
# Middle Arkansas River

## 2009 Field Analysis Summary

April 28, 2010

Basin Management Team

Division of Water Resources
Kansas Department of Agriculture
109 SW Ninth Street - 2nd Floor
Topeka, KS 66612-1283
785-296-6087

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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.

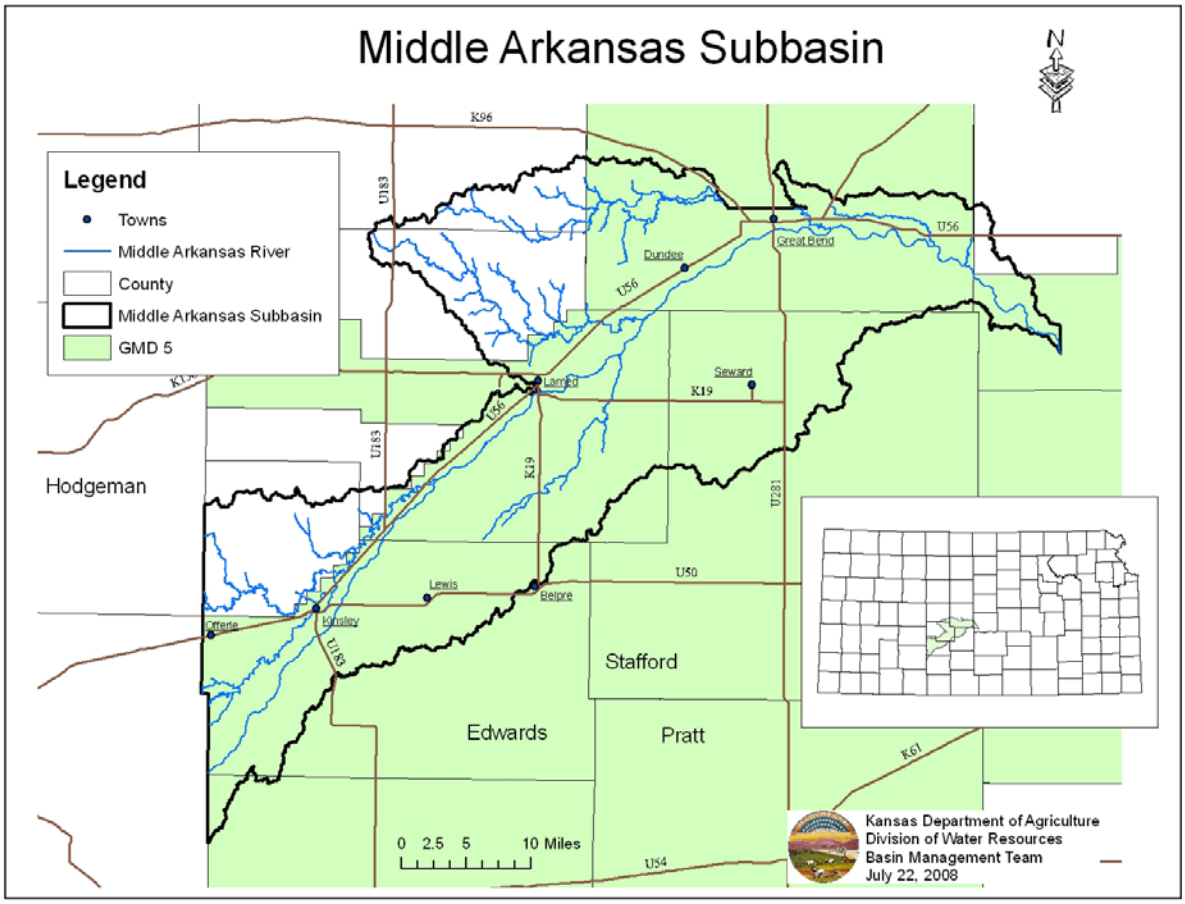


**Figure 1: Middle Arkansas River Subbasin**

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 25.1 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 2008. Precipitation in 2008 was less than in 2007, but still above the subbasin historical average.

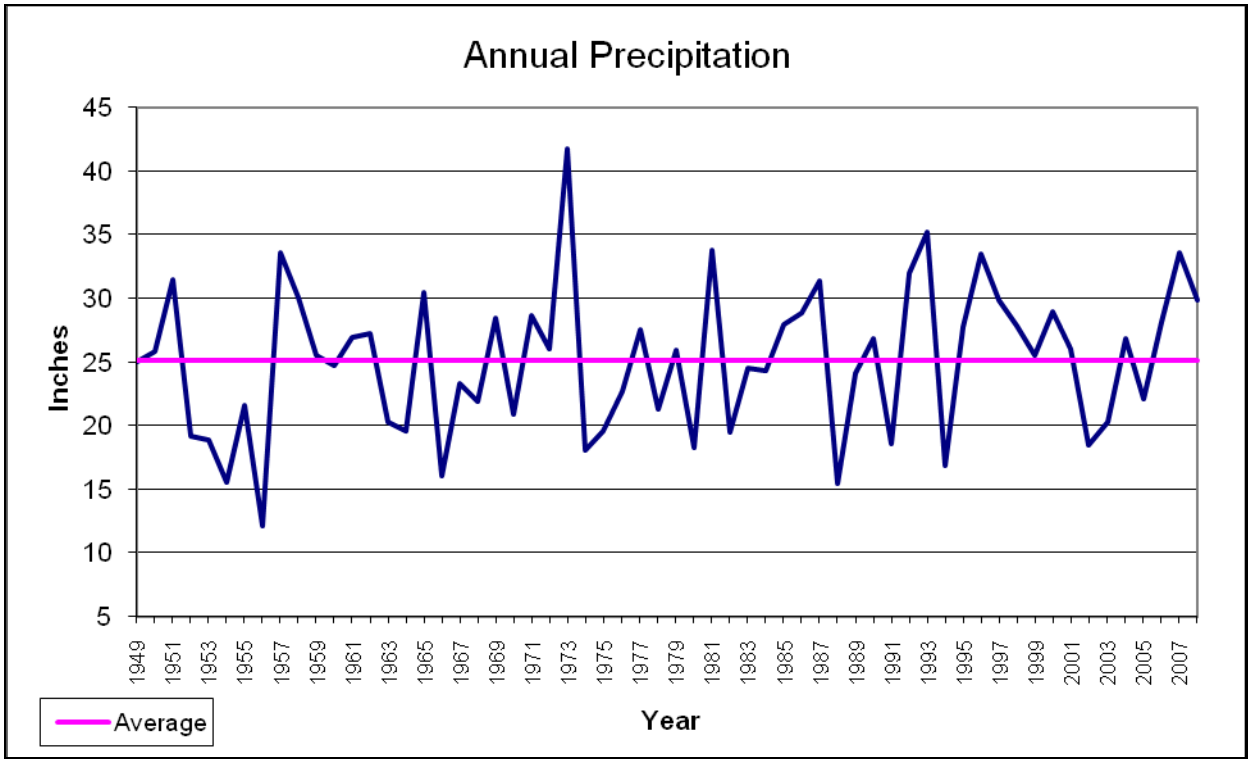


**Figure 2: NCDC Annual Precipitation in Middle Arkansas Subbasin 1949-2008**

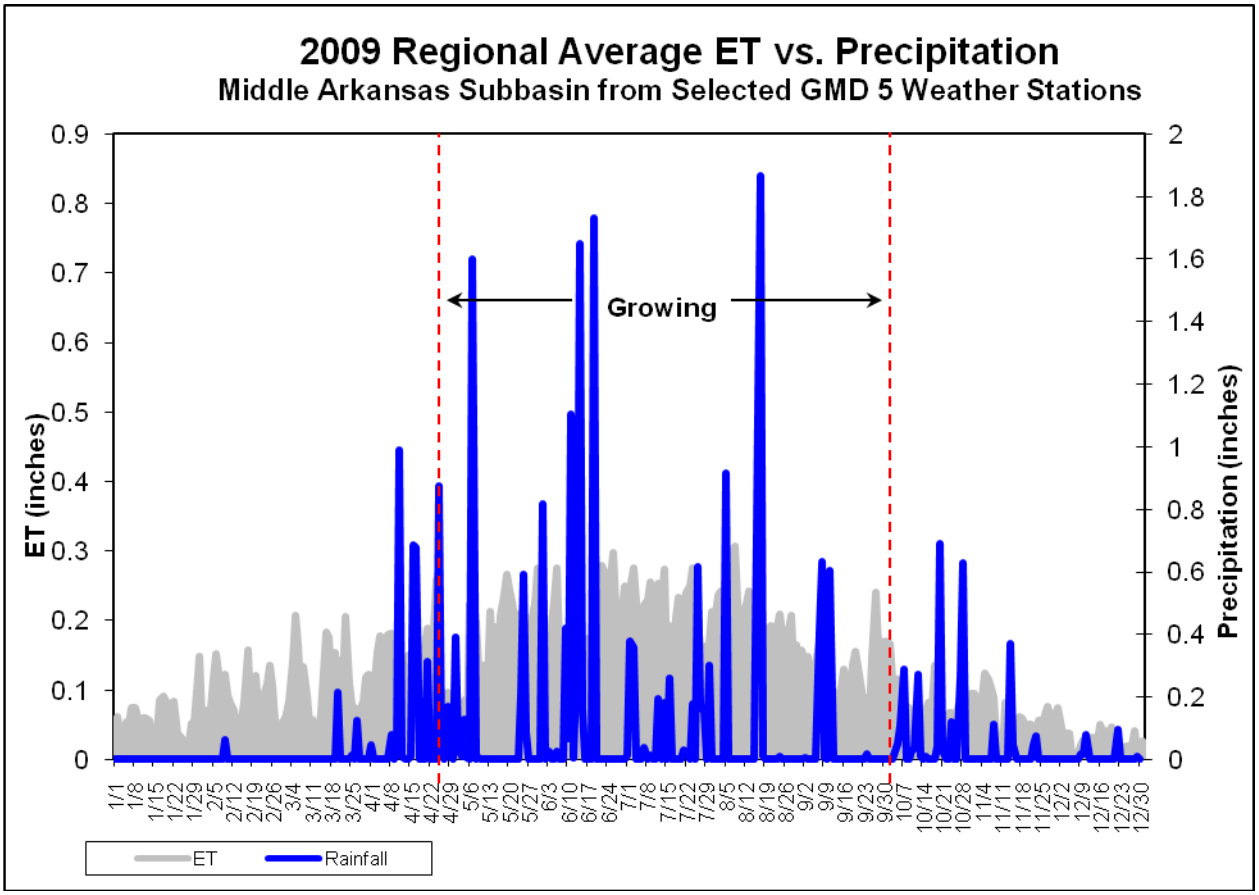


**Figure 3: GMD #5 Evapotranspiration and Precipitation**

Figure 3 shows the 2009 evapotranspiration and precipitation conditions in the Middle Arkansas subbasin. This information comes from three GMD #5 weather stations: Great Bend, Lewis and Radium. The three stations received an average 25.4 inches of precipitation for 2009. This figure is slightly above the average 25.1 inches of precipitation documented over the period of record. Even with the above average precipitation, the subbasin still had a deficit of moisture due to the 41.4 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.**

