Ogallala-High Plains Fringe Area

2010 Field Analysis Summary

May 20, 2011

Basin Management Team

Division of Water Resources
Kansas Department of Agriculture
109 SW 9th Street
Topeka, KS 66612-1283
785-296-3717

Table of Contents

Figures

Tables

I. Introduction

The High Plains aquifer underlies about 174,000 square miles of the central United States in the Great Plains east of the Rocky Mountains. The aquifer underlies portions of eight states including South Dakota, Wyoming, Nebraska, Colorado, Kansas, Oklahoma, New Mexico and Texas (Figure 2). The High Plains aquifer is the most abundant source of water in the region, which leads the economy of the area to depend upon it for irrigated agriculture. The volume of water in the High Plains aquifer in 2000 was about 2.98 billion acre-feet, which ranged from 40 million acre-feet in New Mexico to about 2 billion acre-feet in Nebraska (McGuire et al., 2003; Figure 1).

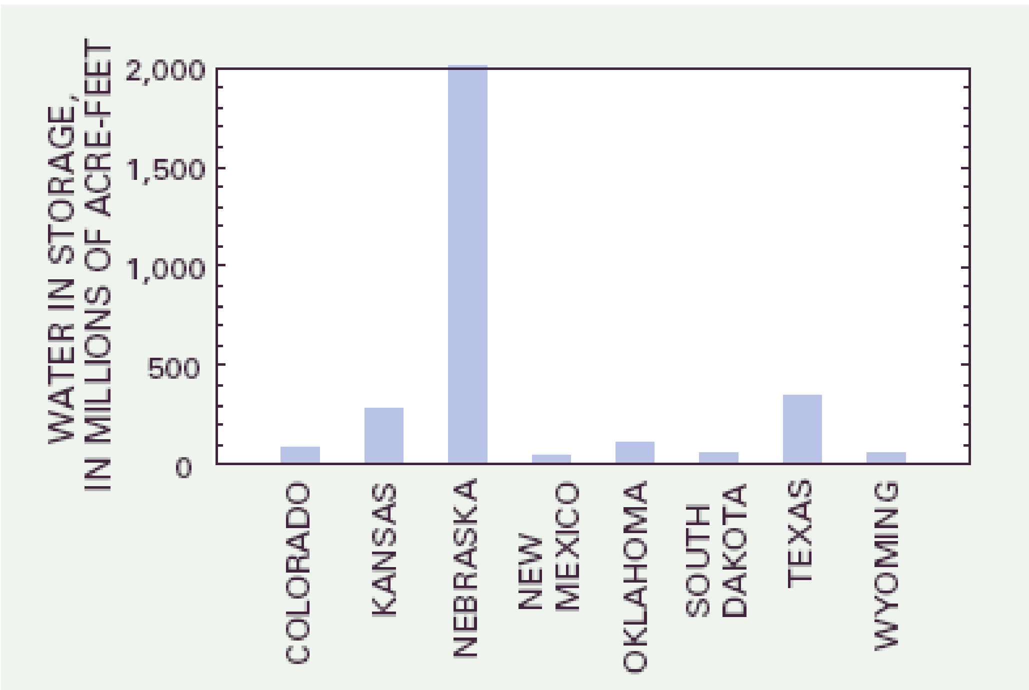

Figure 1: Water in storage in the Ogallala-High Plains aquifer, 2000, by state

The Ogallala Formation is the principal geologic unit in the High Plains aquifer, and it accounts for approximately 134,000 square miles of the High Plains aquifer. Groundwater flow is generally from west to east, at an average rate of approximately 1 foot per day, and discharges naturally to streams and springs and through atmospheric evapotranspiration.

The area is characterized as "between a semiarid to arid environment and a moist sub-humid environment" (Lohman, 1953). Mean annual precipitation increases eastward across the area, from 14 inches in the west to about 30 inches in eastern Nebraska. Seventy-five percent of precipitation falls as rain during the growing season (April – September) as localized thunderstorms. Persistent winds and high summer temperatures cause high evaporation rates. The mean annual pan evaporation ranges from approximately 60 inches in northern Nebraska and southern South Dakota to about 105 inches in western Texas and southeastern New Mexico.

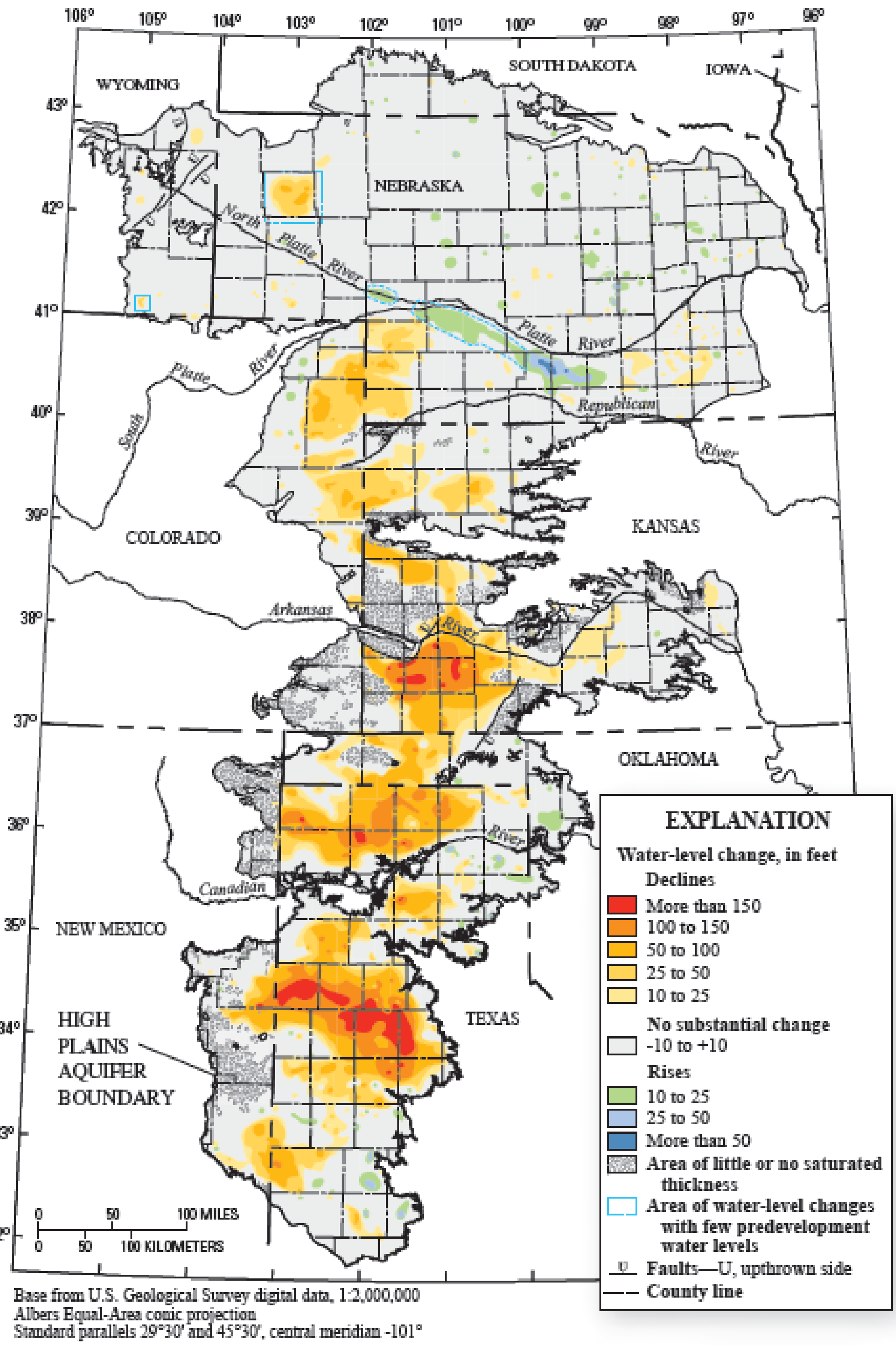

Figure 2: Water level changes in the Ogallala-High Plains aquifer, predevelopment to 2007 (McGuire, 2009)

This report focuses on parts of the Ogallala-High Plains aquifer in western Kansas outside of Northwest Kansas Groundwater Management District No. 4 (GMD 4), Western Kansas Groundwater Management District No. 1 (GMD 1), and Southwestern Kansas Groundwater Management District No. 3 (GMD 3). These parts of the aquifer are known as “fringe areas” because they are generally located on the edge of the aquifer where there is marginal saturated thickness. Along the eastern edges of the fringe area, the aquifer tapers and in some locations terminates in outflow seeps to small streams. The most extensive fringe area is in northwest Kansas (Figure 5 and Figure 10).

II. Precipitation

Precipitation in northwest Kansas historically averages 20.3 inches per year based on 45 precipitation stations from 12 counties. Figure 3 shows the annual variation in precipitation and the long term average precipitation. This chart was derived from National Climatic Data Center (NCDC) stations located in the following 12 counties: Cheyenne, Rawlins, Decatur, Norton, Sherman, Thomas, Sheridan, Graham, Wallace, Logan, Gove and Trego counties. The data is downloaded for each station and then averaged to create the following chart.

The chart shows several years of precipitation below 15 inches per year. In contrast, numerous years had precipitation greater than 25 inches per year. In 2009, the precipitation total was 26.6 inches, which is above average. Annual precipitation data for these NCDC stations is currently available through 2009. Preliminary 2010 average monthly precipitation is shown in Figure 4 along with the long term monthly average. The highest precipitation was in May with an average of 3.5 inches, and the lowest precipitation was in January with an average of 0.1 inches. The preliminary total average precipitation for 2010 was 19.2 inches, which is below average.

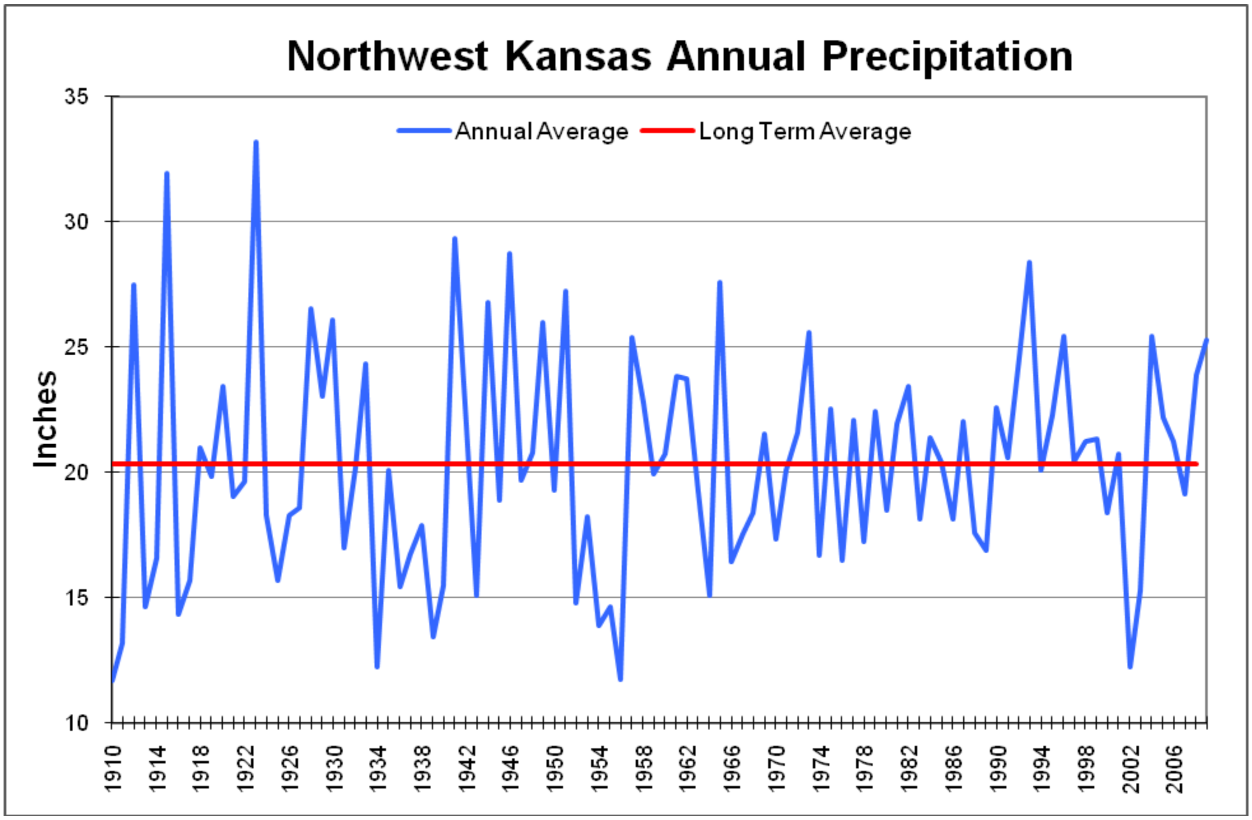

Figure 3: Annual Precipitation for Northwest Kansas, 1910-2009

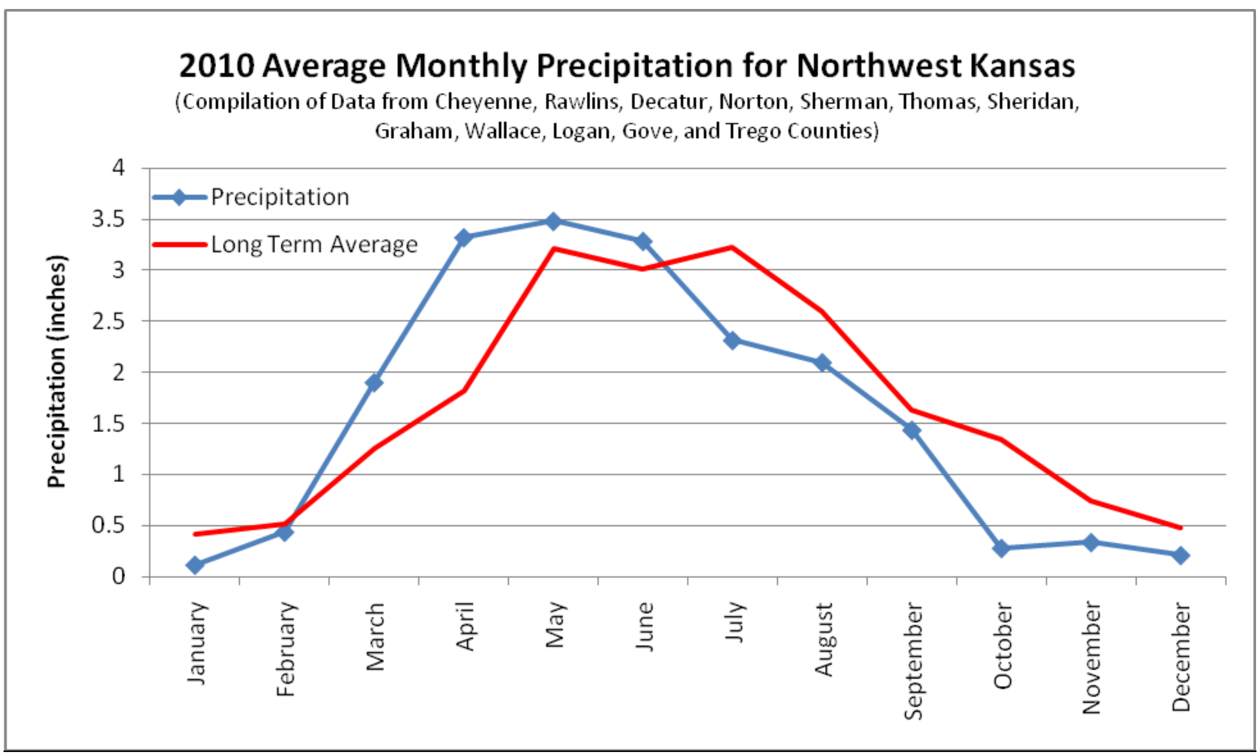

Figure 4: Average Monthly Precipitation 2010

III. Surface Water

Four tributaries in the northwest Kansas Ogallala-High Plains fringe area (outside GMD 4) have historical U.S. Geological Survey (USGS) gage data available. They include the South Fork Republican River, Beaver Creek, Sappa Creek and Prairie Dog Creek (Figure 5). All four tributaries are located in portions of Cheyenne, Rawlins, Decatur, Norton and Phillips Counties.

