



Middle Arkansas River

2008 Field Analysis Summary

Subbasin Water Resource Management Program

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I. Introduction

In 1998, the Kansas Department of Agriculture, Division of Water Resources (KDA-DWR) formed a group of local stakeholders to address water resources within the Middle Arkansas River subbasin through the Subbasin Water Resource Management Program (SWRMP). The project required field verification to obtain an understanding of the water resource conditions within the area while incorporating long-term objectives and management solutions. Field verification activities include streamflow measurements and groundwater level measurements, thus allowing a better understanding of the stream-aquifer interaction between the Great Bend Prairie aquifer (High Plains) and the Arkansas River.

The Middle Arkansas River subbasin has an area of approximately 781,455 acres, including parts 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. Groundwater levels are generally shallower along river corridor and become deeper in portions away from river areas.

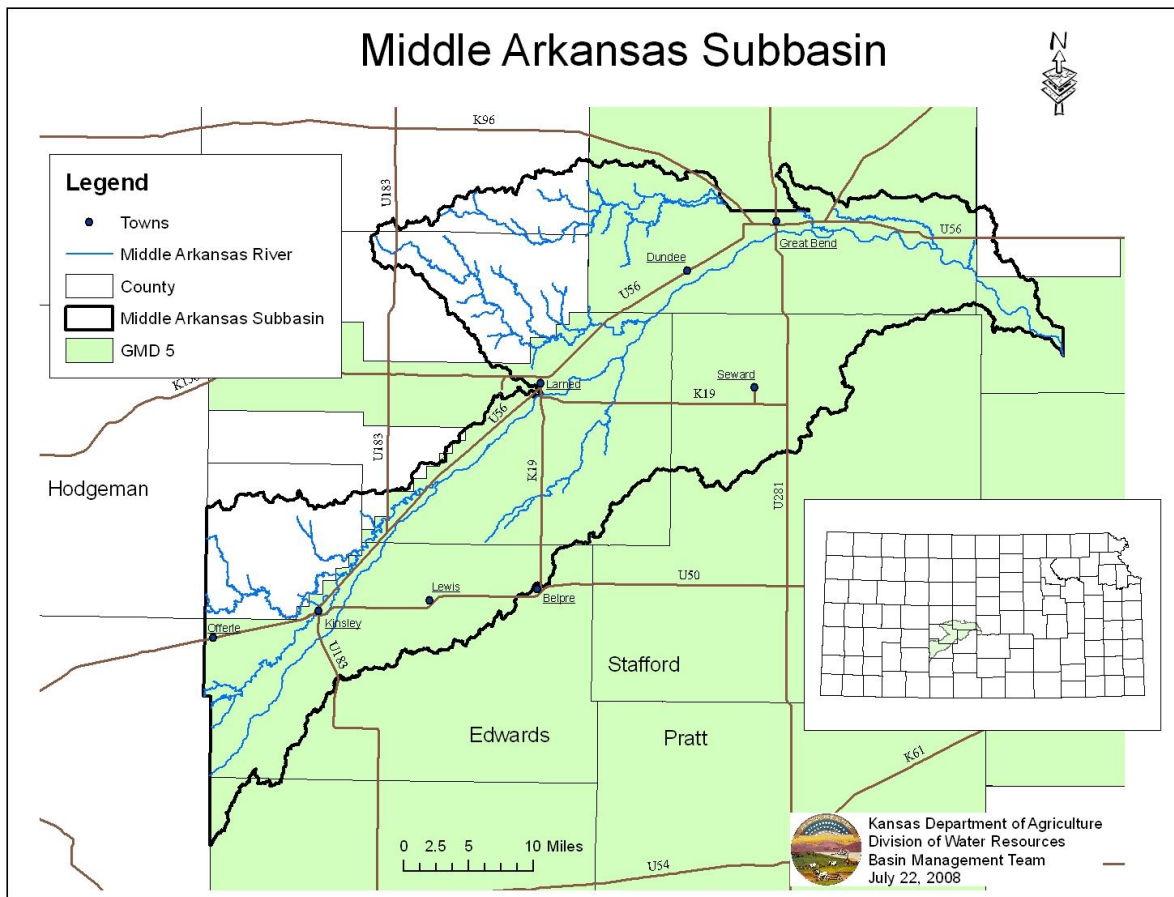


Figure 1: Middle Arkansas River Subbasin

Precipitation averages 25.02 in. per year in this region with highly variable climatic conditions; some areas receive large amounts of rainfall while other areas lack significant rainfall. Water levels respond differently across the subbasin. Areas around 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

Average precipitation in the Middle Arkansas subbasin is based on four precipitation stations located at: Kinsley in Edwards County, Larned in Pawnee County, Great Bend in Barton County, and Albert 5 SE in Barton County. Figure 2 shows the annual variation in precipitation. This chart was derived from National Climatic Data Center (NCDC) weather stations. The chart shows the mid-1950s as a very dry period with 1956 being the lowest precipitation year at 12.14 in. The highest precipitation total occurred in 1973 with 41.75 in. of precipitation. The 1990's had several years of above average precipitation. Annual precipitation data from these NCDC stations is currently available through 2007.