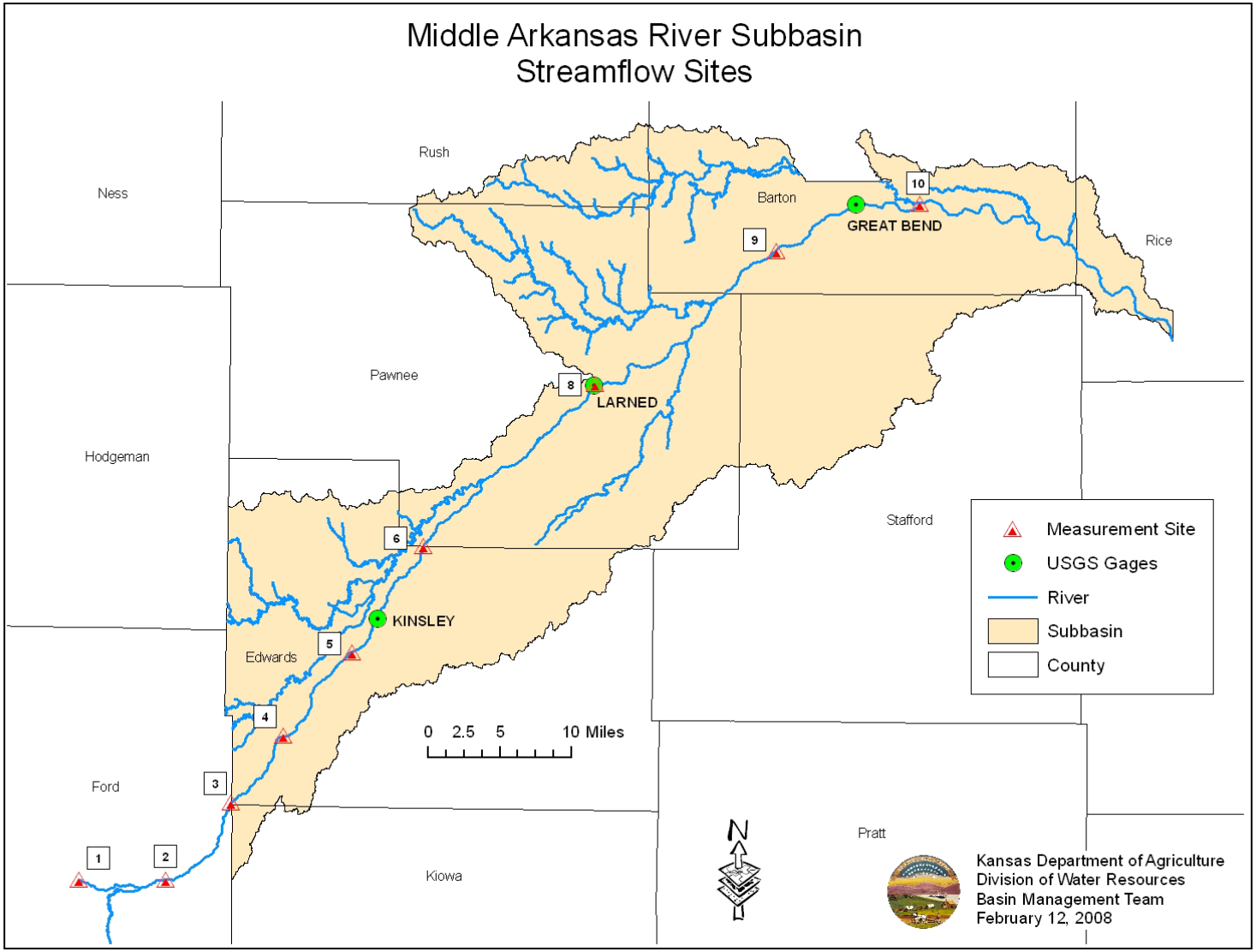


**Figure 4: Streamflow Measurement Sites**

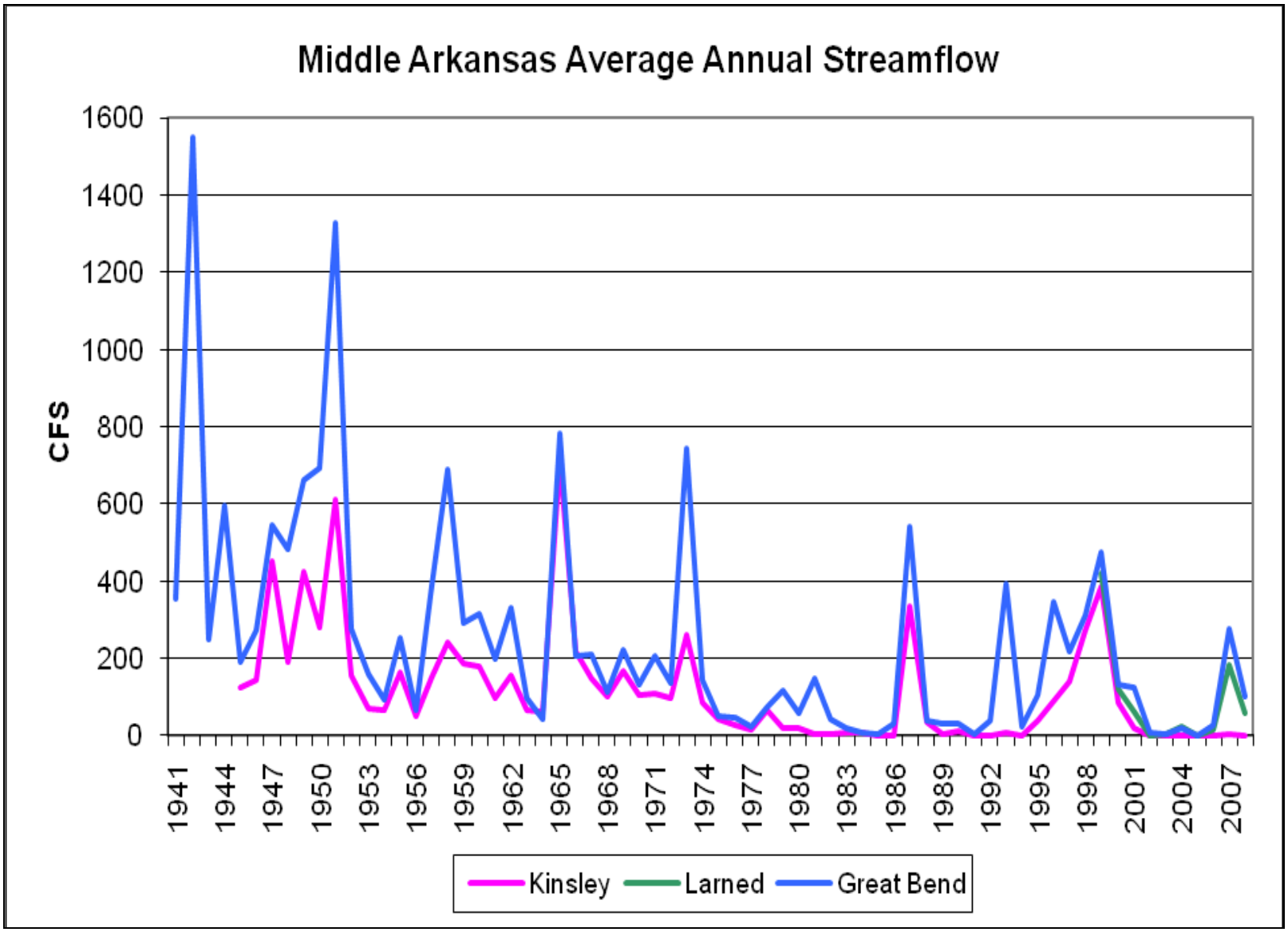


**Figure 5: Streamflow at USGS Gages 1940-2008**

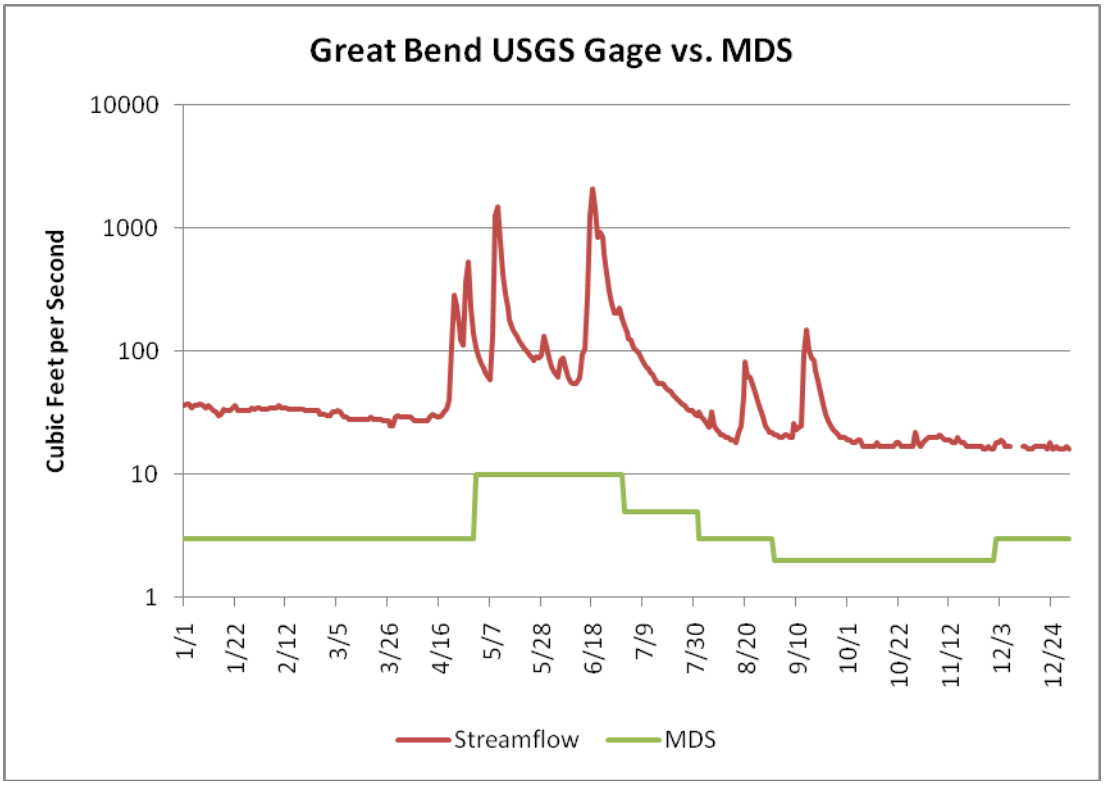


**Figure 6: Great Bend USGS Streamflow and MDS in 2009**

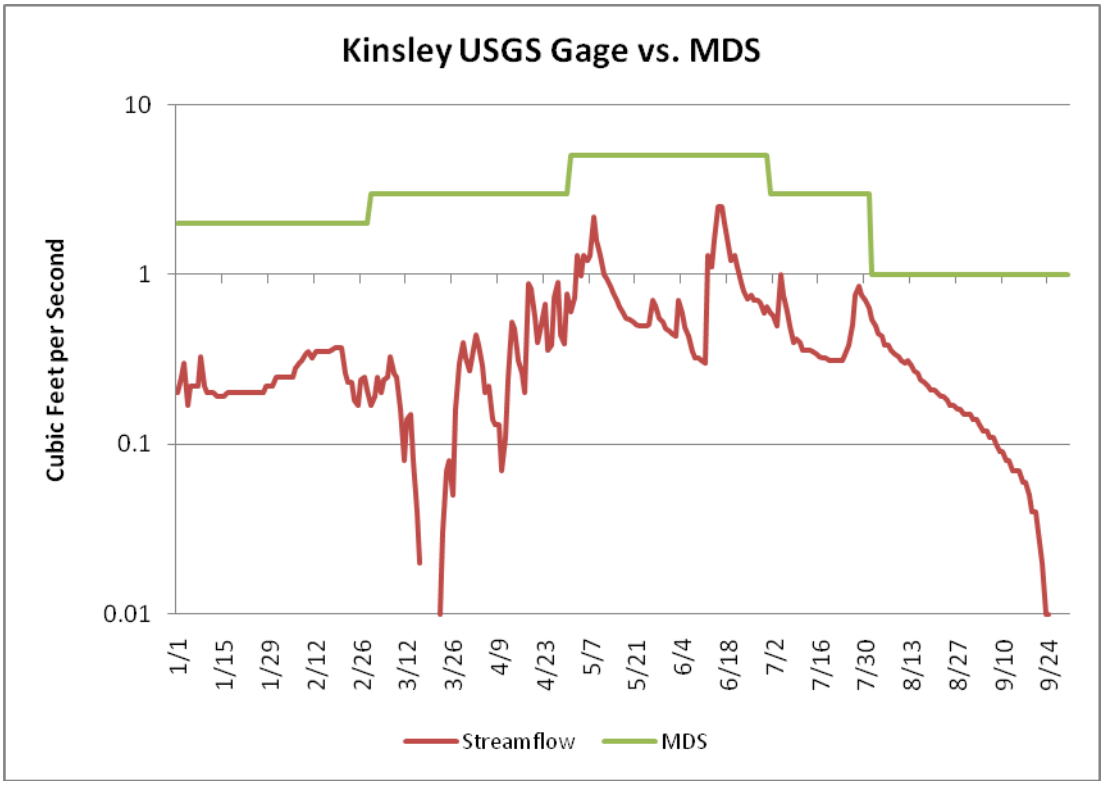


**Figure 7: Kinsley USGS Gage Streamflow and MDS (1-1-2009 thru 9-30-2009)**

**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 88.48 cfs and Great Bend was 248.09 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 76.71 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 and Figure 7 show the streamflow measurements for 2009 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. 