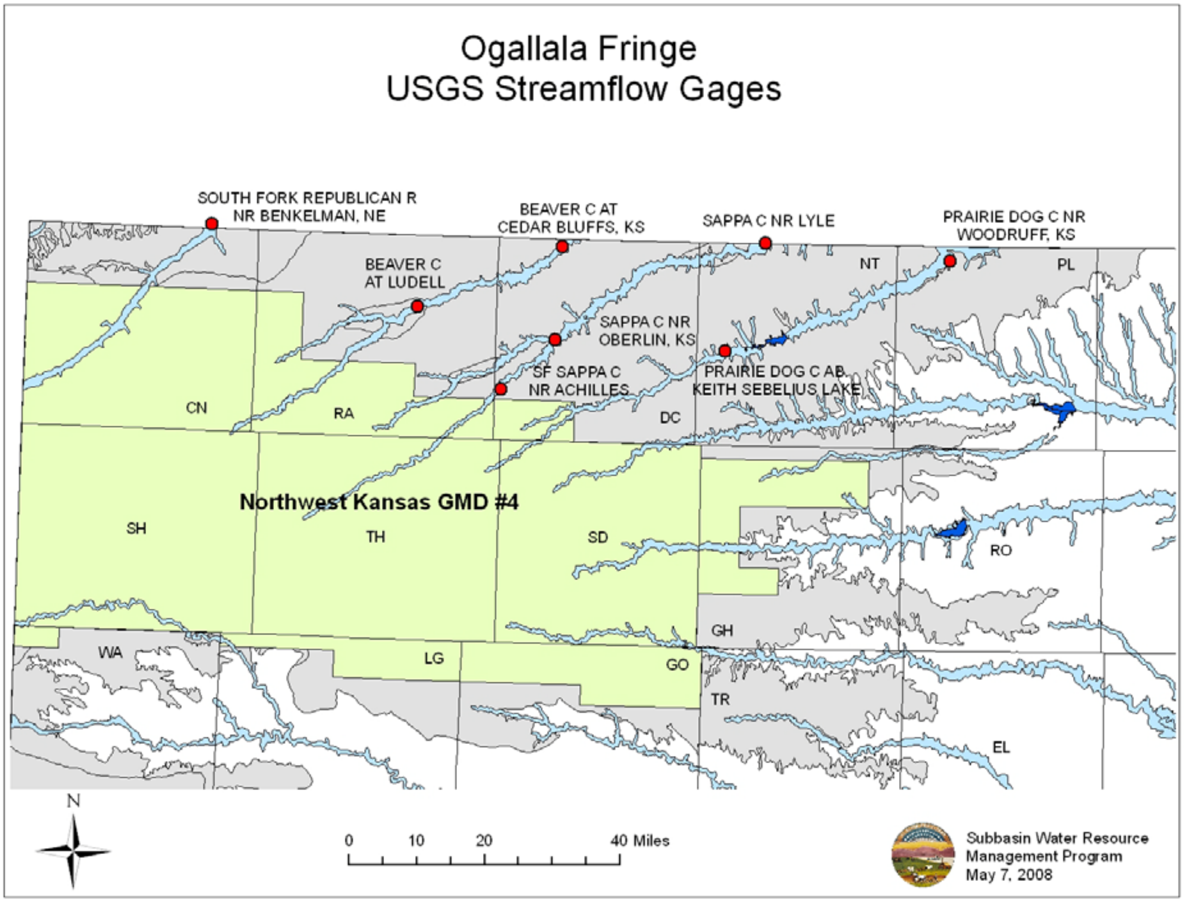

Figure 5: USGS Streamflow gages in the Northwest Kansas Ogallala-High Plains Fringe

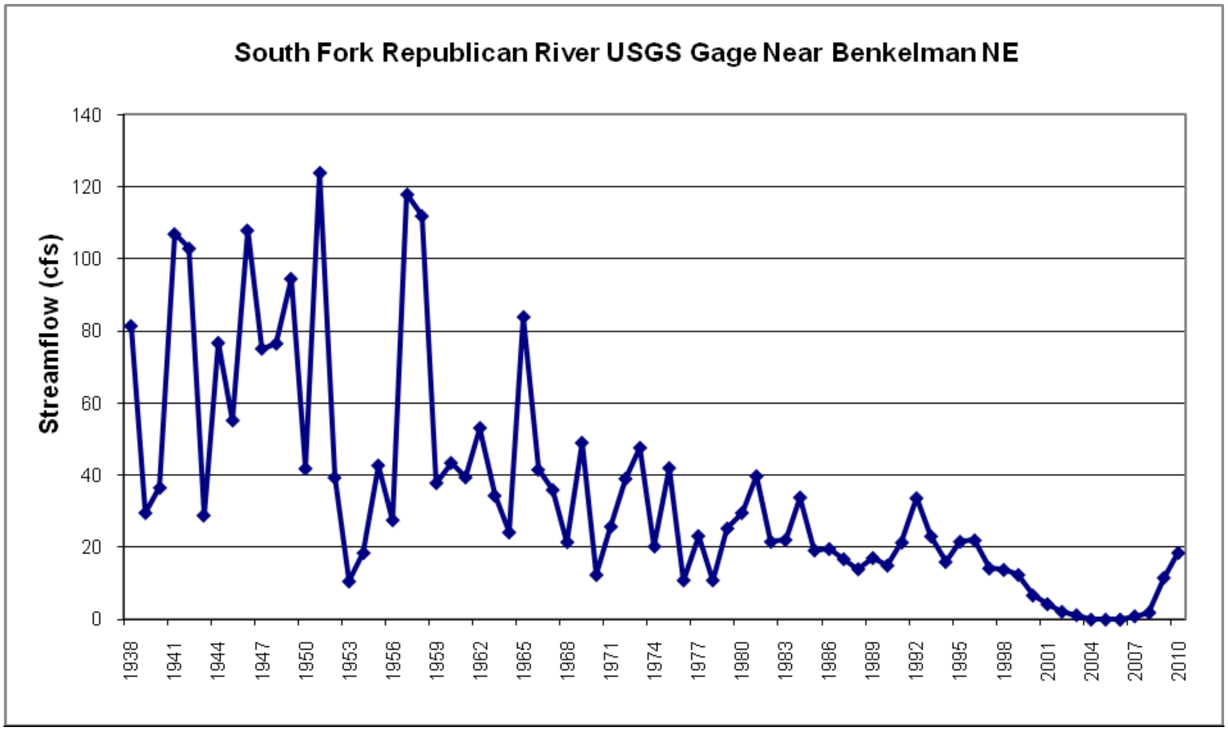

Figure 6: Streamflow for South Fork Republican River near Benkelman, NE 1938-2010

The section of the South Fork Republican River from the GMD 4 boundary to the Kansas-Nebraska state line south of Benkelman, Nebraska (Figure 5) is of interstate significance because this gage is used for Republican River Compact accounting. Due to its proximity, the USGS gage near Benkelman is also useful for examining discharge from the northwest Kansas Ogallala fringe.

The 1938 to 2010 annual mean data at this gage displays a significant decrease in streamflow over time (Figure 6). The long-term average annual streamflow is 35.68 cfs. The last time the annual average streamflow was over 35.68 cfs was in 1981 when it averaged 39.8 cfs. The annual average streamflow at the Benkelman gage was at or near zero for several years; however provisional 2010 average streamflow data was up at 18.52 cfs.

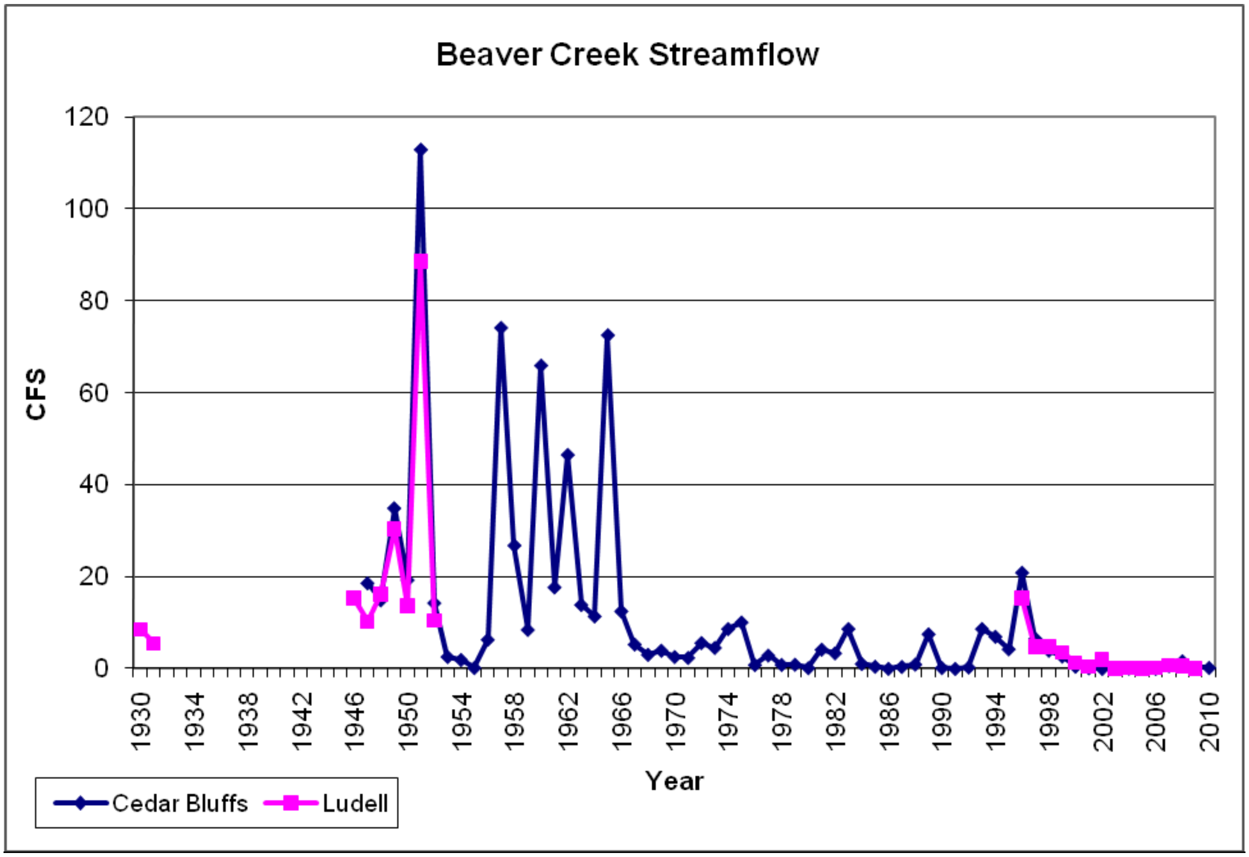

Figure 7: Streamflow for Beaver Creek at Ludell and Cedar Bluffs 1930-2010

The Ludell gage is located about five miles downstream of the confluence of the North and South Forks of Beaver Creek at Atwood and has a record dating back from 1930 to September of 2010, with a large gap in record from 1953 to 1995. Cedar Bluffs gage is located a little over one mile before the Beaver Creek crosses over the state line to Nebraska. It has a record dating back to 1947.

Over the period of record, the average annual streamflow at Cedar Bluffs was 11.13 cfs and 10.08 cfs at Ludell. The highest average yearly streamflow on Beaver Creek was recorded at the Cedar Bluffs gage in 1951 at 113 cfs (Figure 7). Both streamflow gages had decreasing streamflows averaging 0.50 cfs at Ludell and 0.33 cfs at Cedar Bluffs from 2000-2009. Cedar Bluffs 2010 average annual streamflow showed a slight increase from .20 cfs to .22 cfs from 2009.

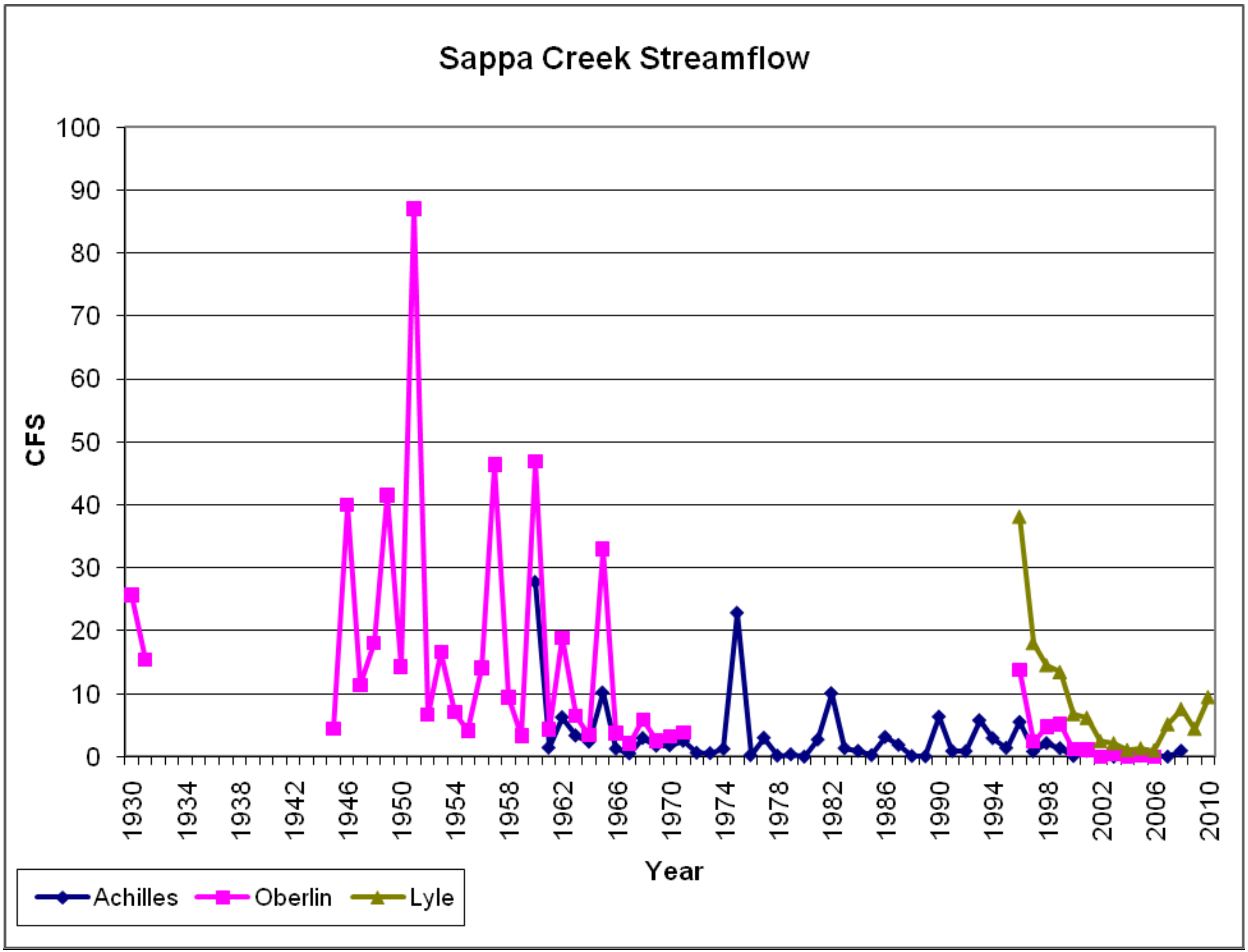

Figure 8: Streamflow for Sappa Creek at Lyle, Achilles and Oberlin 1930-2010

The Achilles gage is located on the South Fork Sappa near where baseflow typically begins and has a record dating back from 1960 to September 2009. The Oberlin gage was located a few miles downstream of the confluence of the North and South Forks of Sappa Creek. It has an inconsistent record starting in 1930 and ending in 2007, when it was removed from the USGS network. The Lyle gage is located on the KS-NE state line and has a record dating back to 1996.

Over the period of record, the average annual streamflow at Achilles was 2.91 cfs, 13.23 cfs at Oberlin, and 8.74 cfs at Lyle. The highest average yearly streamflow was recorded at the Oberlin gage in 1951 at 87 cfs (Figure 8). All three gages had decreasing streamflows from 2000-2008 when compared to the period of record flows, averaging 0.24 cfs at Achilles, 0.44 cfs at Oberlin (2000-2006), and 3.70 cfs at Lyle. At Lyle, 2010 average streamflow is 9.41 cfs, which is greater than 2009 streamflow.

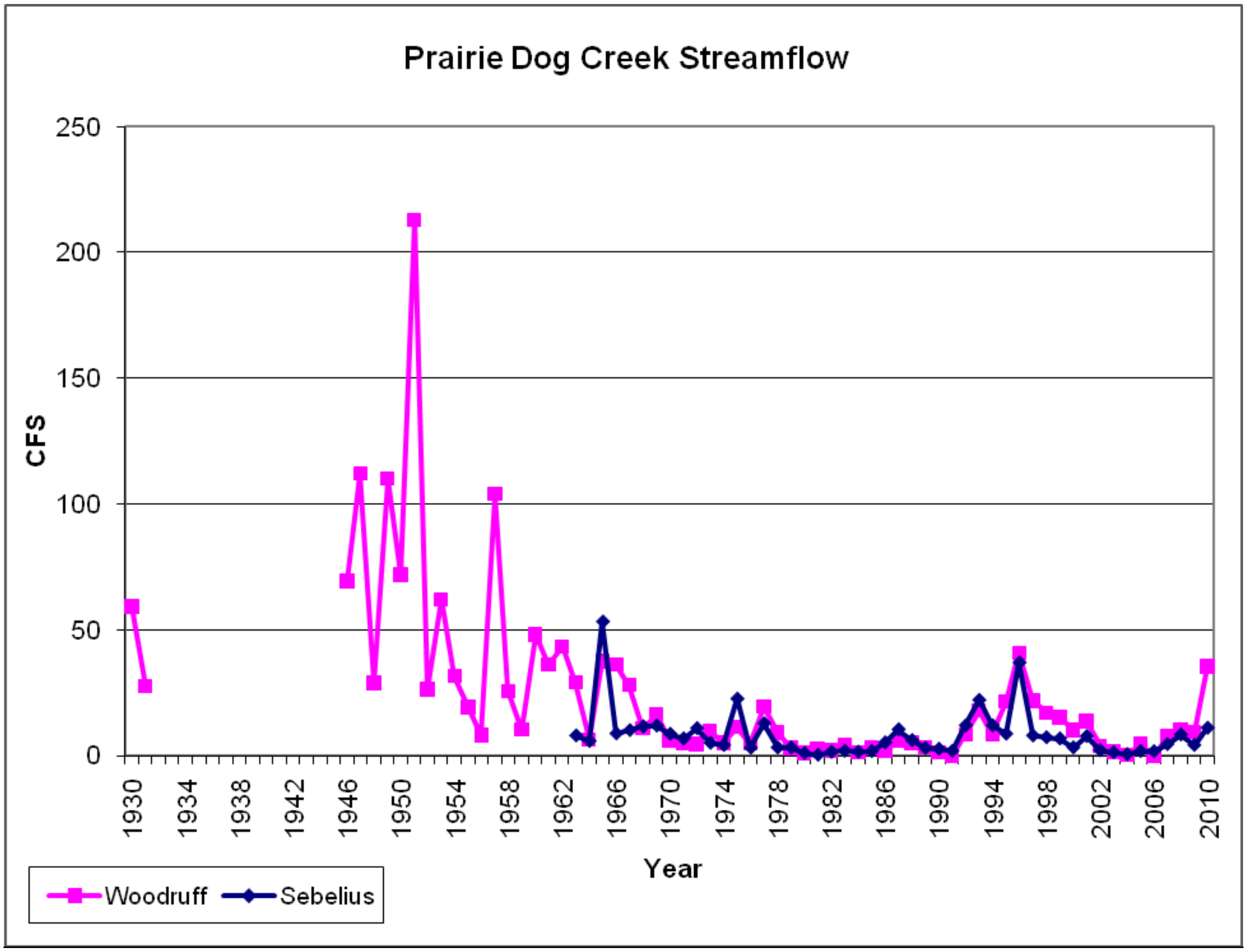

Figure 9: Streamflow for Prairie Dog Creek near Woodruff 1930-2010

The Sebelius gage is located approximately five miles upstream of the upper end of Keith Sebelius Reservoir and has a record dating back to 1963. The Woodruff gage is located near the KS-NE state line and has a record dating back to 1930. Over the period of record, the average annual streamflow at Sebelius was 8.06 cfs and 24.33 cfs at Woodruff. The highest average yearly streamflow on Prairie Dog Creek was recorded at the Woodruff gage in 1951 at 213 cfs (Figure 9). Both streamflow gages had decreasing streamflows when compared to the period of record, averaging 3.54 cfs at Sebelius and 6.17 cfs at Woodruff from 2000-2009. Average annual streamflow in 2010 at Sebelius is 11.03 cfs and at Woodruff is 35.50 cfs, which are higher than 2009 flows.