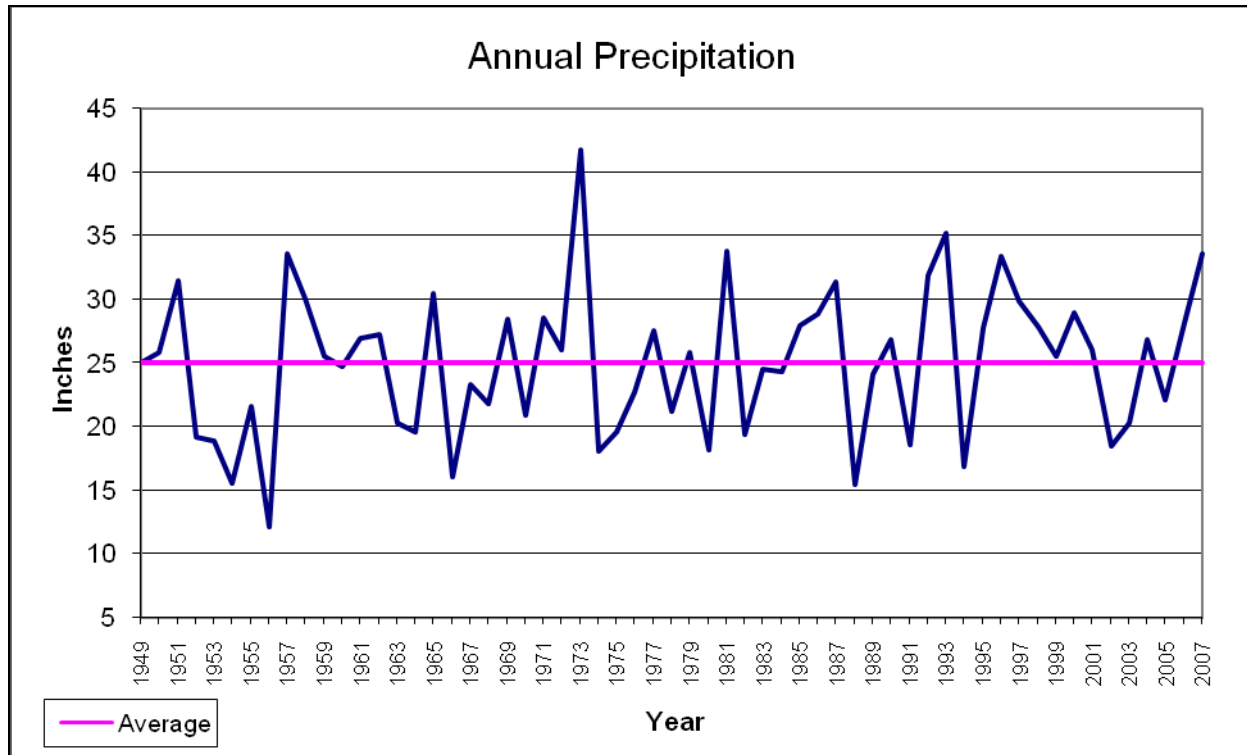


Figure 2: NCDC Annual Precipitation in Middle Arkansas Subbasin 1949-2007

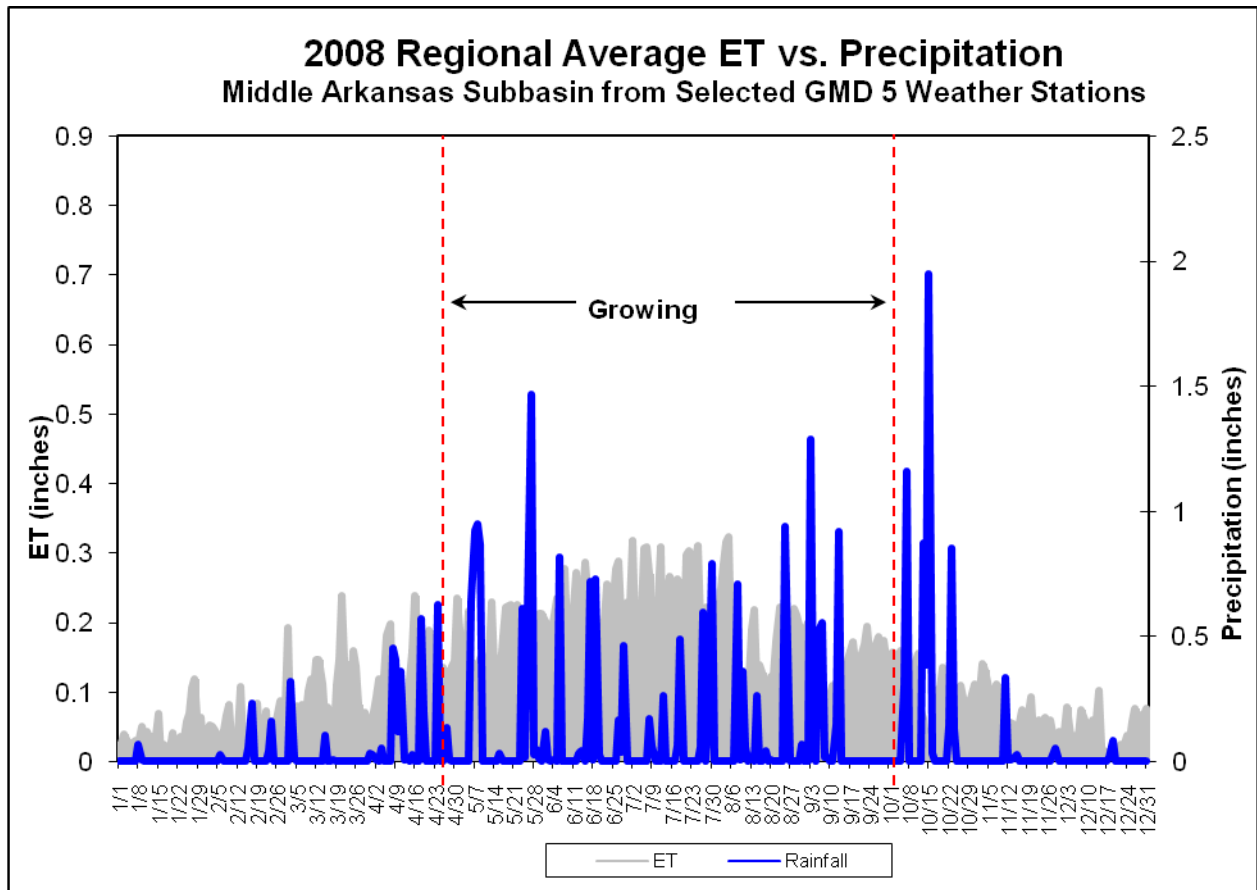


Figure 3: GMD #5 Evapotranspiration and Precipitation

Figure 3 graphs the 2008 evapotranspiration and precipitation conditions in the Middle Arkansas subbasin. This information comes from three GMD #5 weather stations including: Great Bend, Lewis and Radium. The three stations received an average 29.1 in. of precipitation for 2008. This figure is significantly above the average 24.88 in. of precipitation documented over the period of record. Even with the above average precipitation, the subbasin still had a deficit of moisture because evapotranspiration totaled 41.85 in.

III. Surface Water

The Arkansas River flows easterly from the Colorado border until it reaches the Ford/Edwards County line. 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.

The SWRMP measures the flow of the Middle Arkansas River at 10 streamflow sites on a quarterly basis (Figure 4) with site 1 beginning at the Ford Bridge and continuing downstream to the confluence of the Arkansas River and Walnut Creek, near Great Bend (site 10). In addition, there are three USGS stream gage sites at Kinsley, Larned and Great Bend.

