



Middle Arkansas River

2010 Field Analysis Summary

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Basin Management Team

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I. Introduction

In 1998, the Kansas Department of Agriculture, Division of Water Resources (KDA-DWR) convened a group of local stakeholders to address Middle Arkansas River subbasin water resource issues through a Basin Management Team (BMT) project. The project included field work to collect water level and streamflow data to enhance the awareness of the hydrologic conditions within the area. Analyses of these data provide a clearer understanding of the stream-aquifer interaction between the Great Bend Prairie aquifer (High Plains) and the Arkansas River. Understanding this stream-aquifer interaction is key to informing and developing long-term water resource objectives and management solutions.

The Middle Arkansas River subbasin covers approximately 781,455 acres, and includes parts or all of Barton, Edwards, Kiowa, Pawnee, Rice, Rush and Stafford counties (Figure 1). Approximately three-fourths of the Middle Arkansas River subbasin lies within the boundaries of the Big Bend Groundwater Management District No. 5 (GMD #5) and overlies an unconfined/semi-confined aquifer system called the Great Bend Prairie aquifer, which is a part of the High Plains aquifer.

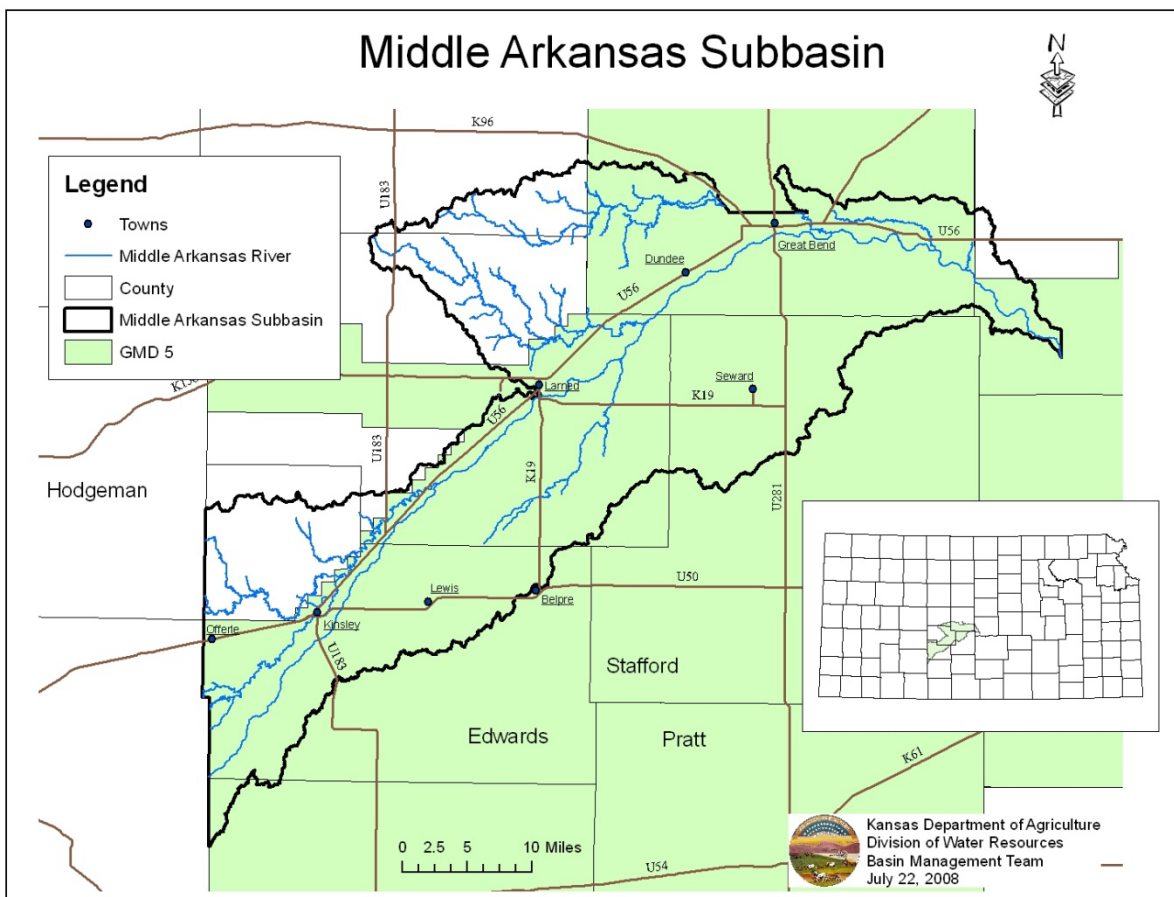


Figure 1: Middle Arkansas River Subbasin

Precipitation in this region can have a highly variable distribution. Water levels respond to precipitation differently across the subbasin. Areas near the river alluvium tend to react quickly to recharge, while in areas where a clay aquitard is present water levels tend to react more slowly.

II. Precipitation

Precipitation in the Middle Arkansas subbasin historically averages 25.14 inches per year based on records from four precipitation stations: Kinsley in Edwards County, Larned in Pawnee County, Great Bend in Barton County, and Albert 5 SE in Barton County. The chart in Figure 2 is based on average data from National Climatic Data Center (NCDC) weather stations. The chart shows a very dry period in the mid-1950s with 1956 being the lowest precipitation year at 12.1 inches. The highest precipitation total occurred in 1973 with 41.8 inches of precipitation. The 1990s had several years of above average precipitation. Annual precipitation data from these NCDC stations is currently available through 2009. Precipitation in 2009 was less than in 2008, but still above the subbasin historical average.