IV. Groundwater

The Ogallala-High Plains fringe area has few monitoring wells with historical data. The historic fringe water level data is statistically inadequate to be applied to a section level approach, which is needed for adequate evaluation of the hydrologic conditions. In an effort to improve the water level data coverage, the Kansas Department of Agriculture, Division of Water Resources (KDA-DWR) added nearly 100 wells to the annual monitoring network in northwest Kansas in January 2004 (Figure 10). This expanded the monitoring well network into Cheyenne, Phillips, Rooks, and Gove counties, as reflected in the below charts. A few of these wells are in areas that have over 100 feet of saturated thickness, which is uncommon to the fringe, a thinly saturated area. The KDA-DWR measures water levels in the Ogallala-High Plains fringe areas throughout western Kansas. There are currently 156 wells measured annually. 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 groundwater pumping. Figure 11 to Figure 28 chart groundwater levels in all fringe monitoring wells (legal descriptions are available in the appendix) and the five-year rolling averages. The y-axis is labeled depth below land surface (DBLS) with units in feet.

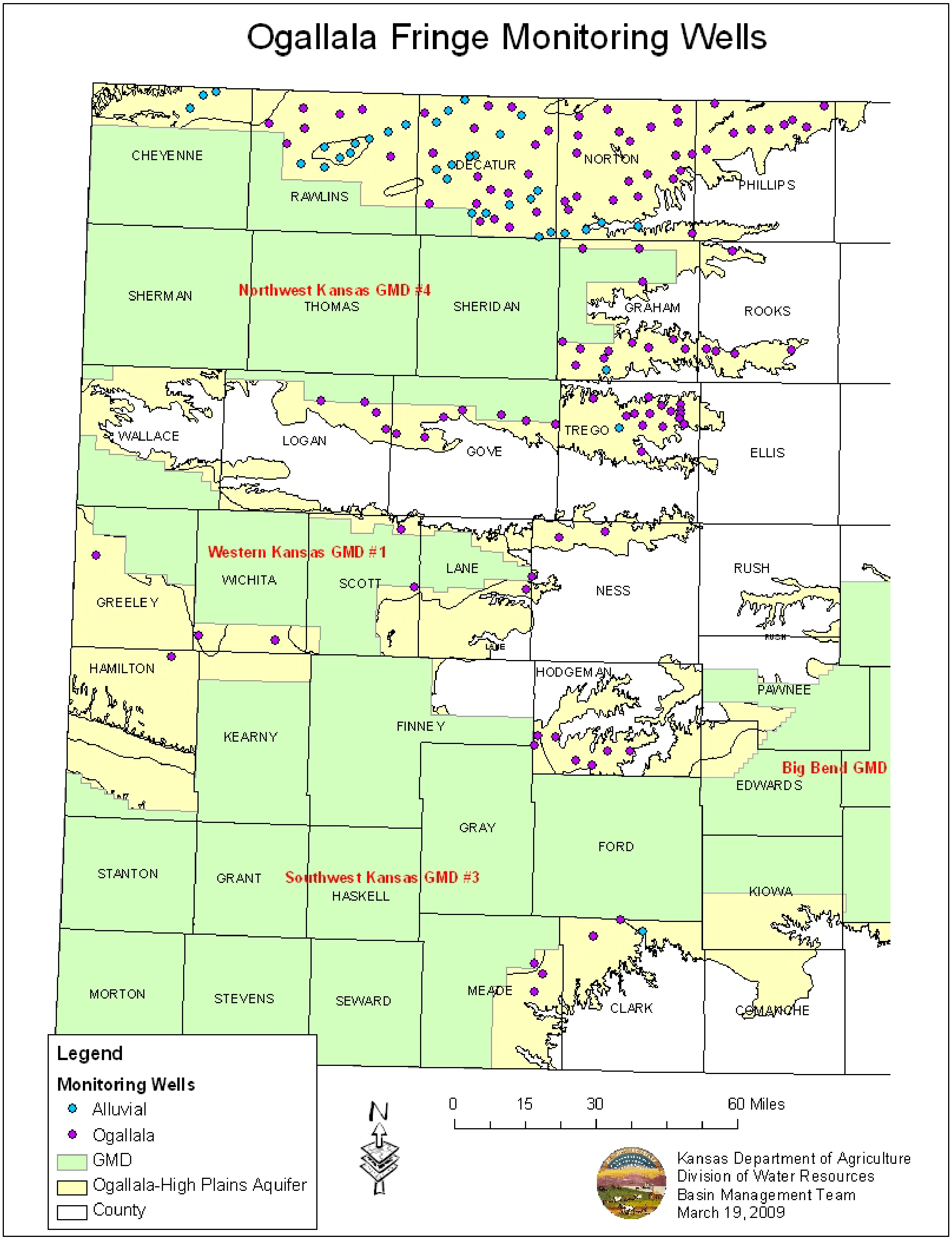

Figure 10: Monitoring wells in the fringe of the Ogallala-High Plains project area

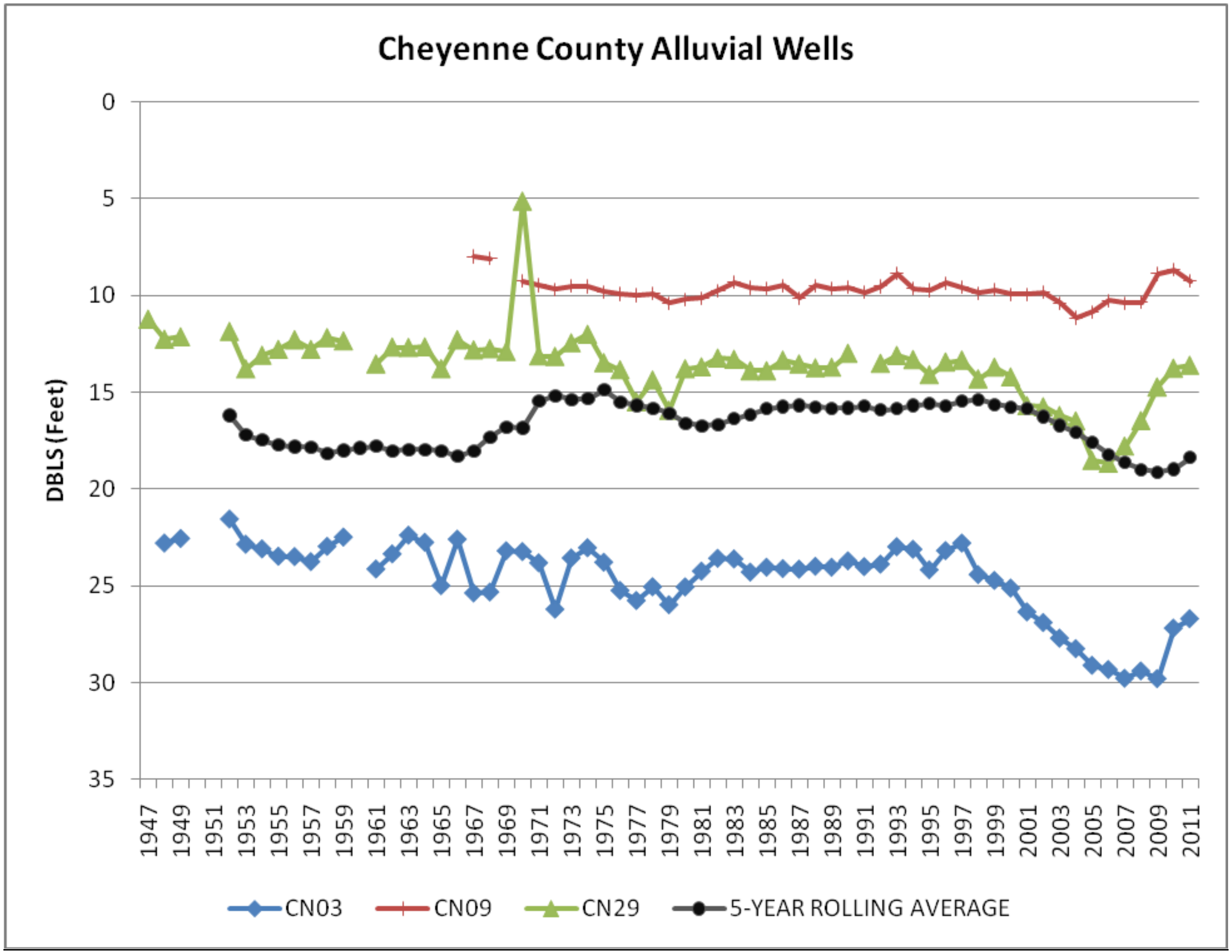

Figure 11: Alluvial Monitoring Well Levels in Cheyenne County Fringe

There are three alluvial monitoring wells in Cheyenne County. CN29 has the longest period or record with measurements from 1947, while CN03 and CN09 have measurements from 1948 and 1967 respectively. CN03 has had the largest net decline of about 3.9 feet since 1948, while CN09 and CN29 have experienced net declines of 1.27 feet and 2.38 feet respectively (Figure 11). From 2010 to 2011 CN03 and CN29 experienced increases of 0.49 feet, 0.15 feet respectively. CN09 decreased 0.58 feet from 2010 to 2011. The five-year rolling average has declined 2.61 feet since 2000.

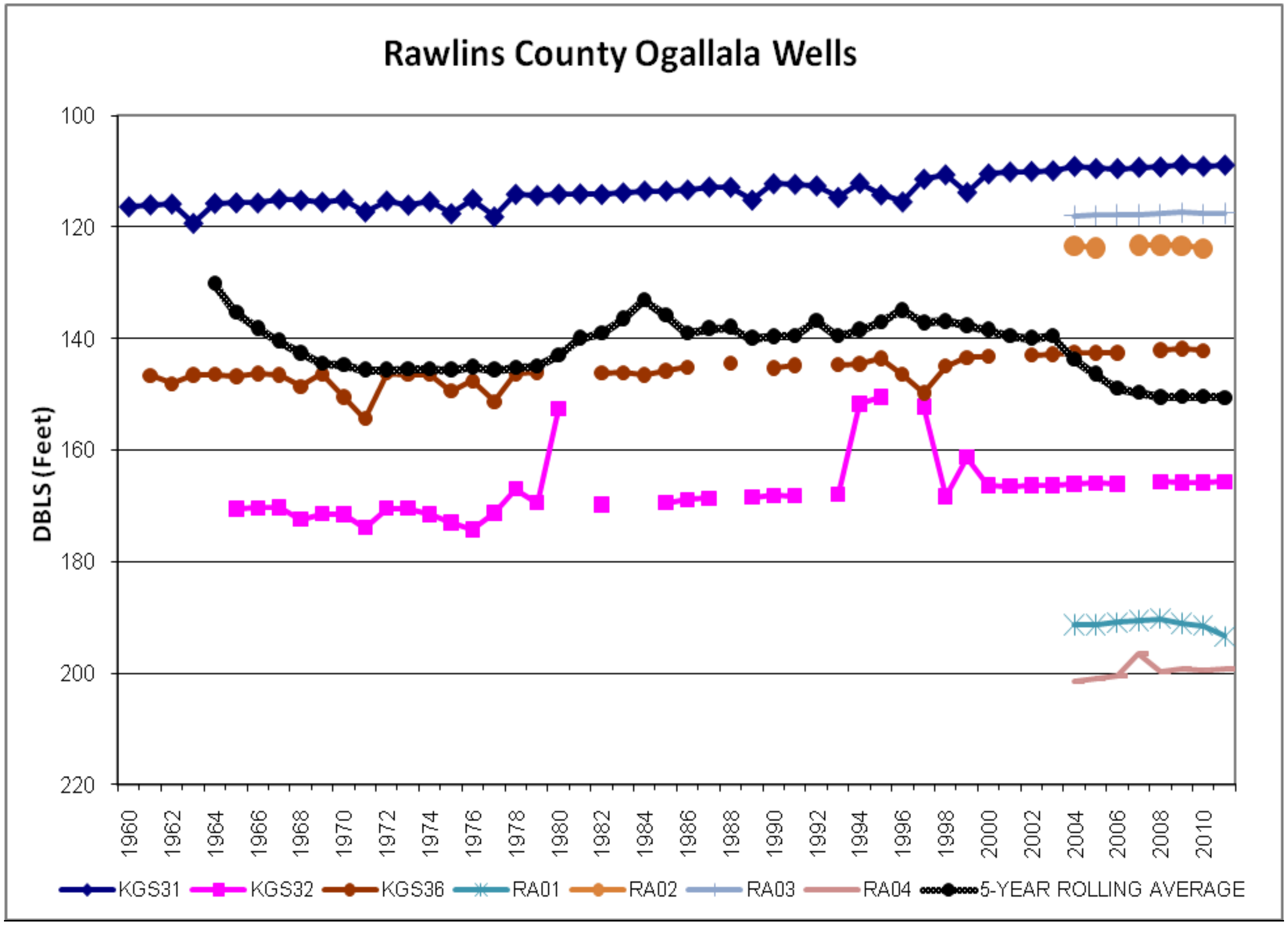

Figure 12: Ogallala-High Plains Monitoring Well Levels in Rawlins County Fringe

Rawlins County has both alluvial and Ogallala-High Plains monitoring wells. There are seven monitoring wells in the Ogallala-High Plains. Three of these wells have data beginning in the 1960s. KDA-DWR added monitoring wells RA01, RA02, RA03 and RA04 and these wells have measurements since 2004. From 2010 to 2011, the wells had an average decline of 0.24 feet. However, over the period of record, the water levels exhibit an average net increase of 2.4 feet (Figure 12). Since 1960, KGS31 has a net increase of 7.39 feet. The five-year rolling average has remained relatively stable with a declining trend starting in 2004 that is likely attributed to the addition of the deeper wells RA01 and RA04.

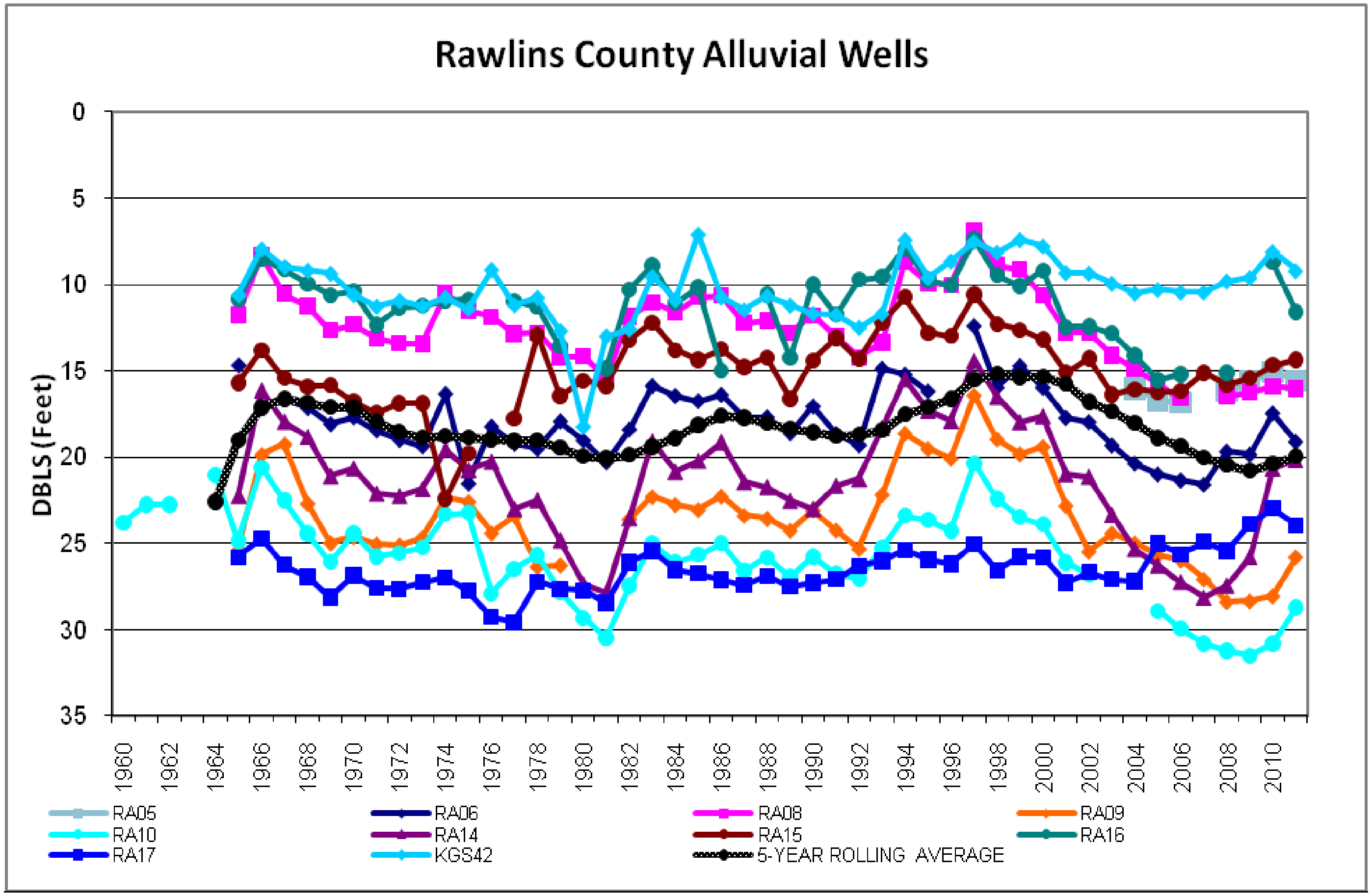

Figure 13: Alluvial Monitoring Well Levels in Rawlins County Fringe

Rawlins County has ten alluvial wells measured annually along Beaver and Sappa Creeks. Wells located in the alluvium along Beaver and Sappa Creek fluctuate over time and do not typically have a pronounced long term rising or declining trend (Figure 13). The five-year rolling average has declined about 4.6 feet since 2000. RA10 has the longest record dating back to 1960. The water levels have increased and declined in that time period. RA10 exhibited a net decline of 4.91 feet since 1960 and RA08 has exhibited a net decline of 4.30 feet since 1965.