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. Figure 7 and Figure 8 show that MDS flows at Kinsley were not maintained for the majority of 2009. 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. 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.

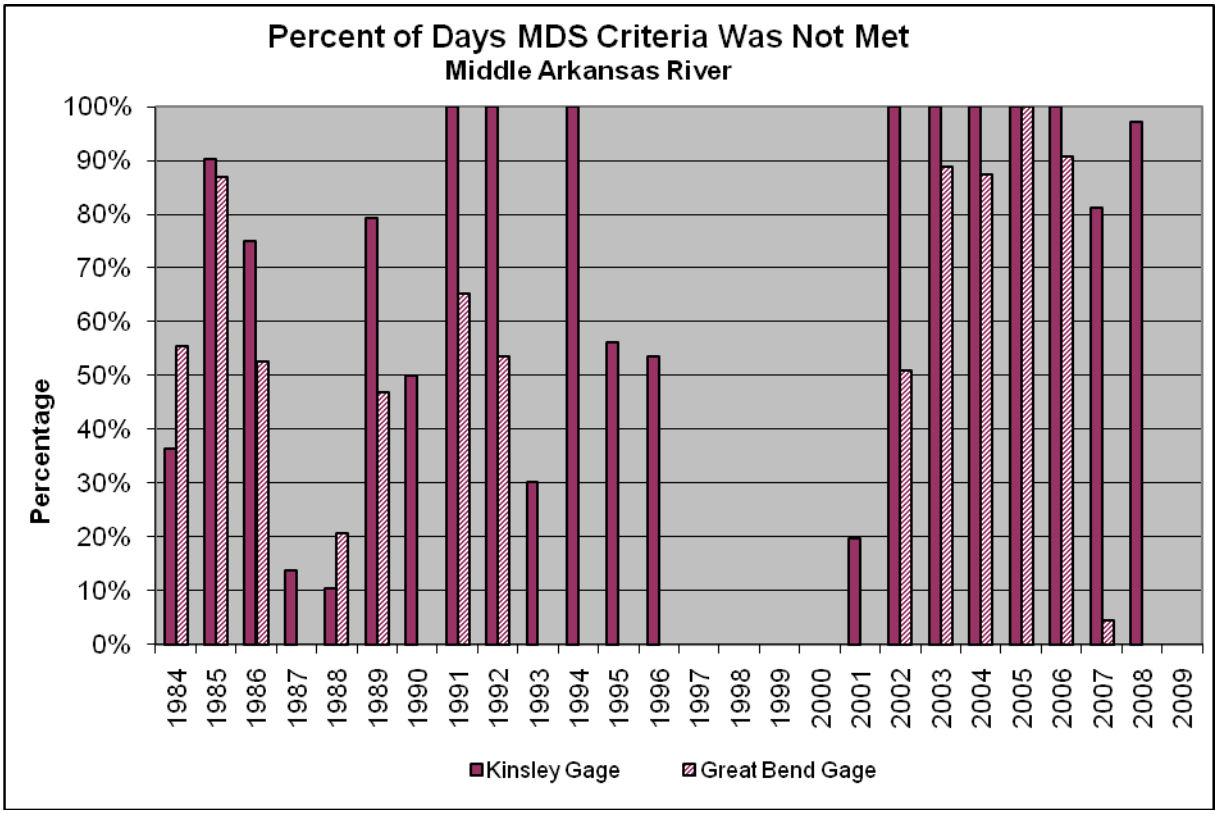


**Figure 8: Streamflow and MDS Criteria**

# 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 to measure 125 groundwater levels in the subbasin (Figure 9). 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 10 to Figure 16 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.