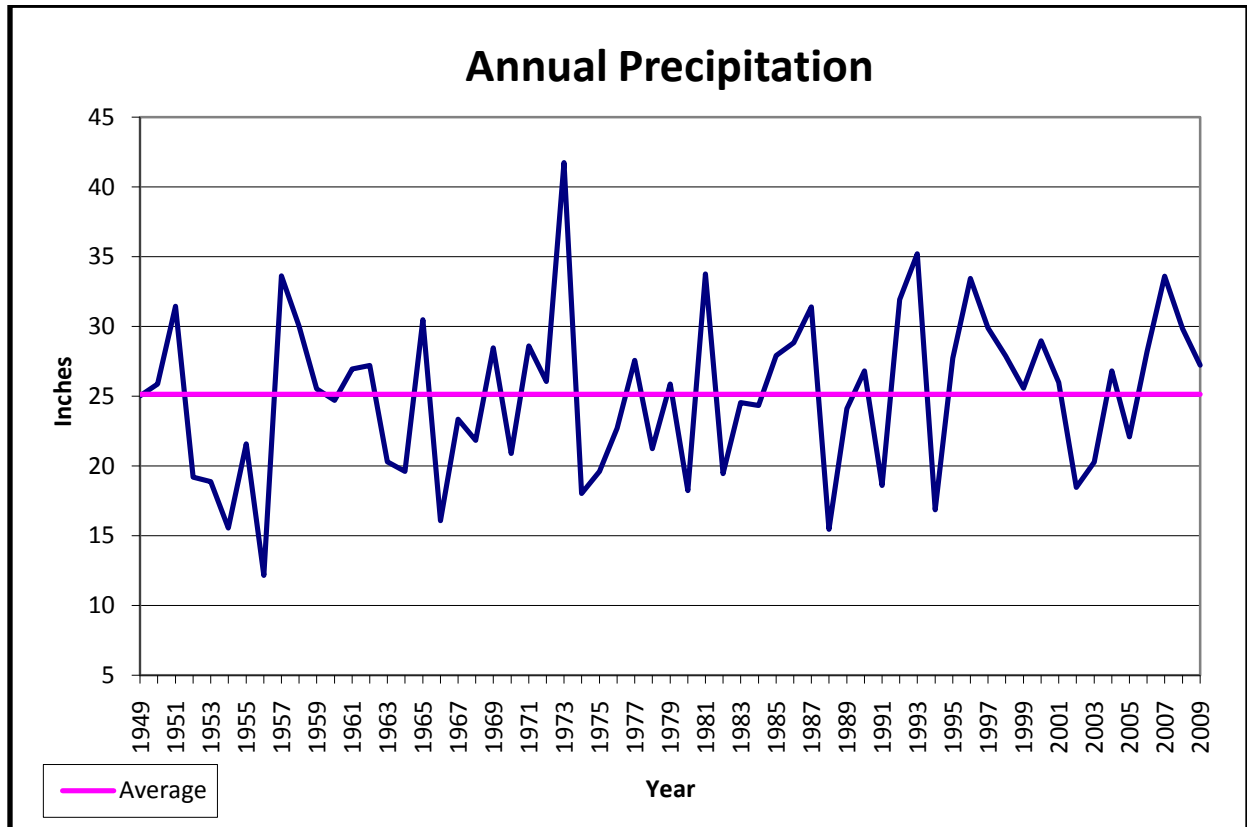


Figure 2: NCDC Annual Precipitation in Middle Arkansas Subbasin 1949-2009

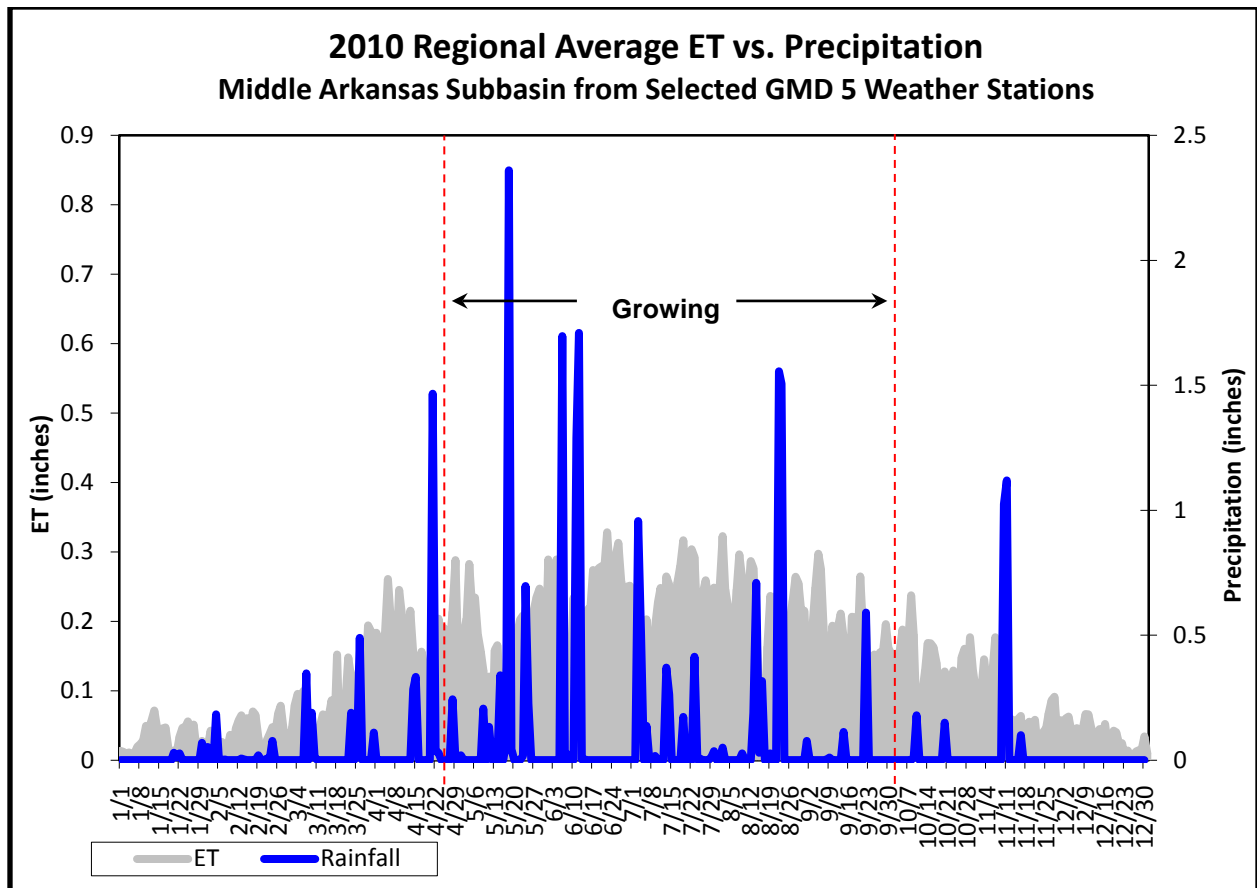


Figure 3: GMD #5 Evapotranspiration and Precipitation

Figure 3 shows the 2010 evapotranspiration and precipitation conditions in the Middle Arkansas subbasin. This information comes from three GMD #5 weather stations: Great Bend, Lewis and Radium. Note: The Lewis Station did not collect data from September 24, 2010 to December 31, 2010. The three stations received an average 23.8 inches of precipitation for 2010. This figure is below the average 25.14 inches of precipitation documented over the period of record. The subbasin had a deficit of moisture due to the 46.8 inches of evapotranspiration.

III. Surface Water

The Arkansas River flows easterly from the Colorado border until it reaches the Ford/Edwards County line in Kansas. From there the river trends to the northeast to Great Bend where it bends to the south and begins to flow towards the Kansas-Oklahoma border.

KDA-DWR measures the flow of the Middle Arkansas River at nine streamflow sites on a quarterly basis (Figure 4) beginning with Site 1 at the Ford Bridge and continuing downstream to the confluence of the Arkansas River and Walnut Creek, near Great Bend (Site 10). Measurements at Site 7 have been discontinued due to site conditions. Additionally, there are USGS stream gages at Kinsley, Larned and Great Bend. **NOTE: USGS discontinued the Kinsley streamflow gage on October 1, 2009 due to budget and site specific problems.**

