

**ASSESSMENT OF HIGH IRRIGATION USE  
STATE OF KANSAS  
1991 – 1999**

*By 2010, reduce the number of irrigation points of diversion for which the amount of water applied in acre feet per acre exceeds an amount considered reasonable for the area (amounts typically considered reasonable area 1.0 AF/A in eastern Kansas, 1.5 AF/A in central Kansas, and 2.0 AF/A in western Kansas) and those that overpump the amount authorized by their water rights.*

**INTRODUCTION**

In October 1998, the Kansas Water Authority approved objectives for the year 2010 as part of the Kansas Water Plan. The objectives were developed to define targets to quantify achievements of the Kansas Water Plan (KWP). The above objective is included in the Water Conservation Section of the FY 2003 Kansas Water Plan.

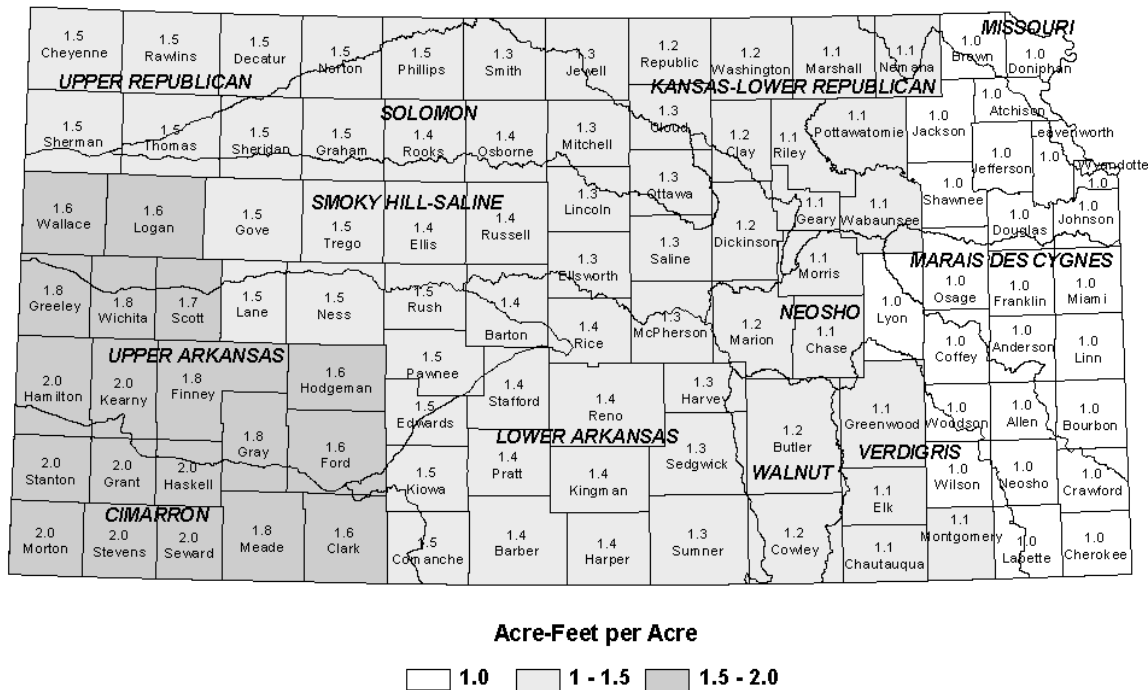
The Kansas Water Office (KWO) used KWP funds to contract with the Kansas Geological Survey to complete and finalize this assessment.

**DEFINITION OF HIGH IRRIGATION USE**

There are two criteria used in this assessment to measure high irrigation use. The first criterion consists of two parts which measures the number of points of diversions and the amount of water applied in acre-feet per acre (AF/A) that exceeds an amount considered reasonable for an area. The Kansas Department of Agriculture, Division of Water Resources (KDA-DWR) used regional AF/A standards as guidelines to consider when reviewing applications for permits to appropriate water for irrigation use. These regional standards consisted of 1.0 AF/A for eastern Kansas, 1.5 AF/A for central Kansas, and 2.0 AF/A for western Kansas.

