation Act appears to recognize this to a degree and does provide a listing of preferred uses when the utilization of water for different purposes conflict. This order of preference consists of the following: Domestic, municipal, irrigation, industrial, recreational, and water power uses. However, the statute is quick to point out that the date of priority for an appropriate water right, not the purpose of use, determines the right to divert and use water at any time when supply is not sufficient to satisfy all water rights attached to it. Only through the process of condemnation, which can be defined as the taking of private property under the right of *Eminent Domain* for public use, can the holder of an inferior use of water be deprived of that use.

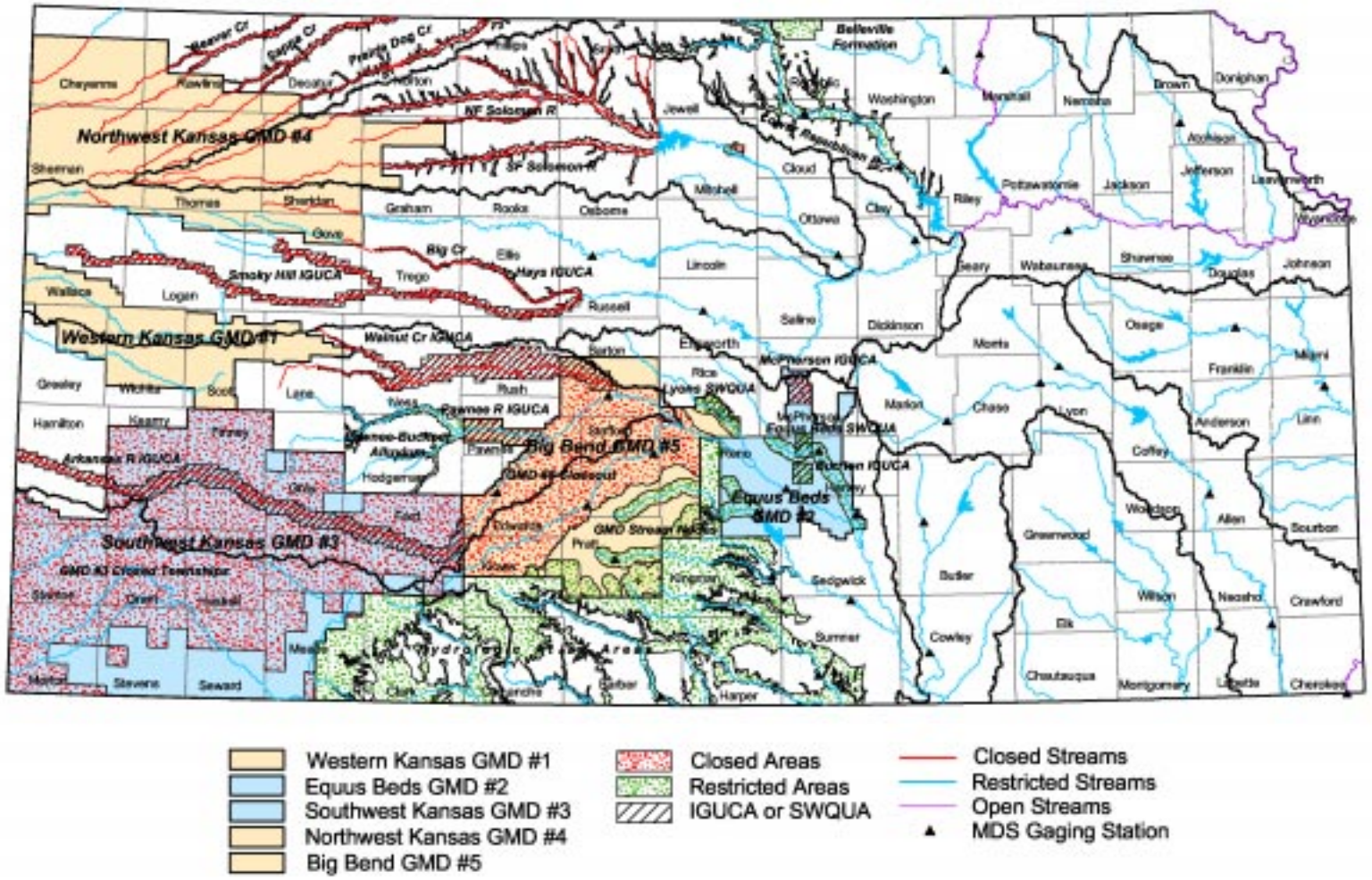
The Chief Engineer of the Kansas Department of Agriculture, Division of Water Resources (KDA-DWR) has the statutory responsibility to enforce the Water Appropriation Act. The Chief Engineer has a broad range of authorities for the adoption of rules and regulations which specify