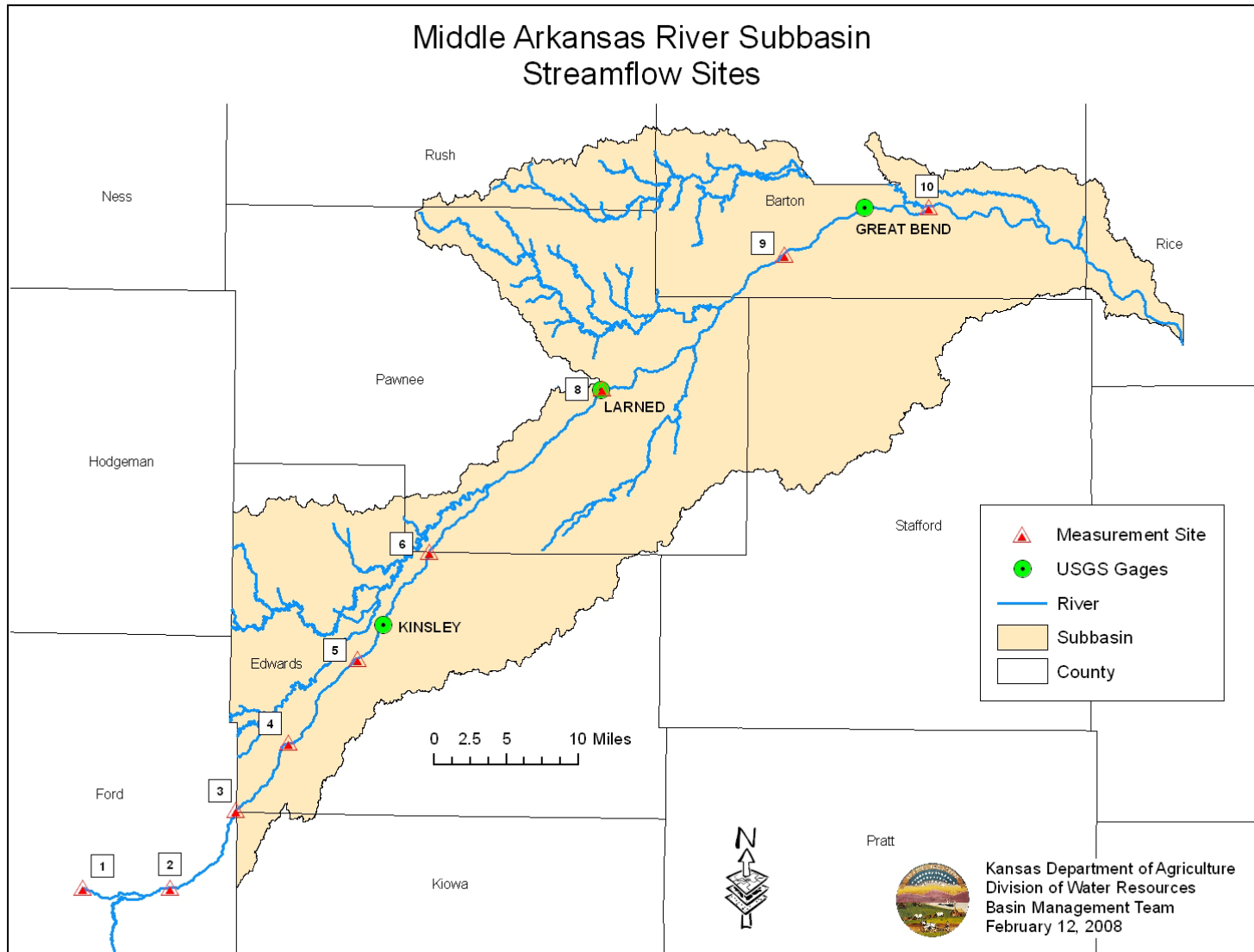


Figure 4: Streamflow Measurement Sites

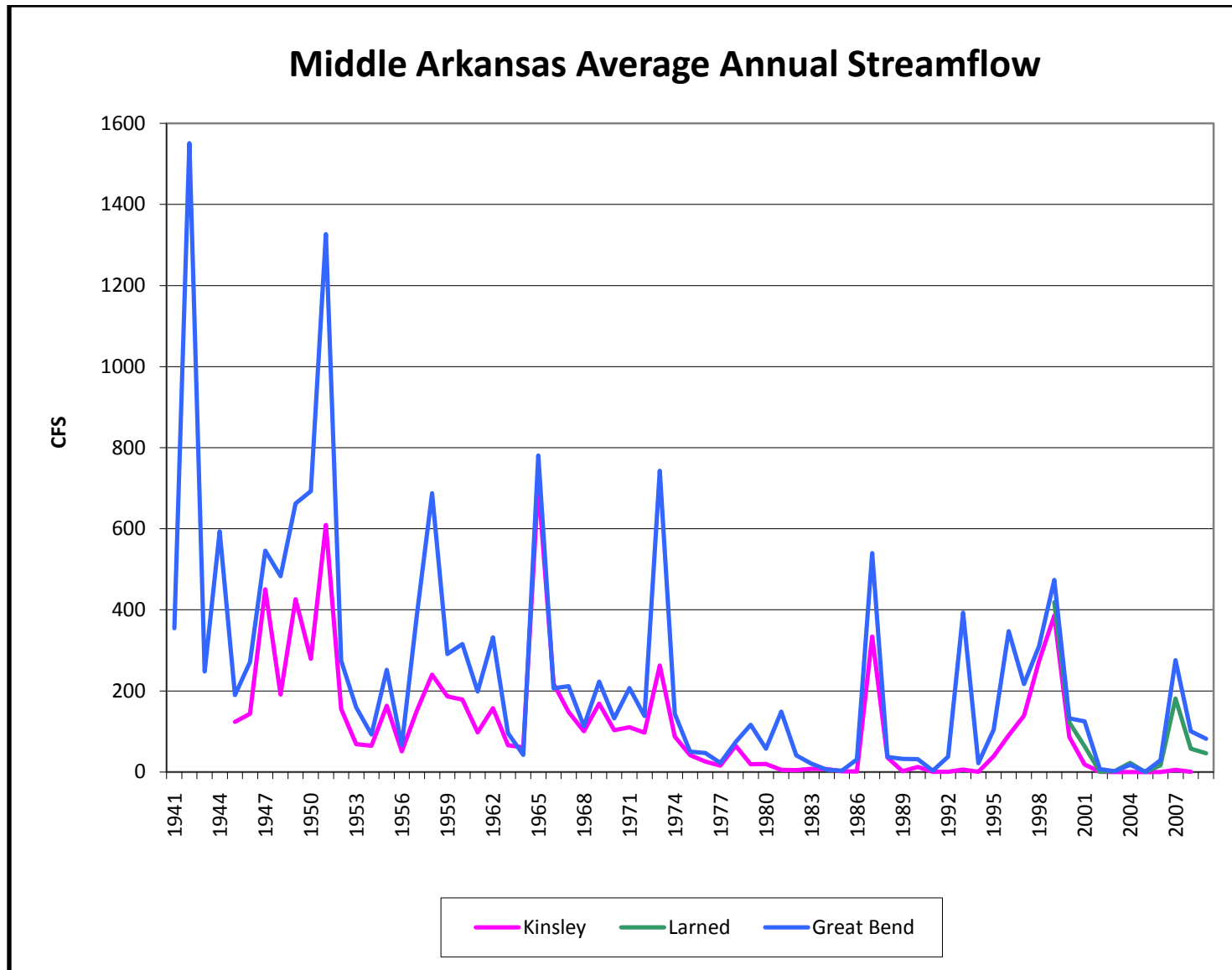


Figure 5: Streamflow at USGS Gages 1940-2009

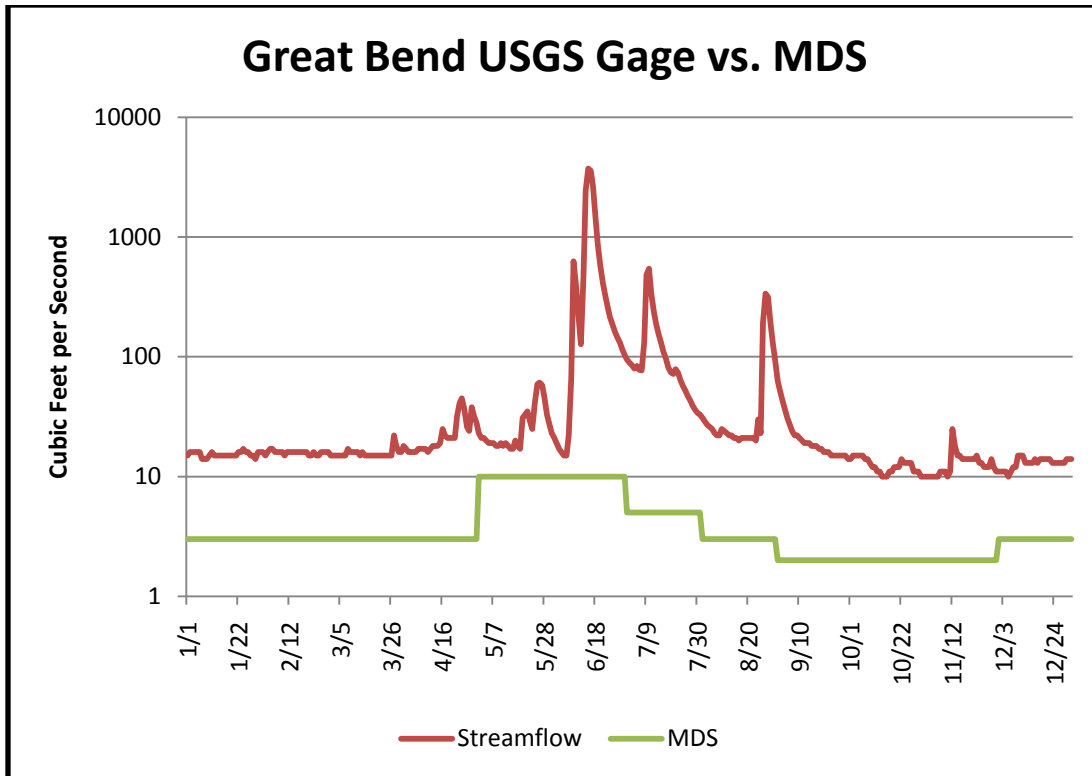


Figure 6: Great Bend USGS Streamflow and MDS in 2010

Table 1: MDS Values at USGS Streamflow Gages

Gage	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Great Bend	3	3	3	3	10	10	5	3	2	2	2	3
Kinsley	2	2	3	3	5	5	3	1	1	1	2	2

The Great Bend streamflow gage has a longer record dating back to 1941, while recording at Kinsley streamflow gage started in 1945 and Larned streamflow gage started in 1999. Over the periods of record, the average streamflows at Kinsley was 117.39 cfs, Larned was 84.62 cfs and Great Bend was 245.67 cfs. During the 1990s, the subbasin received above average precipitation but the streamflow averages were lower with Kinsley gage at 94.71 cfs and Great Bend at 193.86 cfs. Average streamflow continued to decline during the 2000s with Kinsley at 12.27 cfs and Great Bend at 77.21 cfs (Figure 5).

In 1984, the Kansas Legislature amended the Kansas Water Appropriation Act to establish Minimum Desirable Streamflow (MDS) for specific USGS streamflow gages. MDS administration could be enforced if flow at a gage site fell below a set value for seven consecutive days. Once begun, administration will continue until the gage has recorded fourteen consecutive days above the MDS value.

MDS was established at the Great Bend and Kinsley USGS streamflow gages. Table 1 shows the MDS values for both the Kinsley and Great Bend USGS streamflow gages. Figure 6 **Error! Reference source not found.** shows the streamflow measurements for 2010 in comparison to MDS values set at the Great Bend gage. Flow at the Great Bend gage satisfied the MDS criteria

for the entire year of 2010. The Kinsley gage data is available through October 1, 2009 when that gage was decommissioned.

Since MDS was established in 1984, the frequency that the streamflow measured at Kinsley was below MDS criteria has been greater than at Great Bend MDS is not established at the Larned gage.

Figure 7 shows the Middle Arkansas River struggled to meet MDS criteria from 2002-2006. The Great Bend gage did not meet MDS during the year 2005 and the Kinsley gage did not meet MDS from 2002-2006. In 2008, Kinsley only met MDS for 11 days while Great Bend met every day. In 2009, the Great Bend gage met MDS every day. The Kinsley gage was not charted for 2009 because it had only a partial record. In 2010, the Great Bend Gage had flows above MDS all year.

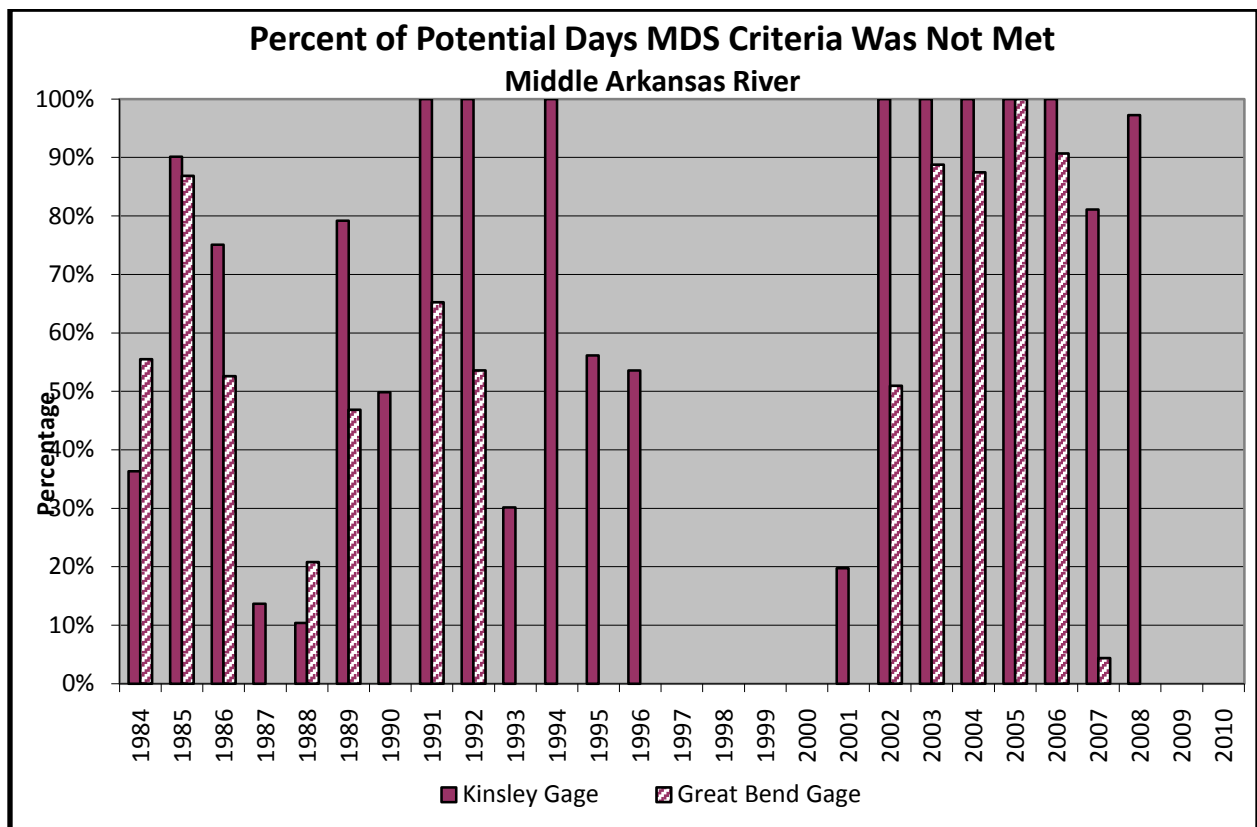


Figure 7: Streamflow and MDS Criteria

IV. Groundwater

The Middle Arkansas River subbasin primarily overlies the Great Bend Prairie portion of the High Plains aquifer. The Kansas Geological Survey (KGS), the Kansas Department of Agriculture and the GMD #5 combine efforts to measure 125 groundwater levels in the subbasin (Figure 8). KDA-DWR collects additional water level measurements tri-annually in the winter, spring and fall.

Only winter measurements, taken in December, January, or February, are used for the monitoring well water level charts, since those measurements are considered to be the least influenced by irrigation well pumping. Figure 9 to Figure 15 chart groundwater levels in all the monitoring wells. The y-axis is labeled DBLS (feet). The DBLS stands for depth below land surface. Legal descriptions are found in the appendix. Some counties were split for ease of viewing. The charts include all monitoring wells known to KDA-DWR with currently available data.