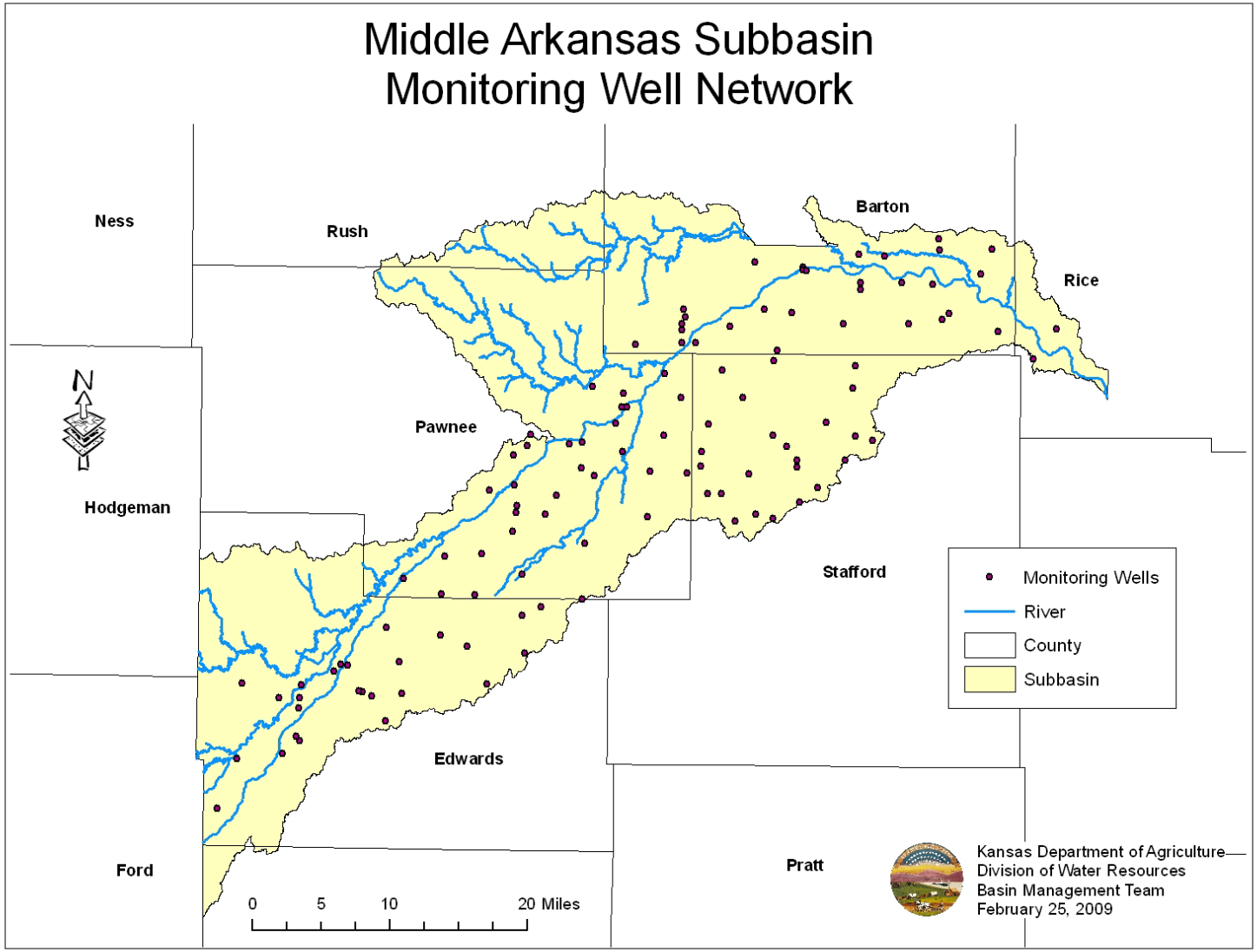


**Figure 9: Middle Arkansas River Subbasin Monitoring Wells**

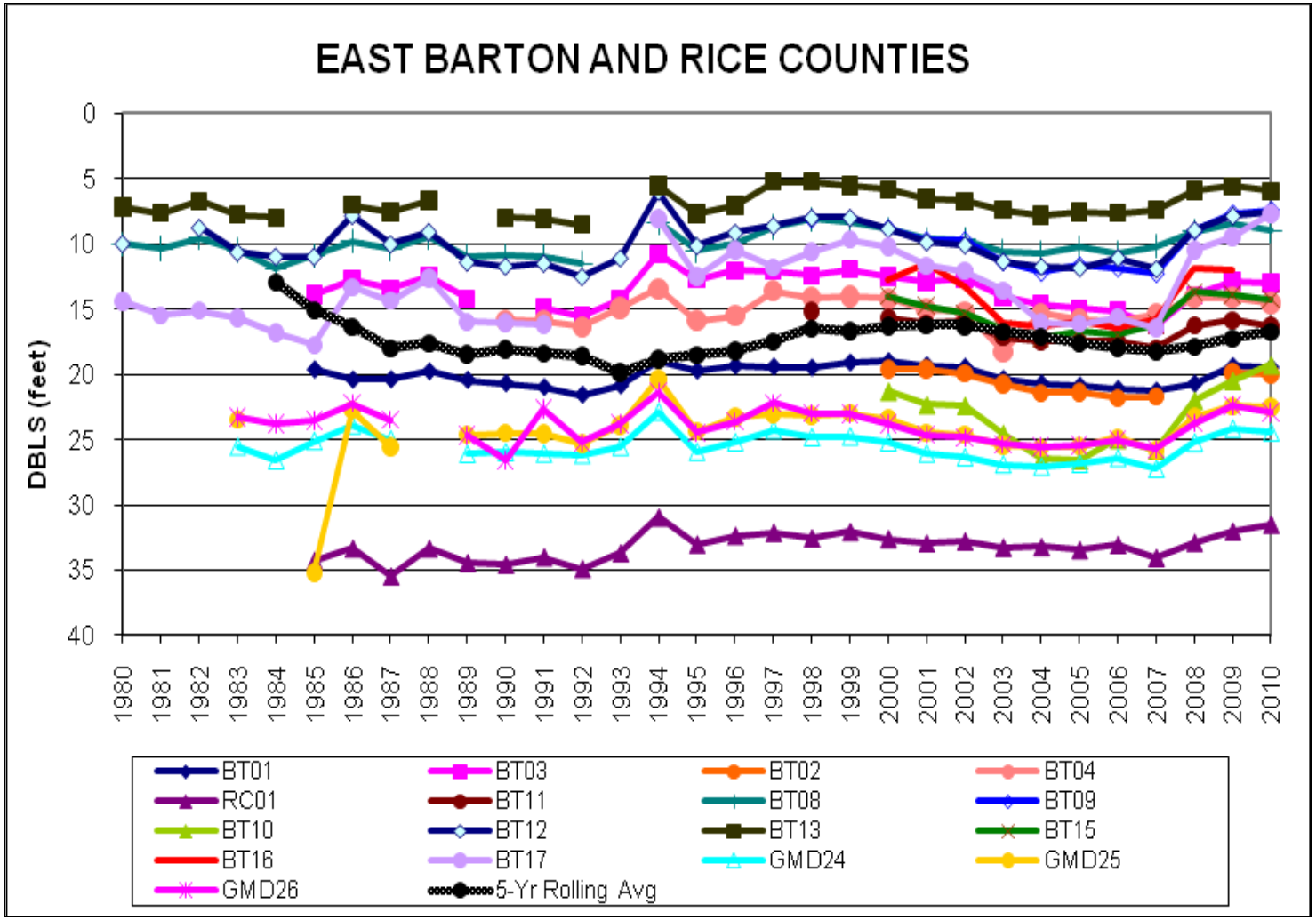


**Figure 10: Groundwater Levels in Eastern Barton County Subsection and Rice County**

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. Twelve of the 17 monitoring wells saw water levels decline from 2009 to 2010.