criteria and standards and the authority to approve, deny or modify applications for water rights. Many of these same regulatory actions can and have taken place under the management plans of individual Groundwater Management Districts (GMD). Under the authority of the Chief Engineer and the local GMDs, there are numerous areas in Kansas either closed to new water right development or are under special management and review considerations. As a whole, most of the special management activities have occurred in the western two-thirds of the state (Figure 1). This can be attributed to a more arid climate in combination with extensive ground water development.

In reviewing the historical sequence, most of these special management areas have become closed to further water appropriations or have a more stringent, demanding review process. In addition, the physical size of the areas affected by the regulations have generally become larger in scope over time, most notably, the officially closed township and subbasin designations of Southwest GMD #3 and Big Bend GMD #5. In two specific cases, the Smoky Hill IGUCA below Cedar Bluff and the Walnut Creek IGUCA, the management strategy specified limitations on the existing water right allocations and usage.

Kansas has several other programs and policies currently established under the authority of several different state agencies to alleviate competing interests over water resources. The legislative mandated *Minimum Desirable Streamflow* and Groundwater Management District *Stream Node Systems* reflect efforts to protect in-stream flow in selected rivers and streams. The Kansas Water Office's *Water Marketing, Water Assurance District, and Multipurpose Small Lake* programs focus efforts to augment or facilitate adequate water supplies. The State Conservation Commission's *Water Resources Cost Share Program*, Kansas State University Research and Extension Office's *Water Conservation Management Program*, and the Kansas Water Office's *Water Conservation Program* all seek to increase water conservation and water use efficiency though the process of system enhancements, educational research, and technical assistance to water users. The formation and development of the Kansas Water Plan, which represents a blueprint for the State's water activities in the coming years, serves as an excellent vehicle for state and federal agency and public input, involvement, and criticism of a wide variety of issues and the techniques targeted to address them. In comparison to the other western states, Kansas is often recognized for its innovative and comprehensive management and planning of its water resources.

Figure 1
Special Water Management Areas in Kansas



Current and Proposed Management Strategies in Kansas

Many of the existing water management policies and activities were enacted in response to degrading water resource conditions or from the determination that the local resource had been fully developed. These areas, combined with a significant amount of the state being closed to further appropriation by either official designation or through the "safe yield" water right review process, indicates the State of Kansas has entered into an era of water management as opposed to water development. Under these circumstances, there are many water management activities that have been proposed or are in their infancy that are focused generally towards the preservation and conservation of existing water supplies.

The KDA-DWR's Subbasin Water Resource Management Program (SWRMP) was initiated in 1993 as an attempt to alleviate competing water needs before conflicts reached a stage where state regulation or judicial intervention was needed. The SWRMP consists of individual Basin Management Teams that strive to form local, public partnerships within specific subbasins of the state to develop comprehensive, holistic management plans for the regional water resources. The use of the local groups throughout the development of the management plan provides a pro-active approach to conflicting water needs, a valuable education process and makes alternative management strategies more acceptable. It has been argued by some that the SWRMP process needs to have an overlying threat of future or expanded water right regulation by the KDA-DWR or a local GMD in order for the subbasin working groups to reach consensus on the formation of a meaningful management plan that truly address the local water issues.