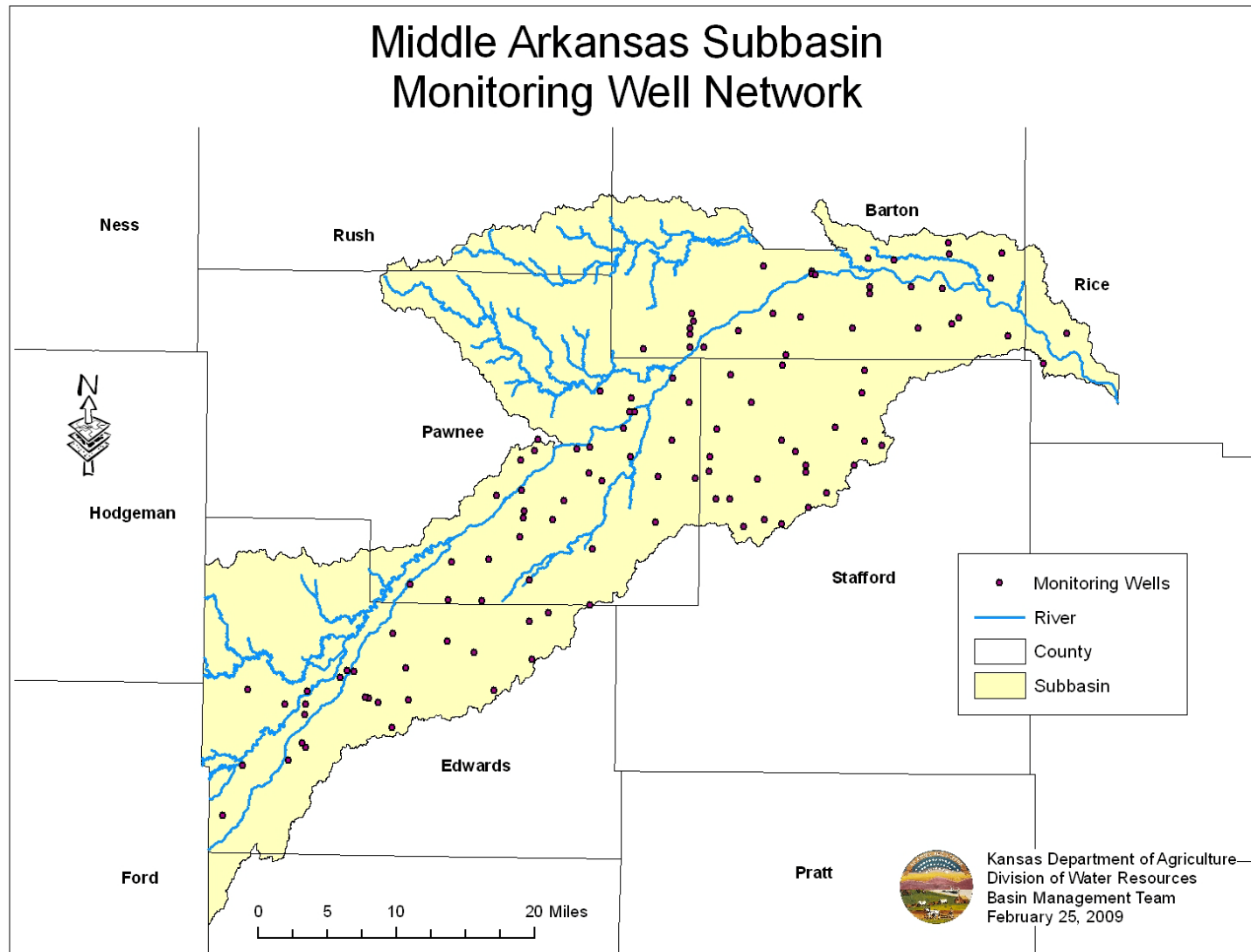


Figure 8: Middle Arkansas River Subbasin Monitoring Wells

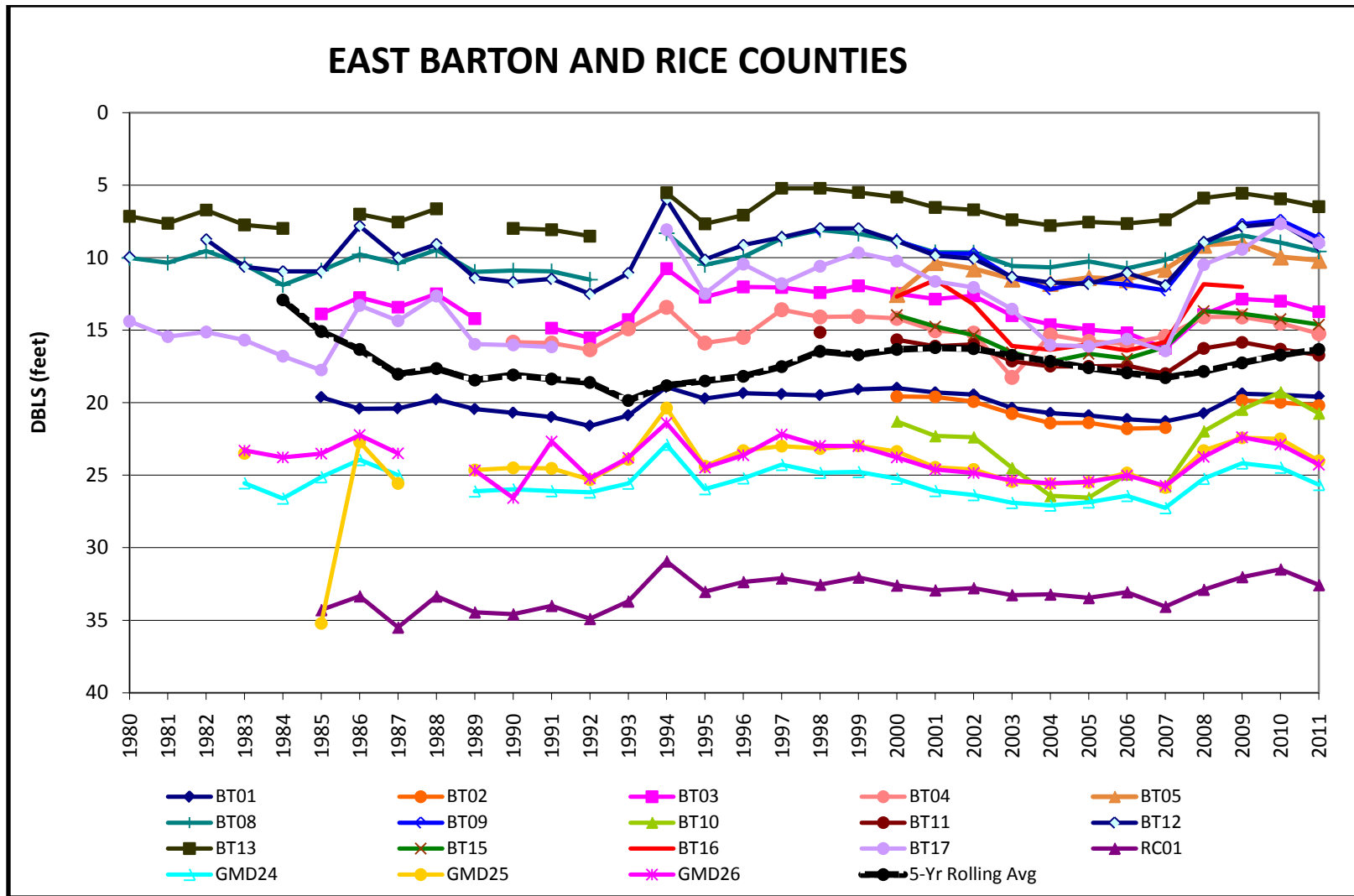


Figure 9: Groundwater Levels in Eastern Barton County Subsection and Rice County

East Barton and Rice counties have 18 monitoring wells (Figure 9). Seventeen of the eighteen monitoring wells had a decline in water levels in 2011. One well went unmeasured in 2010 and therefore could not be included. The average change in water levels for 2011 was a decline of 0.87 feet. Even though the monitoring wells had a decline in water levels the five-year rolling average increased in 2011.

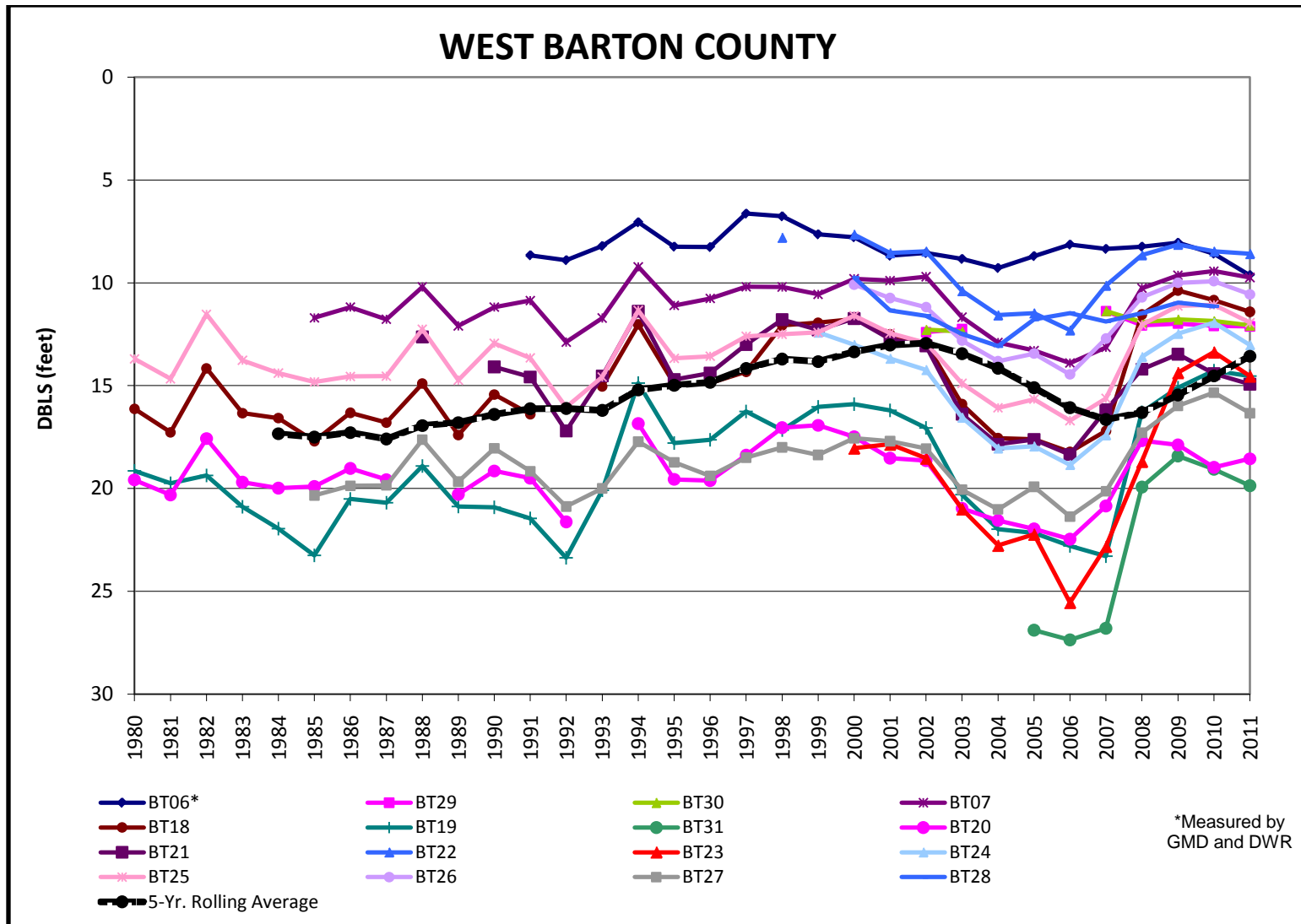


Figure 10: Groundwater Levels in Western Barton County Subsection

West Barton County has 16 monitoring wells (Figure 10). Fifteen of the 16 monitoring wells had a decline in water levels. BT28 was not accessible to measure. West Barton County averaged a decline of -0.55 feet in 2011 compared to 2010 measurements. The five-year rolling average declined for several years but has increased the past four years.

