Rattlesnake Creek

2010 Field Analysis Summary

May 16, 2011

Basin Management Team

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I. Introduction

The Rattlesnake Creek subbasin is located in south-central Kansas, adjacent to and paralleling the southwest-to-northeast reach of the Arkansas River basin. The subbasin covers 1,232 square miles of the Great Bend Prairie aquifer, a sub-region of the High Plains aquifer south of the Arkansas River. The Rattlesnake Creek subbasin is nearly 95 miles long and averages a width of 18 miles. Counties within the subbasin include Barton, Clark, Edwards, Ford, Kiowa, Pawnee, Pratt, Reno, Rice and Stafford.

The Rattlesnake Creek subbasin is situated partially within two Groundwater Management Districts (GMDs). Most of the subbasin is in Big Bend GMD #5. The portion of the subbasin in Ford County is in the Southwest Kansas GMD #3. A very small part of the subbasin, within portions of Clark and Kiowa counties, is not in a GMD.

The subbasin is also home to Quivira National Wildlife Refuge. The Refuge is managed by the Department of Interior, U.S. Fish and Wildlife Service (USFWS). Quivira’s area includes 22,135 acres in Stafford, Rice and Reno counties. It is located near the confluence of Rattlesnake Creek and the Arkansas River. The Wildlife Refuge is dependent on surface water from Rattlesnake Creek.

In order to address the supply and use of water resources in the subbasin, the Rattlesnake Creek Subbasin Partnership was formed in 1993. The Partnership includes GMD #5, Water Protection Association of Central Kansas (Water PACK), Kansas Department of Agriculture – Division of Water Resources (KDA-DWR) and Department of Interior, U.S. Fish and Wildlife Service (USFWS). The partners agreed to use a community involvement approach as the guiding principle to address water resource concerns within the subbasin. A cooperative agreement was signed in June of 1994. The partnership designated priority areas within the Rattlesnake Creek subbasin in order to better manage the subbasin (Figure 1).

The Partnership designed a management program that was signed by the chief engineer in July, 2000. The program outlines strategies to reduce water use. It includes a twelve-year implementation schedule with a review of progress in 2004, 2008 and a final review in 2012. The management program is available on KDA-DWR’s website at http://www.ksda.gov/includes/document_center/subbasin/Rattlesnake/RSC_Management.pdf.
Figure 1: Rattlesnake Creek Subbasin with Priority Areas
II. Precipitation

Precipitation in the Rattlesnake Creek subbasin historically averages 24.3 inches per year based on four precipitation stations. The chart in Figure 2 is based on averaged data from National Climatic Data Center (NCDC) stations: Bucklin in Ford County, Greensburg in Kiowa County, Trousdale 1NE in Edwards County and Hudson in Stafford County. The chart shows a dry period in the 1950s. Since the 1950s other years have had low precipitation but not in the consecutive years that characterized the drought of the 1950s. The highest annual precipitation occurred in 1973 with over 40 inches. The 1990s had several years of above average precipitation. Annual precipitation data for these NCDC stations is currently available through 2009.

Figure 2: Rattlesnake Creek Precipitation 1939-2009
Figure 3 graphs the 2010 evapotranspiration and precipitation conditions in the Rattlesnake Creek subbasin. This information comes from six GMD #5 weather stations: Greensburg, Lewis, Macksville, Radium, Stafford and Sterling. The six stations received an average 25.2 inches of precipitation during 2010. This is slightly greater than the average 24.3 inches of precipitation documented over the period of record for this subbasin. Even with the above average precipitation, the subbasin had a deficit of moisture due to the 46.1 inches of evapotranspiration.

III. Surface Water

Rattlesnake Creek subbasin has several tributaries. The West Fork, South Fork and East Fork combine to establish the main channel in northern Kiowa County. From there the stream flows northeast. An unnamed ephemeral tributary joins Rattlesnake Creek in southwest Stafford County. Another tributary, Spring Creek, enters the main streambed south of St. John. The other tributary in the subbasin is Wildhorse Creek which joins Rattlesnake Creek north of St. John. Rattlesnake Creek is a perennial stream from just north of St. John to its northerly bend near Quivira National Wildlife Refuge. Otherwise, the stream is classified as intermittent. Rattlesnake Creek has two United States Geological Survey (USGS) streamflow gages, located at Macksville and Zenith (Figure 4). The Macksville gage is the upstream gage and Zenith measures inflow to Quivira.
Figure 4: Rattlesnake Creek USGS Streamflow Gages
Figure 5: Streamflow at USGS Gages 1960-2009
Figure 6: Daily Streamflow and MDS for 2010
The Macksville gage is located near where baseflow typically begins for the Rattlesnake Creek, and therefore reflects less baseflow than measurements at Zenith. The Macksville gage record dates to 1960 while recording at the Zenith streamflow gage began in 1974 (Figure 5). Over the periods of record, the average streamflow at Zenith was 44.36 cfs and 22.69 cfs at Macksville. During the 1990s, the Zenith gage had higher flows and averaged 51.08 cfs while the Macks ville gage recorded an average 18.97 cfs. Both streamflow gages had reduced streamflows in the period 2000 to 2009, averaging 37.36 cfs at Zenith and 10.03 cfs at Macksville.