On September 22, 2000, the KDA-DWR adopted new county-based AF/A standards on reasonable quantities for irrigation use (Figure 1), The new county-based standards were established either on the net irrigation requirement for corn for an 80 percent chance rainfall event **or** a value equivalent to one standard deviation from the mean reported water use for a county, which ever is higher. These values are the considered the maximum amount that can be authorized for a new irrigation water right permit. As such, it is expected that the annual water use would typically be less than these value and only approach these maximum levels during dry climatic periods.

**Figure 1**  
**KDA-DWR Reasonable Acre-Foot Per Acre Quantities**  
**for Irrigation Use in Kansas, by County**



Source- KDA-DWR KAR 5.3-24

In accordance to the FY 2003 KWP, the newly adopted county-based standards will be used as the benchmark for amounts considered reasonable for irrigation in this assessment. It should be noted that water use in excess of the new county-based AF/A standards does not necessarily imply that an irrigator has exceeded the authorized quantity for a water right or violated the Kansas Water Appropriation Act.

The second criterion to measure high irrigation use is to identify the number of irrigation water rights for which the reported water use exceeds the annual authorized allocation under their respective water right permits or certificates.

There are many reasons for high irrigation water use ranging from climatic factors to irrigated crop and soil types. As directed under this 2010 State Water Plan objective, this assessment is an attempt to measure potentially inefficient irrigation water usage and possibly target enhance water conservation measures where appropriate.

## **ASSESSMENT DATA SETS**

High irrigation use is determined by using annual irrigation water use report data collected under the authority of the KDA-DWR. All reported water use data used in this assessment was retrieved from the KDA-DWR's Water Right Information System (WRIS). For the reported AF/A comparisons to the KDA-DWR county-based standards, the assessment data subset represents only irrigators which reported both the amount of water diverted and the number of acres irrigated during the growing season. The data set represents both ground and surface water based water rights and excludes water use reports from surface water ditch companies in south and northwest Kansas.

As of late March 2002, there were approximately 26,600 active irrigation water rights and approximately 30,600 irrigation points of diversion in the State of Kansas. The number of irrigation points of diversion for which the annual water use reports contained a valid diverted quantity amount and total number of acres irrigated ranged from a low of 20,063 in 1993 to a high of 23,434 in 1991 with an average of 22,182 for the 1991 – 1999 time period.

For comparison purposes, monthly total precipitation data was retrieved from Hydrodata<sup>®</sup> software of Hydrosphere Data Products Inc., which is based on National Climate Data Center (NCDC) weather stations. The number of stations in the State of Kansas that contain usable monthly precipitation data varies from year to year and range from 264 to 276 stations with an average of 270 for the 1991-1999 time period.

## **ASSESSMENT TIME PERIOD**

The time period used for this assessment was 1991 – 1999. 1991 was the earliest year for which both the amount of water reported diverted and the number of acres reported irrigated from the annual water use reports were reviewed as part of the KWO and KDA-DWR cooperative Irrigation Water Use Program- a data quality control and assurance program. 1999 was the most recent year of data available when the assessment of this objective was initiated.

## **ASSESSMENT DATA PARAMETERS**

There are three data parameters used for this assessment of high irrigation use: 1) the total number of irrigation points of diversion that reported higher AF/A than the county-based AF/A standards, 2) The total amount of irrigation water reported used over the county-based AF/A standards, and 3) the number of irrigation water rights that appear to use water in excess of their respective authorized quantities.

In order to identify both the number of points of diversion and the amount of water reported over the county-based AF/A standards, the amount of water reported diverted was divided by the number of acres reported irrigated to get the reported AF/A. The reported AF/A values were then compared to each respective county-based AF/A standards. The total number of points of diversion which exceeded those standards was then summarized for each basin. If an individual point of diversion had more than one water right reporting usage over the county-based AF/A standard, the point of diversion was only counted once.

For those water rights/points of diversion that reported water use over their respective county-based AF/A standards, the total amount of water used in excess was calculated by subtracting the maximum amount of water that is considered reasonable (the reported acres irrigated multiplied by the county-based AF/A standard) from the total reported water diverted. The total amount of water used over the county-based AF/A standard was then summarized by basin for each year in the assessment.