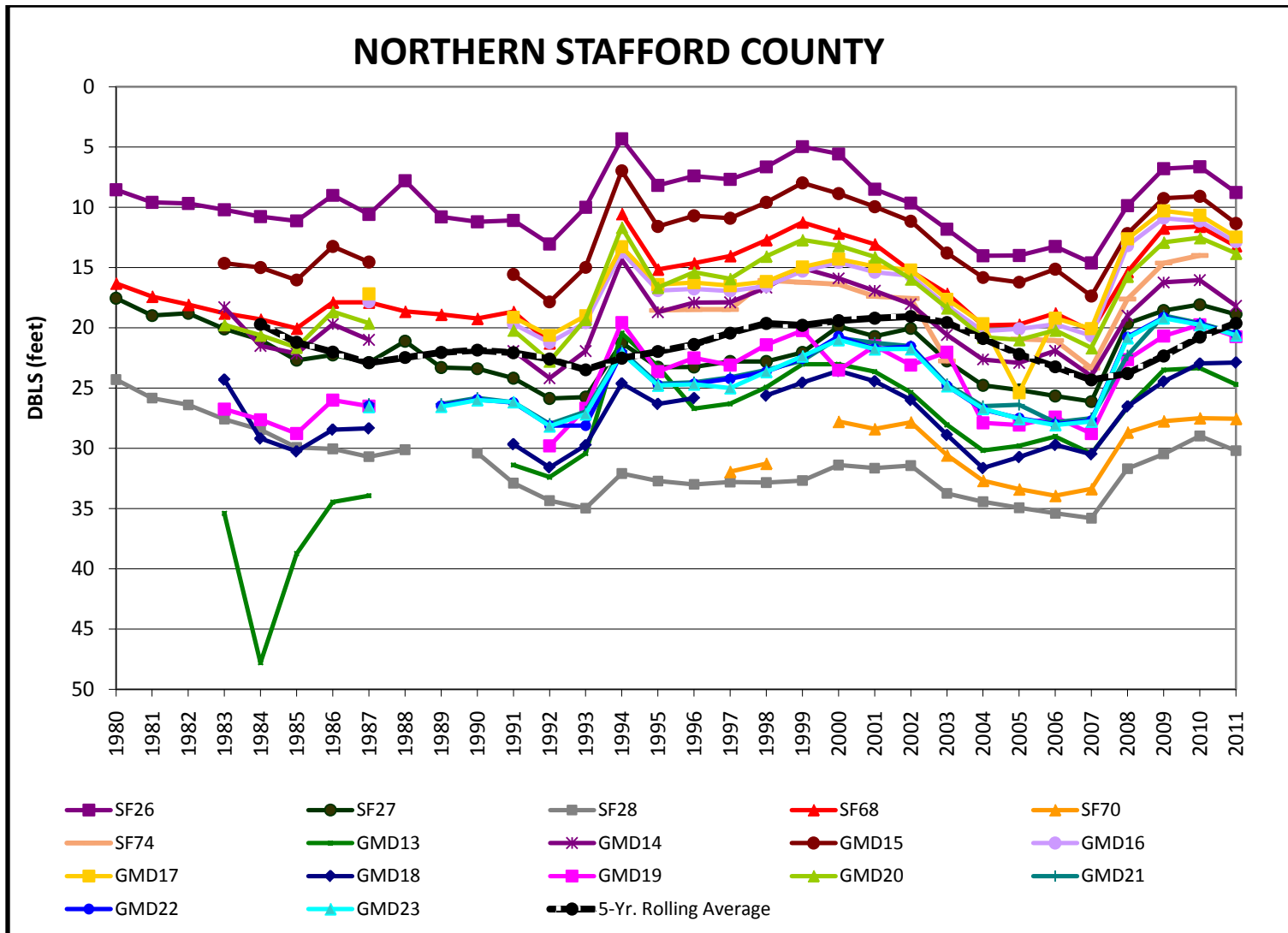


Figure 11: Groundwater Levels in Northern Stafford County Subsection

Northern Stafford County has 17 monitoring wells (Figure 11). Only one monitoring well had a rise in water levels (GMD18), SF74 went unmeasured and the other 15 wells had declines in water levels. The average change in water levels for 2011 was a decline of 1.24 feet. The five-year rolling average continued to increase.

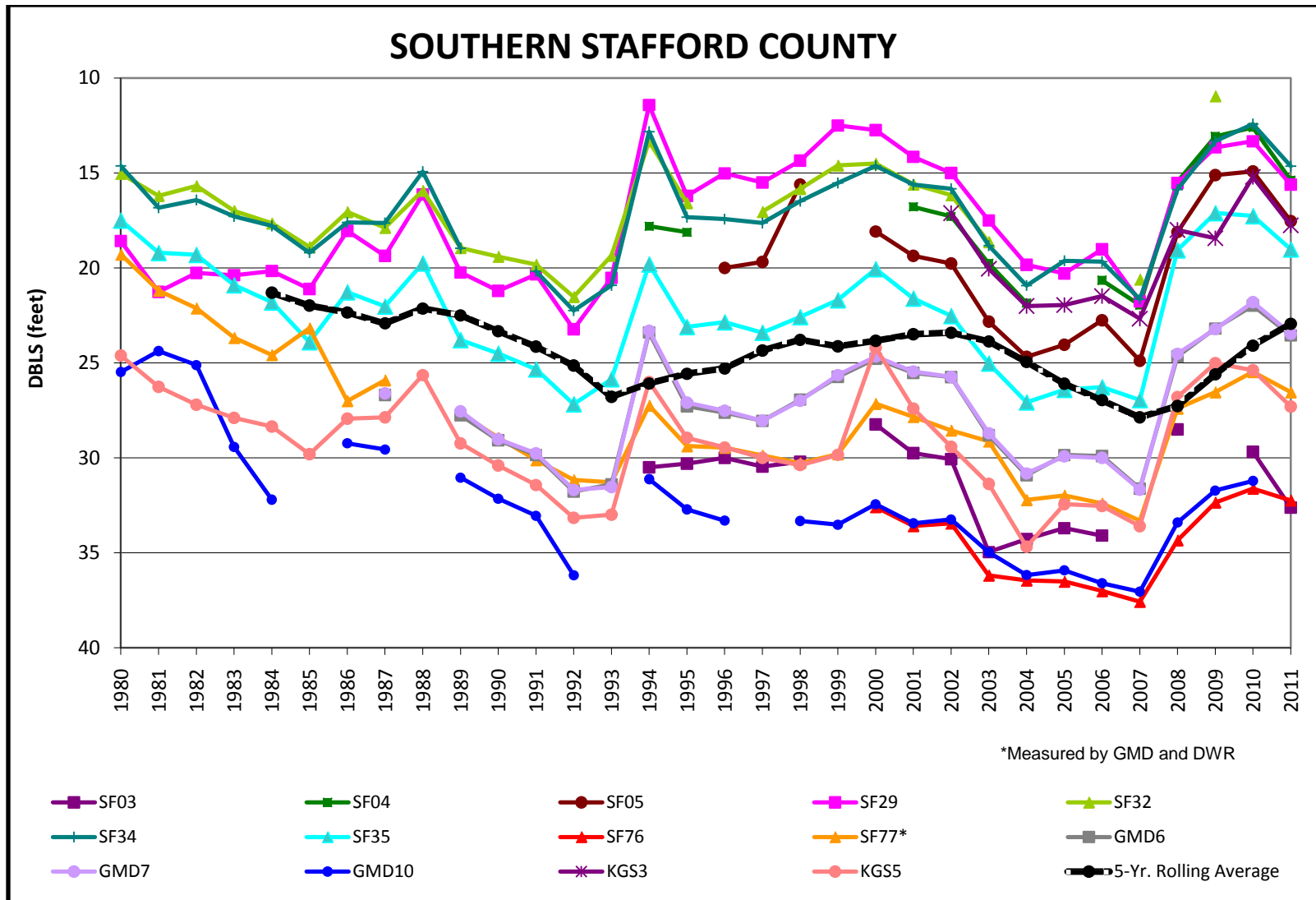


Figure 12: Groundwater Levels in Southern Stafford County Subsection

Southern Stafford County has 14 monitoring wells (Figure 12). Twelve of the fourteen monitoring wells had a decline in water levels. The two other monitoring wells were not able to be measured. The average change in water levels was a decline of 2.0 feet. Even with the declines in water levels, the five-year rolling average had an increase.

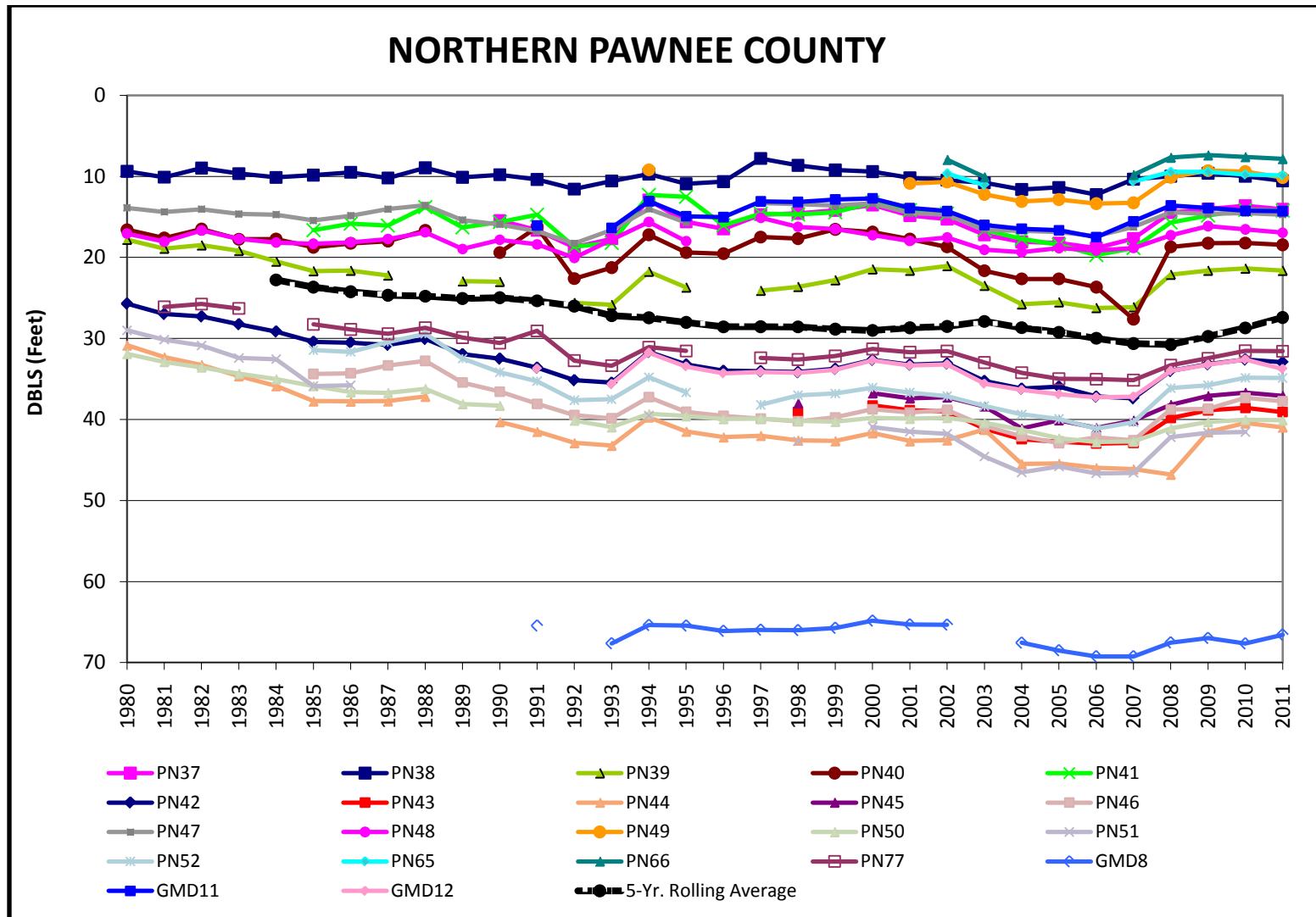


Figure 13: Groundwater Levels in Northern Pawnee County Subsection

Figure 13 displays 22 monitoring wells in northern Pawnee County. Only one monitoring well (GMD8) had an increase in water levels, one was unmeasured and the other 20 had declines in water levels. The average change in water levels was a decline of 0.27 feet. The five-year rolling average has a net decline, but has risen the last three years.