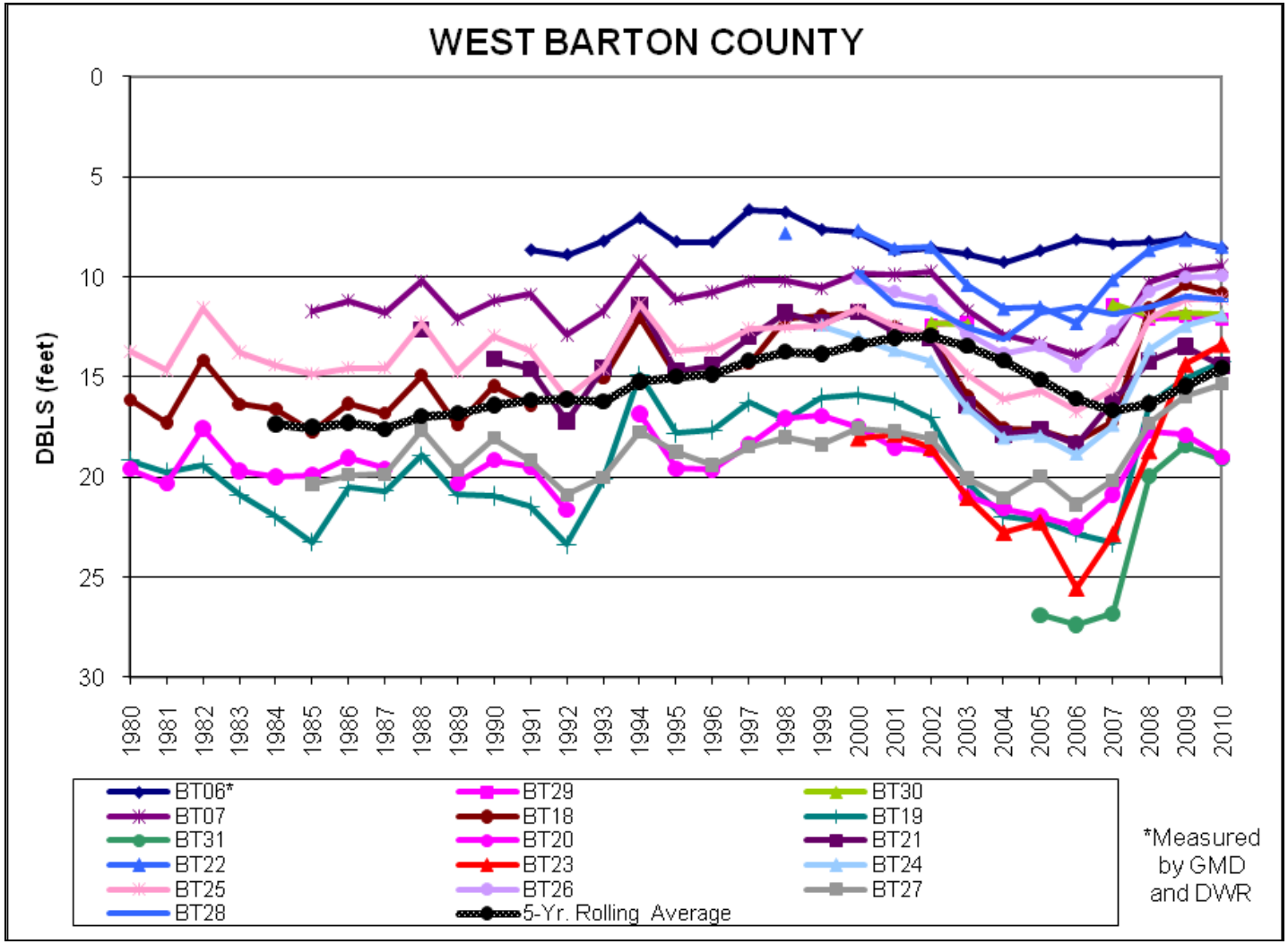


**Figure 11: Groundwater Levels in Western Barton County Subsection**

West Barton County has 16 monitoring wells (Figure 11). Many of the wells saw an increase in water levels in 2008, some by several feet. Nine of the 16 water levels declined in 2010. West Barton County averaged a decline of -0.1 feet in 2010 compared to 2009 measurements. The five-year rolling average declined for several years but has increased the past three years. It has a net increase of 2.8 feet since 1984.

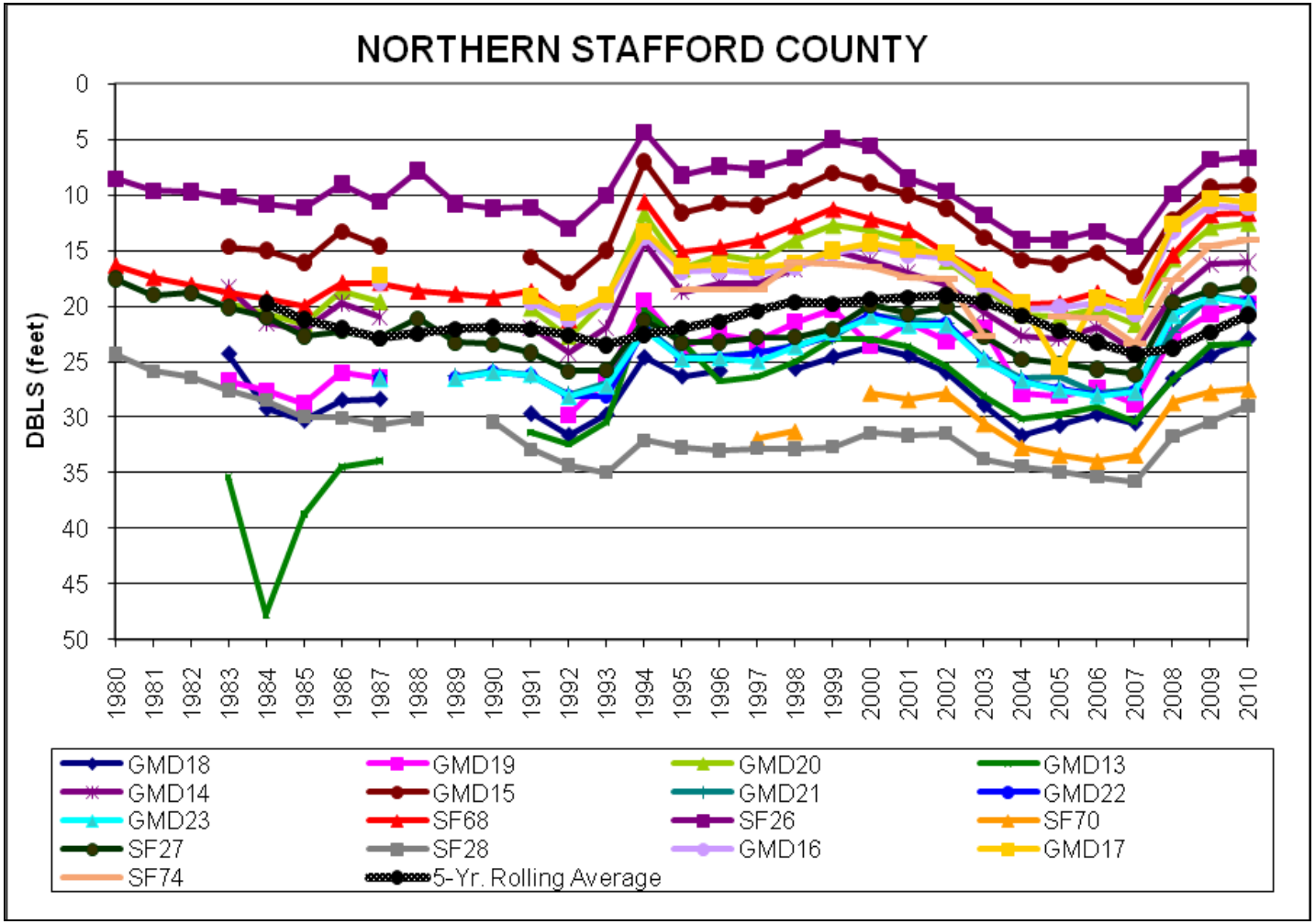


**Figure 12: Groundwater Levels in Northern Stafford County Subsection**

Northern Stafford County has 17 monitoring wells (Figure 12). Water levels gradually decreased 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. Twelve wells saw water levels increase in 2010. The five-year rolling average continued to increase but has a net decline of 1.06 feet over the period of record.

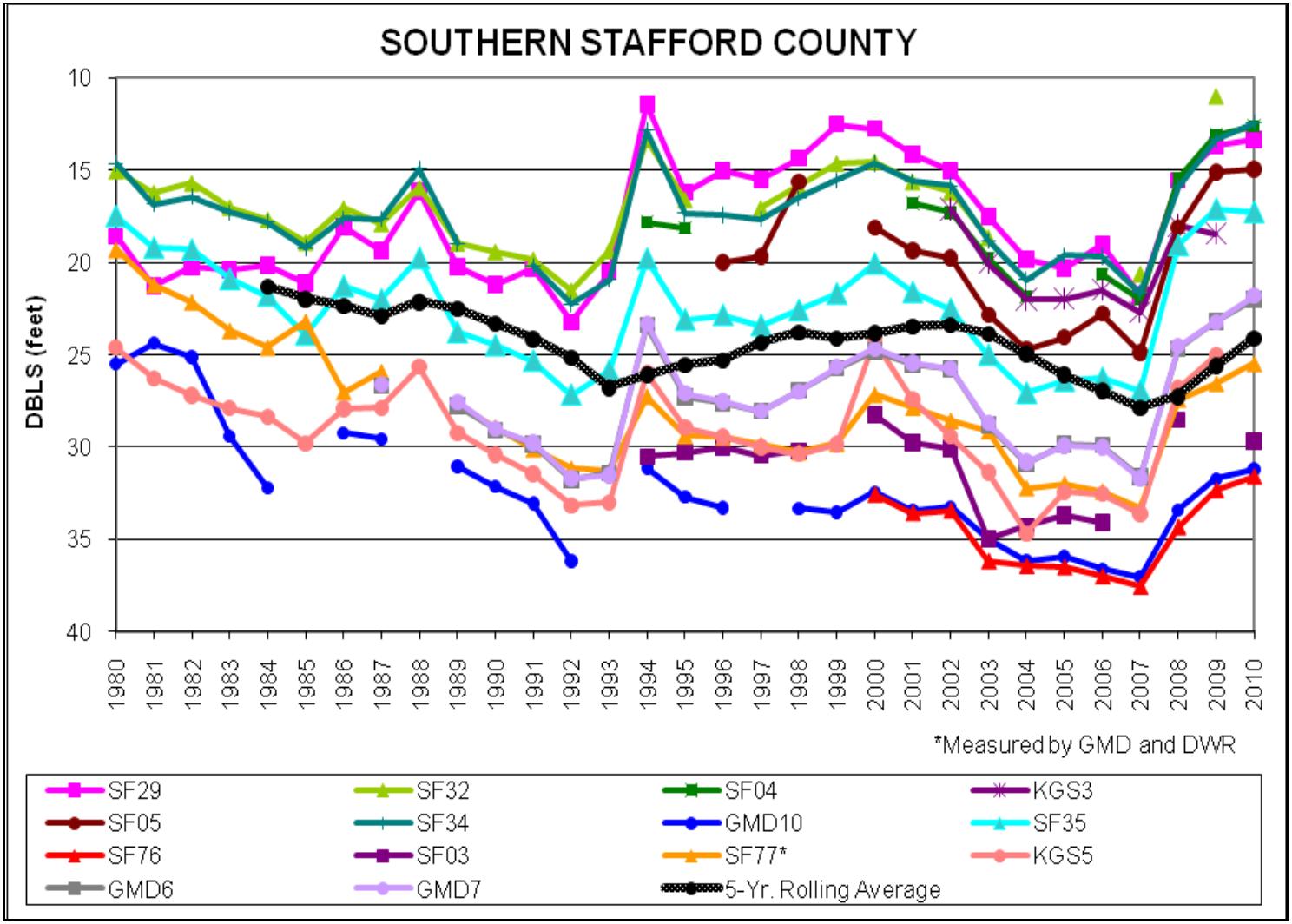


**Figure 13: Groundwater Levels in Southern Stafford County Subsection**

Southern Stafford County's 14 monitoring wells show a declining trend in water levels from 1980 to 1993 (Figure 13). Water levels increased approximately seven feet in 1995, and then declined the following years three to four feet. From 1996 to 1999, water levels increased and then generally declined through 2007. Thirteen of the fourteen wells saw water levels increase in 2010. The five-year rolling average saw an increase of 1.66 feet in 2010 but has exhibited a net decline of 2.64 feet over the period of record.