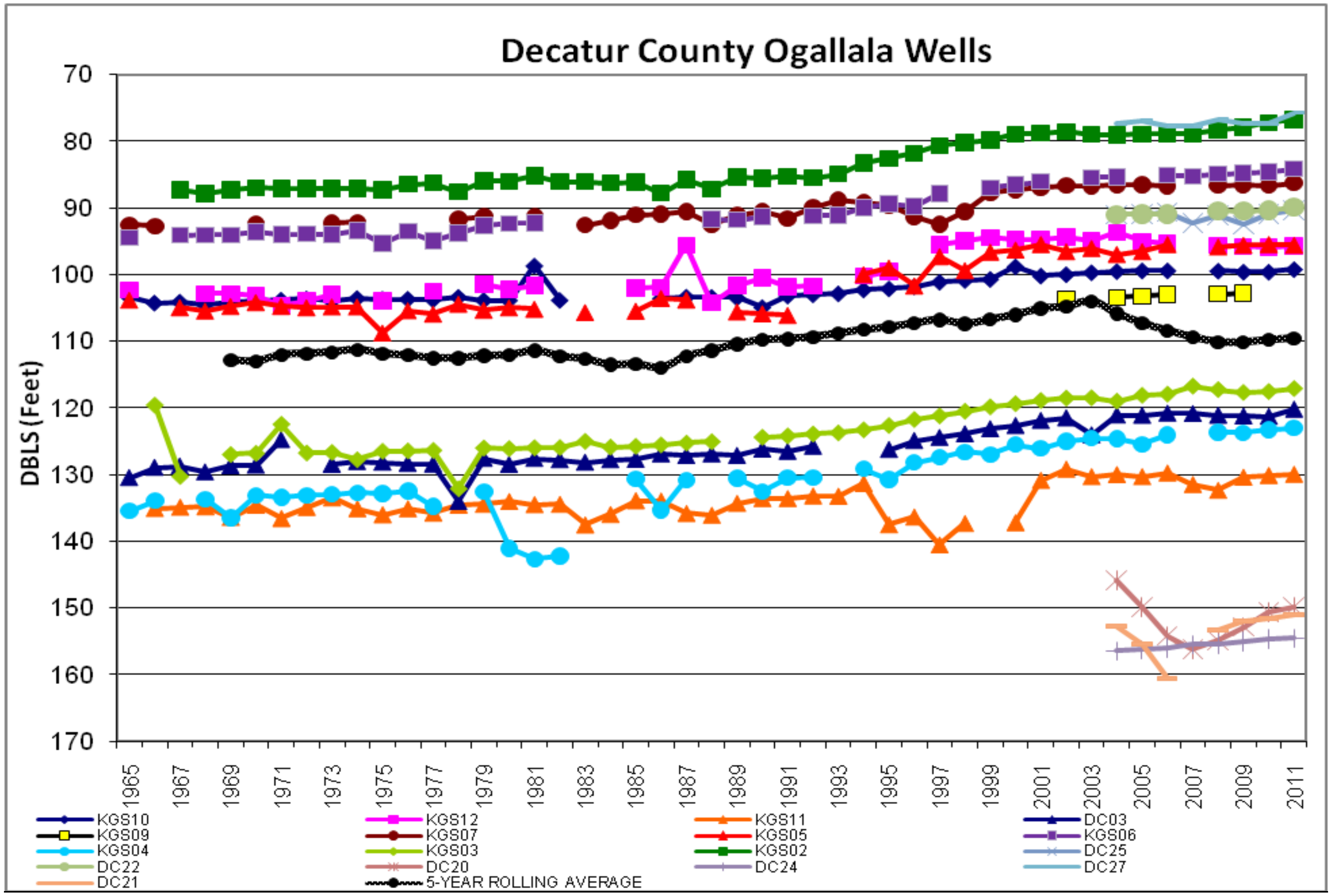

Figure 14: Ogallala-High Plains Monitoring Well Levels in Decatur County Fringe

Decatur County has a number of wells where measurements begin in 1965. Seventeen monitoring wells have been charted in Figure 14. KDA-DWR added monitoring wells DC20, DC21, DC22, DC24, DC25 and DC27 and these wells have measurements since 2004. Ogallala wells in Decatur County show an average 4.62 feet net increase over the period of record. The addition of the deeper wells in 2004 may be pulling the five-year average down slightly.

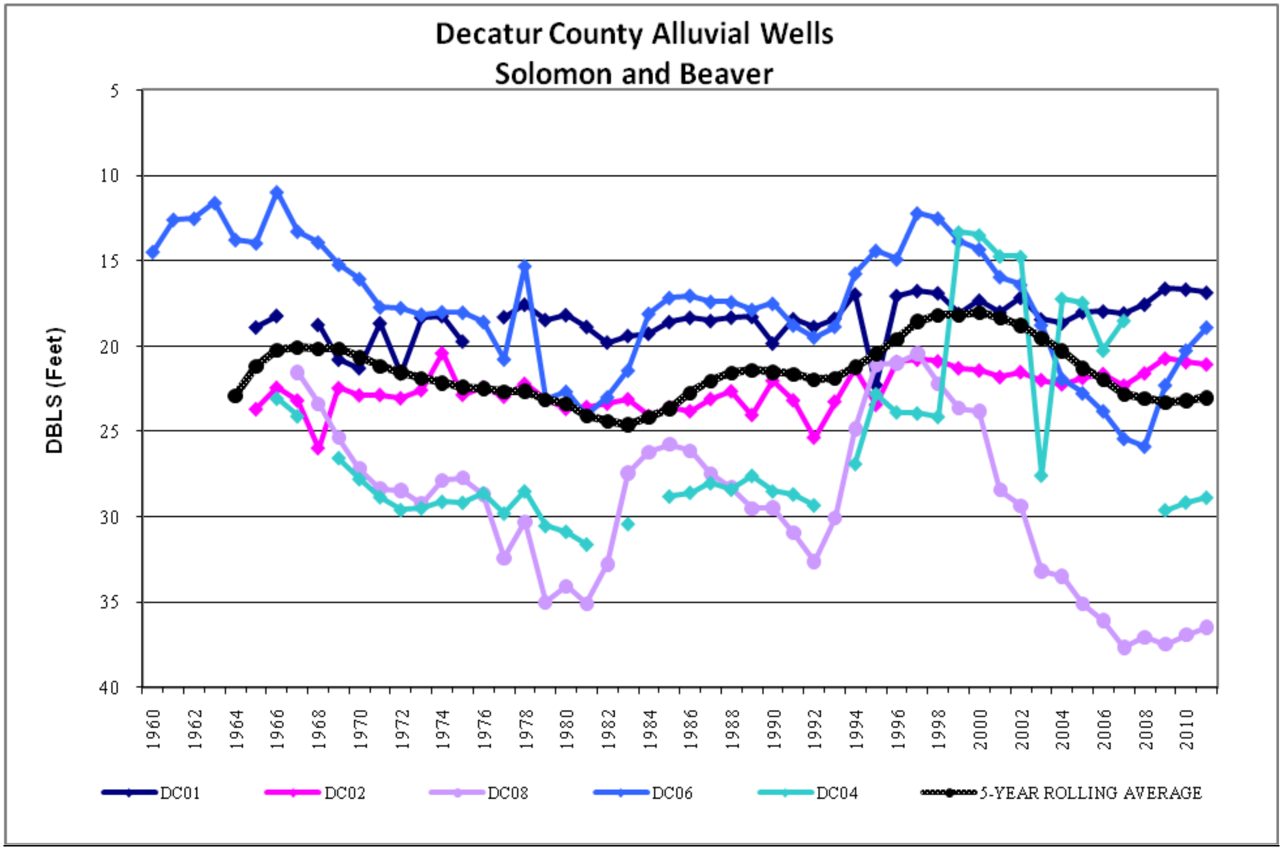

Figure 15: Alluvial Monitoring Well Levels in Decatur County, Upper North Solomon and Beaver Creek Fringe

NOTE: The 5-year rolling average is for all the alluvial wells in Decatur County

Decatur County has five alluvial monitoring wells. DC01 and DC02 are in the upper Solomon alluvium and have increased by a net of 2.05 feet and 2.65 feet respectively since 1965. The other three wells are in the Beaver Creek alluvium. Both DC06 and DC08 have net declines of 4.42 feet and 14.95 feet respectively; however DC06 has risen 6.97 feet since 2008. DC04 had periods of increase in the late 1990s to early 2000s, but has an overall net decline of about 5.81 feet. (Figure 15)

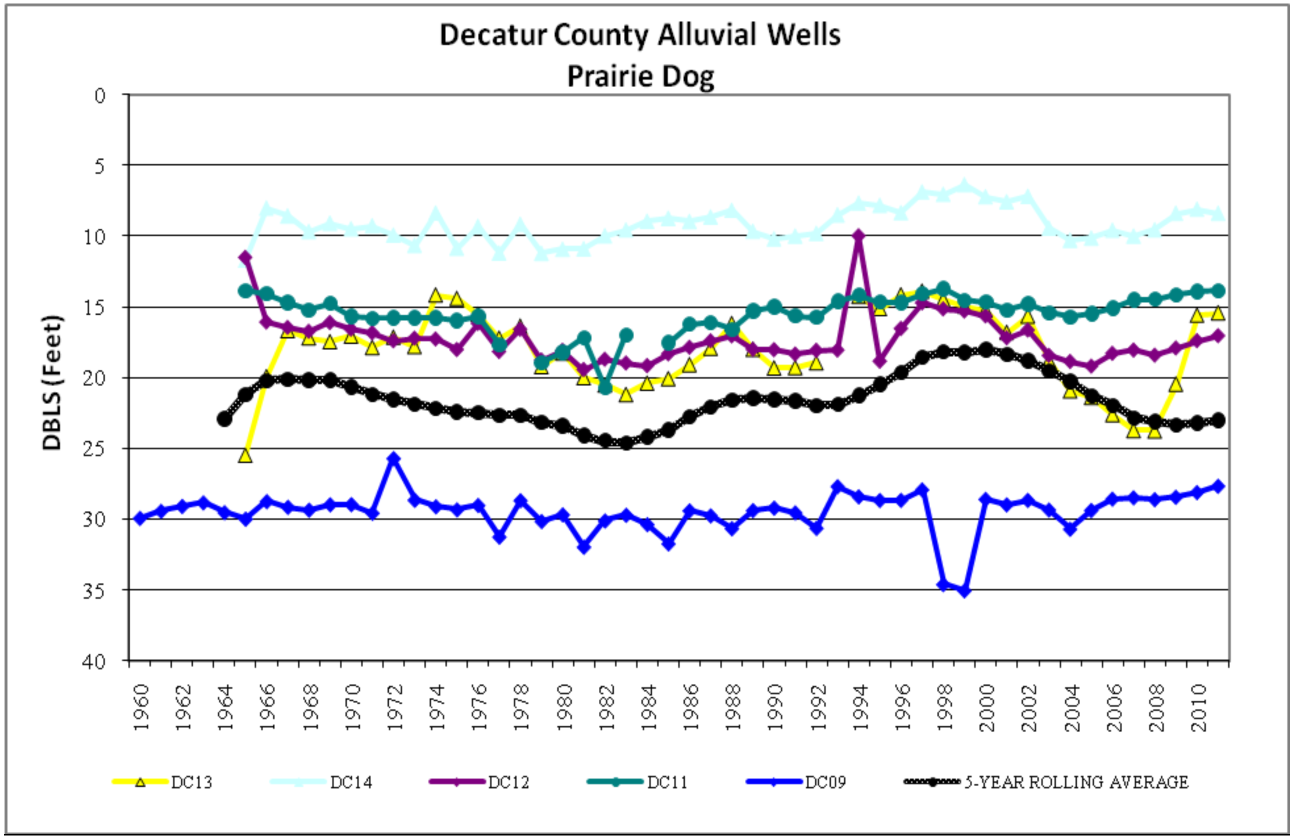

Figure 16: Alluvial Monitoring Well Levels in Decatur County, Prairie Dog Creek Fringe

NOTE: The 5-year rolling average is for all the alluvial wells in Decatur County

Decatur County has five alluvial monitoring wells in Prairie Dog Creek alluvium. Only DC12 has had a net decline (5.55 feet) over the period of record. Even with a declining trend from 2002 to 2008, DC13 has increased about 10 feet since 1965. The other three wells have maintained relatively stable water levels over time with short-term increases and decreases (Figure 16). The five-year rolling average was on a downward trend from 2001 to 2009, but overall remained relatively stable.

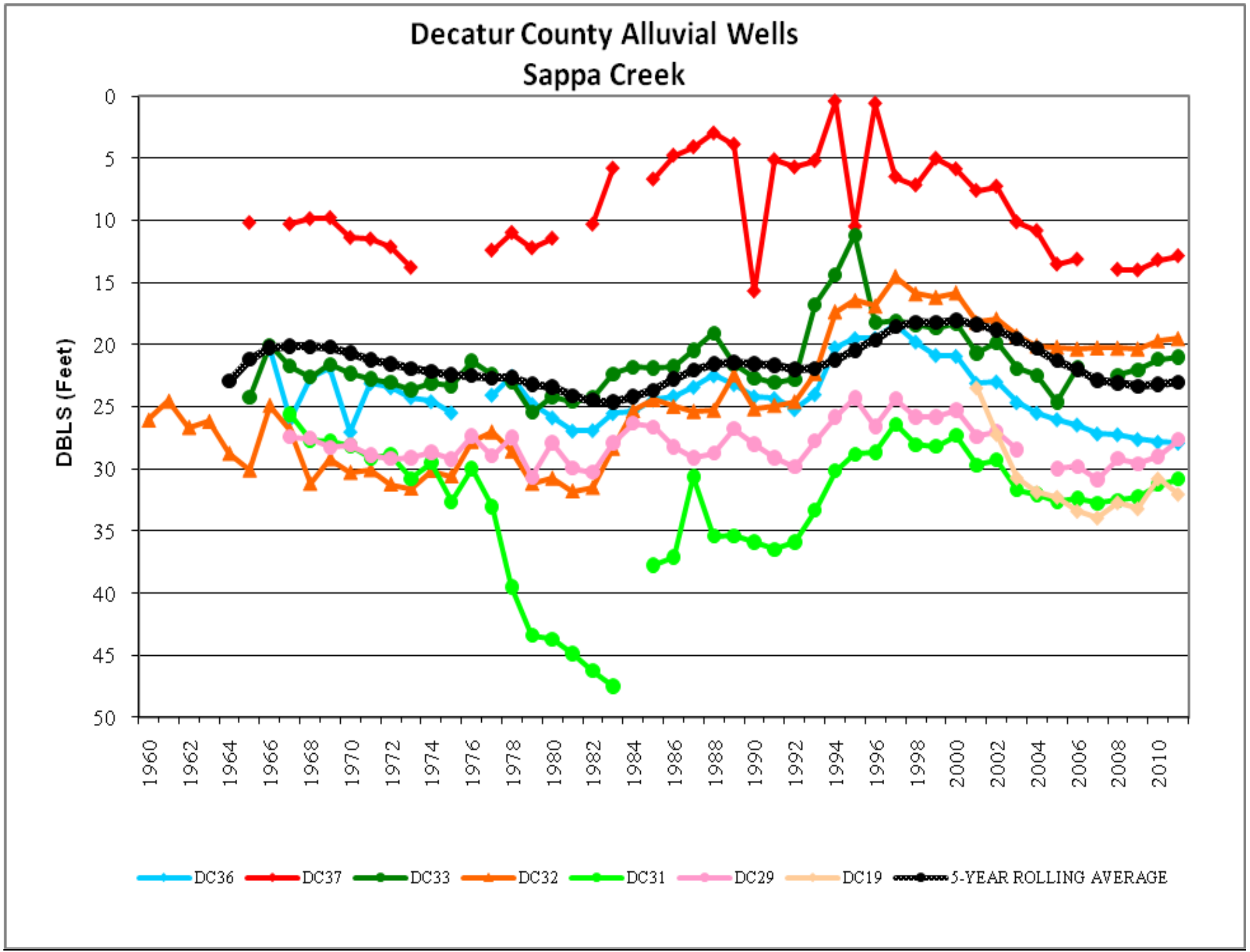

Figure 17: Alluvial Monitoring Well Levels in Decatur County, Sappa Creek Fringe

NOTE: The 5-year rolling average is for all the alluvial wells in Decatur County

Sappa Creek has seven monitoring wells in Decatur County. Five of the seven monitoring wells have had net declines over the period of record, with DC31 declining 5.2 feet and DC19 declining 8.56 feet. DC32 and DC33 had net increases of 6.58 feet and 3.23 feet respectively (Figure 17). From 2010 to 2011 the average change for alluvial wells in Decatur County was a 0.2 foot increase.