The second criterion of this assessment, identifying the number of irrigation water rights that appear to have used water in excess of the amount authorized by their water, required comparing reported water use to the authorized amount or quantity allocated to each specific water right. The KDA-DWR WRIS database maintains only present day annual authorized allocations. Because the amount of water that is authorized to be pumped under a water right may be changed for a variety of reasons (for example, the certification of a water right), comparing the present day authorized quantity to past reported water use amounts can lead to incorrect conclusions. This is especially important in light of the recent completion of the KDA-DWR's "Zero'ed Out" program where DWR finalized the certification process of several thousand water rights.

Another challenge associated with assessing this criterion is the various overlap relationships between water rights, uses of water, points of diversions, and places of use. For example, a water right may be authorized to irrigate numerous tracts of land (places of use) while a single place of use may have part or all of its areas irrigated by multiple water rights. In accordance, most overlapping water rights have authorized quantity limitations when used in conjunction with other overlapping senior water rights in order to keep the use of water within a reasonable AF/A.

To account for these various relationships, water rights were grouped together based on how they overlap one another by either the point of diversion or place of use. Where water rights do not overlap any other water rights, they constitute a group of one. The total authorized quantity and total reported use is then summarized for the group as a whole. The total reported use for the group is then compared to the total authorized quantity (which is valid only for the date the data was accessed from the WRIS) and the number of water right groups that appear to use water in excess of their annual authorized allocations are summarized by basin for each year in the assessment.

## **ASSESSMENT RESULTS**

### Number of Irrigation Points of Diversion and Amount of Irrigation Water Reported Used Over the KDA-DWR County-Based AF/A Standards, 1991 – 1999.

The overall statewide trend in the number of irrigation points of diversion (Figure 2) and the amount of irrigation water used (Figure 3) over the county-based AF/A standards shows a general decline from high exceedences in 1991. In both cases, the number of points of diversions and amount of water used in excess for the state is highly correlated to seasonal precipitation, defined as the amount of precipitation recorded during the months from March to October. This inverse relationship is to be expected given that as more precipitation occurs during the growing season, the need for supplemental irrigation water and the potential to exceed the county standards decreases.

The number of irrigation points of diversion and the amount of water used over the county standards for each basin is listed in Table 1 and Table 2, respectively. As would be expected, those basins containing greater numbers of irrigation rights, namely those located in western Kansas, south-central Kansas, and the Kansas-Lower Republican River Basin have the greatest number of irrigation points of diversion and associated amount of water used in excess of the standards. In most years, the number points of diversions in these basins that reported use over the county standards represent a range of 1 to 15 percent of all the irrigation points of diversions for each respective basin. In addition, the amount of irrigation water used in excess of the county standards for each basin generally represents less than 3 percent of the total amount of irrigation water reported used.

On a regional basis for the basins located in western Kansas, south-central Kansas, and the Kansas-Lower Republican, the number of irrigation points of diversion and the amount of water used in excess of the county standards have greater occurrences in southwest Kansas and becomes progressively lower towards the north and east (Figure 4). This can likely be attributed to a combination of seasonal precipitation and total reported water use. In general,

seasonal precipitation in the southwest is usually the lowest in the state on average and gradually increases towards the north and east while reported water use generally decreases. On average, there is more water reported used each year in the southwest portion of the state and thus the potential of exceeding the respective county-based AF/A standard is greater.

#### Number of Irrigation Water Rights that Appear to Have Exceeded the Amount Authorized by Their Water Right Allocations

As can be seen Figure 5, the number of irrigation water right groups that appear to use water in excess of their authorized quantity is highly correlated to seasonal precipitation and resembles the graph of the number of irrigation points of diversion that used water over the county AF/A standards (Figure 2). The state-wide trend shows an overall general declining trend from 1991. Table 3 lists the number of irrigation water right groups that appeared to have used more water than their authorized quantity for each basin.

Similar to the number of irrigation points of diversions that exceeded the county AF/A, the basins with greater number of irrigation rights, namely those located in western Kansas, south-central Kansas, and the Kansas-Lower Republican River Basin have the greatest number of irrigation water right groups that appear to have used more water than their authorized quantities. This correlated relationship between exceeding the both annual allocations and county-based AF/A should be expected in that with higher reported use volumes, there would be a greater chance each parameter would be exceeded. In most years, the number of irrigation water right groups that appear to use water in excess of their authorized quantity, also represents 1 to 15 percent of all the irrigation water right groups for each respective basin.