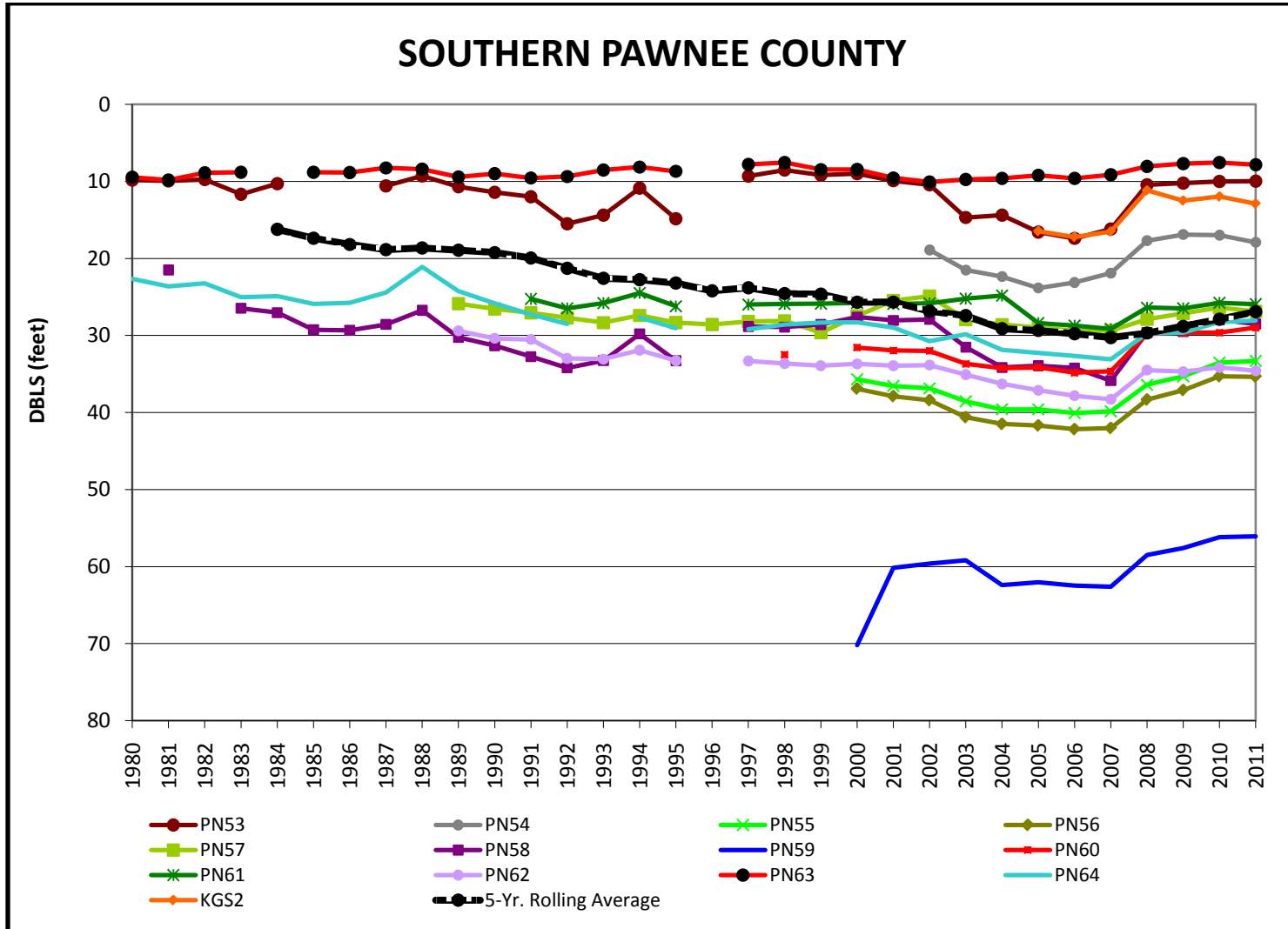


Figure 14: Groundwater Levels in Southern Pawnee County Subsection

The 13 monitoring wells in southern Pawnee County react similarly to those in the northern part of the county (Figure 14). Nine of the 13 monitoring wells had a decline in water levels in 2011. The average change in water levels was a decline of 0.25 feet. The five-year rolling average had an increase in 2011, but it has a net decline over the period of record.

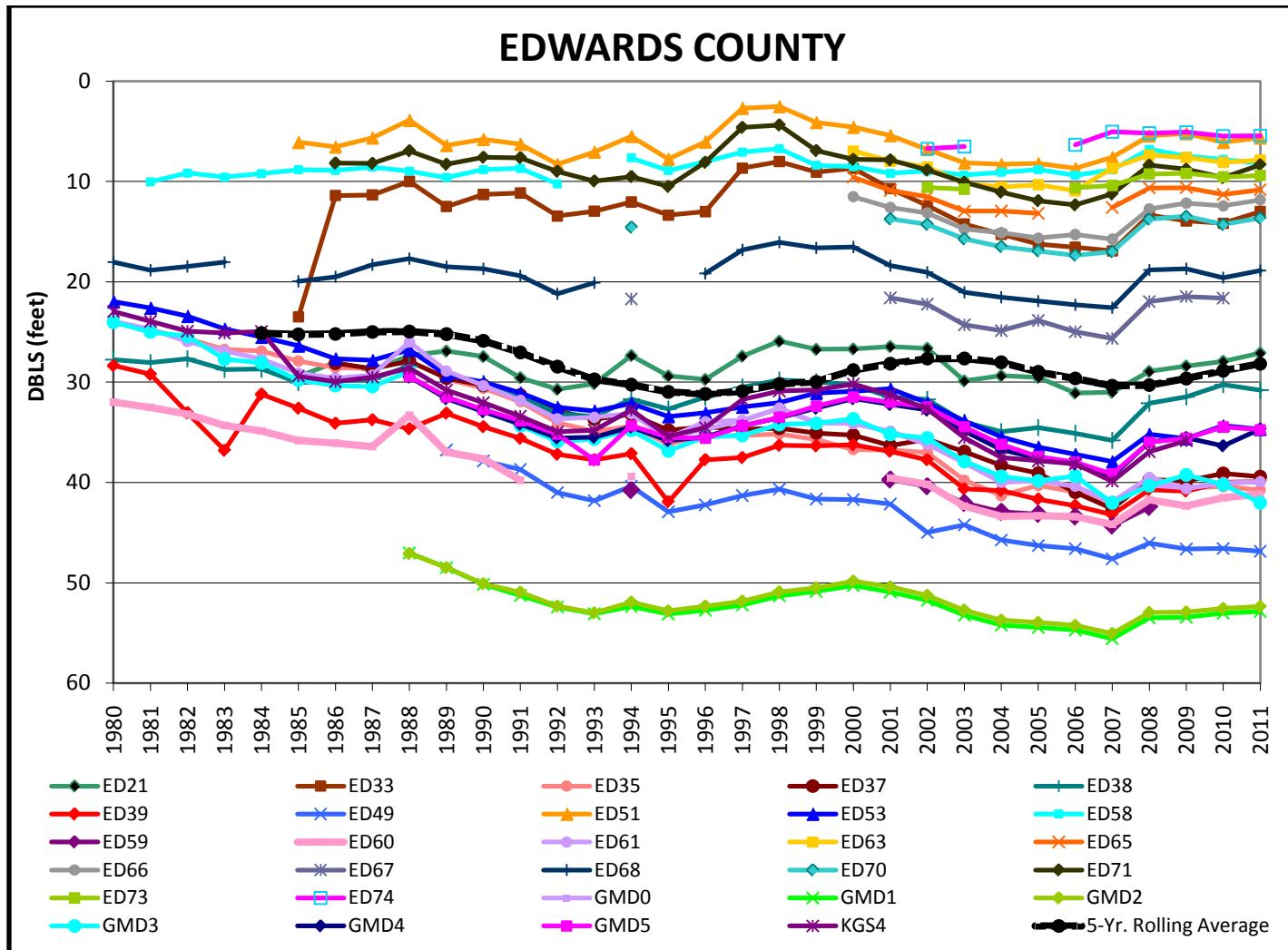


Figure 15: Groundwater Levels in Edwards County

Edwards County has 29 monitoring wells (Figure 15) and 26 were measured in 2011. Most of the water levels in Edwards County have a gradual downward trend. Eighteen of the 26 monitored water levels increased in 2011. The average 2010 change in water levels throughout the county was 0.18 feet. The five-year rolling average increased 2011 but exhibits a net decline over the period of record.

V. Water Use

The Middle Arkansas River subbasin has a total of 1,451 water rights with an authorized quantity of 262,071 acre-feet. A very small percentage of the water rights in the subbasin are vested. Surface water rights make up less than 1 percent of the number of rights in the subbasin but almost 10 percent of the authorized quantity (Table 2). This is due to Kansas Department of Wildlife and Parks' Cheyenne Bottoms Wildlife Area in Barton County which hold the right to over 18,000 acre-feet of surface water. Appropriated groundwater rights are authorized for 232,117 acre-feet per year. Irrigation, stock, domestic, recreation, industrial and municipal water rights are used for this water use analysis (Figure 17).

