Mainstem Solomon River

2010 Field Analysis Summary

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Basin Management Team

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I. Introduction

The Solomon River Basin is divided into three sections: Upper Forks, Lower Forks and Mainstem. This field summary will cover the Mainstem section. The Mainstem subbasin starts below Waconda (Glen Elder) Reservoir flowing southeast towards Solomon, Kansas where it joins the Smoky Hill River. The Mainstem begins in Mitchell County and continues through Cloud, Ottawa, Saline and Dickinson County. It also includes the Salt Creek subbasin.

Glen Elder Irrigation District, supplied by Waconda Reservoir, is the only irrigation district on the Mainstem. Water allocations from reservoir storage are specified in contracts between the U.S. Department of Interior, Bureau of Reclamation and the District. In 2009, the total amount of water used by Glen Elder Irrigation District was 11,592 acre-feet of which 9,439 acre-feet was natural flow and 2,153 was diverted flow. The district irrigated 6,318 acres. In 2010, the acreage decreased to 5,434 acres. The district used 7,314 acre-feet of which 6,507 acre-feet was natural flow and only 744 had to be diverted from the reservoir.

With over 3,500 residents, Beloit is the largest town in the Mainstem subbasin and is the largest in the entire Solomon Basin. Brackish waters from the Dakota Aquifer springs flow into the Solomon River and are the source of water quality problems with Beloit's drinking water supply. Timely releases from Waconda Lake dilute the chlorides and sulfates and bring the water closer to meeting drinking standards.

The Mainstem flows in the easternmost range of the Solomon River Basin. The eastern boundary of the Smoky Hills is in Clay County where the Flint Hills Physiographic region begins. On average, the Mainstem riverbed drops 5 feet in altitude each mile. The elevation at the eastern boundary of the basin is 1,150 feet above mean sea level.