On a regional basis, the number of water rights that appear to use water in excess of their annual allocations also follows roughly the same pattern as the number of irrigation points of diversion that reported use over the county-based AF/A standards. There are a greater number of groups that appear to exceed their authorized quantities in the southwest portion of the state, and in general, the number progressively lessens towards the north and east.

## **CONCLUSION**

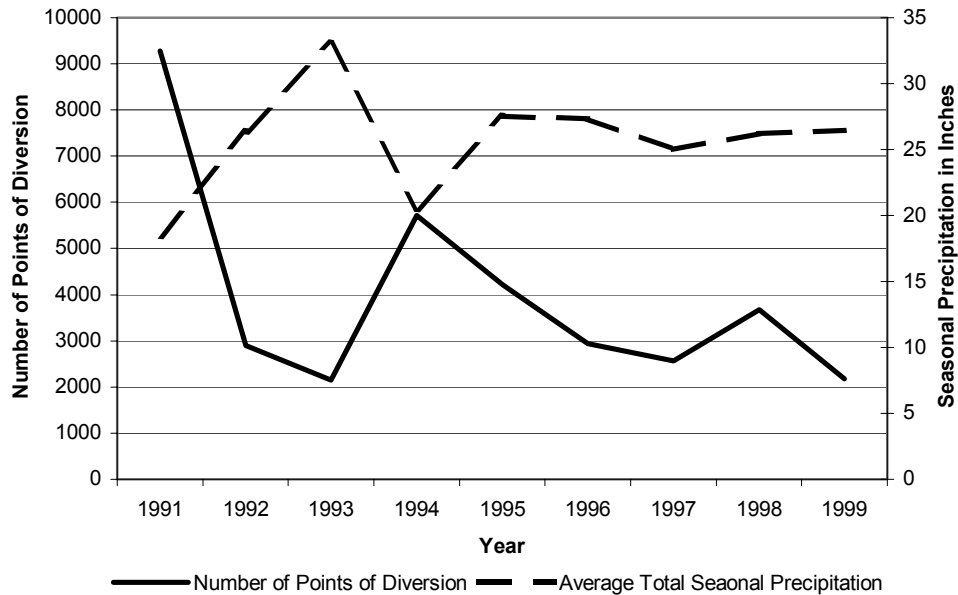
This assessment of high irrigation use has documented overall declining trends for the State of Kansas in the number of irrigation points of diversion and amount of irrigation water reported used over the KDA-DWR county-based AF/A standards and the number of irrigation water rights that appear to have used water in excess of the amount authorized by their water rights from 1991 to 1999. In both cases, irrigation exceedences are greater in the southwest portion of the

state and progressively become less towards the north and east. It is likely this is a function of precipitation, which increases spatially towards the north and east from average lows in southwest Kansas. In relation, overall reported water usage and the number of water rights generally decreases spatially towards the north and east.

Given the correlation between high irrigation use and seasonal precipitation, the trend in high irrigation use will likely be highly dependent on future precipitation patterns and the timing of those precipitation events. Based upon the trends and correlations in this assessment, if precipitation patterns continue to be favorable, the chance occurrence of high irrigation usage will be lessened. However, if the state enters into climatic patterns with below normal or untimely precipitation levels, the number and amount of irrigation water used in excess of both the county-based standards and their respective annual authorized quantities will likely increase.

Information provided in this assessment can be used to target cost-share funds, technical assistance and water conservation planning assistance to the irrigators that have the highest amount of irrigation water used over the county-based standards and therefore would benefit the most from a cost-effective reduction of irrigation water use. However, given the data limitations associated with the authorized allocations for water rights, any planning activities associated with the number of water right groups that appear to have used water in excess of the amount authorized by their water rights should be approached with caution.

**Figure 2**  
**Number of Irrigation Points of Diversion Reporting Water Usage**  
**Over the KDA-DWR County Based AF/A Standards <sup>a/</sup> and Seasonal**  
**Precipitation (March to October), State of Kansas, 1991- 1999**



a/ Water use in excess of the county-based AF/A standards does not necessarily imply that any specific irrigator has exceeded a water right's authorized quantity or violated the Kansas Water Appropriation Act.