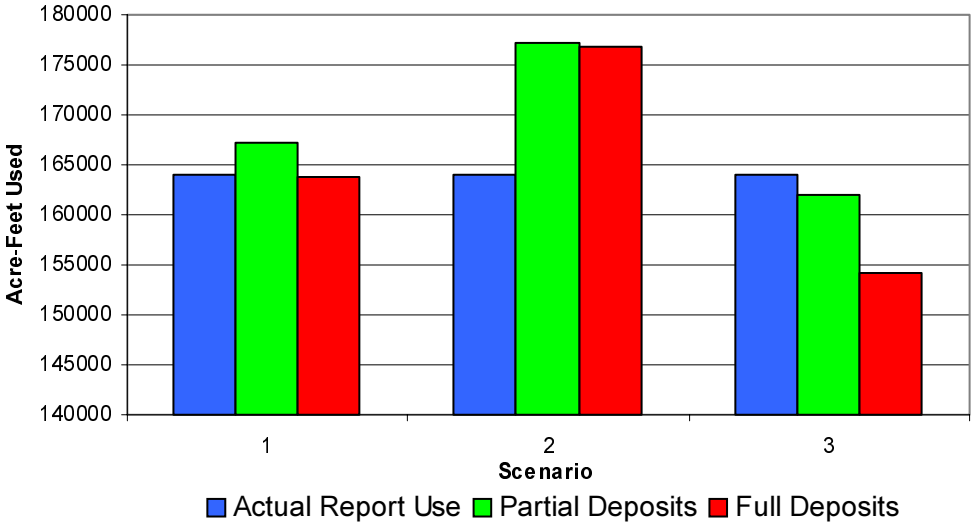
Another proposed management alternative to address potential competing water needs is the use of "water right banks" where water right allocations are "deposited" into a water bank which are then available for future "leases" by other users. This concept is somewhat controversial and was submitted as Senate Bill 388 in the 2000 Legislative session where it died at the close of the session, although it is expected to be re-introduced in subsequent sessions. This report addresses the concept of water right banks in Kansas in some detail primarily due to the complexity of how a water right bank may operate, its potential impacts on water resource conditions, and affects on regional water usage. In addition, it is one of the few management proposals that can be modeled with existing data sets under the use of certain assumptions.

Water Right Banking, also referred to as Water Marketing, is employed primarily in other western states as a water transfer tool which generally facilitate the transfer of irrigation water to other users. Operating in a economic environment, water right holders would be encouraged to finance conservation efforts, change existing water use practices, and reallocate water from low-valued to high-valued uses. Under most appropriation doctrines in the western states, water is usually "owned" by the public or government which are usually not influenced by the actual value of that water when competing uses arise, as would be in a market setting. The transfer of water is a contractual arrangement and thus is usually less politically sensitive since there is no permanent removal of agricultural land or transfer of water rights.

If a water right bank is improperly structured or inadequately balanced with other interests, the operations of the bank may actually exacerbate the problem it is trying to remedy. This is particularly true with ground water based water right banks and the potential impact on third parties that do not have a proprietary stake in the water right exchange. Given that the bank by its structure serves to maximize the use of water to an established level, the involvement of "paper water" (defined as water that that is allocated but has or would not be used) could proliferate ground water declines in aquifer systems. In ground water systems, the exchanges between depositors and leasers should be based on a consumptive use criteria or a qualification on how much water could be transferred.

In a review of the possible affects of a water right bank in Kansas, this report estimated potential water usage under the operation of a hypothetical water right bank using three different scenarios (Figure 2). Conditions and rules governing the operations of the hypothetical water right bank were based on criteria listed in SB 388 . The scenarios were based an estimated 15 percent participation of water rights in the area using differing level of criteria to select the groups. The operations of the bank under these scenarios serve to show a range of estimates based on extremes. The first scenario is based on randomly selecting the participation group, scenario 2 represent the participation of "paper water rights" by including only the water rights that reported to use the lowest amount of water, while scenario 3 including only the water rights that had reported to use the highest amount of water. Figure 2 illustrates the critical importance in properly defining and establishing the organization of a water right bank if the conservation or reduction of water use were primary goals.

Figure 2
Comparision of Water Right Banking Scenarios



Scenario 1 - Randomly selected 15% participation group. Scenario 2 - 15% participation group consists of water rights reporting the lowest water use. Scenario 3 - 15% participation group consists of the highest water rights reporting the highest water use.

There are several additional proposed management strategies or concepts designed to alleviate competing water interests reviewed in this report. The City of Wichita and the Equus Bends GMD #2 are finishing up the last stages of a pilot program that seeks to artificially recharge the local aquifer. This form of "physical water banking" diverts water during periods of high stream flow, treats the water if necessary, and uses it to recharge the Wichita Well Field in order to augment future water supplies and protect the aquifer from saltwater pollution. There are many advantages to this type of program and it is a common strategy used in many western states.

Other possible management programs focus on adjusting water right conditions. The Five-Year Water Right Program reduces overall water allocations for irrigators that can demonstrate significant water conservation techniques while providing increased flexibility in authorized application amounts during the 5 year period. The Water Appropriation Transfer was presented in the 2000 Legislative Session where it was not passed but centered on providing flexibility in transferring existing water rights to other locations in the state. Both programs have the advantages of reducing overall allocations or moving the water usage out of areas where water resources are declining, however, the impact on existing water rights, third parties and resource conditions during period of drought are of concern.