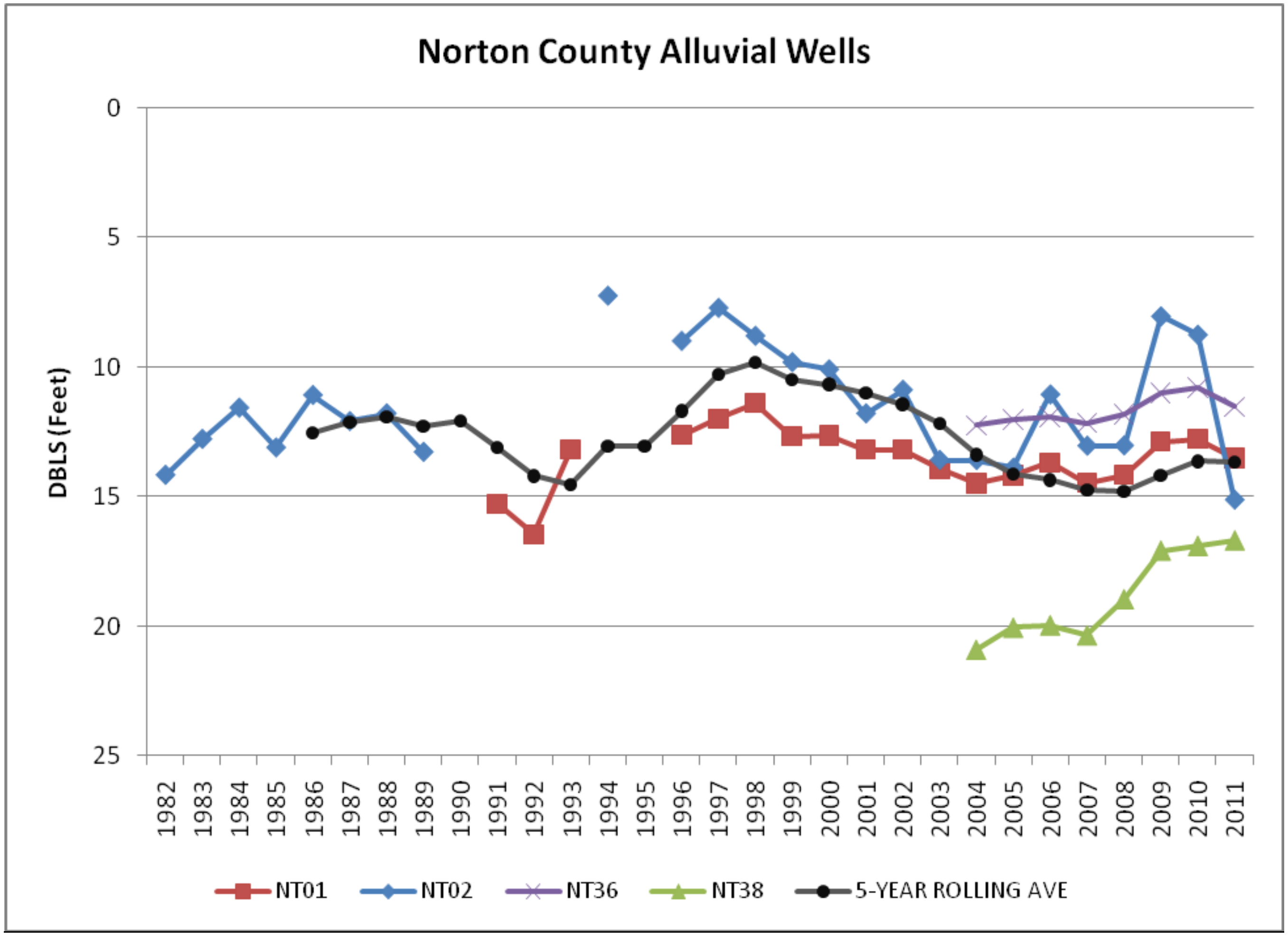

Figure 18: Alluvial Monitoring Well Levels in Norton County Fringe

Norton County has four alluvial monitoring wells. NT02 has the longest record beginning in 1982. NT01 has records from 1991, while NT36 and NT38 began measurements in 2004. Overall, the wells had an average decline of 1.91 feet from 2010 to 2011. Wells NT01, NT38, and NT36 have had net increases over the period of record, but well NT02 has had a net decline of about 0.96 feet (Figure 18).

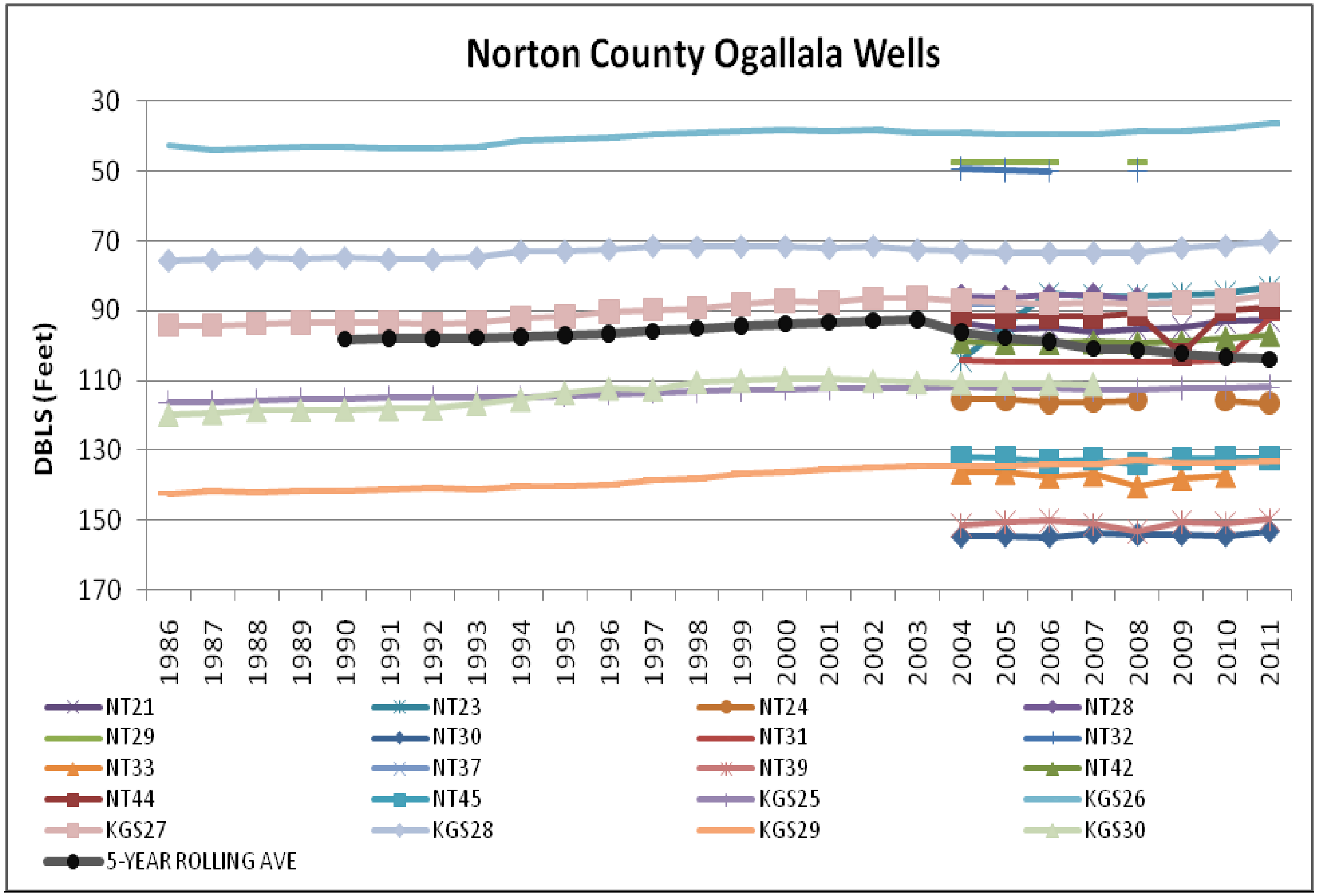

Figure 19: Ogallala-High Plains Monitoring Well Levels in Norton County Fringe

Norton County has twenty Ogallala monitoring wells. KDA-DWR added fourteen of these wells with measurements since 2004. The water levels have remained relatively stable with an average increase of 1.56 feet from 2010 to 2011. The water levels ranged from an increase of 11.98 feet in NT31 to a 0.95 feet decrease in NT24. The five-year rolling average has remained relatively stable with a declining trend starting around 2004, which is likely attributed to the deeper wells added to the analysis at that time.

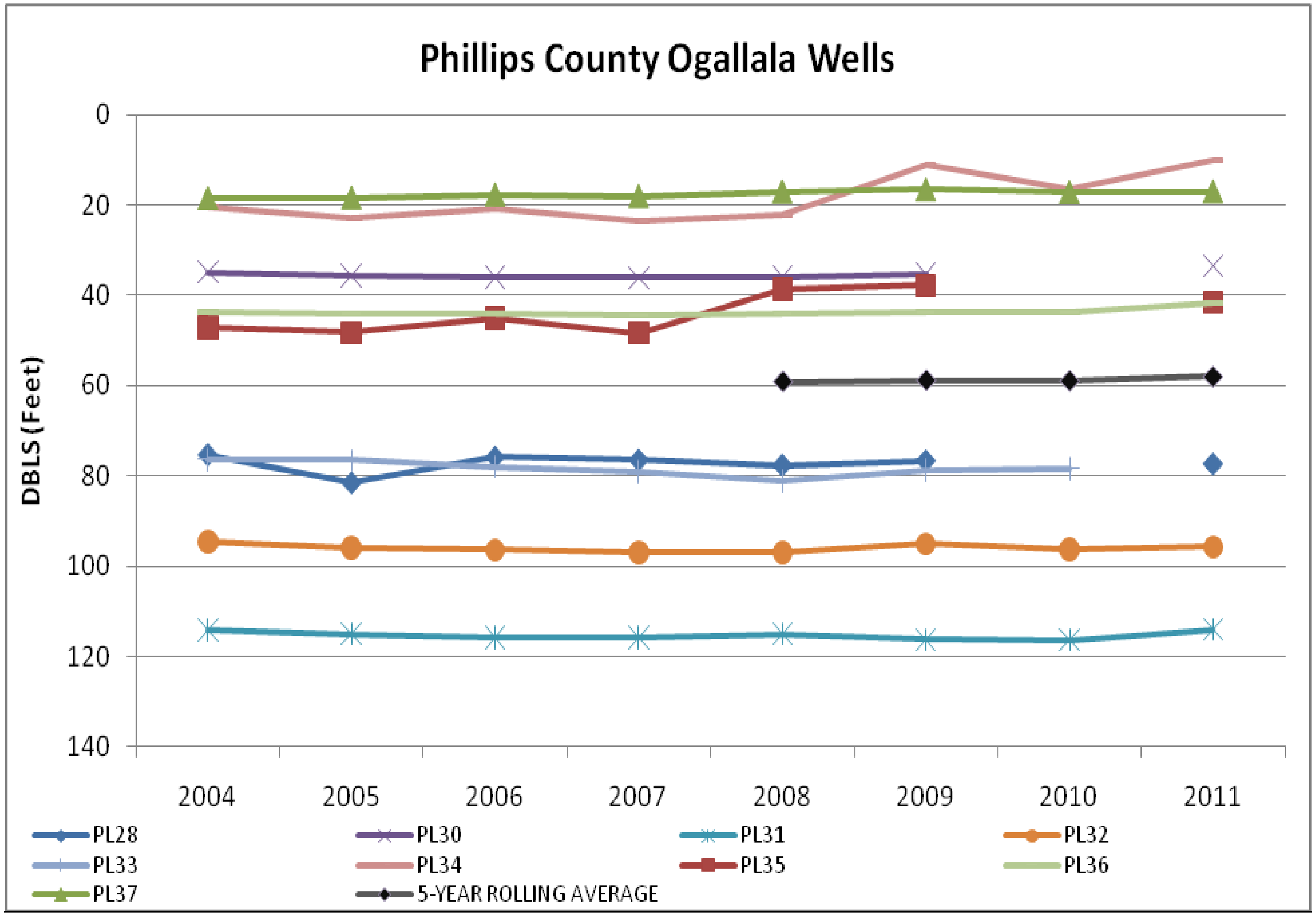

Figure 20: Ogallala-High Plains Monitoring Well Levels in Phillips County Fringe

There are nine total monitoring wells in the fringe area of Phillips County with measurements from 2004. Over the period of record, all wells experienced an average net increase of 1.74 feet. From 2010 to 2011, wells showed an average increase of 2.45 feet.

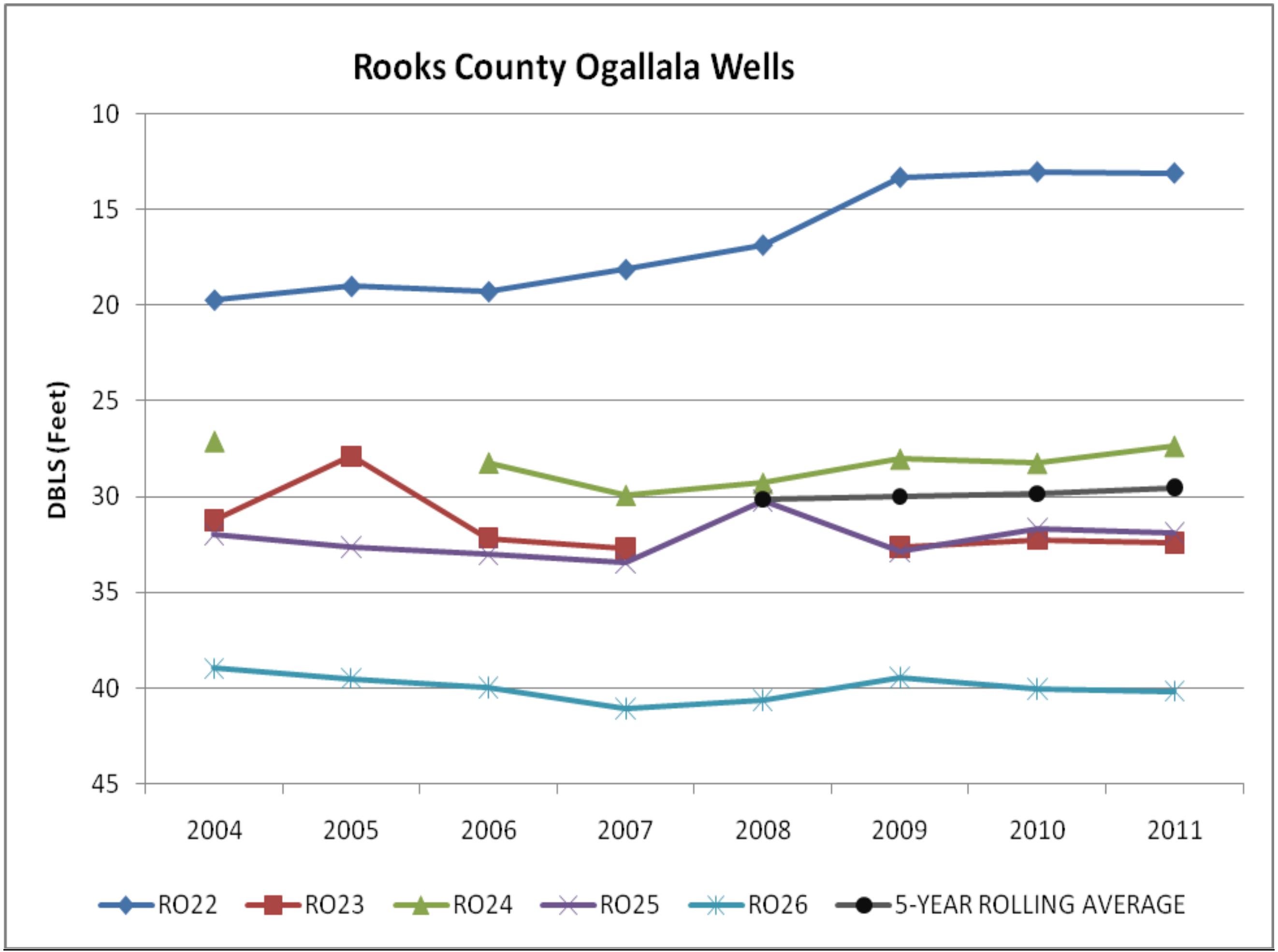

Figure 21: Ogallala-High Plains Monitoring Well Levels in Rooks County Fringe

There are five monitoring wells in Rooks County with measurements since 2004. Over the period of record, the wells had a net average increase of 0.82 feet. From 2010 to 2011, the wells increased an overall average of 0.06 feet ranging from an increase of 0.89 feet for RO24 to a decrease of 0.24 feet in RO25.

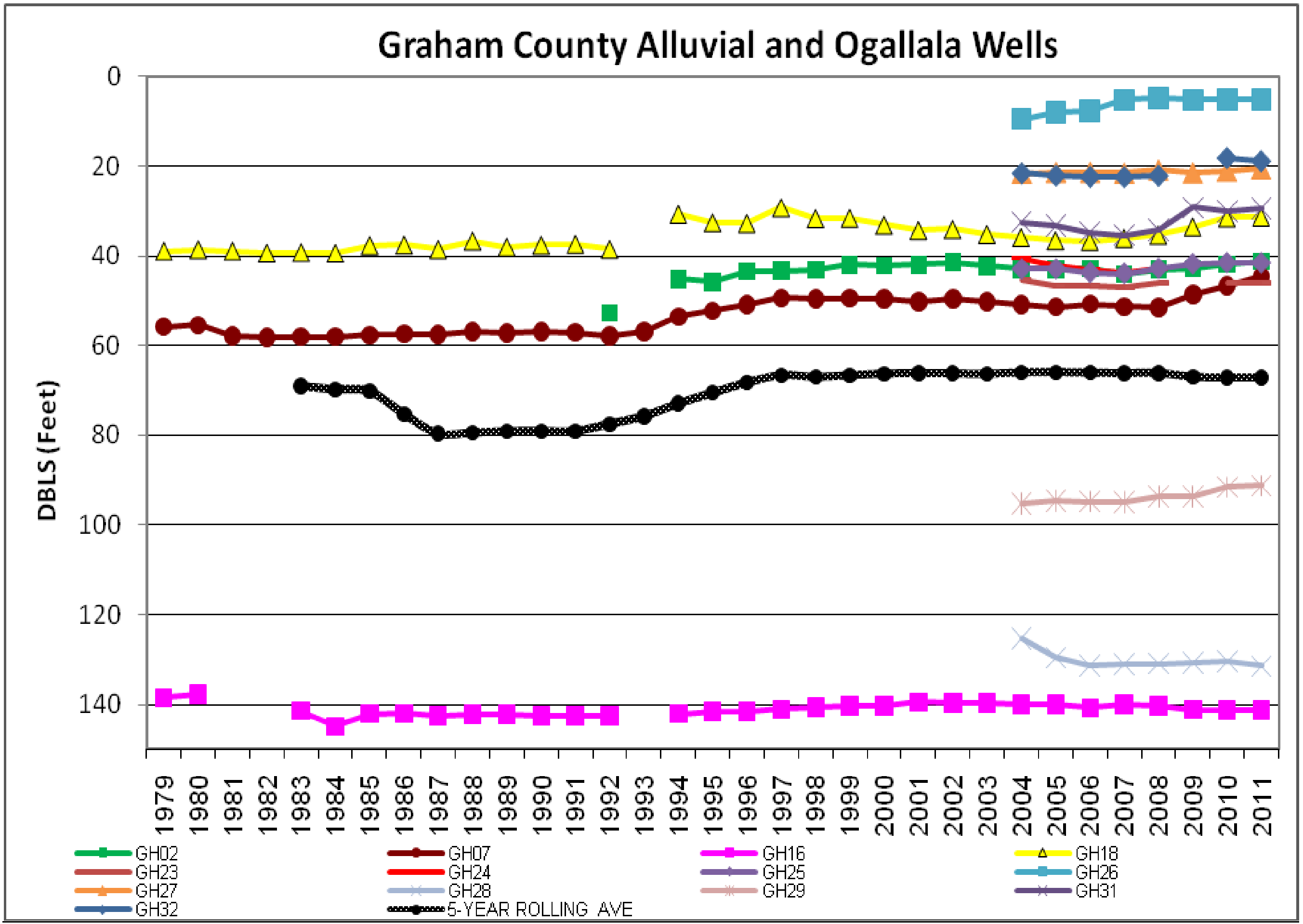

Figure 22: Monitoring Well Levels in Graham County Fringe

Graham County has thirteen Ogallala and alluvial monitoring wells. Measurements begin for three of the wells in 1979. GH02 was added to the network in 1992, while the remaining wells were added in 2004. GH16 has had a net decline of 2.71 feet since 1979 and GH28 has had a net decline of 6.22 feet since 2004. Overall, the water levels increased an average of 0.25 feet from 2010 to 2011, ranging from a 1.15 feet decrease in GH28 to an increase of 2.21 feet in GH07. The five-year rolling average for Ogallala wells has remained fairly consistent since 1996.