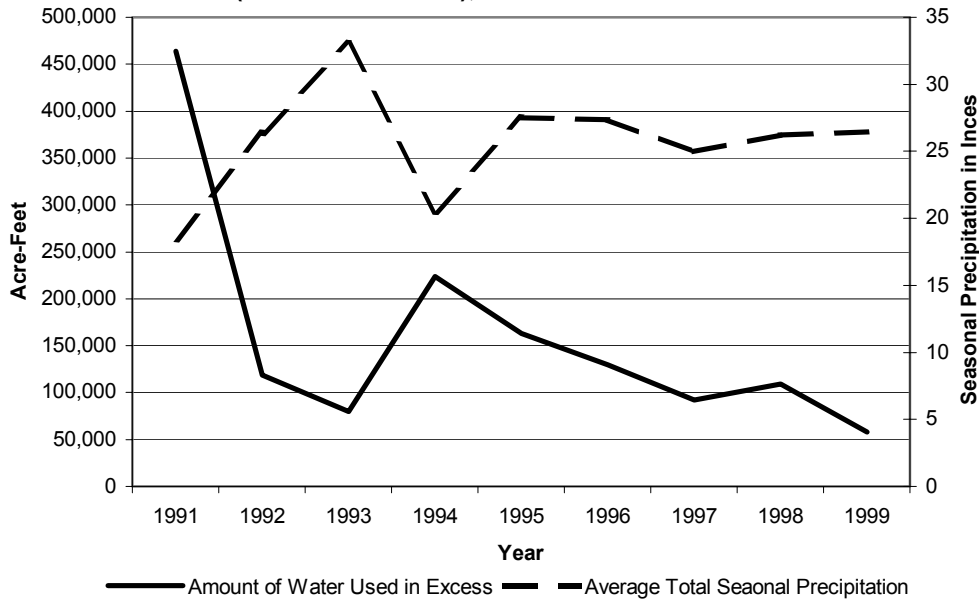
**Table 1**  
**Number of Irrigation Points of Diversion Reporting Water**  
**Usage Over the KDA-DWR County-Based AF/A Standards <sup>a/</sup>**  
**State of Kansas, 1991 – 1999**

Basin Name	1991	1992	1993	1994	1995	1996	1997	1998	1999	Average
Cimarron	1,445	883	587	832	805	666	331	470	236	695
KS-LWR Republican	608	31	6	144	213	181	242	168	184	197
Lower Arkansas	1,691	229	260	1,388	593	308	178	899	476	669
Marais des Cygnes	8	2	1	1	3	4	4	3	6	4
Missouri	0	1	0	1	1	1	1	1	6	1
Neosho	15	3	2	9	7	6	5	6	9	7
Smoky Hill-Saline	941	377	181	568	458	377	327	260	205	410
Solomon	544	84	35	200	267	146	160	121	85	182
Upper Arkansas	3,191	1,055	854	2,103	1,478	981	819	1,385	752	1,402
Upper Republican	819	231	217	461	387	265	498	361	211	383
Verdigris	2	0	0	1	1	1	0	1	1	1
Walnut	13	4	6	2	1	3	2	4	3	4
<b>Total</b>	<b>9,277</b>	<b>2,900</b>	<b>2,149</b>	<b>5,710</b>	<b>4,214</b>	<b>2,939</b>	<b>2,567</b>	<b>3,679</b>	<b>2,174</b>	<b>3,957</b>

a/ Water use in excess of the county-based AF/A standards does not necessarily imply that any specific irrigator has exceeded a water right's authorized quantity or violated the Kansas Water Appropriation Act.