The State Conservation Commission's Water Right Purchase Program has never been funded or operated but would provide cost-share assistance to local entities to purchase existing water rights that would be kept in permanent custodial care of the state in order to improve trends in water resource conditions. This program can have direct impacts on stabilizing or reversing trends in water resources, however, it will likely be extremely expensive to reach an appropriate level of water right removal. The introduction and evolution of Subsurface Drip Irrigation (SDI) systems may have strong potential to increase water use efficiency which reduces the gross amount of irrigation water diverted. This in turn can extend the usable life of State's aquifers so long as that conserved water is not shifted to other uses. Economic factors affecting the installation and operational life of SDI systems may be an impediment to its acceptance and are still being researched. The concept of establishing a special water fee or tax structure on water usage is also explored. This proposed fee would be based on the efficient use of water by having a dynamic billing component that increases proportionally with excessive use. The fee assessment would be based and dependent upon the type of use (i.e. irrigation, municipal, etc…) and based on normalizing factors (i.e. water applied per acre for a given crop or regional per capita water consumption). Finally, the role of federal policy is briefly explored under the assertion that farm subsidies for water intensive crop yields may discourage water conservation.

Current and Potential Water Conflicts in Kansas

All of the existing and proposed management programs and policies have developed in response to conditions and trends occurring in the State's water resources and the demands placed upon them. Given the physical properties and extreme variations in climatic conditions across the state, the competition over water in Kansas will continue to occur. In many cases, the use of water in one location will have an impact on the water resources in another location that may not be realized for years or decades. This report attempts to answer the difficult question on

where and over what water resource these disputes will arise and provides an illustration on how that competition will arise.

In the companion report to this document that addresses *Aquifer Resources, Recharge Rates, the Availability of Surface Water and the long-term prospect related to any necessary transition to dry land farming in areas of the state to maintain sustainable yield and minimum streamflow*, the trends and conditions in the High Plains Aquifer, specifically ground water declines in the Ogallala Aquifer, are documented. This region of the state will represent the primary location and circumstances for continued and expanded conflicts over water in the State of Kansas. Many areas of the Ogallala Aquifer are considered non-renewable based on current ground water development and usage. The reduction in available water will have direct social and economic ramifications given that it represents the primary source of water for most uses.

Ground water declines in the Ogallala Aquifer, along with other areas of the state, are the result of significantly more water being authorized and actually used than is recharged naturally to the aquifer system. Like other western states, Kansas historically has promoted the development of its water resources through its policies and laws. In this light, all water rights since 1945 have been approved under the premise that it was in the public's interests to do so. Although the Water Appropriation Act directs the Chief Engineer to take into account the public's interest when reviewing water right applications, there is no exact definition on what that is. It is this definition of the public interests that may be challenged in the future.

As a case example, the Solomon River Basin Advisory Committee (BAC) recommended the FY 2002 Kansas Water Plan contain a timetable of 2015 be established for the basin to reach a sustainable use of water. To reach a level of sustainable water use would require drastic reductions in present day water right allocations and usage, specifically in the Ogallala Aquifer region of the basin and could effectively end large scale irrigation practices. It is the general opinion of the Solomon BAC that the continued use and eventual exhaustion of a non-renewable resource does not reflect the public interests of all people in the region.

Water level declines in the High Plains Aquifer can also have secondary impacts that will continue to dictate where competition of water will occur. The High Plains Aquifer contributes a certain amount of water to surface streams in the form of baseflow. As the aquifer levels drop, so does the amount of baseflow. Many streams in Kansas, especially in the western portion of the State have been experiencing a progressive reduction in streamflow much of which can be attributed to the lowering of the ground water table and increased agricultural water conservation practices. If this reduction in streamflow affects the water usage by senior surface water right holders, any call for administration protection of water rights as authorized under the Water Appropriation Act, can have significant impacts. In addition, it is the reduction of surface water, which has public value and use that will most likely be the catalyst to create increased regional awareness and support for corrective actions.

The desire for in-stream flow versus support for other water uses represents the classic competition over water in many western states. In Kansas, this type of competition will most likely arise from administration of Minimum Desirable Streamflows (MDS). Specified by statute, MDS seeks to protect a specific level of streamflow at selected locations along streams and

rivers. When the flow falls below a specified level for more than seven consecutive days, MDS will be investigated and possibly administered. This administration can include both surface and ground water based water rights. Given advances in computer technology and real-time data sharing across the Internet, the potential for detecting MDS violations and administration will be more prevalent. Figure 3 shows the percent achievement of MDS stations in the 1990s and the locations where potential MDS administration could occur.