Table 2: Water Rights and Authorized Quantities in the Middle Arkansas Subbasin

Source	Type	No. of Rights	Authorized Quantity (AF)
Surface	Vested	1	75
Ground	Vested	46	5,488
Surface	Appropriated	6	24,391
Ground	Appropriated	1,398	232,117

Water use in the subbasin ranged from 200,537 acre-feet in 1991 to 89,412 acre-feet in 1993. The average water use over the twenty year span was 154,648 acre-feet (Figure 16). Water use in the late 1990s tended to be below average. However, the early 2000s were a time of higher water use. Water use in 2009, the most recent year for which complete records are available, was 139,739 acre-feet, which is higher than 2008 and below the historical average.

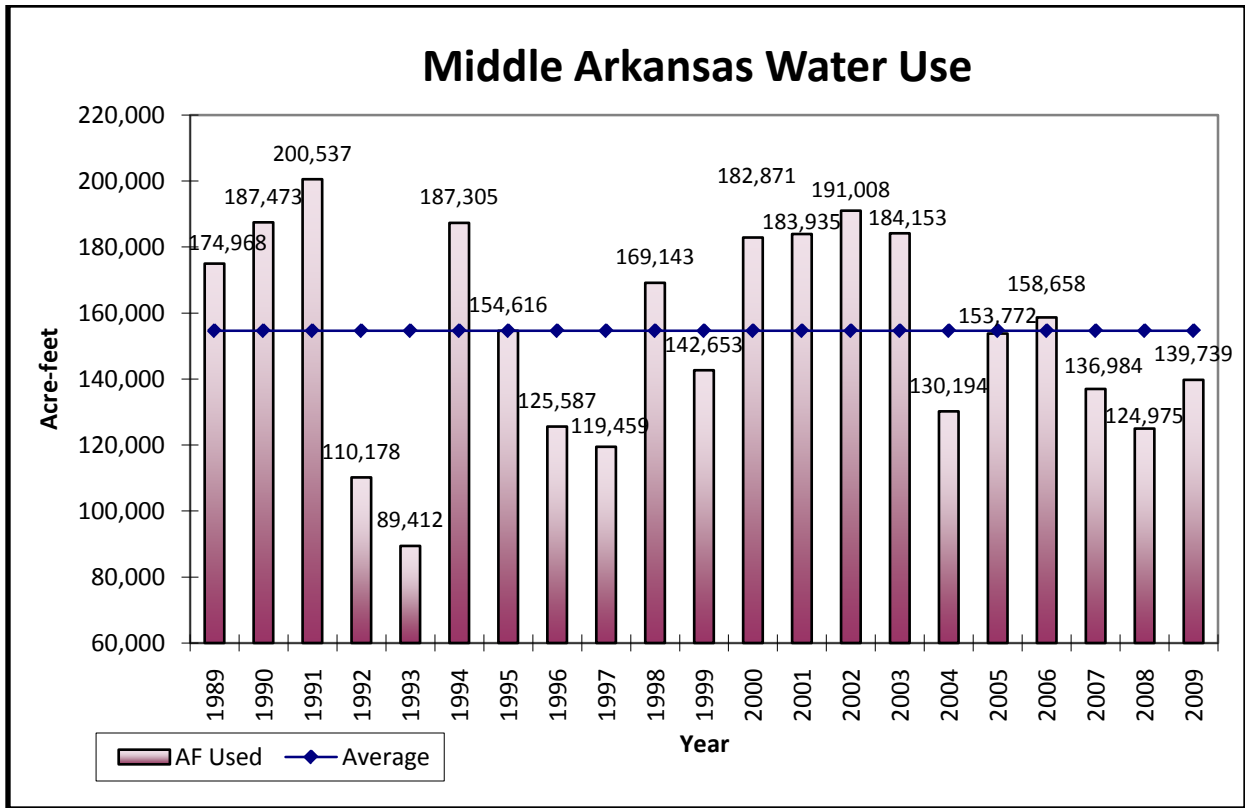


Figure 16: Middle Arkansas Subbasin Water Use 1989-2009

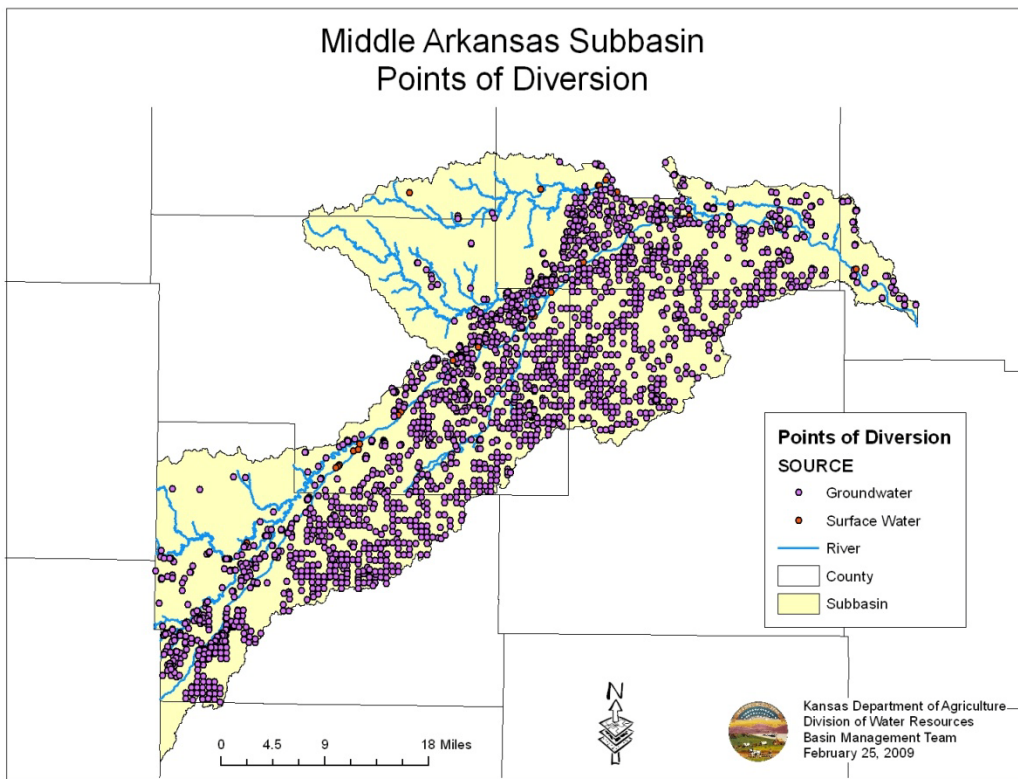


Figure 17: Middle Arkansas Points of Diversion

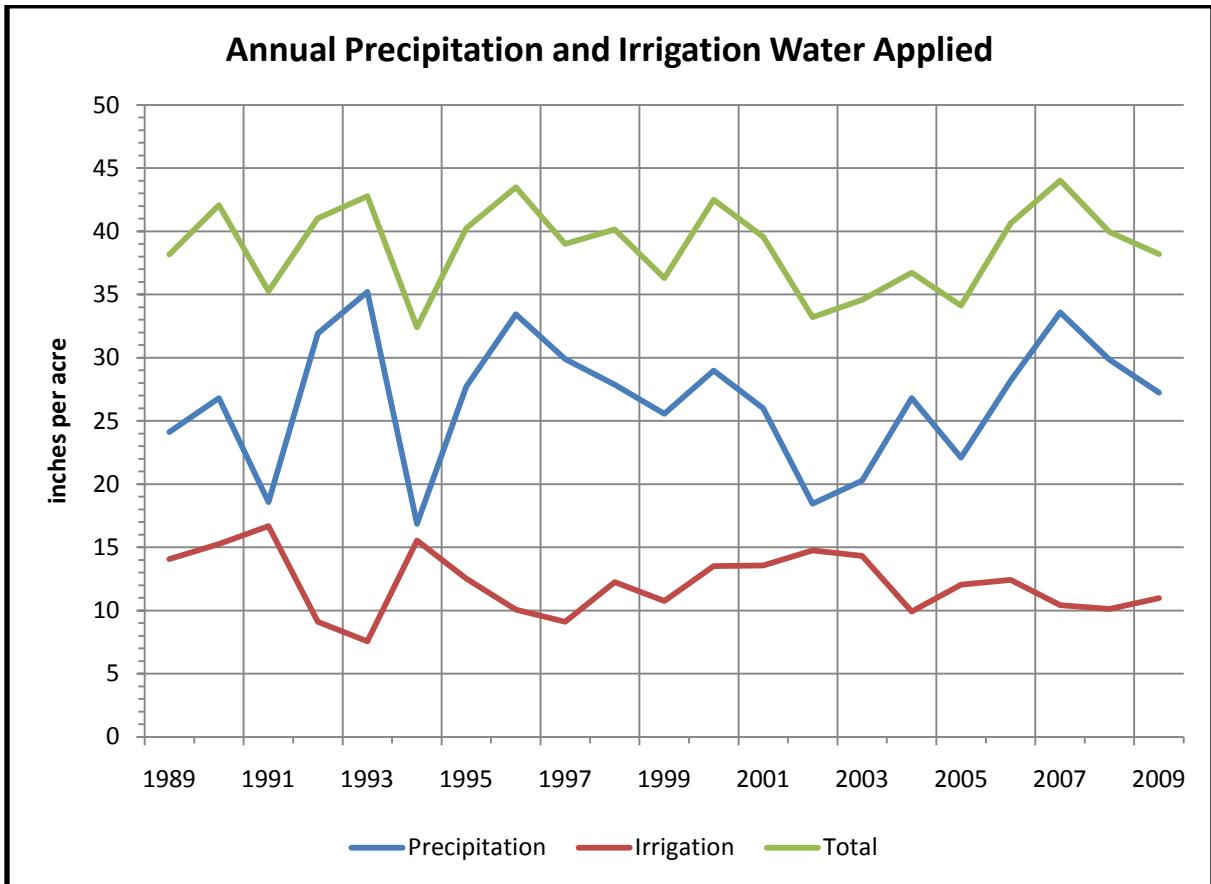


Figure 18: Annual Precipitation and Irrigation (inches per acre) 1989-2009

Since 1989, the Middle Arkansas subbasin averaged 26.64 inches of precipitation and 12.15 inches of irrigation pumping (Figure 18) but there is significant variability in both of those figures. Irrigators in the subbasin pump more water in drier years to compensate for the lack of precipitation. In 2009, the subbasin received 27.23 inches in precipitation and pumped 10.98 inches. Irrigation season precipitation (Figure 19) averages 19.27 inches, which is over five inches below the annual average.