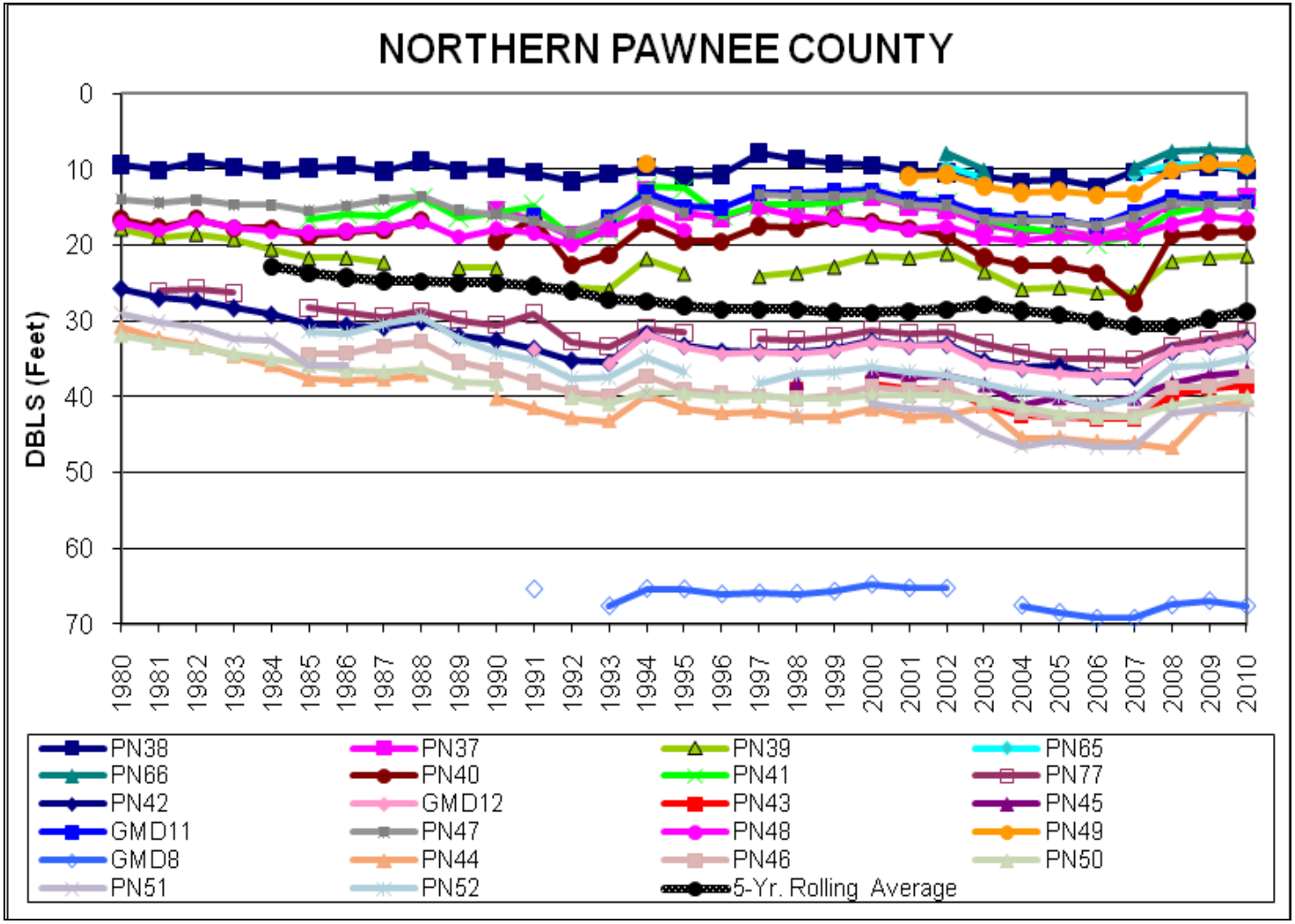


**Figure 14: Groundwater Levels in Northern Pawnee County Subsection**

Figure 14 displays 22 monitoring wells in northern Pawnee County. Most 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. Fifteen of the 22 wells increased in water levels in 2010 compared to 2009. The five-year rolling average shows a net decline of 5.92 feet since 1984, but has risen the last two years.

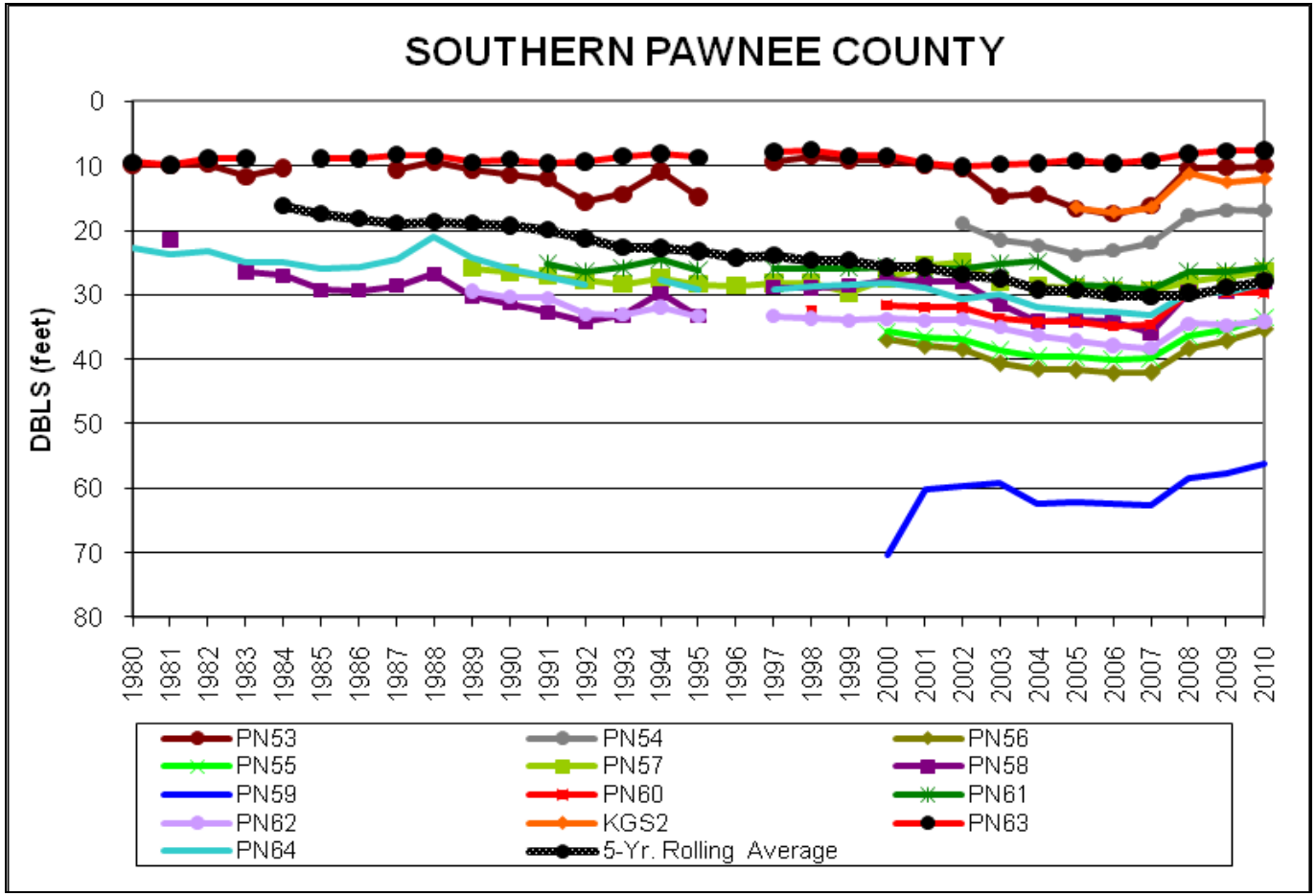


**Figure 15: Groundwater Levels in Southern Pawnee County Subsection**

The 13 monitoring wells in southern Pawnee County react similarly to those in the northern part of the county (Figure 15). Water levels in seven monitoring wells declined prior to 1993 then increased 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. Twelve of the monitoring wells had an increase in water levels in 2010 compared to 2009. The five-year rolling average had an increase of 0.93 feet in 2009, but it has a net decline of 11.66 feet over the period of record.