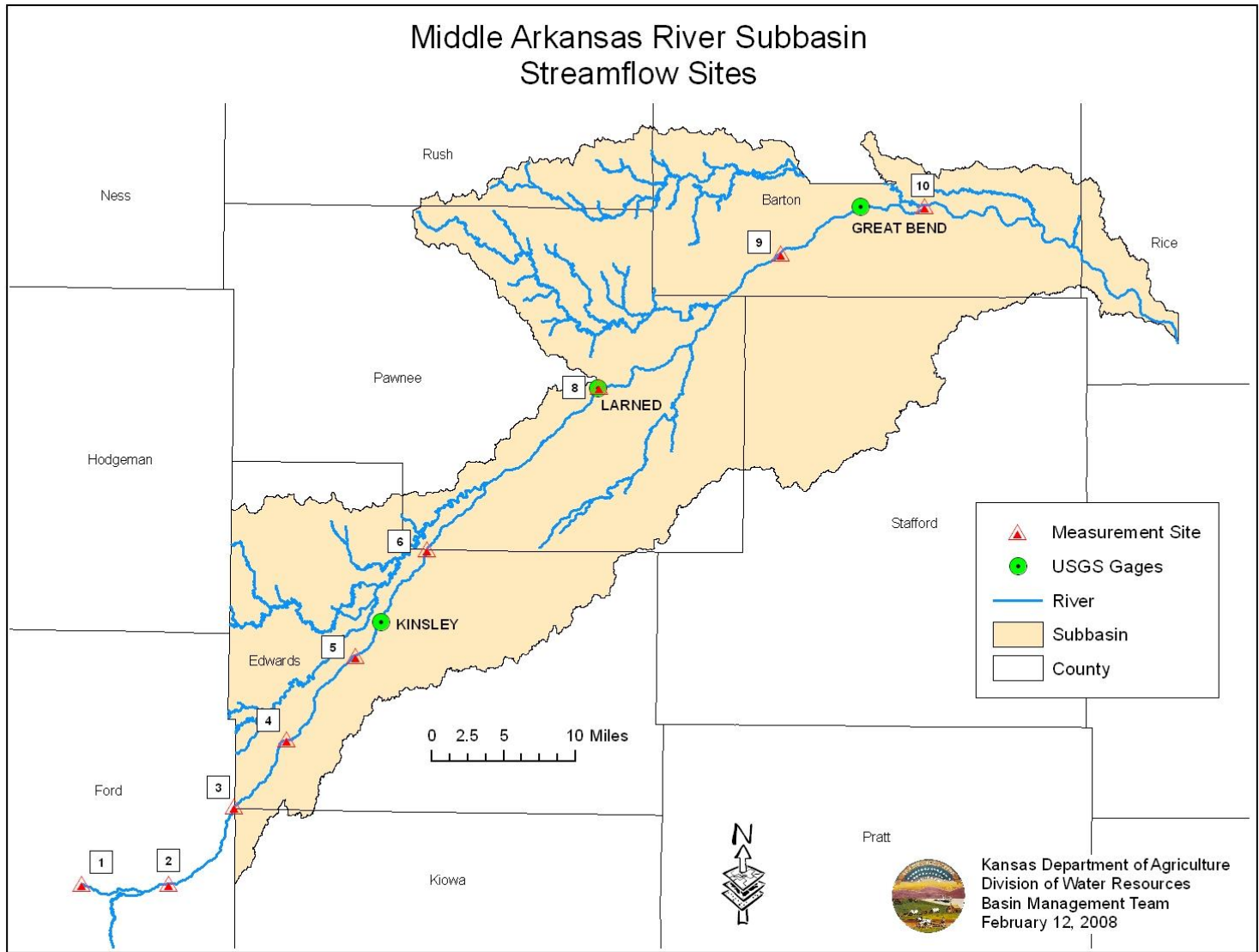


Figure 4: Streamflow Measurement Sites

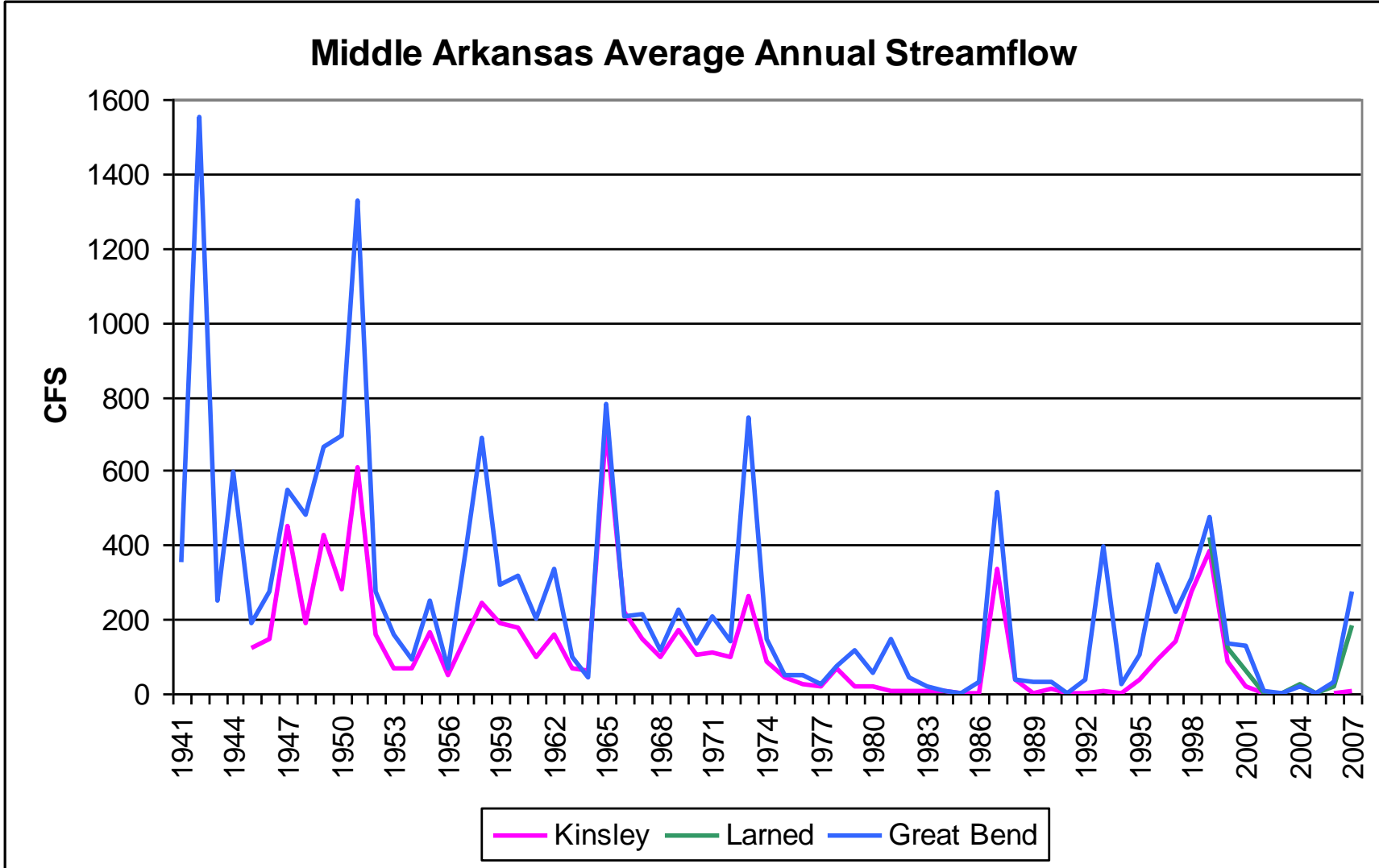


Figure 5: Streamflow at USGS Gages 1940-2007

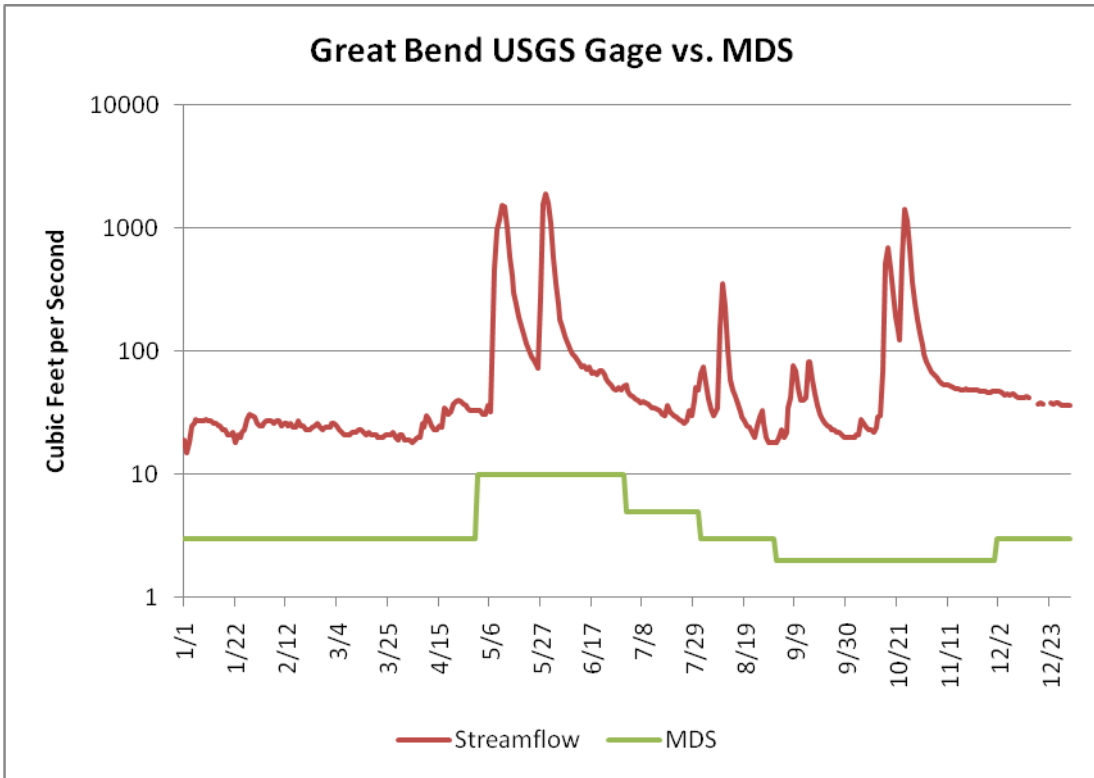


Figure 6: Great Bend USGS Streamflow and MDS in 2008

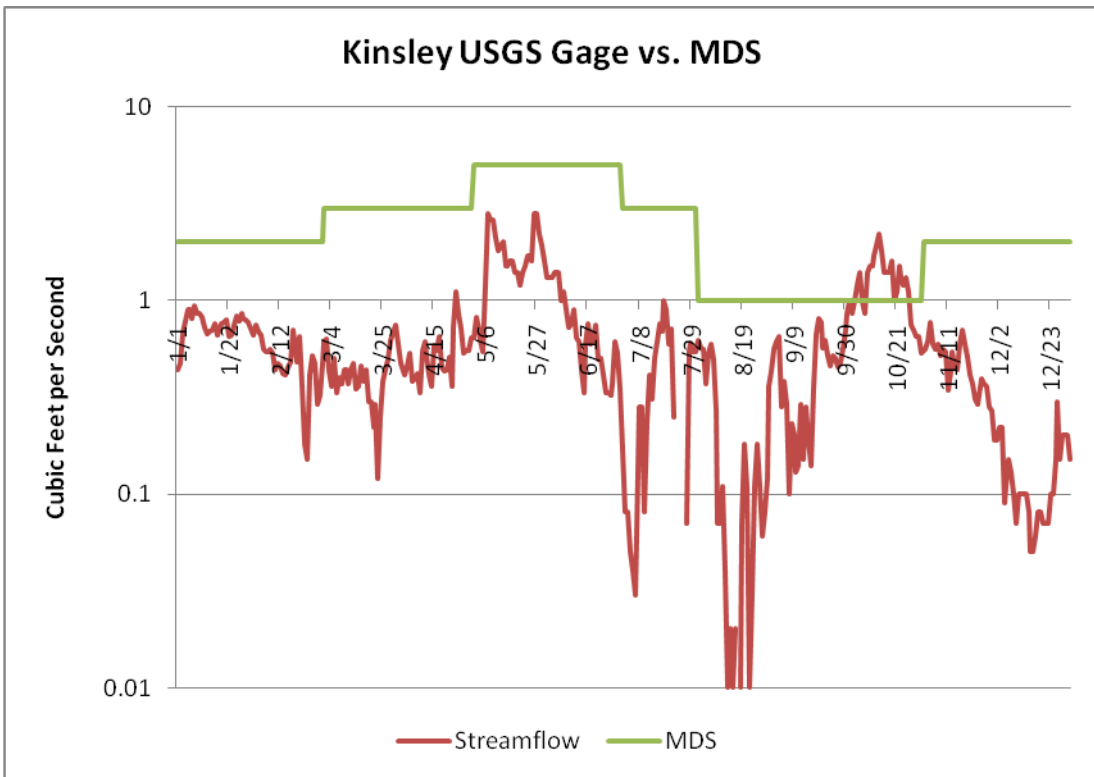


Figure 7: Kinsley USGS Gage Streamflow and MDS

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 123.15 cfs, Larned was 92.21 cfs and Great Bend was 250.30 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 18.30 cfs and Great Bend at 73.84 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 enacted by legislature if flow at a gage site fell below a set value for seven consecutive days. It would be lifted if flow continued above the value for fourteen consecutive days. 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 and Figure 7 show the streamflow measurements for 2008 in comparison to MDS values set at each gage. Flow at the Great Bend gage satisfied the MDS criteria for the entire year of 2008. Kinsley met MDS criteria for only a short period of time in the fall of 2008.

Since MDS was established in 1984, the frequency of streamflow at Kinsley below MDS criteria has been greater than at Great Bend. Figure 7 and Figure 8, show the low flow conditions at the Kinsley gage the majority of year and MDS criteria was not maintained. Kinsley did not meet MDS criteria for 355 days in 2008. On the other hand, high flows at the Great Bend gage resulted in MDS criteria not being for the entire year (Figure 6). MDS is not established at the Larned gage.

Figure 8 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.