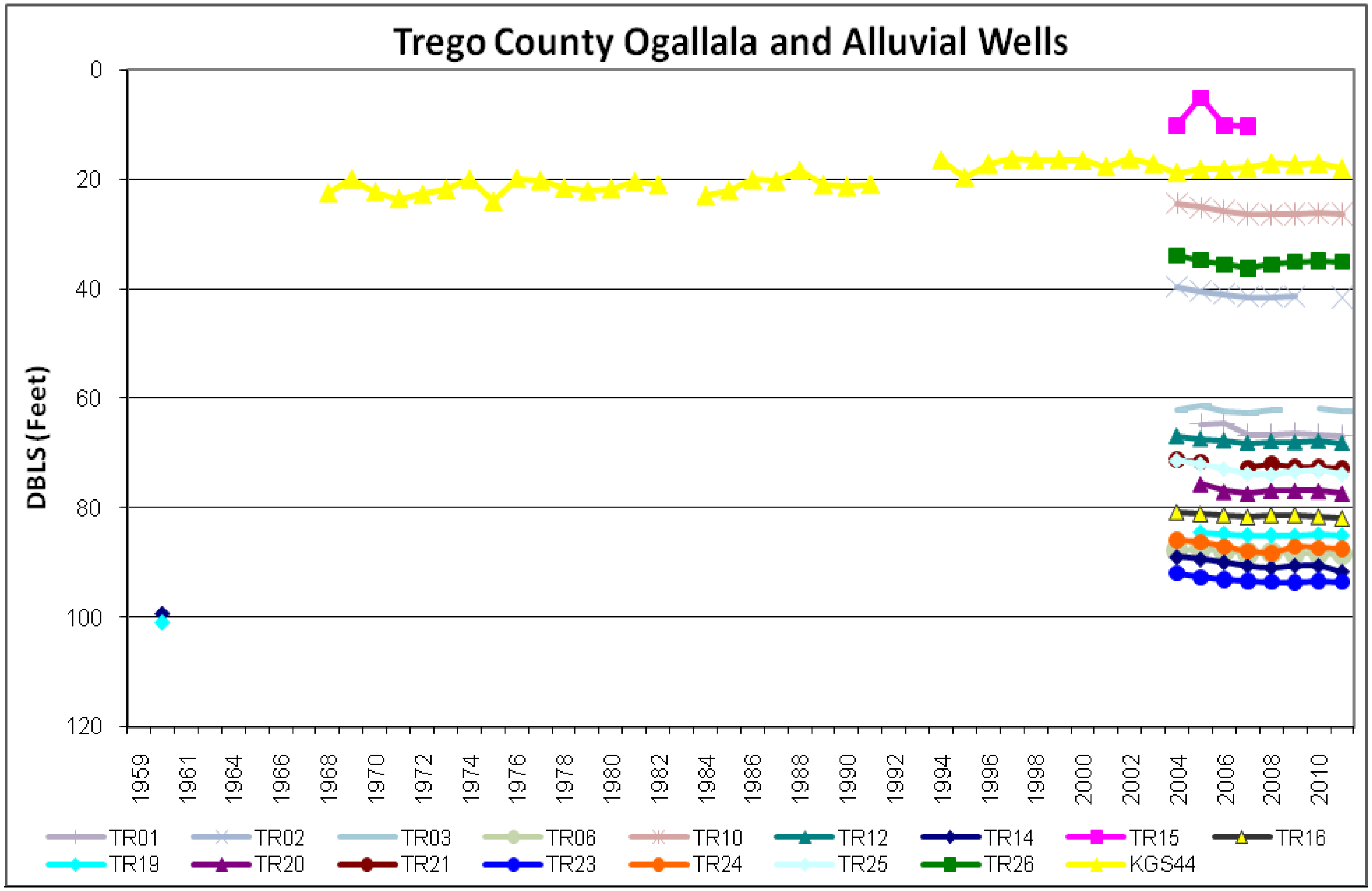

Figure 23: Monitoring Well Levels in Trego County Fringe

Trego County has seventeen monitoring wells. KGS44 has a record dating back to 1968 and is located in the alluvium of Big Creek. TR14 and TR19, Ogallala wells, were first measured in 1960, but were not measured again until 2004 and 2005, and have a net increase of 7.76 feet and 15.83 feet, respectively. The alluvial well KGS44 showed a net increase of 4.44 since 1968. The rest of the wells were not added to the network until 2004 and show a net average decrease of 0.27 feet since 2004 (Figure 23).

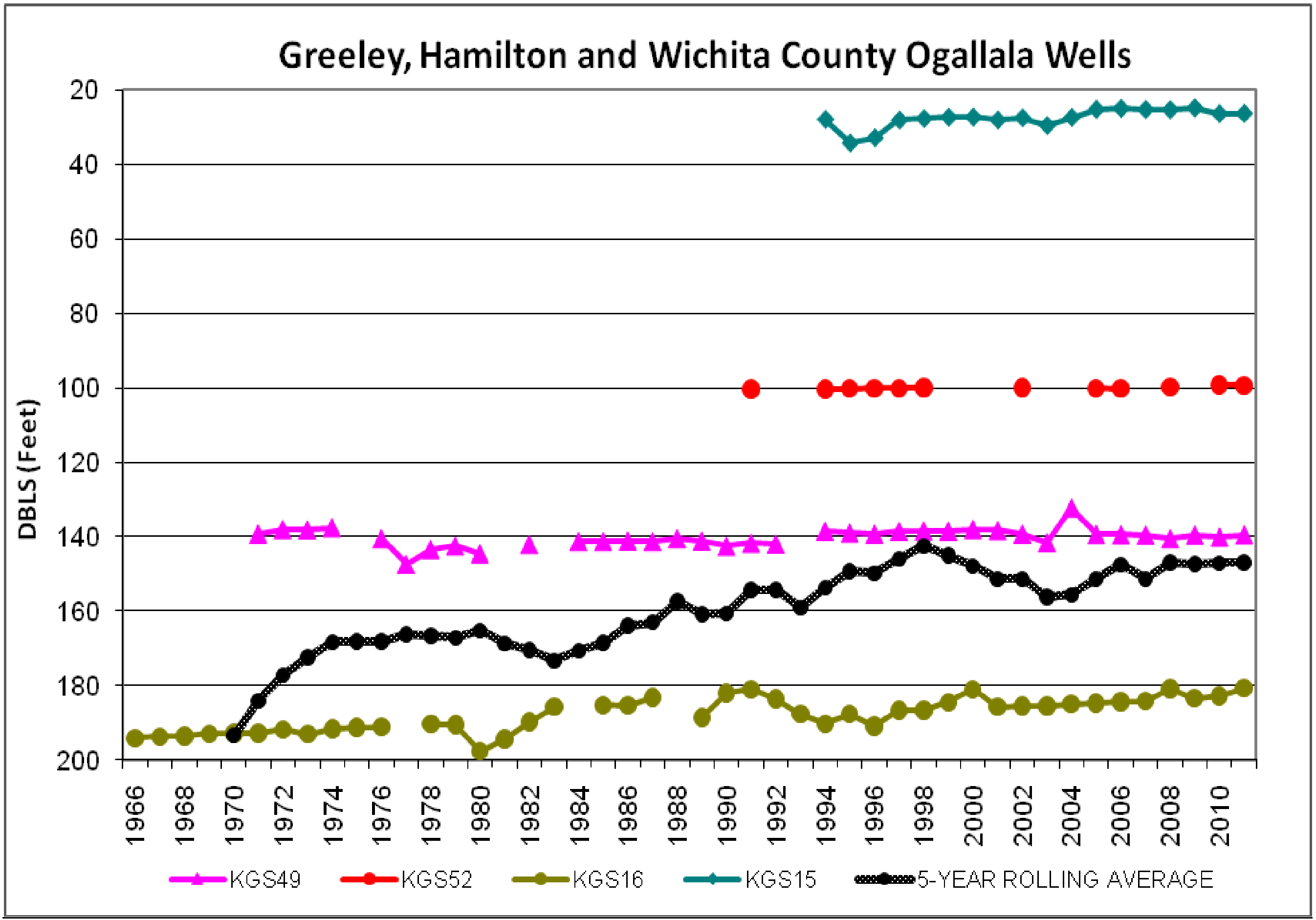

Figure 24: Monitoring Well Levels in the Fringe Area of Greeley, Hamilton and Wichita Counties

Hamilton County has one monitoring well, Greeley County has one monitoring well and Wichita County has two monitoring wells. KGS52 showed a net increase of 0.93 feet since 1991 (Figure 24). The Hamilton County well KGS16 is located outside GMD 3 and had a net increase of 13.39 feet for 1966-2011, with an increase of 2.1 feet from 2010-2011. The Greeley County well KGS15 located outside GMD 1 had a net increase of 1.59 feet for 1994-2011 (Figure 24).

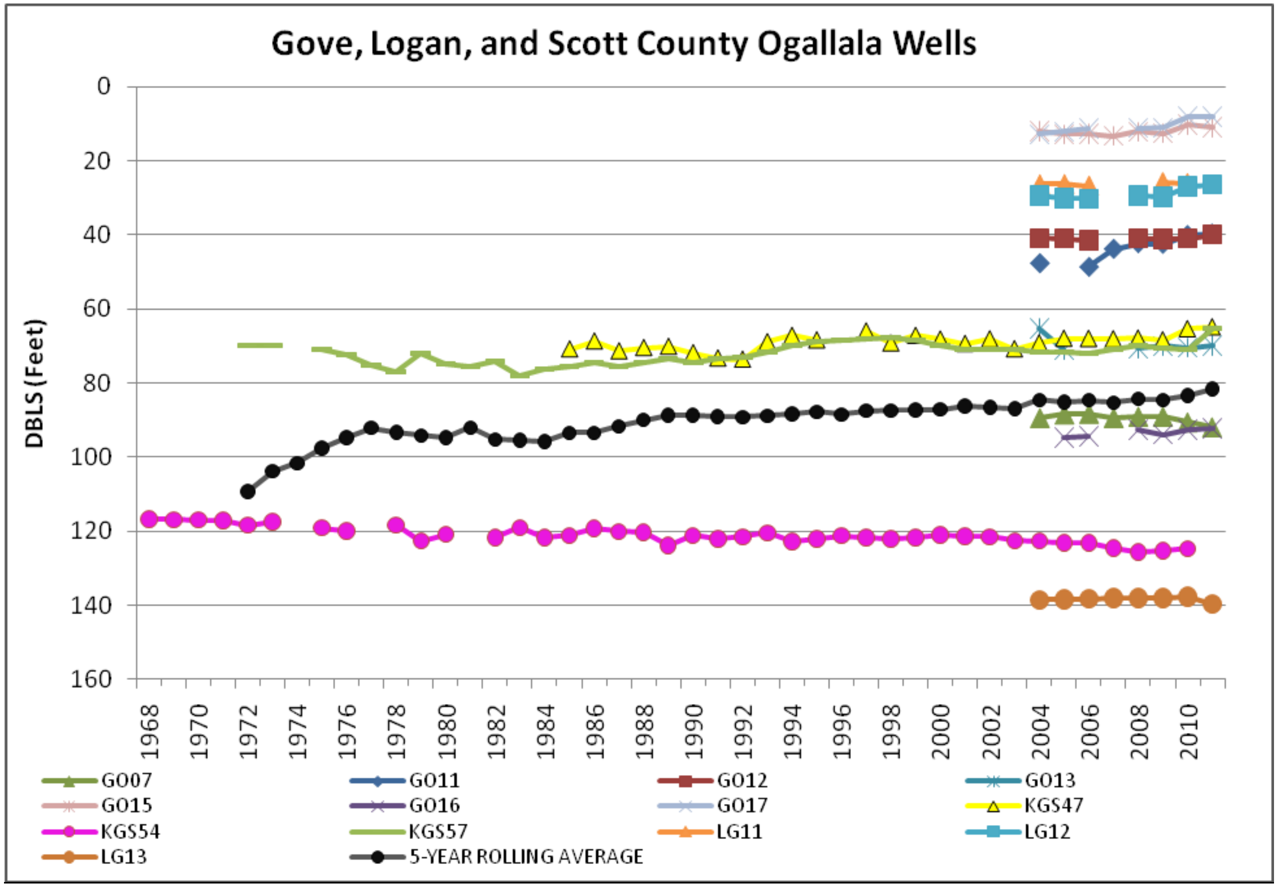

Figure 25: Monitoring Well Levels in the Fringe Area of Logan and Scott Counties

Gove, Logan, and Scott counties have thirteen monitoring wells located outside of the GMD 1. Water level measurements date back to 1968 for KGS54, 1972 for KGS57 and 1984 for KGS47. KGS54 (Scott County) has had a net decline of 7.96 feet since 1968. KGS47 has had a net increase of 5.99 feet since 1985. From 2010 to 2011, the wells increased an average of 0.41 feet. Overall, the wells have remained relatively stable with an average net increase of 1.12 feet (Figure 25).

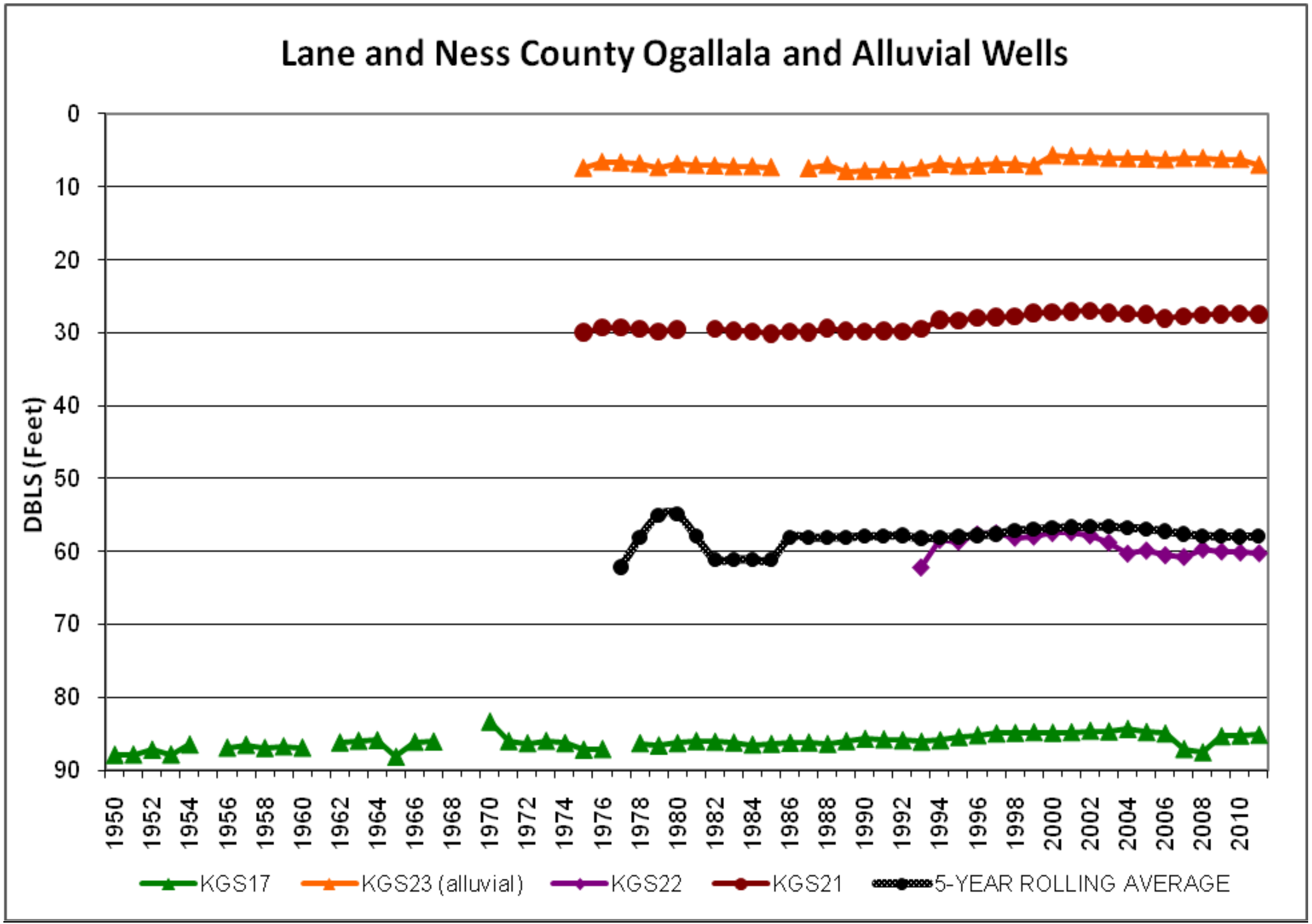

Figure 26: Monitoring Well Levels in the Fringe Area of Wallace, Lane and Ness Counties

Lane County has one monitoring well, KGS17, outside GMD 1 in the Ogallala. Ness County has three monitoring wells, one in the alluvial aquifer and two in the Ogallala (Figure 26). KGS17 has measurements dating back to 1950, and has a net increase of 2.74 feet. The three wells in Ness County, two dating back to 1974 (KGS23 and KGS21) had net increases of 0.43 feet and 2.4 feet, respectively. KGS22 had a net increase of 1.96 feet. From 2010 to 2011, the wells had an average decrease of 0.24 feet. The five-year rolling average for Ogallala wells is showing a slight decline (0.17 feet) in water levels since 2004.