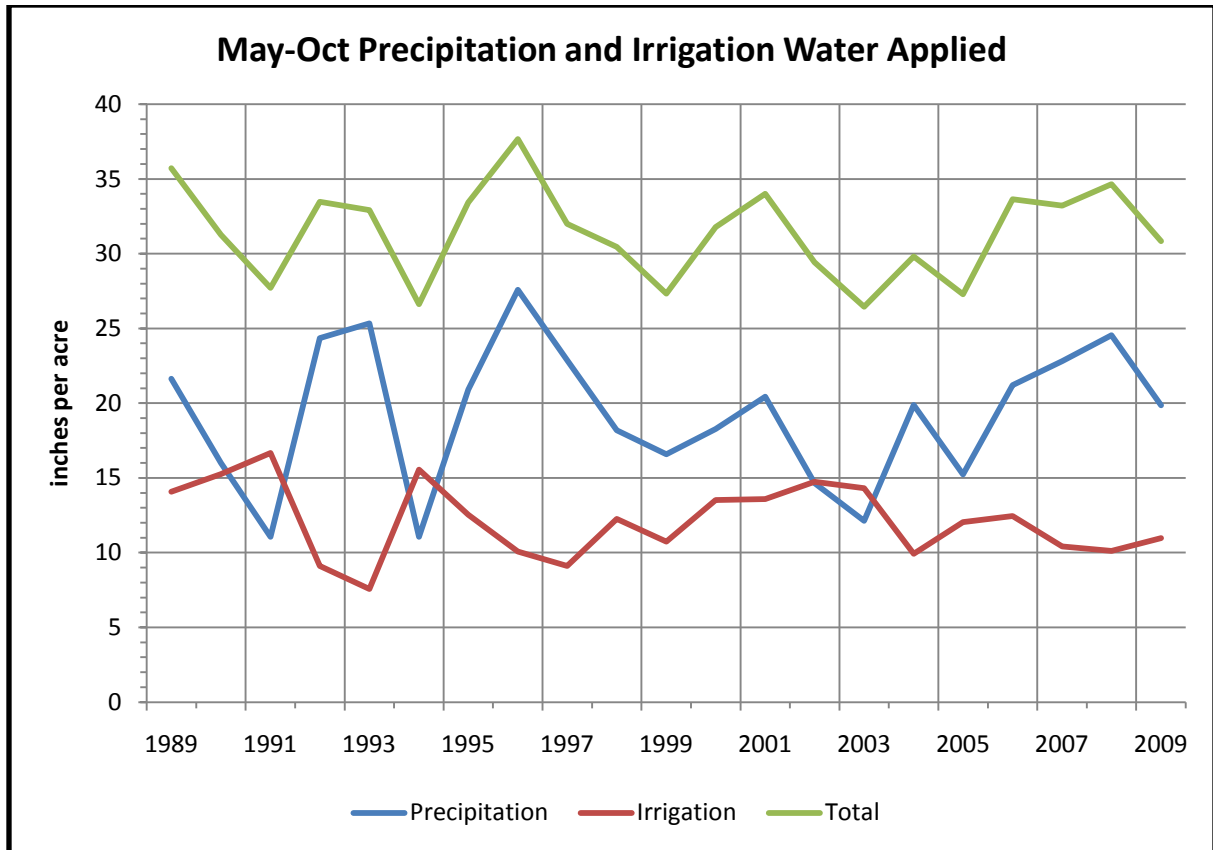


Figure 19: May-October Precipitation and Irrigation (inches per acre) 1989-2009

VI. Conclusions

Precipitation in the Middle Arkansas River subbasin was slightly above average in 2009. MDS values were met 100 percent of the time at the Great Bend USGS gage during 2010. Many of the water levels throughout the subbasin declined in 2011 compared to 2010. Water use increased in 2009 but was still below the subbasin average. It is important to continue to increase our understanding of the impacts of pumping, how fast the system recovers after recharge events, and other characteristics of the hydrologic system in order to evaluate the long-term effects of water usage on this subbasin, protect property rights, and ensure the benefits of these water resources to future generations.

VII. Appendix

GMD #5 Weather Stations			
S-T-R	Station	County	
NW 5-28-18	Greensburg	KW	
NW 30-24-17	Lewis	ED	
SW 5-22-18	Rozel	PN	
SW 6-22-14	Radium	SF	
SW 18-19-13	Great Bend	BT	
Monitoring Wells			
Location	Code	County	USGS_ID

21S 13W 06NWSWSW 03	GMD23	SF	381517098480503
21S 13W 06NWSWSW 02	GMD22	SF	381517098480502
21S 13W 06NWSWSW 01	GMD21	SF	381517098480501
21S 12W 06SWSWNW 03	GMD20	SF	381456098412803
21S 12W 06SWSWNW 02	GMD19	SF	381456098412802
21S 12W 06SWSWNW 01	GMD18	SF	381456098412801
21S 14W 09NWNWSE 01	SF70	SF	381439098522201
21S 13W 13NESWSE 01	SF68	SF	381338098414301
21S 14W 22NENESW 01	SF27	SF	381253098503401
21S 13W 27SESESE 02	SF26	SF	381120098434802
21S 14W 32NWNESW 01	SF28	SF	381108098531801
21S 14W 36SESESE 02	GMD17	SF	381030098481302
21S 14W 36SESESE 01	GMD16	SF	381030098481301
21S 12W 31SWSWSW 03	GMD15	SF	381028098413003
21S 12W 31SWSWSW 02	GMD14	SF	381028098413002
21S 12W 31SWSWSW 01	GMD13	SF	381028098413001
22S 12W 05NWNWSE 01	KGS7	SF	381015098401201
22S 13W 05SWSWSW 01	SF32	SF	380948098465901
22S 14W 07NENESW 01	GMD10	SF	380923098535101
22S 13W 12SWNESW 02	KGS3	SF	380855098421602
22S 13W 08SESENW 01	SF04	SF	380849098460901
22S 13W 17NENESW 01	SF05	SF	380832098461001
22S 14W 18NESWSW 01	SF76	SF	380830098535101
22S 14W 14SWSWNE 01	SF35	SF	380757098500901
21S 13W 22SWNWSW 01	SF74	SF	380703098443801
22S 14W 29NWNWSE 01	SF77*	SF	380652098532601
22S 14W 28NWSWNE 01	SF03	SF	380642098522101
22S 13W 29SENESE 01	KGS6	SF	380617098460101
22S 14W 35SESENW 01	KGS5	SF	380519098492701
23S 13W 06NWNWNW 02	GMD7	SF	380509098480402
23S 13W 06NWNWNW 01	GMD6	SF	380509098480401
23S 14W 03NW 01	KGS1	SF	380456098511001
20S 10W 27 NWNWNW 01	RC01	RC	381718098251501
21S 10W 06 NENESE 03	GMD26	RC	381529098271803
21S 10W 06 NENESE 02	GMD25	RC	381529098271802
21S 10W 06 NENESE 01	GMD24	RC	381529098271801
21S 15W 11SWNWNW 01	PN38	PN	381419098565201
21S 16W 14NESESW 01	PN41	PN	381333099025001
21S 15W 17SWSWSW 01	PN37	PN	381316098595801
21S 15W 24NWNWSE 01	PN39	PN	381253098553801
21S 15W 30NENWNE 01	PN66	PN	381210099003401
21S 15W 29NWNENE 01	PN65	PN	381210098594601
21S 15W 31NWNENE 01	PN40	PN	381108099005301
22S 15W 03NENENE 04	GMD12	PN	381025098565901
22S 15W 03NENENE 02	PN42	PN	381022098570002
22S 15W 03NENENE 01	PN77	PN	381022098570001
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22S 16W 03SWNWSW 02	PN47	PN	380949099043602
22S 16W 06SWSWSW 01	PN49	PN	380939099074901
22S 15W 07NESESE 01	PN43	PN	380927099001801
22S 17W 12SWNWNW 01	GMD9	PN	380903099090101
22S 16W 15NESESE 01	GMD8	PN	380820099033401
22S 15W 15SWNWNW 01	PN45	PN	380815098575801
22S 15W 13SESWNE 01	PN44	PN	380758098550501
22S 16W 23NENENE 01	PN50	PN	380744099023201
22S 17W 24SWNWSW 01	PN53	PN	380712099090001
22S 17W 27NWNWSE 01	PN54	PN	380648099105801
22S 16W 28NWSWSE 01	PN51	PN	380645099053301
22S 17W 36NWNENE 01	PN56	PN	380556099083901
22S 17W 36SW 01	PN55	PN	380523099084701
22S 16W 32SWSESE 01	PN52	PN	380513099062201
22S 15W 33SESESE 01	PN46	PN	380513098580601
23S 17W 12NWNWSW 02	PN59	PN	380412099085601
23S 16W 11SWSESW 01	PN57	PN	380328099031201
23S 17W 16SESENE 01	PN60	PN	380246099112401
23S 18W 13SESESE 01	KGS2	PN	380240099142901
23S 17W 25NENESW 01	PN61	PN	380131099080901
23S 18W 28SENESE 01	PN63	PN	380105099174801
23S 18W 36SENESE 01	PN64	PN	380013099143901
23S 17W 33SWSWNE 02	PN62	PN	380005099121102
23S 16W 35SWSWSE 02	PN58	PN	375958099032002
24S 16W 05SWNW 02	GMD5	ED	375926099064002
24S 16W 05SWNW 01	GMD4	ED	375926099064001
24S 17W 12NESWNE 01	ED53	ED	375847099081601
24S 18W 17NENWSE 01	ED38	ED	375801099191001
24S 18W 13SENESE 01	ED37	ED	375732099144301
24S 17W 20NESESE 01	ED35	ED	375655099123501
24S 17W 24SESESE 01	KGS4	ED	375629099075901
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24S 19W 26SWSESE 01	ED74	ED	375544099224201
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25S 20W 03NWSWSE 01	ED21	ED	375406099303401
25S 18W 06SWSWSW 01	ED59	ED	375358099205601
25S 19W 01SESESW 02	GMD2	ED	375357099211202
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20S 14W 13SESE 01	BT20	BT	381827098485101
20S 13W 17SESE 01	BT18	BT	381821098463901
20S 11W 17SWSWSE 01	BT09	BT	381819098340601
20S 11W 19NESWSW 01	BT10	BT	381753098344701
20S 15W 24NESESE 01	BT24	BT	381750098552101
20S 15W 24SENWSE 01	BT25	BT	381739098552101
20S 13W 24SESWNW 01	BT19	BT	381734098423001
20S 12W 23SWSWNE 01	BT17	BT	381734098372501
20S 14W 22SWSESW 01	BT21	BT	381725098514101
20S 11W 26NENESW 01	BT12	BT	381714098300701
20S 15W 25NESWSW 01	BT26	BT	381701098554601
20S 14W 31NENESW 01	BT22	BT	381622098542301
20S 15W 33NESESE 01	BT27	BT	381614098583801
20S 15W 36NESWSW 01	BT28	BT	381610098554601
20S 13W 31SE 01	KGS8	BT	381554098474901