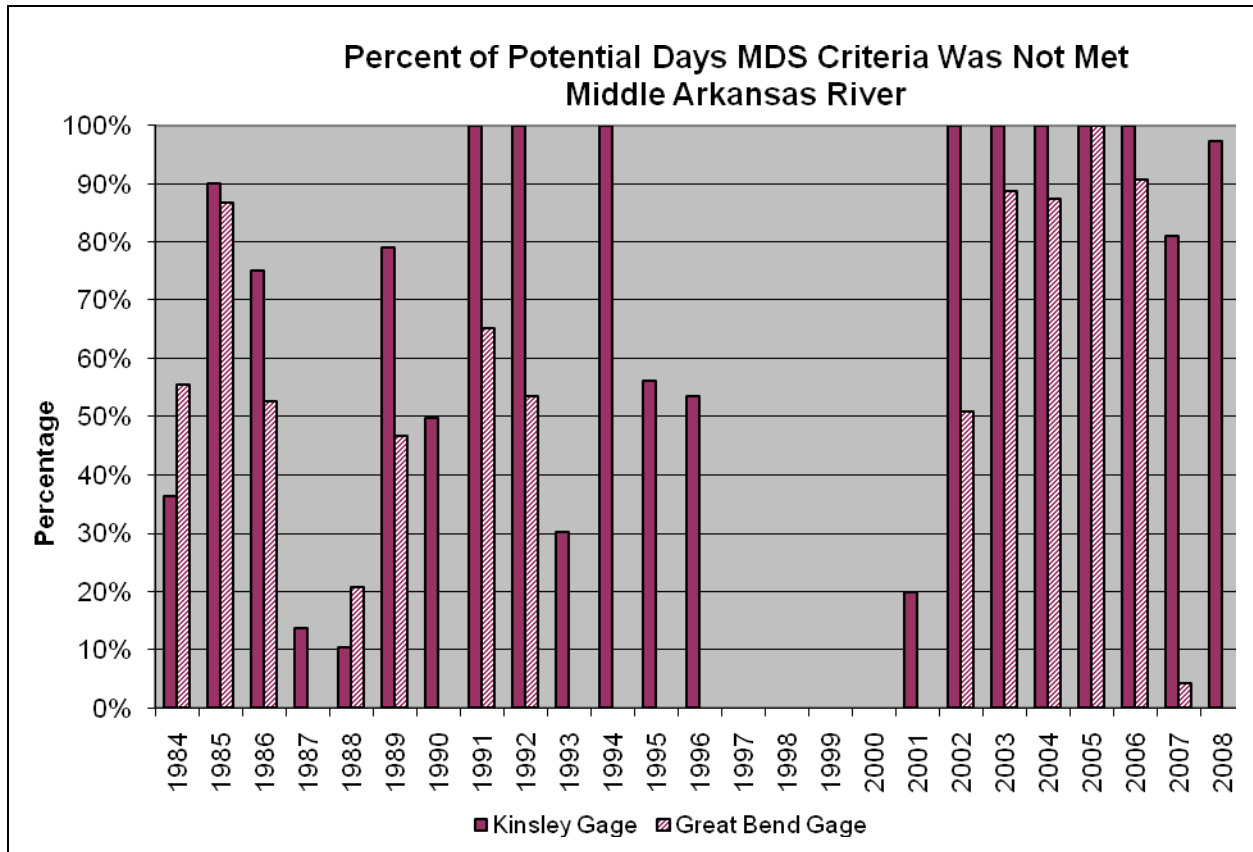


Figure 8: Streamflow and MDS Criteria

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 and measure 125 groundwater levels in the subbasin (Figure 9). SWRMP collects additional water level measurements tri-annually in the winter, spring and fall.

Only winter (December, January, and February) measurements are used for the monitoring well water level charts, since those measurements are considered to be the least influenced by irrigation well pumping. Figure 10 to Figure 16 chart groundwater levels in all the monitoring wells current and historic water levels. 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 current available data.

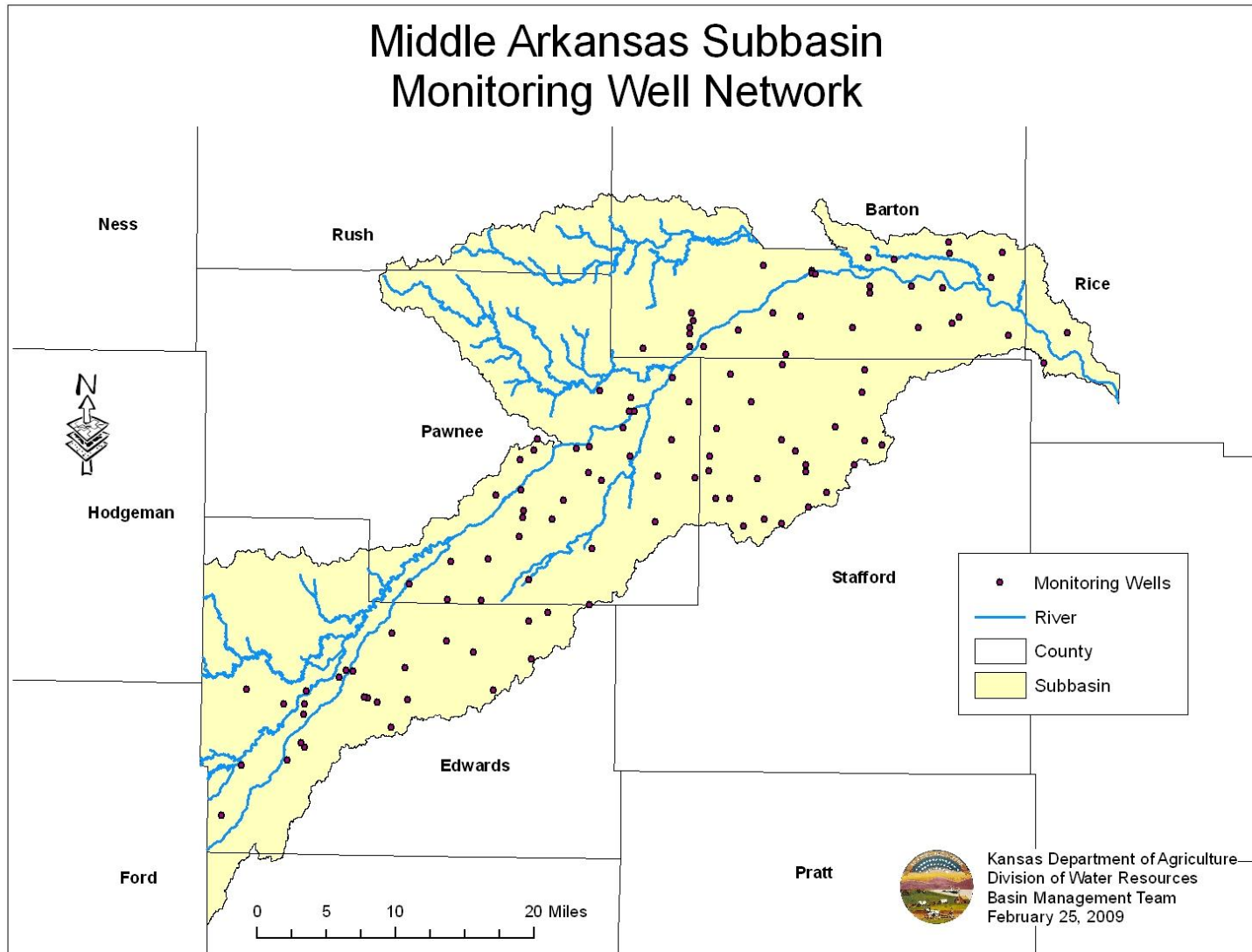


Figure 9: Middle Arkansas River Subbasin Monitoring Wells

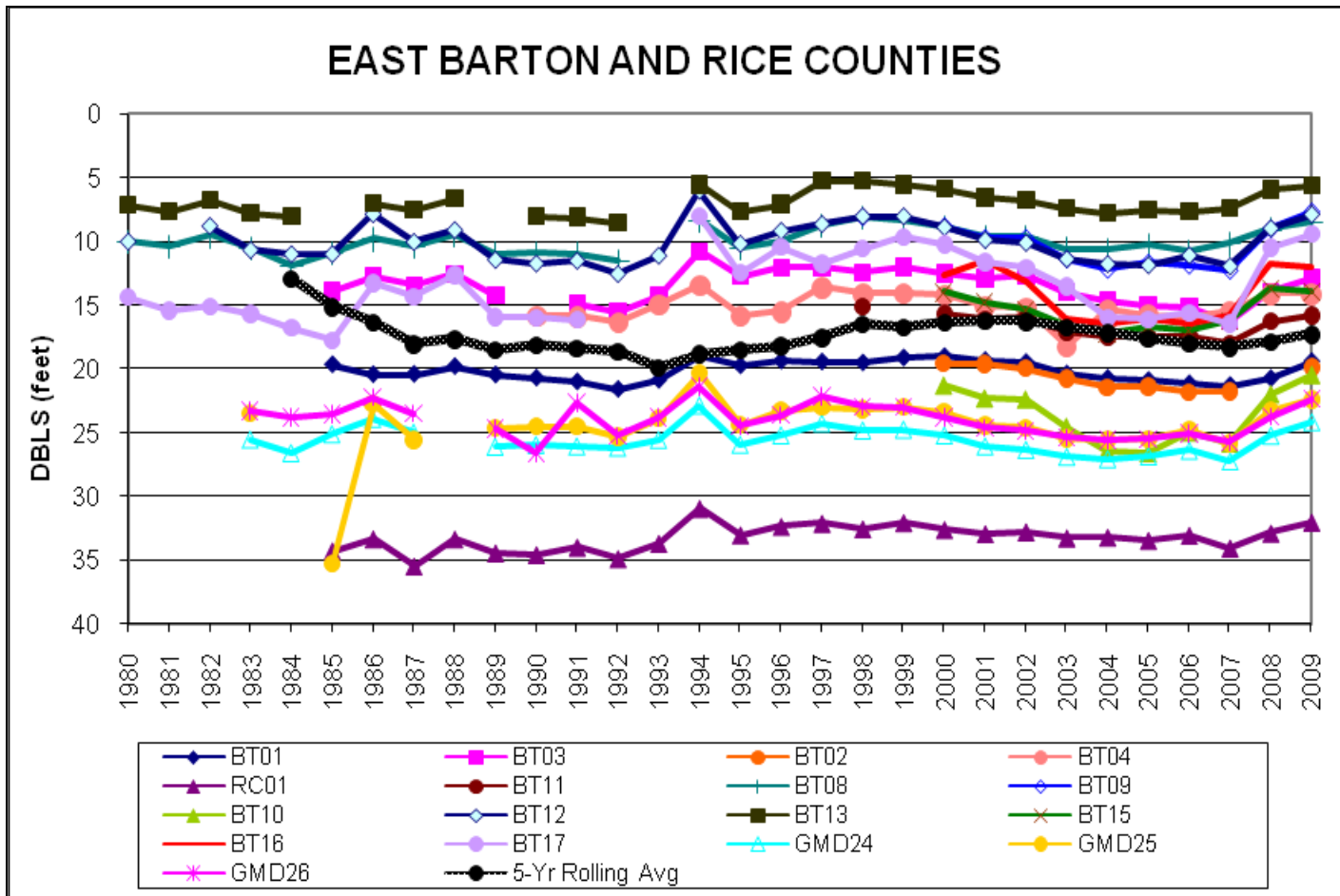


Figure 10: Groundwater Levels in Eastern Barton County Subsection and Rice County