**Figure 3**  
**Amount of Irrigation Water, in Acre-Feet, Reported Used Over the KDA-DWR County Based AF/A Standards <sup>a/</sup> and Seasonal Precipitation (March to October), State of Kansas 1991- 1999**



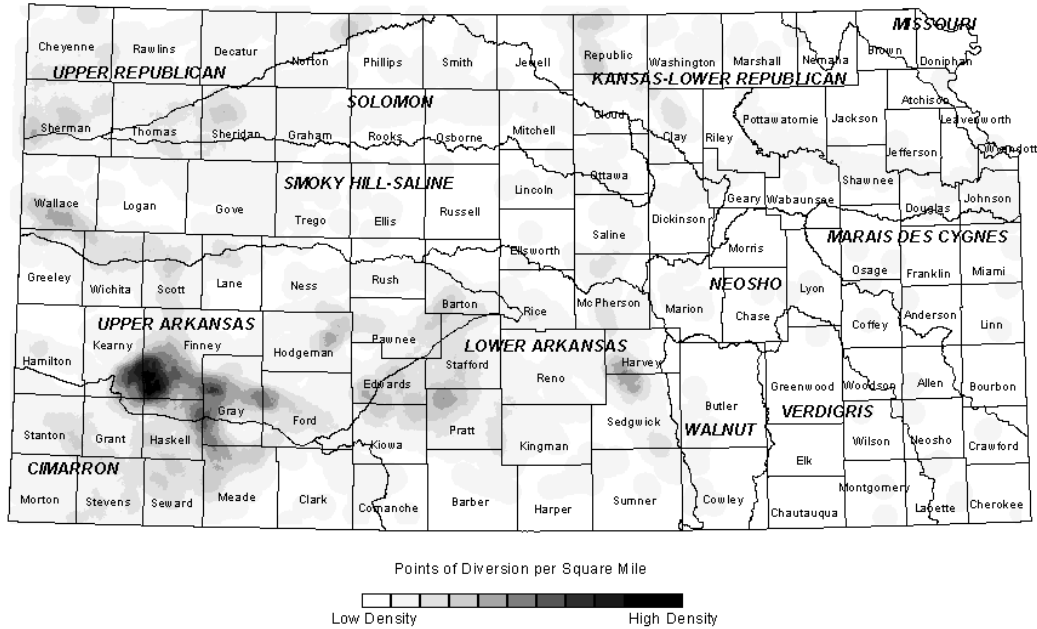
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**Table 2**  
**Amount of Irrigation Water, in Acre-Feet, Reported Used Over the KDA-DWR County-Based AF/A Standards <sup>a/</sup> State of Kansas, 1991 – 1999**

Basin Name	1991	1992	1993	1994	1995	1996	1997	1998	1999	Average
Cimarron	136,180	54,956	32,443	56,855	56,664	50,479	22,287	22,739	11,209	49,312
KS-LWR Republican	17,138	343	173	3,547	4,833	4,240	5,064	2,687	2,991	4,557
Lower Arkansas	51,530	6,825	6,212	47,122	16,846	6,734	5,115	19,789	9,252	18,825
Marais des Cygnes	179	26	7	2	50	22	15	20	117	49
Missouri	0	12	0	29	44	7	52	9	90	27
Neosho	311	14	4	159	45	78	30	40	110	88
Smoky Hill-Saline	40,467	12,236	5,508	16,749	13,920	15,433	9,307	6,700	5,253	13,953
Solomon	22,985	2,751	1,723	6,059	6,216	3,905	3,050	2,401	1,550	5,627
Upper Arkansas	159,055	33,469	25,666	81,224	54,276	39,692	33,244	46,390	21,928	54,994
Upper Republican	35,482	7,760	7,707	12,017	10,170	8,660	14,044	8,306	5,136	12,142
Verdigris	11	0	0	12	1	6	0	0	1	3
Walnut	272	69	83	106	8	142	33	384	91	132
<b>Total</b>	<b>463,610</b>	<b>118,461</b>	<b>79,526</b>	<b>223,881</b>	<b>163,073</b>	<b>129,398</b>	<b>92,241</b>	<b>109,465</b>	<b>57,728</b>	<b>159,709</b>