| Table 1: Minimum Desirable Streamflow (MDS) |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Macksville      | 5     | 5     | 10    | 10    | 10    | 10     | 10     | 1      | 1      |
| Zenith          | 15    | 15    | 15    | 15    | 15    | 15     | 10     | 3      | 3      |

In 1984, the Kansas Legislature amended the Kansas Water Appropriations Act to establish Minimum Desirable Streamflow for specific USGS streamflow gages. Table 1 shows MDS for both the Macksville and Zenith USGS streamflow gages. Figure 6 shows the streamflow measurements for 2010. Both Zenith and Macksville started the year above the MDS levels. In the late spring and early summer of 2010, flows at Macksville dipped below MDS for the only time during the year. Zenith streamflow stayed above MDS for all of 2010.
Since MDS was established in 1984, the streamflow at the Zenith gage has met MDS more often than at the Macksville gage (Figure 7). When a USGS gage station records streamflow for seven consecutive days below the MDS value, administration can begin. Once begun, administration continues until the gage has recorded fourteen consecutive days above the MDS value. The chief engineer can prohibit the use of certain diversions for this period if they are affecting streamflow.

**IV. Groundwater**

The majority of the Rattlesnake Creek subbasin overlies the Great Bend Prairie portion of the High Plains aquifer. However, the headwaters begin in the Ogallala portion of the High Plains aquifer. Approximately 80 percent of the southwest portion of the Rattlesnake Creek subbasin is underlain by unconfined Dakota Aquifer. The Dakota Aquifer is considered hydraulically connected to the overlying High Plains aquifer.

GMD #5 and the Kansas Geological Survey in cooperation with KDA-DWR combine efforts to measure 168 wells in the basin annually (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, were used for the monitoring well water level charts, since those measurements are considered to be the least influenced by irrigation well pumping. Three monitoring wells have been abandoned and replaced. ED09 was replaced by ED76, ED31 was replaced by ED77 and KW25 was replaced by KW45. Figure 9 through Figure 21 chart groundwater levels in all the monitoring wells and the five-year rolling averages. Legal descriptions of the well locations are available in the appendix. The y-axis on each chart is labeled as “DBLS (ft)”. DBLS stands for depth below land surface.
Figure 8: KGS, GMD 5 and DWR Monitoring Wells
Figure 9: Monitoring well levels in Priority Area 1

Priority Area 1 has 20 monitoring wells. KGS115 recorded water level measurements above land surface as this used to be an artesian well. In 2011, most monitoring wells had a decline in water levels. The average decline was 0.49 inches, but the five-year rolling average increased by 0.60 feet in 2011 (Figure 9).
Priority Area 2 has only five monitoring wells. SF43 has the longest record starting in 1978, but is no longer being measured because the well has been destroyed. Water levels in SF43 have experienced a net decline of 7.04 feet since 1978 despite an increase of 7.98 feet since 2007. Three of the remaining four wells had a decline in water levels for an average decline of 0.58 feet. The five-year rolling average continued to increase, but may be influenced by lack of a measurement at SF43 (Figure 10).
Priority Area 3 has 10 monitoring wells. Eight of the monitoring wells had a decline in water levels in 2011. Only SF65 and KGS31 had a rise. The average change in water levels was a decline of 0.26 feet in 2011. The five-year rolling average saw another rise in 2011 (Figure 11).
Figure 12: Monitoring well levels in Priority Area 4 South