East Barton and Rice counties have 17 monitoring wells (Figure 10). These wells show slight fluctuations in water levels until 1994. At this time, levels increase approximately two to three feet followed by a decline of similar magnitude in 1995. After a period of increase during the late 1990s, water levels started a downward trend from 1999 to 2007. The 2008 water levels were up for all the wells. Water levels continued to rise in 2009. The five-year rolling average exhibited a net decline of 4.34 ft over the period of record.

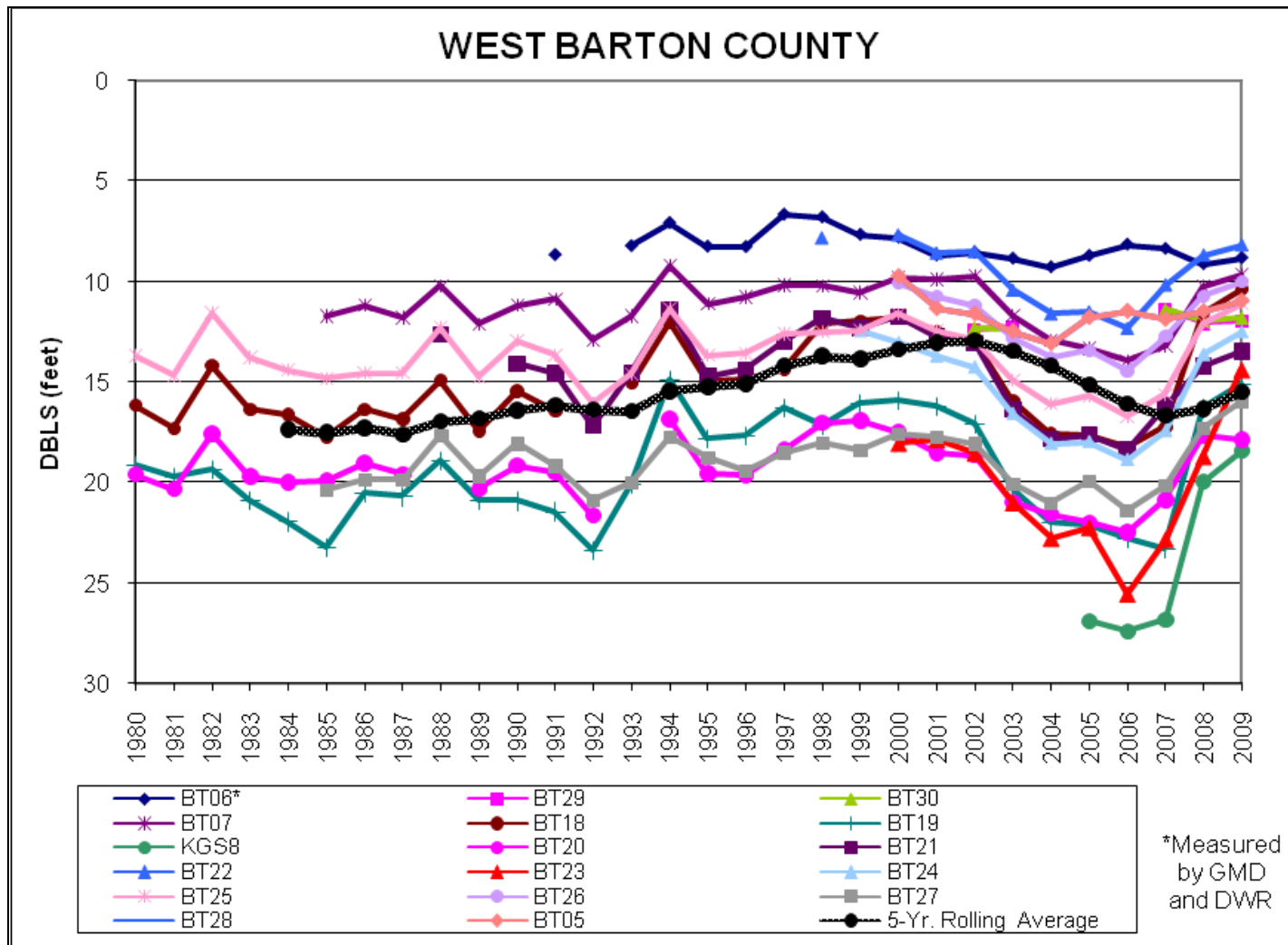


Figure 11: Groundwater Levels in Western Barton County Subsection

West Barton County has 18 monitoring wells (Figure 11). Many of the wells saw an increase in water levels in 2008, some by several feet. All the wells except for BT20 had an increase in water levels in 2009. The five-year rolling average declined for several years but has increased the past two years. It has a net increase of 1.86 ft since 1984.

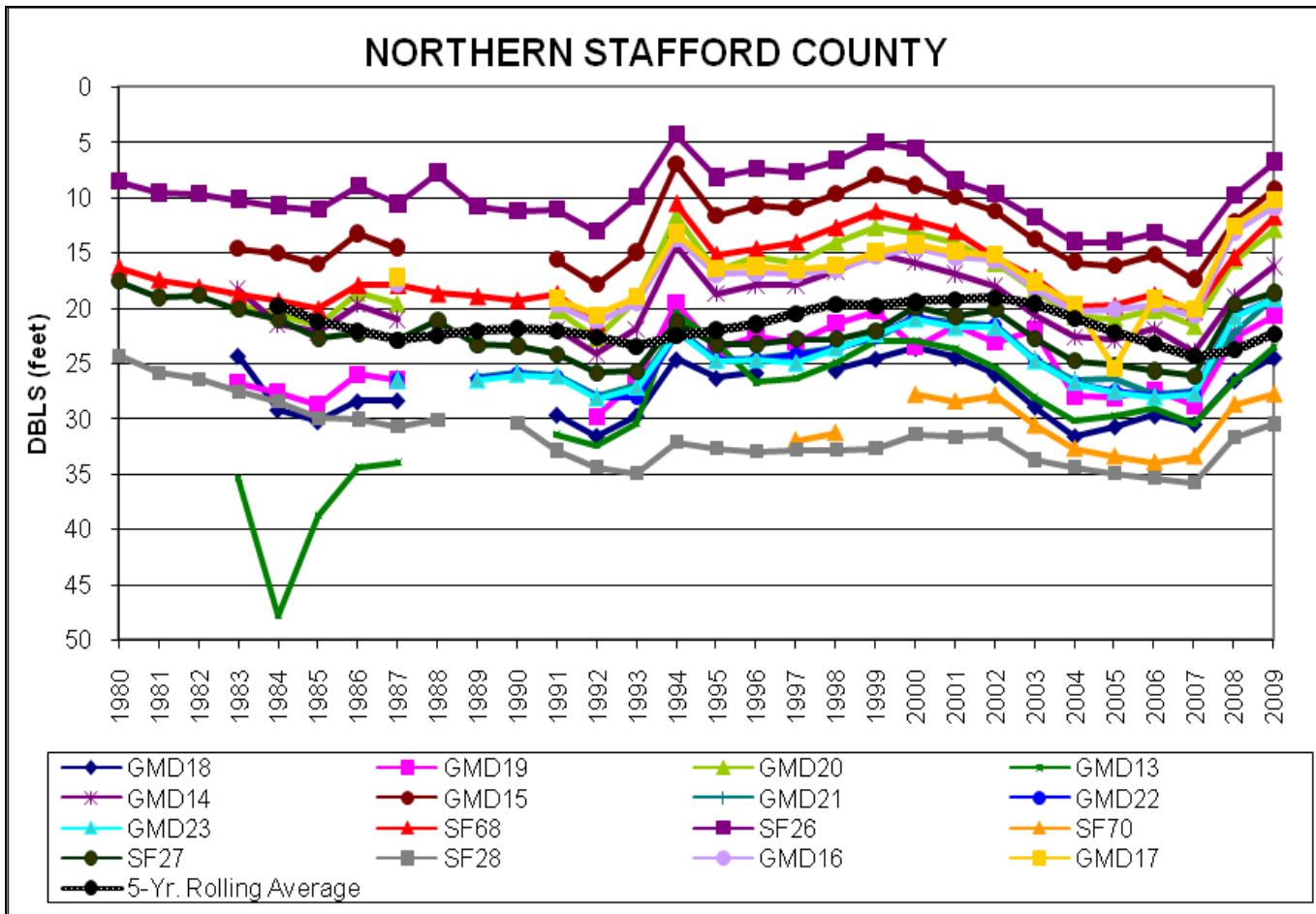


Figure 12: Groundwater Levels in Northern Stafford County Subsection

Northern Stafford County has 16 monitoring wells (Figure 12). The monitoring wells display a gradual decrease in water levels from 1980 until 1993. An increase in water levels can be seen in 1994 of about seven to eight feet. A decline occurs in 1995 followed by a gradual increase in levels until around 1999, and then overall declines through 2007. All the monitoring wells exhibited an increase in water levels in 2008 and 2009. The five-year rolling average continued to increase but a net decline of 2.62 ft over the period of record.