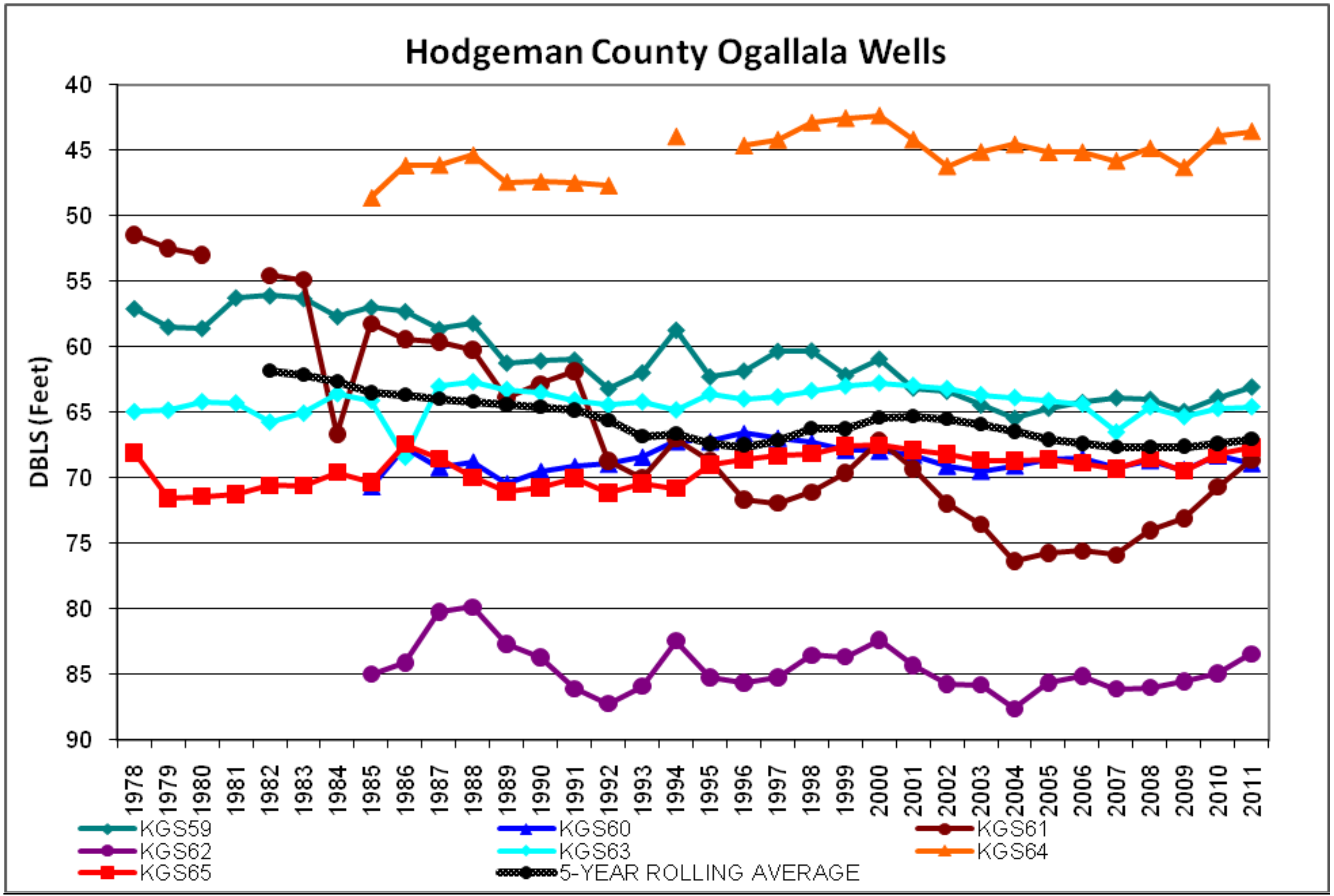

Figure 27: Monitoring Well Levels in Hodgeman County Fringe

In Hodgeman County, there are seven monitoring wells in the fringe area outside GMD 3. From 1954 to 2011, the wells have shown an overall net decline of 2.00 feet. KGS61 has a net decline 17.18 ft since 1978. From 2010 to 2011, wells showed an average increase of 0.67 feet. This ranged from a decrease of 0.60 feet in KGS60 to an increase of 2.06 feet in KGS61 (Figure 27). The five-year rolling average has a net decline of 5.19 feet.

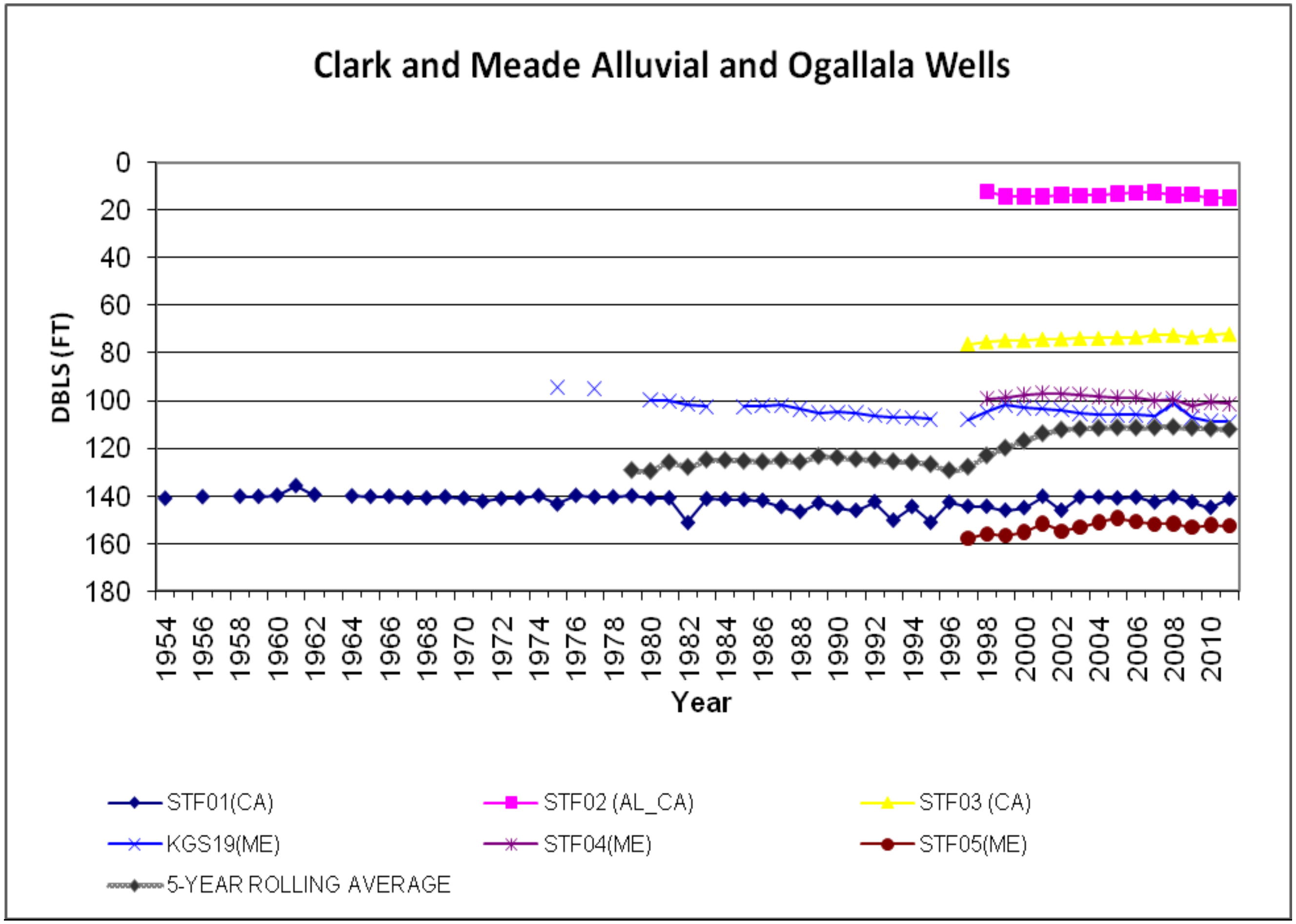

Figure 28: Monitoring Well Levels in the Fringe Area of Clark and Meade Counties

Clark County has three monitoring wells located in the fringe area of GMD 3. STF02 is an alluvial well where as STF01 and STF03 are Ogallala wells. These wells increased an average of 1.31 feet from 2010 to 2011. STF02 has had a net decline of 2.73 feet for the period of record (Figure 28). Meade County has three monitoring wells that are all Ogallala wells. KGS19 had a net decline of 14.64 feet since 1975, with a 0.50 foot decline from 2010 to 2011. The other two wells, STF04 and STF05, had a net decrease of 2.13 feet and net increase of 5.33 feet, respectively. The increase in the five-year rolling average for the Ogallala wells in Meade and Clark counties seen in 1997 is likely due to the addition of shallower wells to the network.

V. Water Use

The Ogallala-High Plains fringe area has a total of 1,361 water rights with an authorized quantity of 184,230 acre-feet (Table 1). The majority of the water rights are appropriated groundwater rights. Points of diversion and the area queried for water rights are shown in Figure 29. A water right may have more than one point of diversion associated with it.

Table 1: Water Rights in Ogallala-High Plains Fringe

Type	Source	No. of Rights	Authorized Quantity (acre-feet)
Vested	Surface	25	12,415
Appropriated	Surface	61	16,955
Vested	Ground	98	10,306
Appropriated	Ground	1,177	144,455
	Total	**1,361**	**184,230**

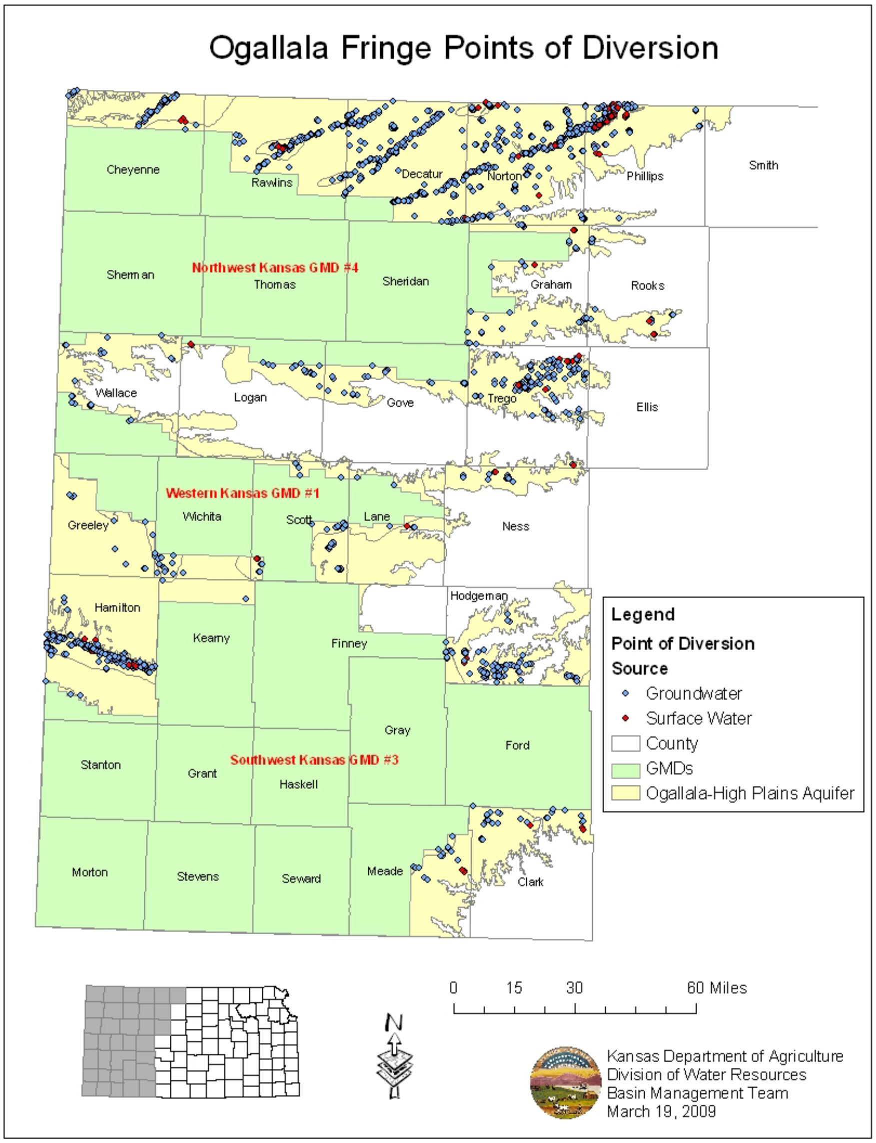

Figure 29: Points of Diversion within the Fringe of the Ogallala-High Plains Aquifer

The water use ranges from 57,081 acre-feet in 1993 to 114,226 acre-feet in 2002. The average water use since 1992 was 85,903 acre-feet (Figure 30). Water use in 2009 (the most recent year for complete records are available) was 73,794 acre-feet. This was down from 2008, and below average for the area (Figure 30). Average groundwater use for the Ogallala Fringe is 75,387 acre-feet and averages about 88 percent of the total average water use since 1992.

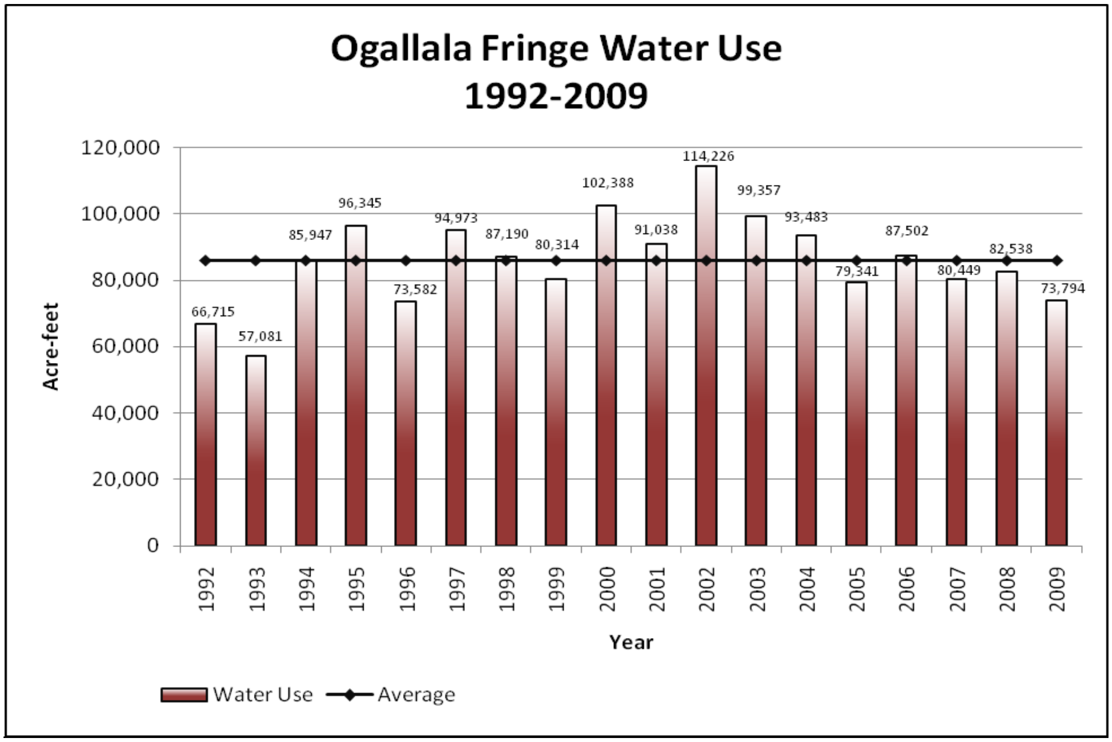

Figure 30: Surface and Groundwater Use in the Ogallala-High Plains Fringe by Year

Since 1992, Ogallala Fringe averaged 21.6 inches of precipitation and 13.31 inches of irrigation pumping; (Figure 31) however, there is significant variability in both of those figures. Irrigators in the region typically pump more water in drier years to compensate for the lack of precipitation. For instance in 2002, the subbasin received 12.3 inches of precipitation and pumped 16.3 inches. Irrigation season precipitation (Figure 32) averages 16 inches, which is about five inches below the annual average. In 2007, the precipitation from May-October was low at 11.9 inches, but the associated irrigation was near average. This is likely due to 7.2 inches of precipitation occurring outside of the irrigation season that year. For 2009, precipitation was above average and as a result, the irrigation was below average.