Priority Area 4 is divided into two areas along the main stem corridor, South and North. South is upstream located primarily in Edwards County and has 12 monitoring wells. Seven monitoring wells had a decline in water levels while the other five had a rise. The average change in water levels is a decline of 0.16 feet in 2011. The five-year rolling average slightly increased (0.78 feet) between 2010 and 2011 but exhibits a net decrease of 3.7 feet since 1983 (Figure 12).
Priority Area 4 North has 12 monitoring wells and is located primarily in Stafford County. Eleven of the twelve monitoring wells had a decline in water levels for an average loss of 0.89 feet (Figure 13). SF78 had the biggest decline with 2.45 feet. The five-year rolling average continued to increase.
Because of its size and hydrologic variability, Priority Area 5 is charted on three separate graphs separated by county. Kiowa County has 11 monitoring wells, but only 10 are measured since KW25 has been replaced by KW45. Half the monitoring wells increased in water levels and the other half had declines. The Kiowa County five-year rolling average continued to decline in 2011. The Priority Area 5 five-year rolling average had a small rise in 2011 (Figure 14).
Priority Area 5 in Edwards County has 29 measured monitoring wells and two wells previously measured. Many of the measurements began in 1979. Fourteen of the 29 monitoring wells had declines in water levels and the average change in water levels was a decline of 0.52 feet (Figure 15). The Edwards County (red line) five-year rolling average exhibits a net decline, but a small rise in 2011.
Priority Area 5 in Stafford and Pawnee counties includes 12 monitoring wells. Seven wells were first measured in 1978. Five monitoring wells had a decline in water levels, six had an increase and one was not measured (Figure 16). The average change in water levels was an increase of 0.35 feet. The Stafford/Pawnee County five-year rolling average (red line) has a net decline even with the recent rise in trend.
Figure 17: Monitoring well levels in Priority Area 7, Shallow Wells (Note: Rolling Average includes ALL wells in the Priority Area)

Priority Area 7 has 23 monitoring wells. The monitoring wells were charted separately based on depth to water. Figure 17 charts the shallow depth to water wells whereas Figure 18 charts the deeper wells. Twelve of the fourteen shallow wells had declining water levels in 2011. The 5-year rolling average for all the wells has a net decline and continues to decline in 2011 (Figure 17).
Records for wells KW31, KW35 and KW30 began in 1979. In 2010, the five monitoring wells saw an increasing trend in water levels (Figure 18). The five-year rolling average shown on Figure 17 includes all the wells within the priority area, including those plotted on Figure 18.
The Mineral Intrusion Priority Area has 25 monitoring wells. All but one monitoring well (KGS11) had a decline in water levels in 2011. The average change in water levels was a decline of 2.25 feet. The five-year rolling average increased in 2011, but still has a net decline (Figure 19).
Twelve monitoring wells fall outside the defined priority areas. They have been charted based on depth to water. Three of the four shallow wells have seen net declines. In 2011, all but FO32 had declining water levels (Figure 20). The five-year rolling average for all of the wells outside the defined priority areas is shown on Figure 21.
FO26 has a net decline since 1978 while other wells, KW41, KW15 and KW42, maintained their water levels over the nearly 30-year time span. Four of the eight deep wells had a decline in water levels in 2011. The five-year rolling average may be affected by the shallow wells added in the 1990s but since 1999, the trend is declining (Figure 21).
V. Water Use

The Rattlesnake Creek subbasin has a total of 1,377 water rights with an authorized quantity of 266,726 acre-feet (Table 2). A small percentage of the water rights in the basin are vested. Water uses considered in this report include irrigation, municipal, domestic, stock, recreation and industrial (Figure 23).

Table 2: Water Rights in the Rattlesnake Creek Subbasin

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Water use ranges from 216,347 acre-feet in 2002 to 119,204 acre-feet in 1997. The average water use over the twenty-year span was about 175,656 acre-feet. Water use in 2009, the most recent year for which complete records are available was 170,599 acre-feet. This is a decrease from 2008 and also below the average for the subbasin (Figure 22).
Figure 23: Rattlesnake Creek Points of Diversion

Figure 24: Annual Precipitation and Irrigation (inches per acre) 1989-2009
Irrigation pumping is the number of inches applied to an acre for that year. As more precipitation falls, irrigation pumping declines (Figure 24). For the period, 1989 to 2009 Rattlesnake Creek subbasin received an average of 26.01 inches of precipitation while water users applied an average of 13.63 inches per year of water for irrigation. The year 2009 had 24.05 inches of precipitation and 12.6 inches of irrigation water applied. The timeliness of precipitation affects the amount of irrigation water applied. Figure 25 compares irrigation season (May through October) precipitation with irrigation water applied.

![May-Oct Precipitation and Irrigation Water Applied](image)

**Figure 25: May-October Precipitation and Irrigation (inches per acre) 1989-2009**

VI. Conclusions

The year 2010 appears to have been slightly above-average year for precipitation. Streamflows were above MDS criteria for most of the year at Macksville and all year at Zenith. Water levels in the alluvial aquifer declined within each of the Rattlesnake Creek subbasin priority areas. The change in the five-year rolling averages varied across the subbasin. The 2009 water use was below the historical average water use for the subbasin. 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

### Monitoring Well Network Information

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