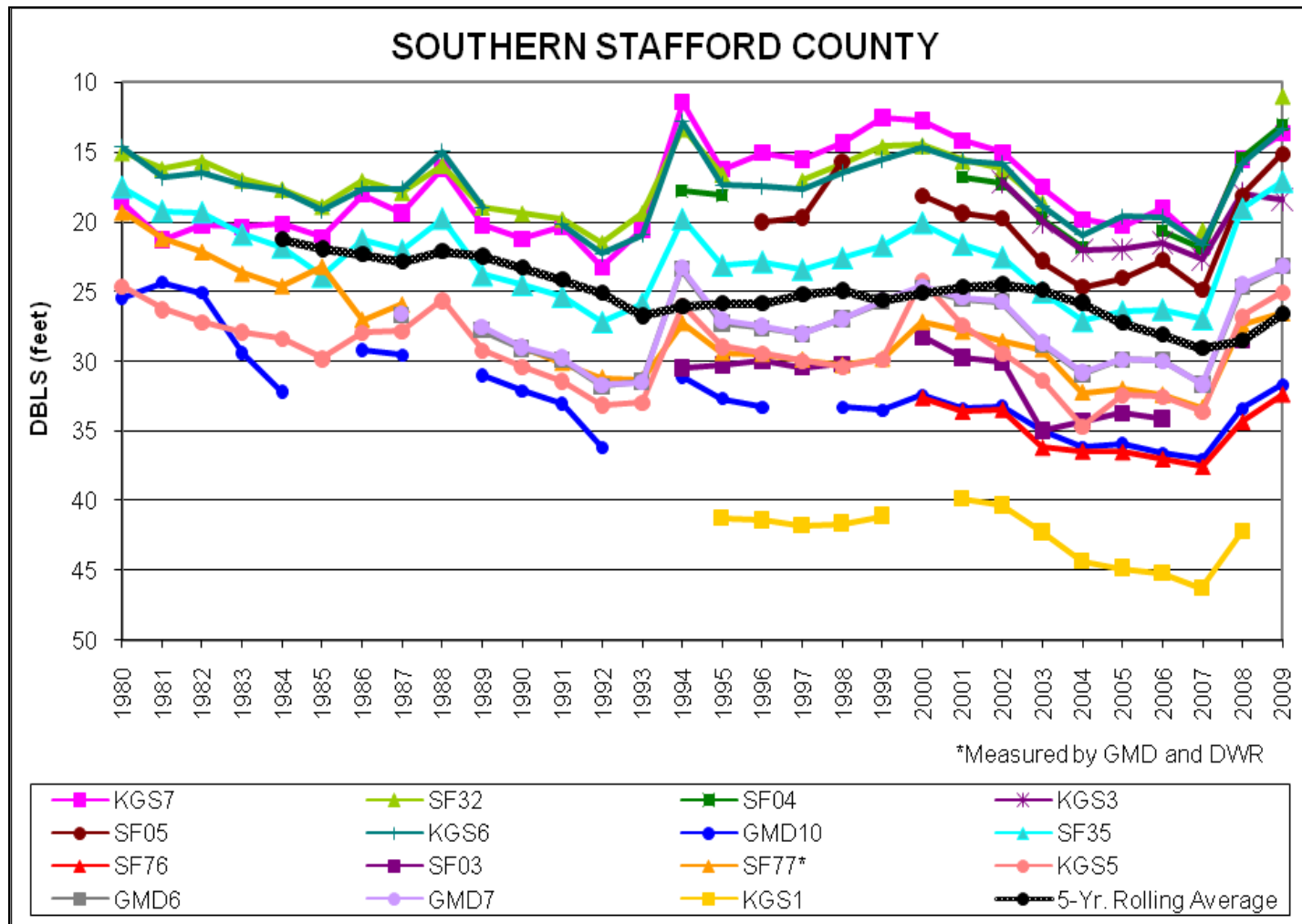


Figure 13: Groundwater Levels in Southern Stafford County Subsection

Southern Stafford County’s 15 monitoring wells show a declining trend in water levels from 1980 to 1993 (Figure 13). Water levels then increased approximately seven feet in 1995, and then declined the following years three to four feet. From 1996 to 1999, water levels increase and then generally decline through 2007. All measured wells saw an increase in water levels in 2008. One monitoring well declined in 2009, KGS3. The five-year rolling average saw an increase 1.89 ft in 2009 but has exhibited a net decline of 5.33 ft over the period of record.

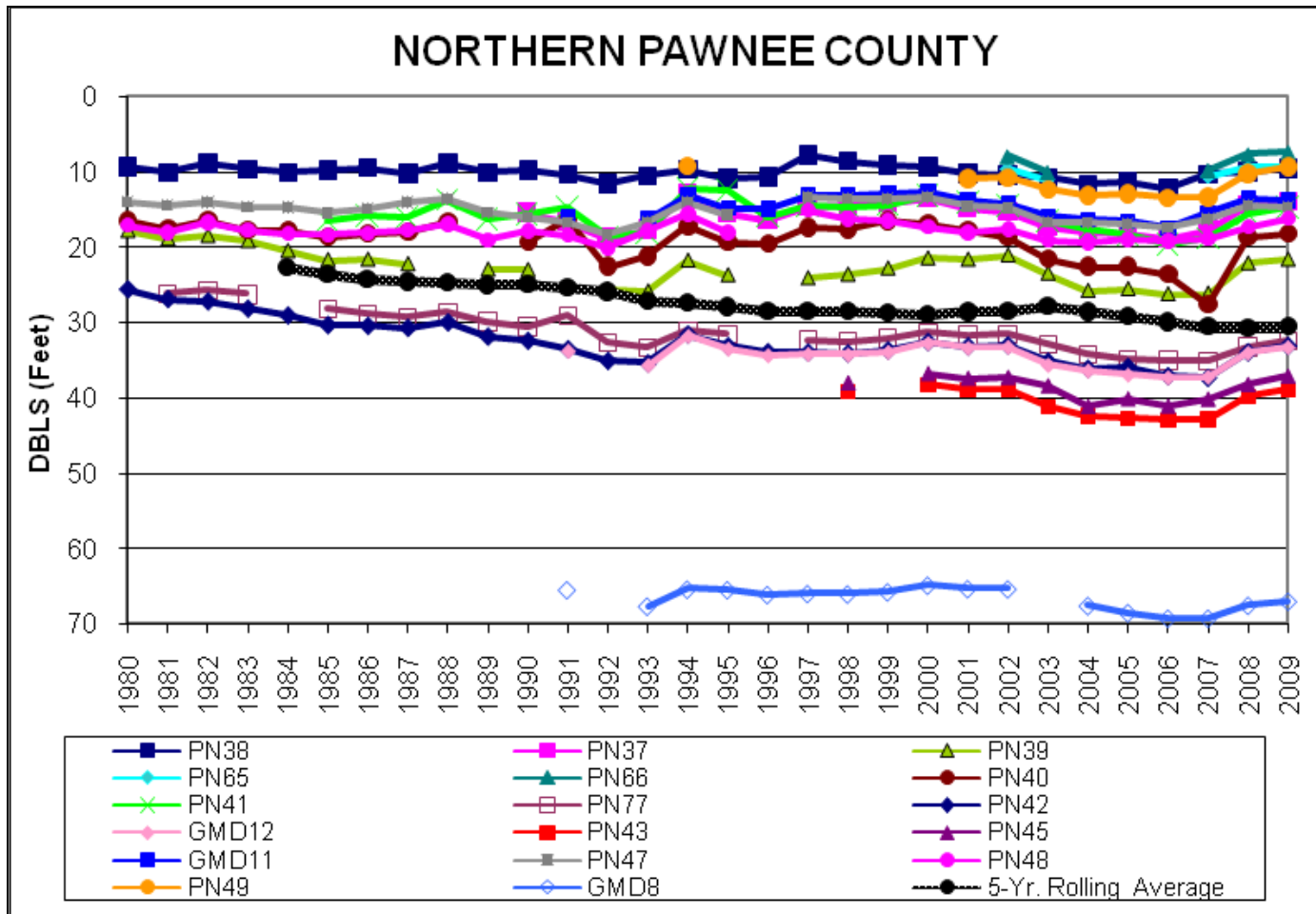


Figure 14: Groundwater Levels in Northern Pawnee County Subsection

Figure 14 displays 17 monitoring wells in northern Pawnee County. The water levels decreased gradually until around 1993 and increased approximately three to four feet in 1994. At this point, a decrease of about two feet occurred over several years followed by a rebound of about a foot occurring until 2007. All the wells saw a rise in water levels in 2008. Only two wells, GMD11 and PN47, had a decline in water levels. The five-year rolling average shows a net decline of 7.74ft since 1984.