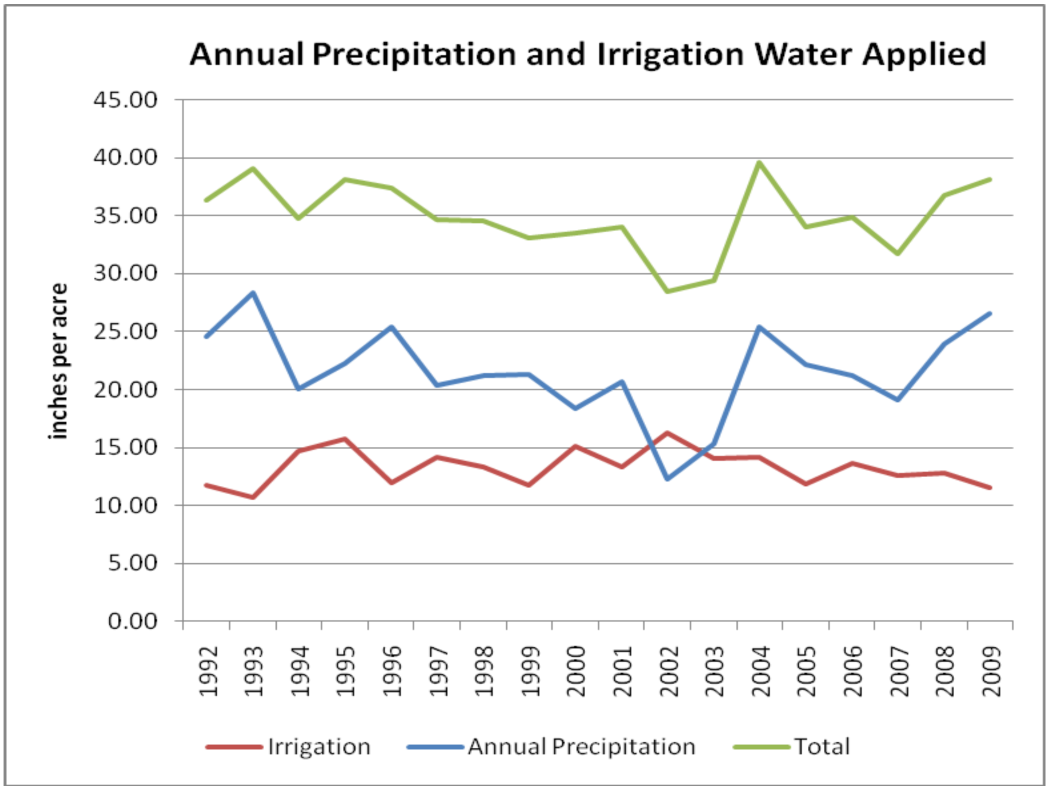

Figure 31: Annual Precipitation and Irrigation Water Applied (inches per acre) for Ogallala Fringe

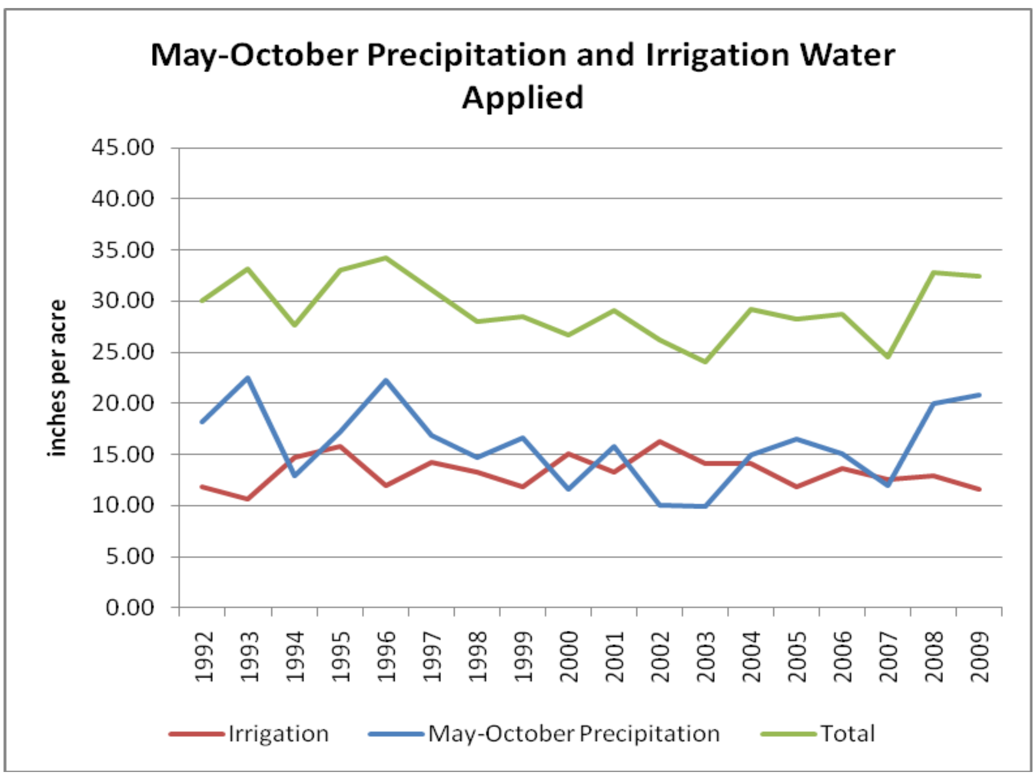

Figure 32: May-October Precipitation and Irrigation Water Applied (inches per acre) for Ogallala Fringe

VI. Conclusions

The year 2010 appears to have been a below average year for precipitation. However, preliminary 2010 average annual streamflows at the USGS gages were up at all locations from 2009. Groundwater levels in most areas of the fringe continued to remain relatively consistent, with local water levels varying by region. Water use in 2009 was down from 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 of this subbasin, protect property rights, and ensure the benefits of these water resources to future generations.

VII. References

Lohman, S.W. 1953. High Plains of west-central United States, general aspects,
Chapter 4 of subsurface facilities of water management and patterns of supply-type area studies, v. four of the physical and economic foundation of natural resources: U.S. 83d Congress, House Committee of Interior and Insular Affairs, p. 70-78.

McGuire, V.L., 2003, Water-level changes in the High Plains aquifer, predevelopment to 2001, 1999 to 2000, and 2000 to 2001: U.S. Geological Survey Fact Sheet FS-078-03, 4 p.

McGuire, V.L., 2004, Water-Level Changes in the High Plains Aquifer, Predevelopment to 2003 and 2002 to 2003: U.S. Geological Survey Fact Sheet FS-2004-3097, 6 p.

McGuire, V.L., 2009, Water-level changes in the High Plains aquifer, predevelopment to 2007, 2005–06, and 2006–07: U.S. Geological Survey Scientific Investigations Report 2009–5019, 9 p., available at: *http://pubs.usgs.gov/sir/2009/5019/.*

VIII. Appendix

Monitoring Well ID	**USGS ID**	**Legal Description**	**County**
CN03	395921101331801	01S 38W 02 SWSESW 01	Cheyenne
CN09	395606101391601	01S 39W 25 SWNWSW 01	Cheyenne
CN29	395829101362501	01 38W 08 SWSWSE 01	Cheyenne
STF01	Stafford F.O.	30S 23W 06 NENENE 01	Clark
STF02	Stafford F.O.	30S 23W 13 NWSENW	Clark
STF03	Stafford F.O.	30S 24W 20 SWSWSE	Clark
DC01	393407100143101	05S 26W 33 SESWSW 01	Decatur
DC02	393505100115901	05S 26W 26 SESENE 01	Decatur
DC03	393853100150901	05S 26W 05 NESESE 01	Decatur
DC04	395925100331901	01S 29W 03 SESENW 01	Decatur
DC06	395708100370701	01S 29W 19 NWSESE 01	Decatur
DC08	395458100395501	01S 30W 34 SESESE 01	Decatur
DC09	394248100150801	04S 26W 08 SESESE 01	Decatur
DC11	394110100163301	04S 26W 19 SESWNE 01	Decatur
DC12	394005100215501	04S 27W 33 NWNWNW 01	Decatur
DC13	393814100305401	05S 28W 07 NWNWSW 01	Decatur
DC14	393820100273201	05S 28W 10 NWNWNW 01	Decatur

DC19	395636100192601	01S 27W 26 NWNWNE 01	Decatur
DC20	395405100305801	02S 29W 01 SESESE 01	Decatur
DC21	395813100272801	01S 28W 15 SWNWNW 01	Decatur
DC22	395807100215901	01S 27W 17 NESENE 01	Decatur
DC24	395115100155301	02S 26W 29 SENENW 01	Decatur
DC25	394913100404001	03S 30W 03 NWNESW 01	Decatur
DC27	395642100425401	01S 30W 20 SWSESW 01	Decatur
DC29	395307100243001	02S 28W 13 NENWNE 01	Decatur
DC31	394859100301701	03S 28W 06 NWSWSE 01	Decatur
DC32	394846100314901	03S 29W 12 NENWNW 01	Decatur
DC33	394715100355501	03S 29W 17 NWSWSE 01	Decatur
DC36	394432100370401	03S 29W 31 SWSWSE 01	Decatur
DC37	394610100395001	03S 30W 26 NWNWNW 01	Decatur
KGS02	395358100124001	02S 26W 11 NWNWNE 01	Decatur
KGS03	394544100172202	03S 26W 30 SWNWNW 02	Decatur
KGS04	394504100293601	03S 28W 32 NWSWNE 01	Decatur
KGS05	394208100221101	04S 27W 17 SENESW 01	Decatur
KGS06	394241100263201	04S 28W 15 NENENE 01	Decatur
KGS07	394011100295401	04S 28W 30 SESESE 01	Decatur
KGS09	393954100405901	04S 30W 34 NWSWNW 02	Decatur
KGS10	393557100214701	05S 27W 21 SWSWNE 01	Decatur
KGS11	393709100252601	05S 28W 14 NESESE 01	Decatur
KGS12	393656100285601	05S 28W 17 SENESW 01	Decatur
GO07	390139100320301	12S 29W 10 NWNWSENW 01	Gove
GO11	385707100473001	13S 31W 05 NWNESW 01	Gove
GO12	385635100402501	13S 30W 08 NESENW 01	Gove
GO13	390100100223701	12S 28W 13 NENWNE 01	Gove
GO15	385941100095001	12S 26W 24 NENWSW 01	Gove
GO16	390014100164201	12S 27W 14 SESESE 01	Gove
GO17	390022100363001	12S 30W 13 NWSWSW 01	Gove
GH02	391451099512701	09S 23W 26 NENENW 01	Graham
GH07	393216099503801	06S 23W 13 NWNWNW 01	Graham
GH16	393223100040801	06 25W 12 SWSWSW 01	Graham
GH18	392611099493301	07 22W 19 NWNWNW 01	Graham
GH23	391400099474801	09S 22W 32 NENENWNE 01	Graham
GH24	391312099573601	09S 24W 35 SESESE 01	Graham
GH25	391153099584301	10S 24W 10 SESENE 01	Graham
GH26	390943099580101	10S 24W 23 SWSWSE 01	Graham
GH27	391031100052901	10S 25W 22 NENENE 01	Graham
GH28	391450100083601	09S 25W 29 NWNWNW 01	Graham
GH29	391340100041901	09S 25W 35 SESENE 01	Graham
GH31	391401099391001	09S 21W 34 NENENW 01	Graham
GH32	391545099420601	09S 21W 19 NWNENE 01	Graham
KGS15	383247101573601	17S 42W 28 SENENW 01	Greeley
KGS16	381422101385501	21S 39W 07 SWNWNE 01	Hamilton
KGS59	375912099503201	24S 23W 03 SWSWSW 01	Hodgeman
KGS60	380135100081001	23S 26W 26 SENENE 01	Hodgeman
KGS61	375911099560301	24S 24W 02 SWSWSW 01	Hodgeman

KGS62	375719100033001	24S 25W 22 NWNENW 01	Hodgeman
KGS63	375636099592101	24S 24W 20 SWSWSW 01	Hodgeman
KGS64	380149100122201	23S 26W 20 SWSWSW 01	Hodgeman
KGS65	380005100130401	23S 26W 31 SESESW 01	Hodgeman
KGS17	382857100154501	18S 27W 13 SWSWSW 01	Lane
KGS47	390252100551301	11S 32W 31 SESWSW 01	Logan
LG11	385800100500001	23S 26W 31 SESESW 01	Logan
LG12	390048100522701	12S 32W 16 NESWNE 01	Logan
LG13	390254101053801	11S 34W 33 SWSESE 01	Logan
KGS19	371931100115501	31S 26W 30 NWNWNW 01	Meade
STF04	Stafford F.O.	32S 26W 05 NESWNE	Meade
STF05	Stafford F.O.	32S 26W 30 NWNWNW	Meade
KGS21	384006099574601	16S 24W 15 NENWNW 01	Ness
KGS22	383839100081701	16S 26W 24 SESENE 01	Ness
KGS23	383129100142402	18S 26W 06 NWNENW 02	Ness
KGS24	395820099420601	01S 21W 17 NENENE 01	Norton
KGS25	395806099584801	01S 24W 13 NWSWNW 01	Norton
KGS26	395634100053201	01S 25W 25 NWNWNW 01	Norton
KGS27	394945099420101	02S 21W 33 SWSWSW 01	Norton
KGS28	395214099532101	02S 23W 22 NENENE 01	Norton
KGS29	395306100054301	02S 25W 14 NENENE 01	Norton
KGS30	394156100054101	04S 25W 13 SWSWSW 01	Norton
NT01	393709099594501	05S 24W 14 SWSENW 01	Norton
NT02	393643099505401	05S 22W 18 SESWSW 01	Norton
NT21	395455099481101	01S 22W 33 SWSWSE 01	Norton
NT23	395548099415301	01S 21W 28 SESWSW 01	Norton
NT24	395004099381401	02S 21W 36 NENESW 01	Norton
NT28	394455099532601	03S 23W 34 SESENE 01	Norton
NT29	394207099510301	04S 22W 18 SWNWSW 01	Norton
NT30	394608099473201	03S 22W 27 NENWNW 01	Norton
NT31	394523099423801	03S 21W 29 SWSWSE 01	Norton
NT32	394656099410301	03S 21W 21 SENENE 01	Norton
NT33	393524099375201	05S 21W 25 SWSENE 01	Norton
NT36	393549100032401	05S 24W 20 SWSWSW 01	Norton
NT37	393917100073901	04S 25W 34 SWSESW 01	Norton
NT38	393457100083101	05S 25W 28 SWSWSE 01	Norton
NT39	394054100083801	04S 25W 28 NENENW 01	Norton
NT42	395404099562901	02S 23W 05 SESWSW 01	Norton
NT44	394957100054501	02S 25W 35 NENESE 01	Norton
NT45	394108099565801	04S 23W 19 NWSESE 01	Norton
PL28	395925099326001	01S 20W 02 NWSWSW 01	Phillips
PL30	395103099345401	02S 20W 28 SESENW 01	Phillips
PL31	395359099283601	02S 19W 09 NWNWNW 01	Phillips
PL32	395445099240501	02S 18W 06 SWNWNW 01	Phillips
PL33	395457099200201	01S 18W 34 SESWSE 01	Phillips
PL34	395542099162501	01S 17W 31 NENENE 01	Phillips
PL35	395641099141101	01S 17W 21 SESESE 01	Phillips
PL36	395518099104001	01S 16W 31 NWNWSW 01	Phillips

PL37	395914099063601	01S 16W 10 NENWNE 01	Phillips
KGS31	395551101031601	01S 33W 29 SWSWSW 01	Rawlins
KGS32	395308101114301	02S 35W 13 NWNWNE 01	Rawlins
KGS36	394814100505201	03S 31W 07 SENWSW 01	Rawlins
RA01	395353101200501	02S 36W 11 SWSWNWNW 01	Rawlins
RA02	395007101154101	02S 35W 32 NWNENESE 01	Rawlins
RA03	395648101120501	01S 35W 24 NESWSW 01	Rawlins
RA04	395654100574501	01S 33W 24 SESENESE 01	Rawlins
RA05	395256100512301	02S 32W 13 NENESWNE 01	Rawlins
RA06	395419100471001	02S 31W 03 SENESW 01	Rawlins
RA08	395130100555301	02S 32W 20 SESWSE 01	Rawlins
RA09	395038100592301	02S 33W 26 SWSWSE 01	Rawlins
RA10	394854101003102	03S 33W 03 SWSWSE 02	Rawlins
RA14	394802101030301	03S 33W 08 SWSESW 01	Rawlins
RA15	394940101071501	03S 34W 03 NENWNW 01	Rawlins
RA16	394605101062601	03S 34W 26 NWNESW 01	Rawlins
RA17	394637101122001	03S 35W 24 SWNWNW 01	Rawlins
RO22	393217099281201	06S 19W 17 NWNWNW 01	Rooks
RO23	391354099135401	09S 17W 33 SWNWNW 01	Rooks
RO24	391315099272601	09S 19W 32 SESESE 01	Rooks
RO25	391334099314601	09S 20W 35 NWNWSW 01	Rooks
RO26	391401099340901	09S 20W 32 NENENE 01	Rooks
KGS54	383928100453301	16S 31W 17 SESESE 01	Scott
KGS57	382841100420601	18S 31W 24 NWSWNW 01	Scott
KGS44	385919099542601	12S 23W 20 SWSWSW 01	Trego
TR01	390304099385901	11S 21W 33 NENESE 01	Trego
TR02	390005099392001	12S 21W 21 NWNWNE 01	Trego
TR03	390429100010401	11S 24W 20 SWSWSW 01	Trego
TR06	385938099485301	12S 22W 19 NWNWSW 01	Trego
TR10	385447099491301	13S 23W 24 NWNENE 01	Trego
TR12	390119099531901	12S 23W 09 SWNWNW	Trego
TR14	390341099400601	11S 21W 29 SESESE	Trego
TR15	390458099475001	11S 22W 19 NESESE	Trego
TR16	390334099443101	11S 22W 34 NENENE	Trego
TR19	390149099472801	12S 22W 08 NWNENW	Trego
TR20	385951099435201	12S 22W 23 NENWSW	Trego
TR21	390149099510401	12S 23W 11 NWNWNW	Trego
TR23	390213099421101	12S 21W 06 SWNWNW	Trego
TR24	390238099400701	12S 21W 05 NENENE	Trego
TR25	390156099400802	12S 21W 05 SESESE	Trego
TR26	390060099400801	12S 21W 08 SESESE	Trego
KGS49	381840101324401	20S 38W 17 SENWSW 01	Wichita
KGS52	381804101144001	20S 36W 24S WSWNE 01	Wichita