Figure 3
Percent Achievement of MDS in the 1990s and
Potential MDS Administration Areas

Surface water rights on the darker stream segments and ground water rights in alluvial aquifers along these stream segments are potentially subject to MDS administration

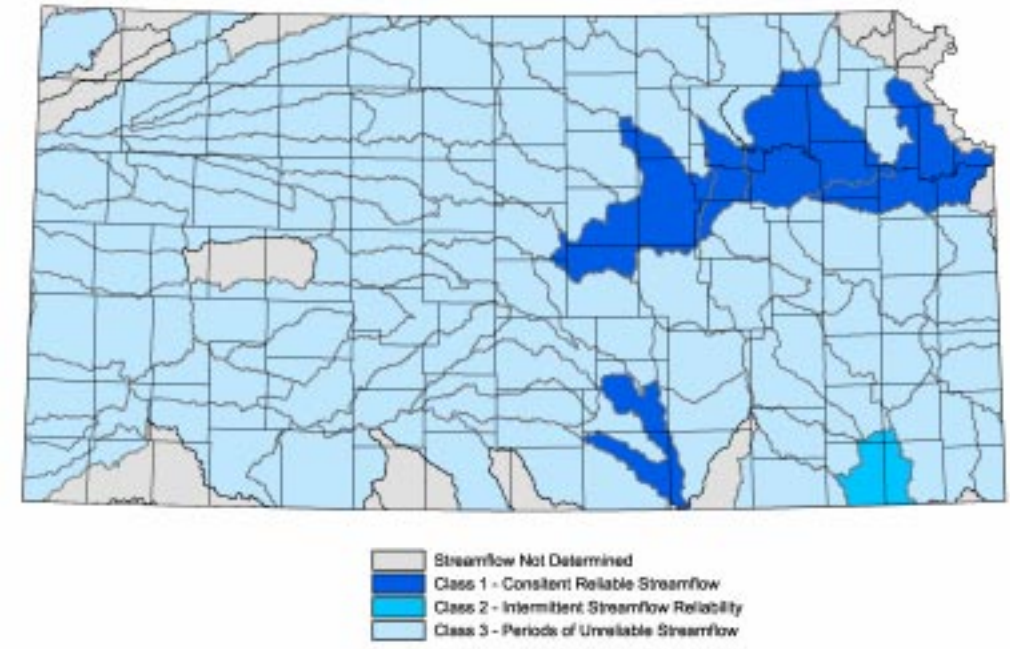
All of the existing MDS stations are located on rivers and streams in the central and eastern portion of Kansas that for the most part, coincides with the majority of the State's population distribution and their associated water sources. As a whole, the State's population base and water demands will continue to grow and as a result, dependable water supplies may be regionally stressed. An investigative project was undertaken to estimate where the potential lies in Kansas for growing regional municipal water demands to conflict with existing water supplies and availability.

Using a triage approach, the rate of change in water demands, the volume of demand in comparison to existing water right allocations, and the time period of projected shortfall were all assessed. On a regional basis, northeast Kansas and communities around south central Kansas were notable because they represented the highest municipal demand and rate of growth in the state. Southeast Kansas has an apparent inequitable distribution between public water supply entities that have independent water right allocations. In areas closed to new appropriations, particularly in southwest Kansas, several communities are near or do not have enough water authorized under existing water right allocations to meet future, projected water demands.

As a whole, most public water supplies in the state have adequate amounts of water under existing allocations, however, a water right and the Water Appropriation Act do not guarantee a water supply. Surface water often represents a large quantity of water in the state, both in terms of its availability and appropriation; however, its seasonal variability can make it unreliable as a sole source of supply. During the summer of 2000, there were several case examples that illustrated this point, specifically the Kickapoo Indian Reservation and the City of Altoona.

Daily mean discharge data for the past thirty years, with particular emphases on flow records of the past ten years were reviewed to assess the reliability of surface streams in Kansas (Figure 4). The reliability classifications by subbasin were based simply on the presence of water in comparison to zero, no flow conditions or any existing MDS value. Under these conditions, water would be either not available for use or under possible restrictions due to MDS regulations. Flow reliability was based on: Class 1 subbasins essentially always have 100 cfs of greater flow, Class 2 subbasins essentially always have 10 cfs but no more than 100 cfs, and Class 3 subbasins have flows that are below 10 cfs in at least 2 periods and flows of under 1 cfs occurring once. Most of the subbasins in the state fall into category 3 where a continuous source of surface water is unreliable or subject to MDS regulation. Any use of water, which depends solely on surface water within these subbasins, can expect periods where flow is unavailable, inconsistent or restricted.