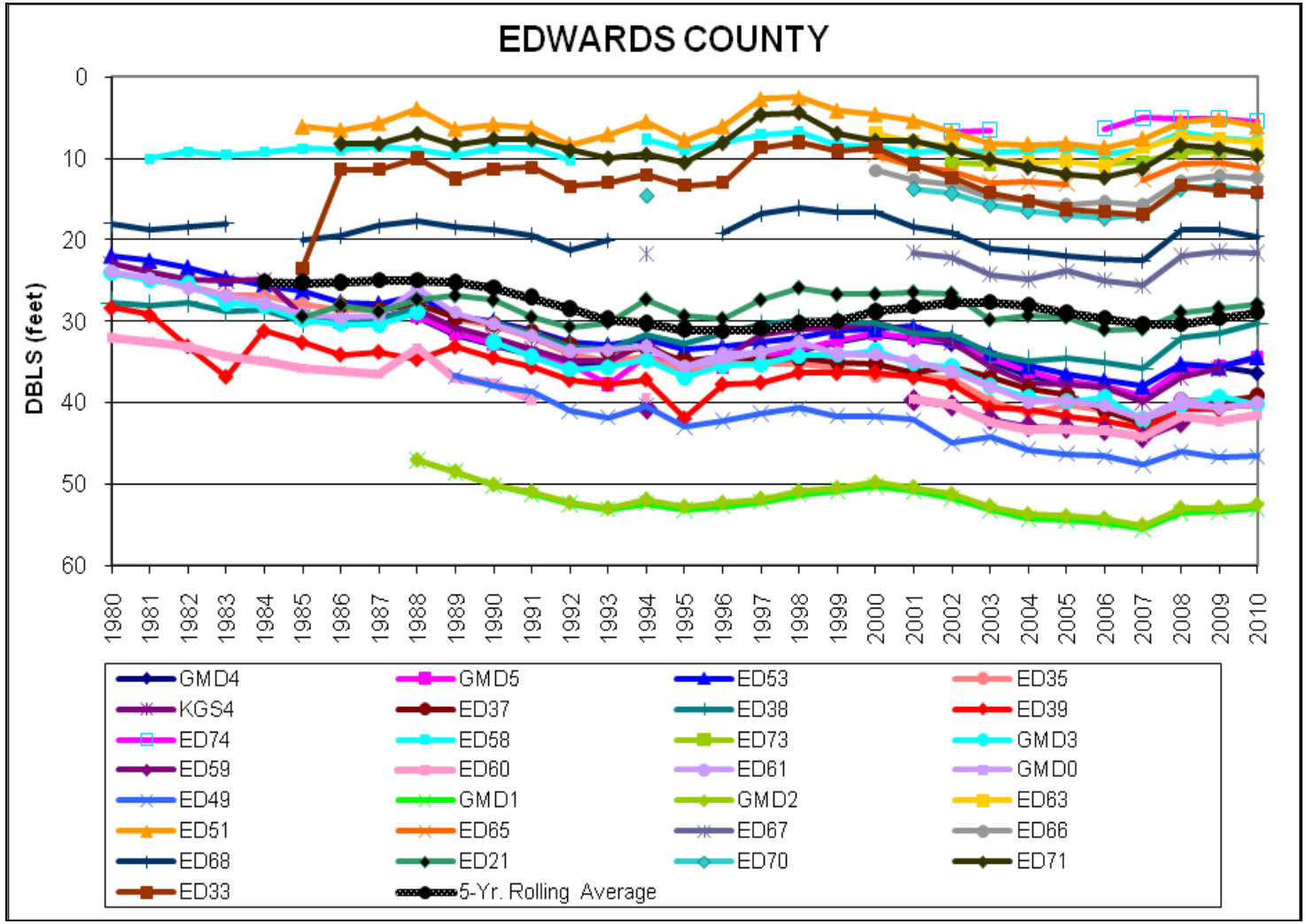


**Figure 16: Groundwater Levels in Edwards County**

Edwards County has 29 monitoring wells. Water levels generally declined from 1980 to 1993 (Figure 16). Most of the water levels in Edwards County have a gradual downward trend. Fifteen of the 29 monitored water levels increased in 2010. The average 2010 change in water levels throughout the county was 0.32 feet. The five-year rolling average increased 0.78 feet in 2010 but exhibits a net decline of 3.72 feet 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. 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 232,477 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 |
| Ground | Vested | 48 | 5,573 |
| Surface | Appropriated | 8 | 24,532 |
| Ground | Appropriated | 1,407 | 232,477 |

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-one year span was 156,152 acre-feet (Figure 17). 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 2008, the most recent year for which complete records are available, was 124,975 acre-feet, which is down from 2007 and below the historical average.