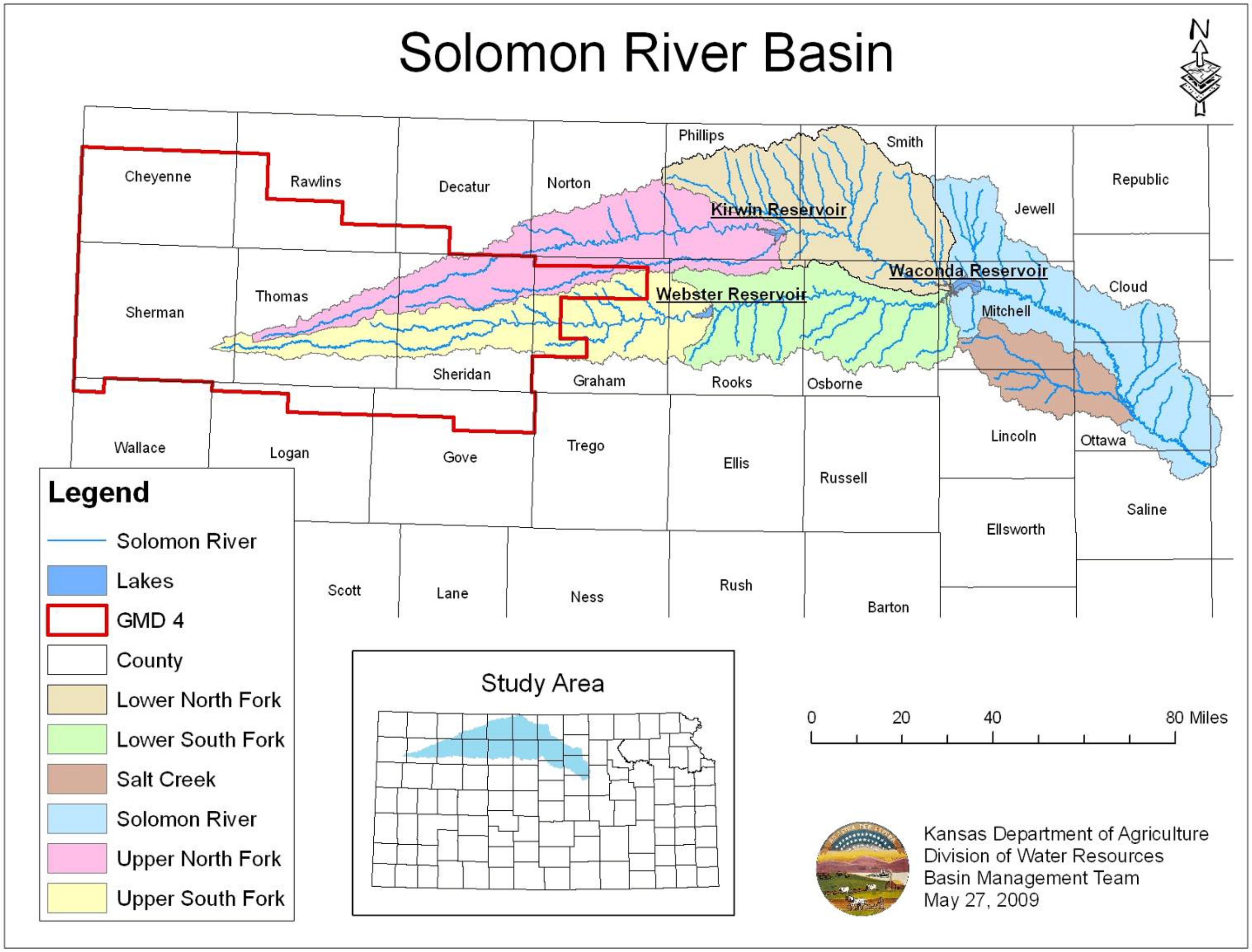

Figure 1: Solomon River Basin divided into subbasins

II. Precipitation

Precipitation in the Mainstem Solomon subbasin historically averages 26.8 inches per year based on seven precipitation stations. The chart in Figure 2 is based on averaged data from National Climatic Data Center (NCDC) stations: Barnard, Beloit, Cawker City, Glen Elder, Ionia, Minneapolis and Tescott. The highest precipitation totals occurred in 1993 with 49 inches and the lowest in 1956 with 12.1 inches. Annual precipitation data for these NCDC stations is currently available through 2009. The subbasin had 26.3 inches of precipitation in 2009.