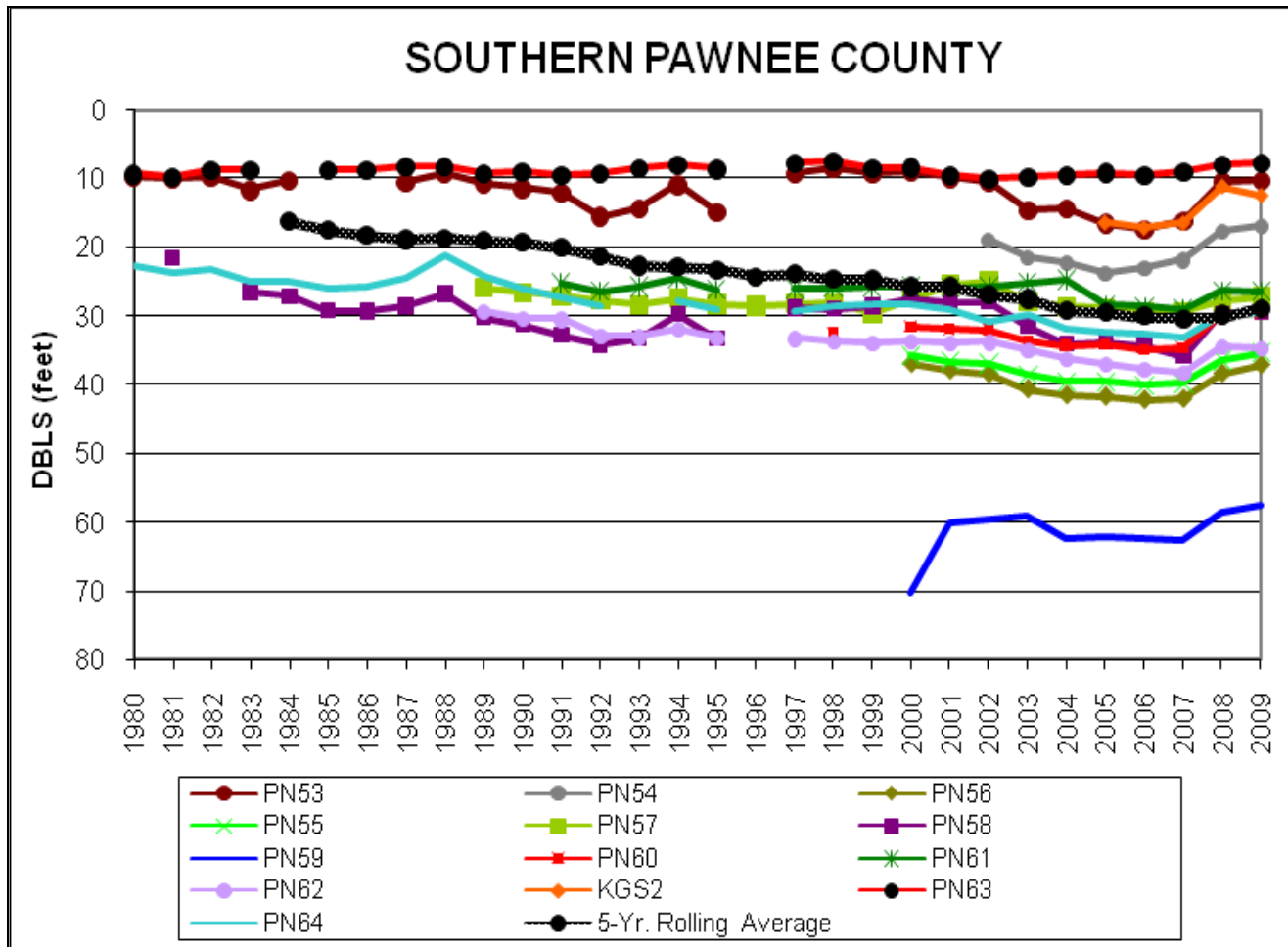


Figure 15: Groundwater Levels in Southern Pawnee County Subsection

Southern Pawnee County, 13 monitoring wells, reacts similarly to northern Pawnee (Figure 15). Seven monitoring wells declined prior to 1993, only to increase three to four feet in 1994. Water levels declined two feet the next year and begin to increase until 2000. At this time, they begin to decline until 2006. All the wells had increasing water levels in 2009 except for three, PN61, PN62 and KGS2. The five-year rolling average had an increase of 0.87 ft in 2009, but it had a net decline of 12.59 ft over the period of record.

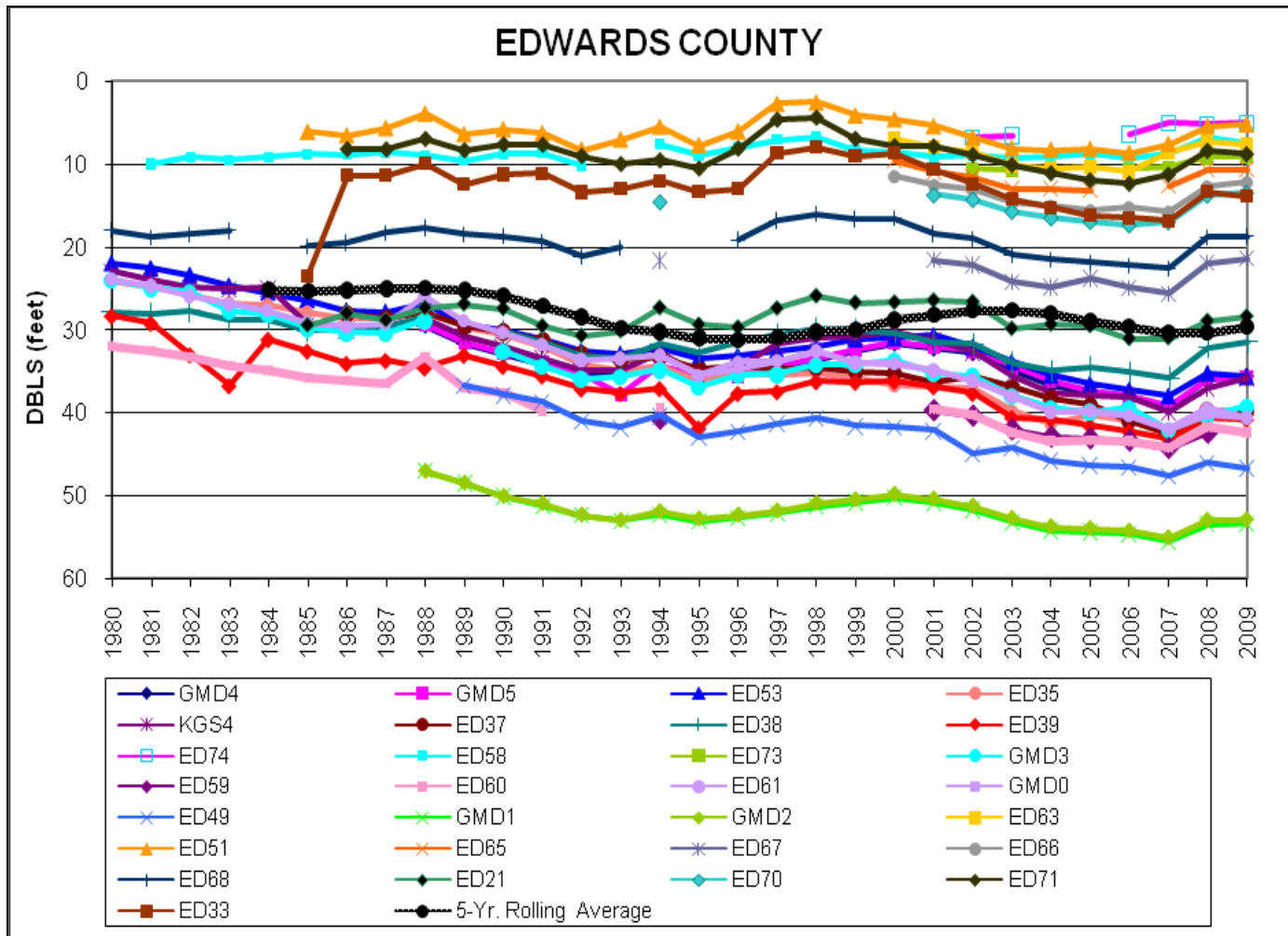


Figure 16: Groundwater Levels in Edwards County

Edwards County has 29 monitoring wells. Water levels show a more prevalent declining trend from 1980 to 1993 than other areas (Figure 16). Most of the wells in Edwards County have a gradual downward trend. Twelve of the 29 monitoring wells had declines in 2009. The average 2009 change in water levels throughout the county was 0.52 ft. The five-year rolling average was up in 2009 (0.66 ft), but exhibits a net decline of 4.5 ft over the period of record.

V. Water Use

The Middle Arkansas River subbasin has a total of 1,464 water rights with an authorized quantity of 262,657 acre-feet. The subbasin has very few vested water rights compared to appropriated water rights. Surface rights make up less than 1% of the number of rights in the subbasin but almost 10% of the authorized quantity (Table 2). This is due to a large surface water right for Kansas Department of Wildlife and Parks, Cheyenne Bottoms Wildlife Area in Barton County for over 18,000 acre-feet. Appropriated groundwater rights are authorized for 232,477 acre-feet per year. Irrigation, stock, domestic, recreation, industrial and municipal water rights are used for this water use analysis (Figure 18).