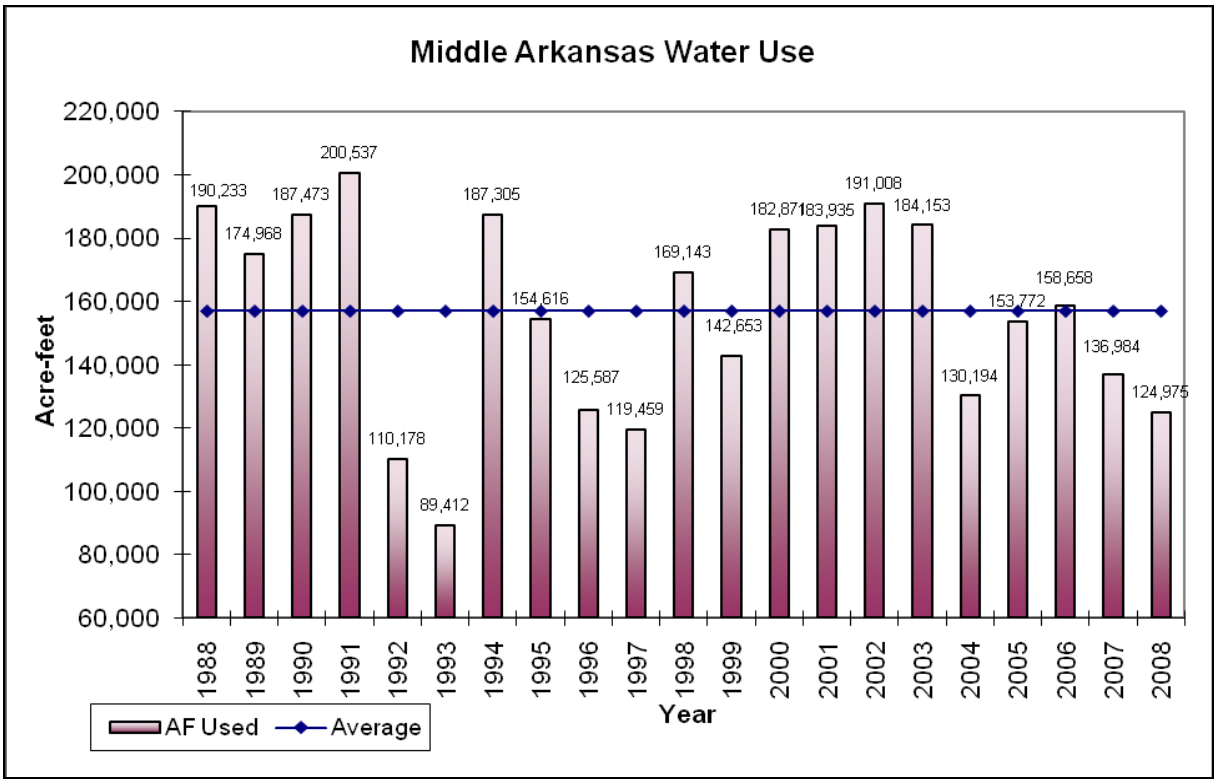


**Figure 17: Middle Arkansas Subbasin Water Use 1988-2008**

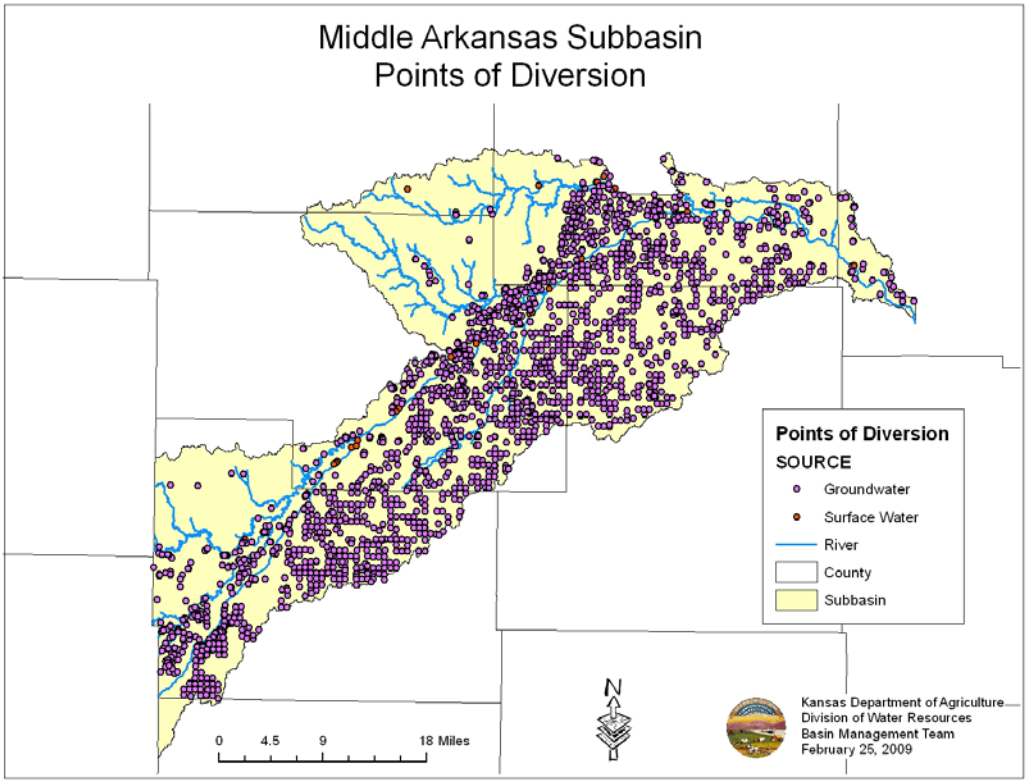


**Figure 18: Middle Arkansas Points of Diversion**

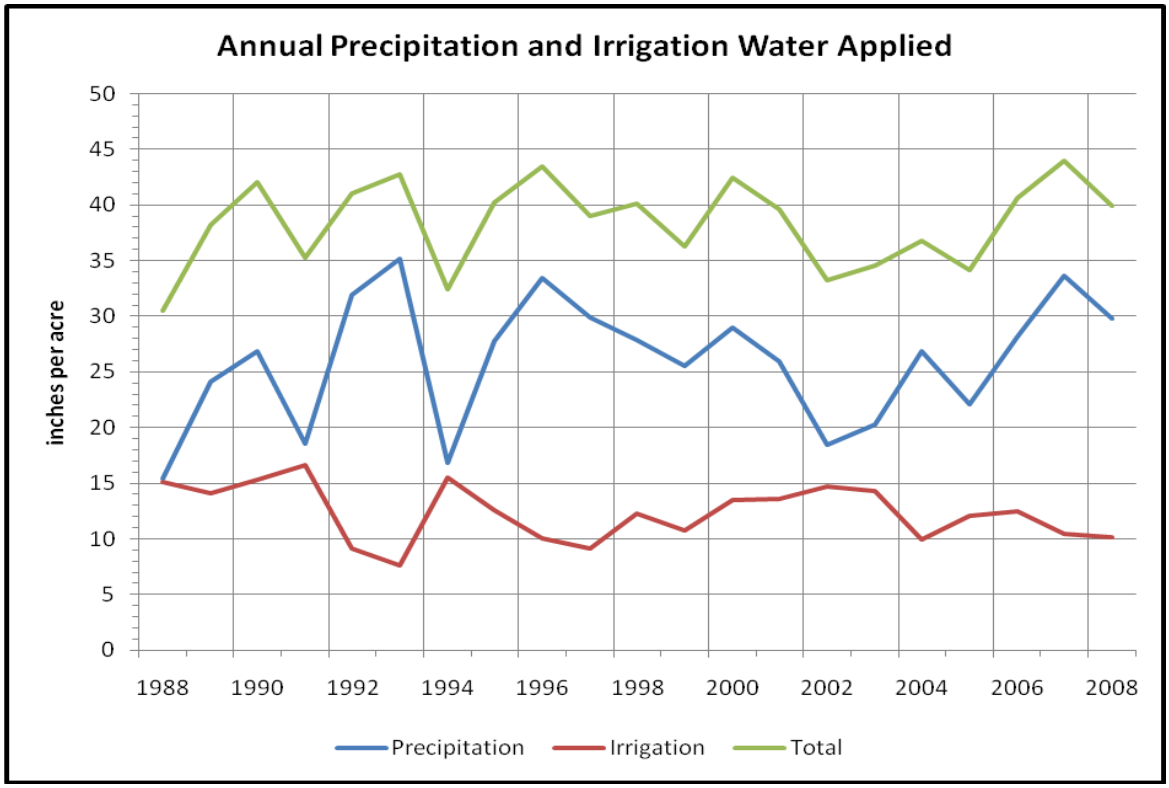


**Figure 19: Annual Precipitation and Irrigation (inches per acre) 1988-2008**

Since 1988, the Middle Arkansas subbasin averaged 26.1 inches of precipitation and 12.3 inches of irrigation pumping (Figure 19) 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 2008, the subbasin received 29.8 inches in precipitation and pumped 10.1 inches. Irrigation season precipitation (Figure 20) averages 18.82 inches, which is over six inches below the annual average.

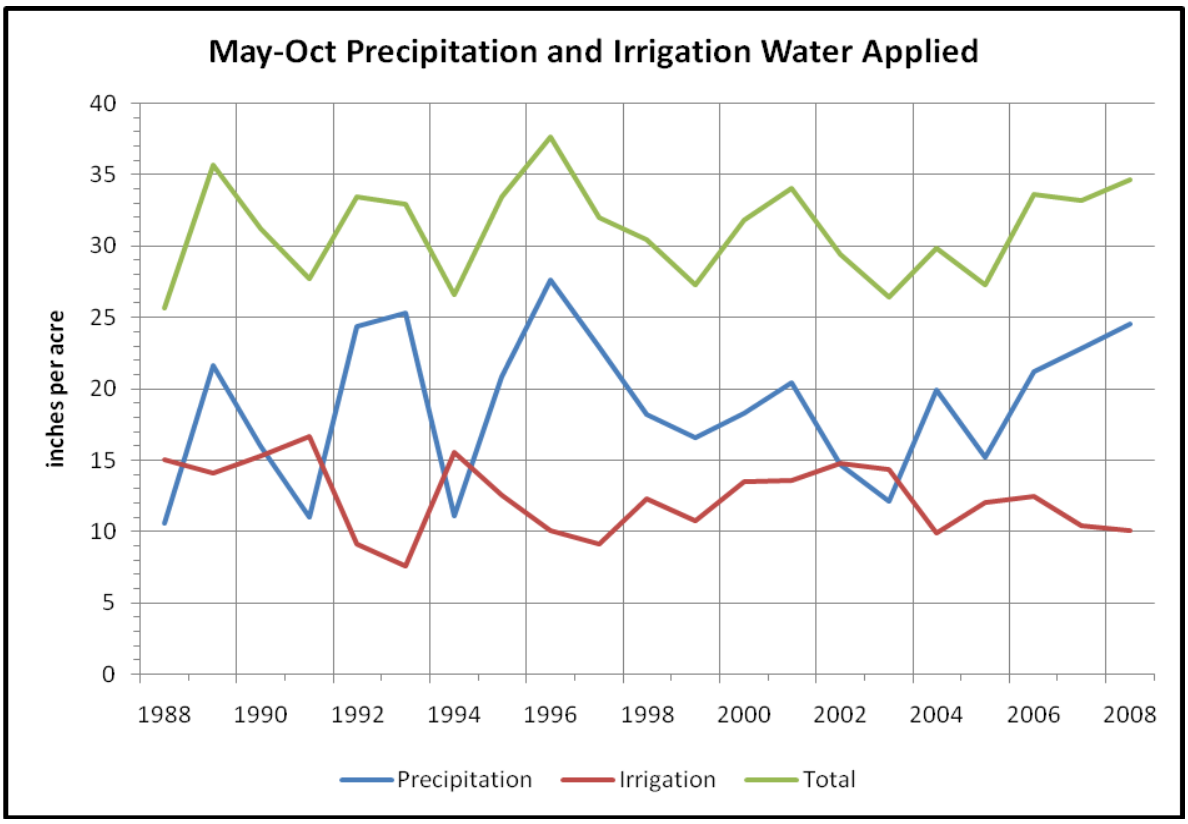


**Figure 20: May-October Precipitation and Irrigation (inches per acre) 1988-2008**

# 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 2009. Most of the water levels throughout the subbasin leveled off in 2010 compared to 2009. Water use was also down significantly in 2008. 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 05SWNWSW 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 |
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| 22S 16W 23NENENE 01 | PN50 | PN | 380744099023201 |
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| 22S 15W 33SESESE 01 | PN46 | PN | 380513098580601 |
| 23S 17W 12NWNWSW 02 | PN59 | PN | 380412099085601 |
| 23S 16W 11SWSESW 01 | PN57 | PN | 380328099031201 |
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| 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 13SENESW 01 | ED37 | ED | 375732099144301 |
| 24S 17W 20NESESW 01 | ED35 | ED | 375655099123501 |
| 24S 17W 24SESESE 01 | KGS4 | ED | 375629099075901 |
| 24S 18W 28SENESW 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 |
| 25S 19W 05NESWSW 01 | ED63 | ED | 375421099254401 |
| 25S 20W 03NWSWSE 01 | ED21 | ED | 375406099303401 |

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|---|---|---|---|
| 25S 18W 06SWSWSW 01 | ED59 | ED | 375358099205601 |
| 25S 19W 01SESESW 02 | GMD2 | ED | 375357099211202 |
| 25S 19W 01SESESW 01 | GMD1 | ED | 375357099211201 |
| 25S 18W 09NENENE 02 | GMD0 | ED | 375350099174701 |
| 25S 18W 09NENENE 01 | ED61 | ED | 375346099174801 |
| 25S 18W 07NENWSE 01 | ED60 | ED | 375339099201601 |
| 25S 19W 08NWSESE 01 | ED51 | ED | 375329099260101 |
| 25S 20W 12SENENE 01 | ED70 | ED | 375326099273801 |
| 25S 19W 17NWNESE 01 | ED65 | ED | 375250099260101 |
| 25S 18W 20NENENW 01 | ED49 | ED | 375201099190201 |
| 25S 19W 29NW 01 | ED66 | ED | 375106099261801 |
| 25S 19W 29NESWSW 01 | ED67 | ED | 375055099255301 |
| 25S 19W 31SWNENW 01 | ED68 | ED | 374954099270701 |
| 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 |
| 19S 11W 26 NWSENE 01 | BT03 | BT | 382225098304401 |
| 19S 11W 30NESWNW 01 | BT02 | BT | 382221098344801 |
| 19S 12W 28SENWSW 02 | BT04 | BT | 382202098391202 |
| 19S 12W 30SENWSW 01 | BT05 | BT | 382150998412401 |
| 19S 14W 36NWNWSW 01 | BT07 | BT | 382137098493201 |
| 19S 13W 33SENWNW 02 | BT29 | BT | 382113098454901 |
| 19S 13W 33SENWSW 01 | BT30 | BT | 382107098454901 |
| 20S 11W 03NENWNW 01 | BT11 | BT | 382047098312801 |
| 20S 12W 06NESWSW 01 | BT14 | BT | 382044098410801 |
| 20S 12W 03SENESW 01 | BT13 | BT | 382018098375001 |
| 20S 12W 06SESENW 01 | BT15 | BT | 382010098410801 |
| 20S 11W 06SWSWSW 01 | BT08 | BT | 382004098352101 |
| 20S 12W 07NESENW 01 | BT16 | BT | 381944098410801 |
| 20S 15W 13NESESE 01 | BT23 | BT | 381843098552101 |
| 20S 14W 13SESENW 01 | BT20 | BT | 381827098485101 |
| 20S 13W 17SESESW 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 |