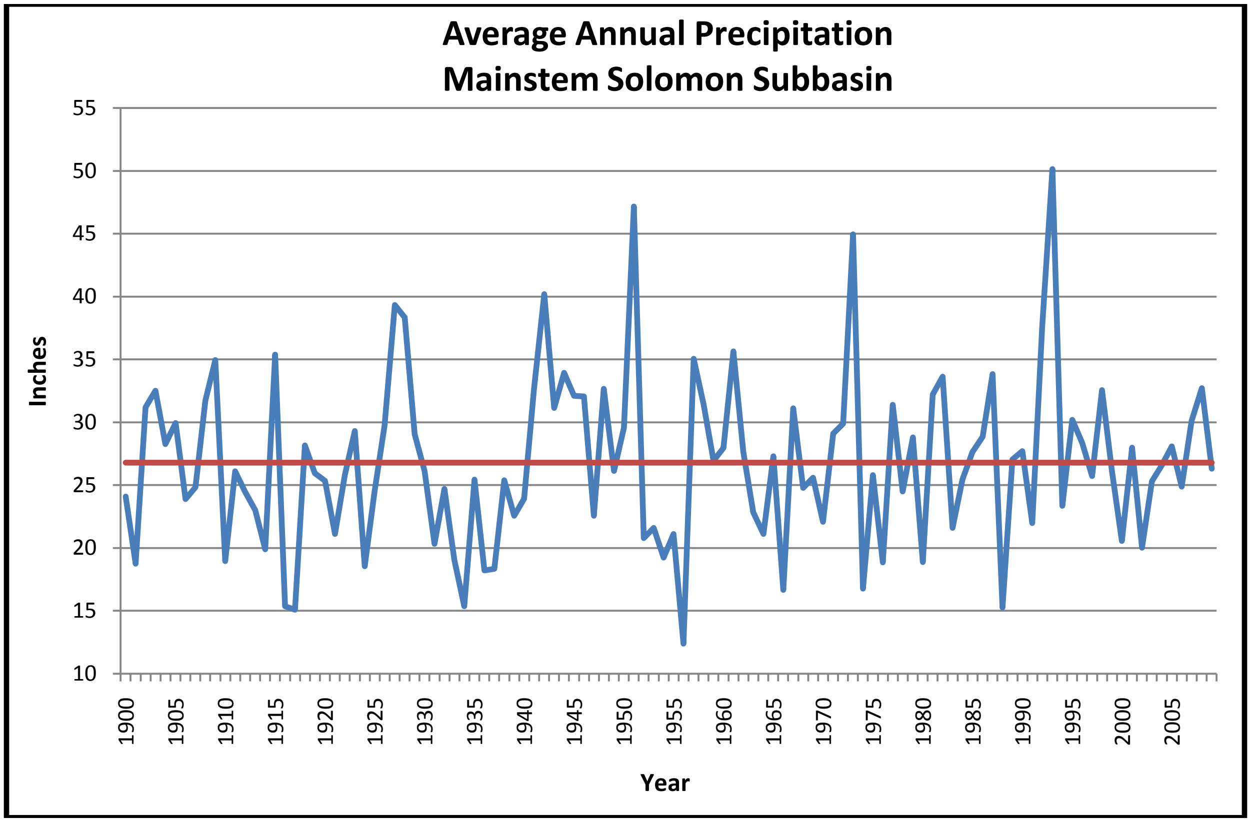

Figure 2: Mainstem Solomon Subbasin precipitation 1900-2009

Figure 3 shows provisional monthly precipitation for January 2010 to December 2010. These measurements averaged a total of 28.7 inches for the subbasin. The precipitation total is higher than the historical annual average. July had the most precipitation with 4.6 inches and January had the least with 0.1 inches.

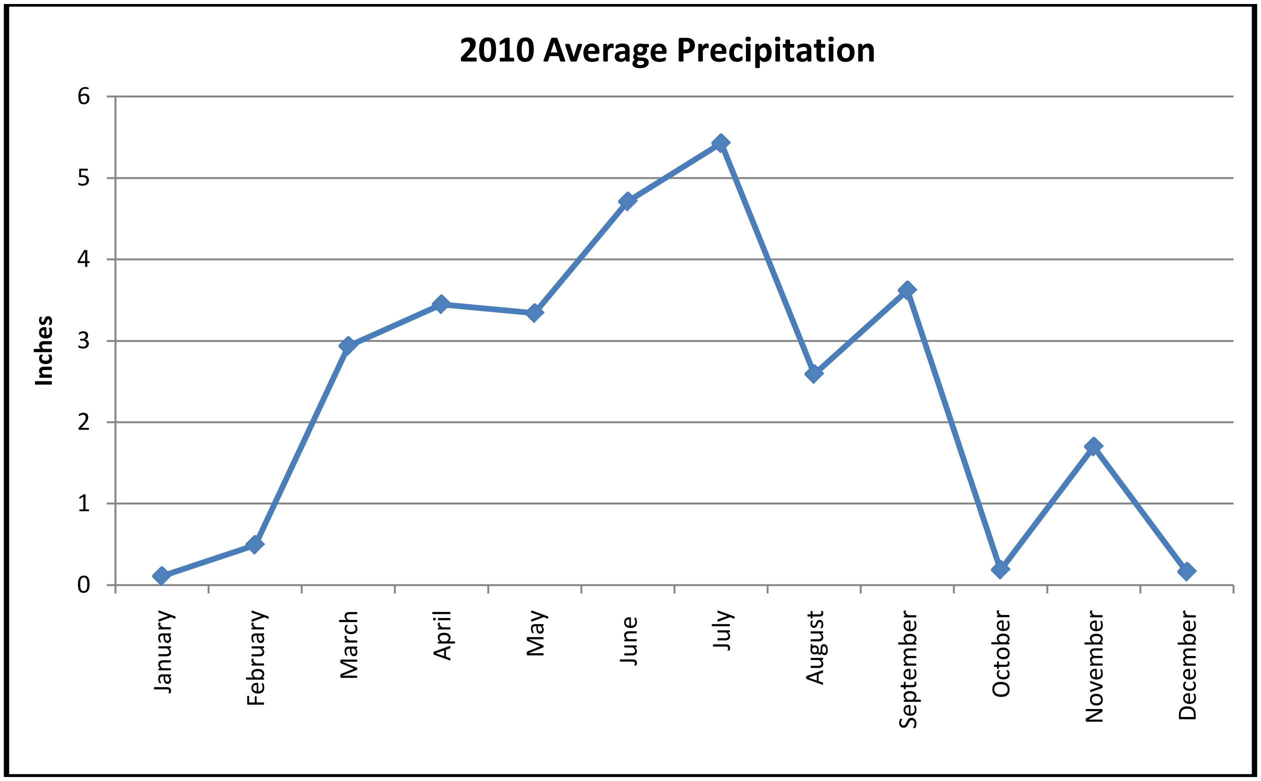

Figure 3: 2010 Monthly Average Precipitation

III. Surface Water

The Mainstem subbasin has three streamflow gages monitored by the USGS. The first is below Glen Elder Reservoir, another downstream at Niles and the final gage is on the Salt Creek at Ada (Figure 4). The streamflow gage at Niles is the only gage with Minimum Desirable Streamflow (MDS) associated with it.