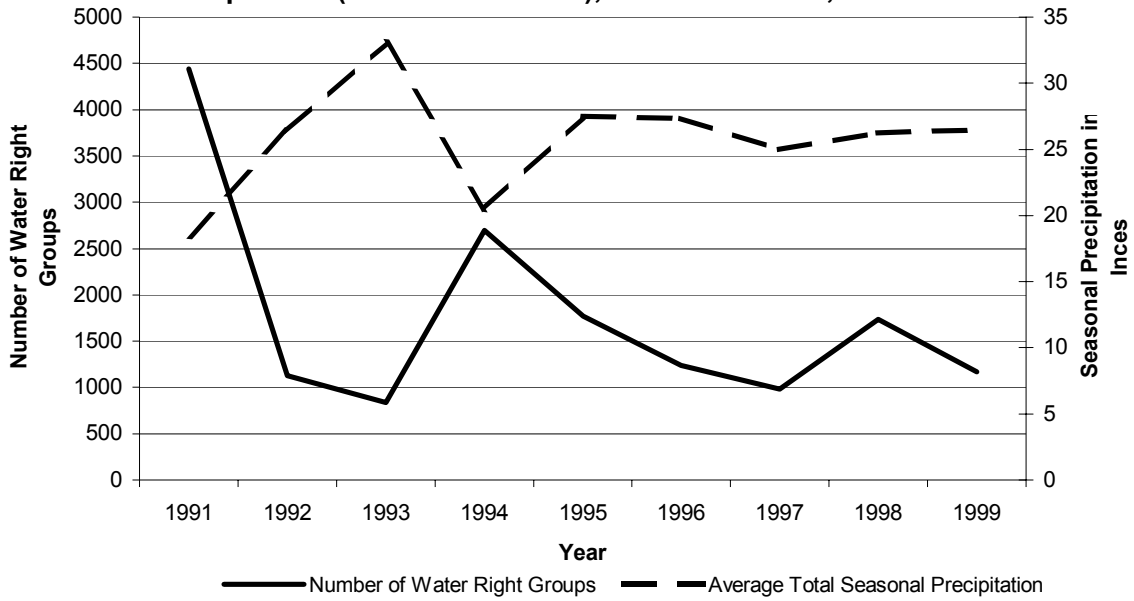
a/ Water use in excess of the county-based AF/A standards does not necessarily imply that any specific irrigator has exceeded a water right's authorized quantity or violated the Kansas Water Appropriation Act.

**Figure 4**  
**Density of Points of Diversion Where the Reported Water Use Exceeded**  
**the KDA-DWR County-based Acre-Feet per Acre Standards**  
**State of Kansas, 1991-1999**



Note- Water rights that solely exceed the county-based AF/A standard are not considered to be in violation of their respective water right conditions. Points of diversion on this map represent 9.6% of all irrigation points of diversion that reported both the amount of water used and the number of acres irrigated in 1999 for the State of Kansas. The reported use in excess of the county-based standard was 1.8% of the total reported water used for irrigation points of diversion that reported both the amount of water used and the number of acres irrigated in 1999 for the State of Kansas.

**Figure 5**  
**Total Number of Water Right Groups that Appear to Have Used Water**  
**in Excess of Their Annual Authorized Quantity and Seasonal**  
**Precipitation (March to October), State of Kansas, 1991 - 1999**



**Table 3**  
**Total Number of Water Right Groups that Appear to**  
**Have Used Water in Excess of Their Annual Authorized Quantity**  
**State of Kansas, 1991 - 1999**

Basin Name	1991	1992	1993	1994	1995	1996	1997	1998	1999	Average
Cimarron	777	463	322	456	444	383	194	247	175	385
KS-LWR Republican	417	20	5	98	124	118	150	99	125	128
Lower Arkansas	1194	143	158	998	399	188	118	644	359	467
Marais des Cygnes	6	1	2	2	4	2	1	3	5	3
Missouri	1	2	0	0	1	0	0	0	0	0
Neosho	17	2	2	6	6	4	2	6	8	6
Smoky Hill-Saline	210	53	21	93	61	66	58	42	53	73
Solomon	184	26	10	51	60	46	52	33	54	57
Upper Arkansas	1446	367	274	902	590	381	308	598	338	578
Upper Republican	170	45	43	84	81	44	97	57	46	74
Verdigris	9	0	1	5	3	2	1	3	2	3
Walnut	7	2	0	4	0	3	0	5	3	3
<b>Total</b>	<b>4438</b>	<b>1124</b>	<b>838</b>	<b>2699</b>	<b>1773</b>	<b>1237</b>	<b>981</b>	<b>1737</b>	<b>1168</b>	<b>1777</b>