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

Source	Type	No. of Rights	Authorized Quantity (AF)
Surface	Vested	1	75.00
Ground	Vested	48	5,572.91
Surface	Appropriated	8	24,531.55
Ground	Appropriated	1,407	232,477.20

The water use ranges from 200,537 acre-feet in 1991 to 89,412 acre-feet in 1993. The average water use over the twenty year span was 157,635.67 acre-feet (Figure 17). Water use in the late 1990's tended to be below average. However the early 2000s were a time of higher water use. Water use in 2007 (the most recent year for which complete records are available) was 136,984 acre-feet. This was down from 2006 and below the average.

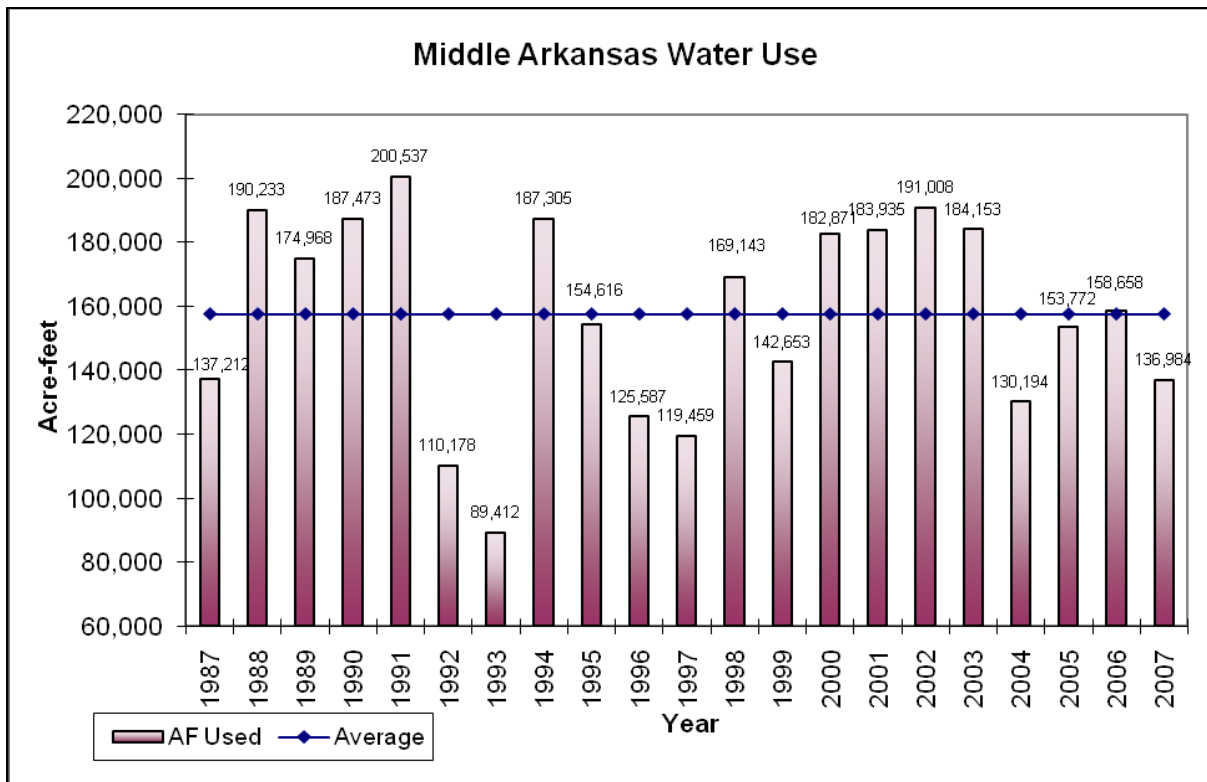


Figure 17: Middle Arkansas Subbasin Water Use 1987-2007

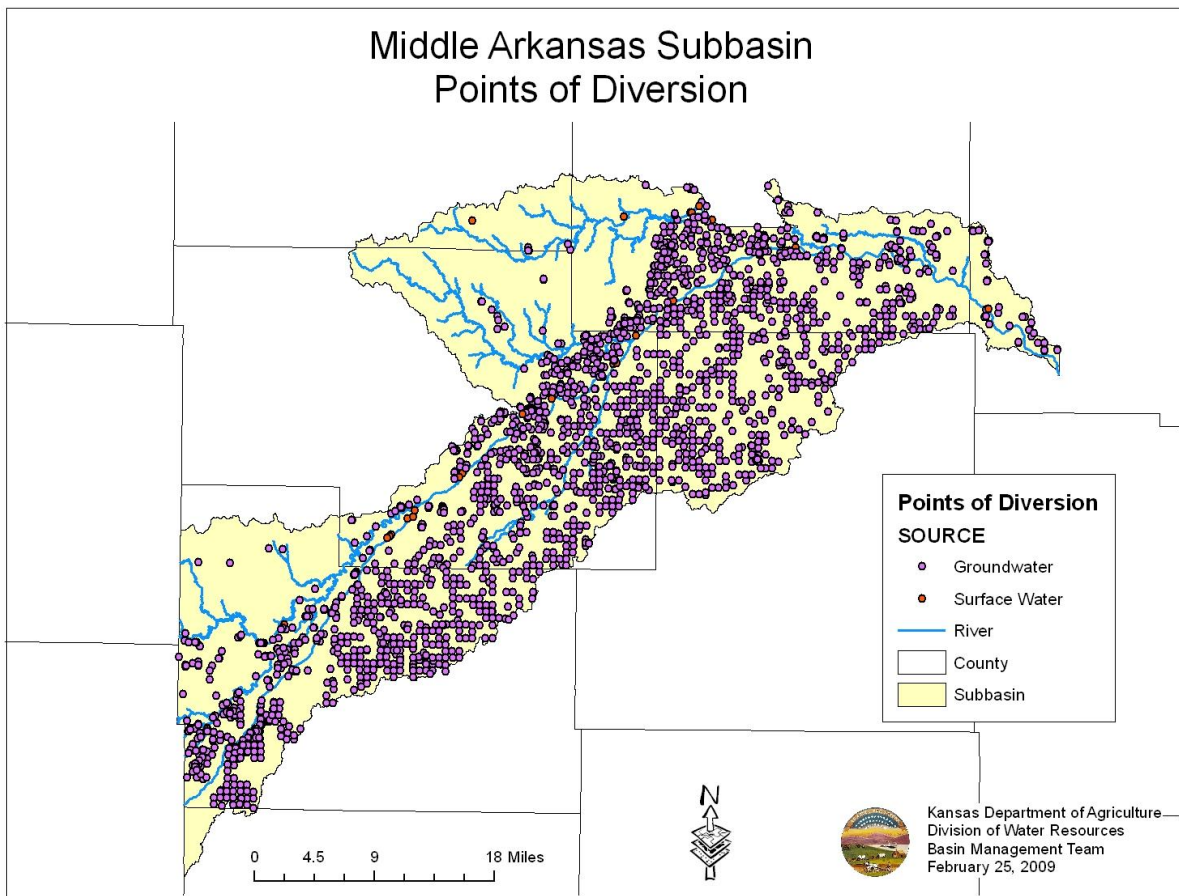


Figure 18: Middle Arkansas Points of Diversion

VI. Conclusions

Precipitation in the Middle Arkansas River subbasin was well above average in 2008. MDS values were met 100% of the time at the Great Bend USGS gage during 2008. At the Kinsley gage, streamflow met MDS values 10 days in 2008. Most of the water levels throughout the subbasin were higher in 2009 compared to 2008, but the increases were not as large as in 2008. The Edwards County monitoring wells had more water levels that declined. Continued monitoring of hydrologic conditions and their response to climate variations is important for evaluating the long-term effects of water usage on this subbasin and protection of property rights. It is equally important to understand how fast the system recovers after recharge events as it is to understand the impacts of pumping and other factors on the hydrologic system.

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 05SWNWSW 01	SF32	SF	380948098465901
22S 14W 07NENESW 01	GMD10	SF	380923098535101
22S 13W 12SWNESW 02	KGS3	SF	380855098421602
22S 13W 08SESENE 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 35SESENE 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

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22S 16W 02SWNENE 01	GMD11	PN	380958099032601
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
24S 18W 28SENESE 01	ED39	ED	375550099175601
24S 19W 26SWSESE 01	ED74	ED	375544099224201
24S 19W 35NENWNE 01	ED73	ED	375537099222601
24S 19W 34NESESE 01	ED58	ED	375513099231701
25S 17W 03NWNESW 01	GMD3	ED	375431099105401
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25S 18W 06SWSWSW 01	ED59	ED	375358099205601
25S 19W 01SESESW 02	GMD2	ED	375357099211202
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25S 19W 29NESWSW 01	ED67	ED	375055099255301
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25S 20W 34SWSWSW 01	ED71	ED	374935099304801
26S 20W 20NWNWSW 01	ED33	ED	374558099321601
19S 13W 36SWSE 01	BT06*	BT	382517098481501
19S 11W 19NWSESE 01	BT01	BT	382307098345601
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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 22SWSESE 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