Figure 4
Streamflow Reliability Classifications by Subbasin



Recommendations on the Means to Address Water Competition in Kansas

Most of the water conflicts in the state are regionally based and are temporal in nature affected by normal fluctuations in climatic conditions. As in the case of MDS and the availability of surface water supplies, variations in water flow and availability are typical. With proper planning and preparation measures, most competing water demands can be lessened or diminished. In general, conflicts over water in Kansas have not or will not reach a stage where substantial changes to the cultural or economic base of a region will be altered. Most of the programs listed above have been effective in targeting the issues they were defined to facilitate while many of the proposed programs and strategies will serve to further lessen the demands upon the state's water resources. However, there are some areas of the state very close or are at a stage where significant changes will take place despite past management efforts and are currently in transition to less water dependency resulting from reductions in available water supply.

As a whole the Ogallala Aquifer in western Kansas is essentially a mined, non-renewable resource based on current water usage and ground water development. As such, of all the conflicts over water resources presented in this paper, the decline of the Ogallala poses the greatest challenge in that once the aquifer reaches a point where it is unable to support all existing uses, it will take on the order of decades to centuries to replace the water under natural conditions. This in turn will challenge the very basics of water needs and represents more than just an inconvenience in variations of water supply. Some areas of Kansas are at or very close to reaching this situation.

It is important in the water planning process for the State of Kansas to develop a public awareness of the aquifer characteristics and the future of depleting ground water resources in the western part of the state, particularly in the Ogallala portion of the High Plains. This awareness should include the distinction that the remaining water supply of these depleting resources consists of two separate volumes of water- one is composed of the amount of water that is equivalent to the effective recharge minus stream outflow and baseflow contributions and another volume of water in excess of this quantity that will be depleted over time when used. The first volume of water is replenishable over time as precipitation occurs and therefore is a supply that could be sustainable for all time. The remaining amount of water stored in the aquifer will be exhausted within some time frame depending on the level of use but once consumed, it will no longer be available in the future. Water planning and management for the future should consider an approach that recognizes the distinctions between these two volumes of water within the aquifers of the state.

The water planning process should initiate discussion of a management strategy that would recognize preserving the replenishable portion of the aquifer as a way to ensure healthy regional communities which includes towns and the surrounding areas. The quantity of water needed to sustain healthy communities would be the amount of water required for human consumption and the social structure of the region. The volume of water available for this purpose would be limited by the amount and distribution of effective recharge and any required aquifer outflows to streams. The presence and amount of water would vary geographically depending on the regional and local aquifer characteristics within the state.

In most areas of the Ogallala, existing water right allocations operating under existing state laws and management practices use stored ground water that is in excess of that available from effective recharge minus stream baseflow contributions. Aquifer depletion is a result. This use must change as the level of aquifer depletion approaches the replenishable volume of water in the aquifer. Ultimately, water usage must be limited to an amount that will not deplete the replenishable water supply in the aquifer, protecting first of all the volume of water defined for use to sustain a healthy community.

The State of Kansas should either establish regulations that aggressively address the decline and resulting cultural impacts of aquifer depletion, or establish policies that are structured to assist in the transition from an irrigated agricultural economy to one based on dryland practices. The distinction that the State's aquifer resources are composed of two distinct volumes of water, one that is replenishable and another that can be exhausted, can facilitate the management, transition, and acceptance of reduced but sustainable regional water dependency. The future challenge lies in defining the line that separates these two volumes of water.

Institutional processes would be used to insure consistency with water law and the protection of high value users as specified in the Water Appropriation Act. Water marketing strategies would likely be needed to address the transition from aquifer depleting, high water use economy to one which would rely on much more limited, sustainable water use. The distinction between the volume of water within the aquifer that is replenishable and that volume that would be depleted on a regional scale will aid in this transition.

Summary of Recommendations

The Kansas Water Authority recommends that existing programs and policies that can alleviate competing water needs should be continued and enhanced. The following recommendations should also be included for management of the Ogallala portion of the High Plains Aquifer:

1) Increase educational and awareness efforts on regional water resource conditions, trends, and management strategies.

2) Use the water planning process with its integration between local Basin Advisory Committees, Groundwater Management Districts, 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's ground water resources start to become exhausted.
c. Regional aquifer subunit delineations based on aquifer characteristics that quantify the replenisable portion of the aquifer.