The Niles gage has an extensive record dating back to the late-1800s. Unfortunately, there is a gap in data from 1903 through 1917. The streamflow gage at Ada on Salt Creek began its record 1960. In 1965, the USGS installed a streamflow gage at Glen Elder.

Over the period of records, the average annual streamflow at Niles was 537.55 cfs, Ada was 63.50 cfs, and below Glen Elder was 219.87 cfs. During the 1990s, annual average streamflow maintained higher levels at these gages; with Niles at 882.76 cfs, Ada at 107.53 cfs and below Glen Elder at 467.55 cfs. Average annual streamflow declined during the 2000s with Niles at 254.35 cfs, Ada at 31.37 cfs and below Glen Elder at 110.61 cfs (Figure 5).

During 2010, streamflow at Niles stayed above MDS (Figure 6). Streamflow at the Glen Elder gage records more consistent flow due to reservoir releases. The Ada, Salt Creek and Niles streamflow gages show more variation due to the random nature of precipitation events throughout the year.

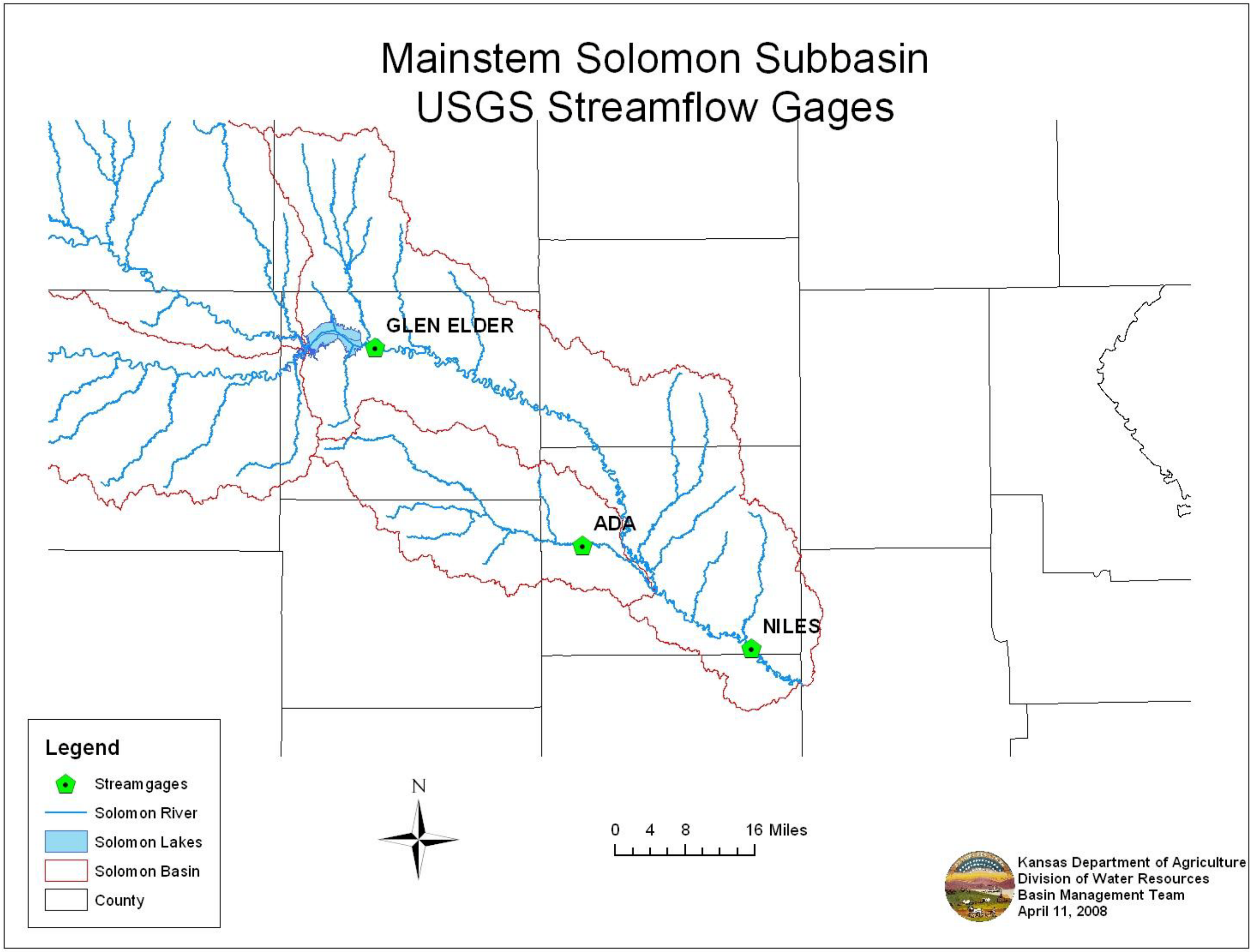

Figure 4: Solomon River USGS Streamflow Gages

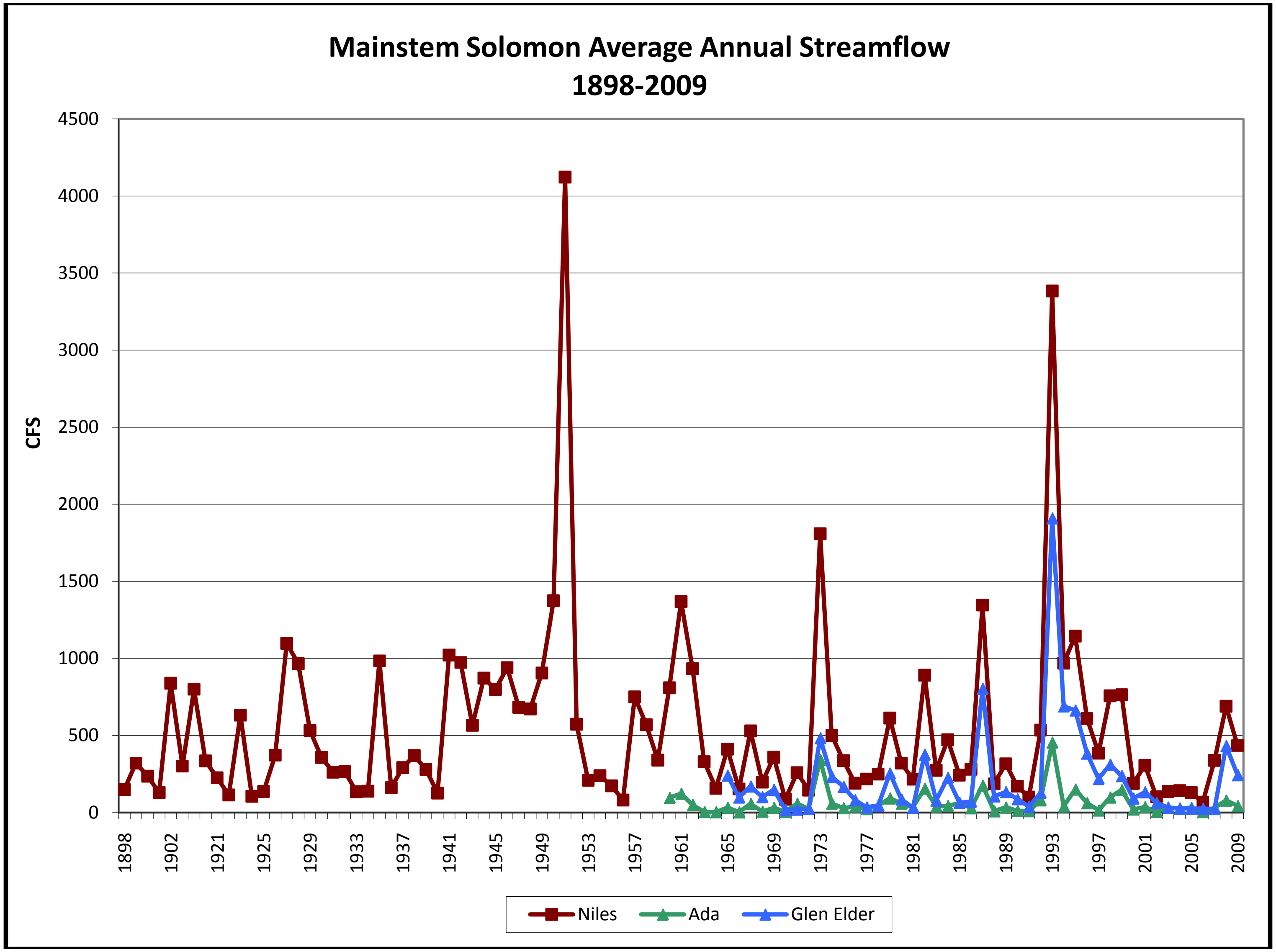

Figure 5: Average Annual Streamflow at USGS Gages 1898-2009

NOTE: There is no data for 1903-1917

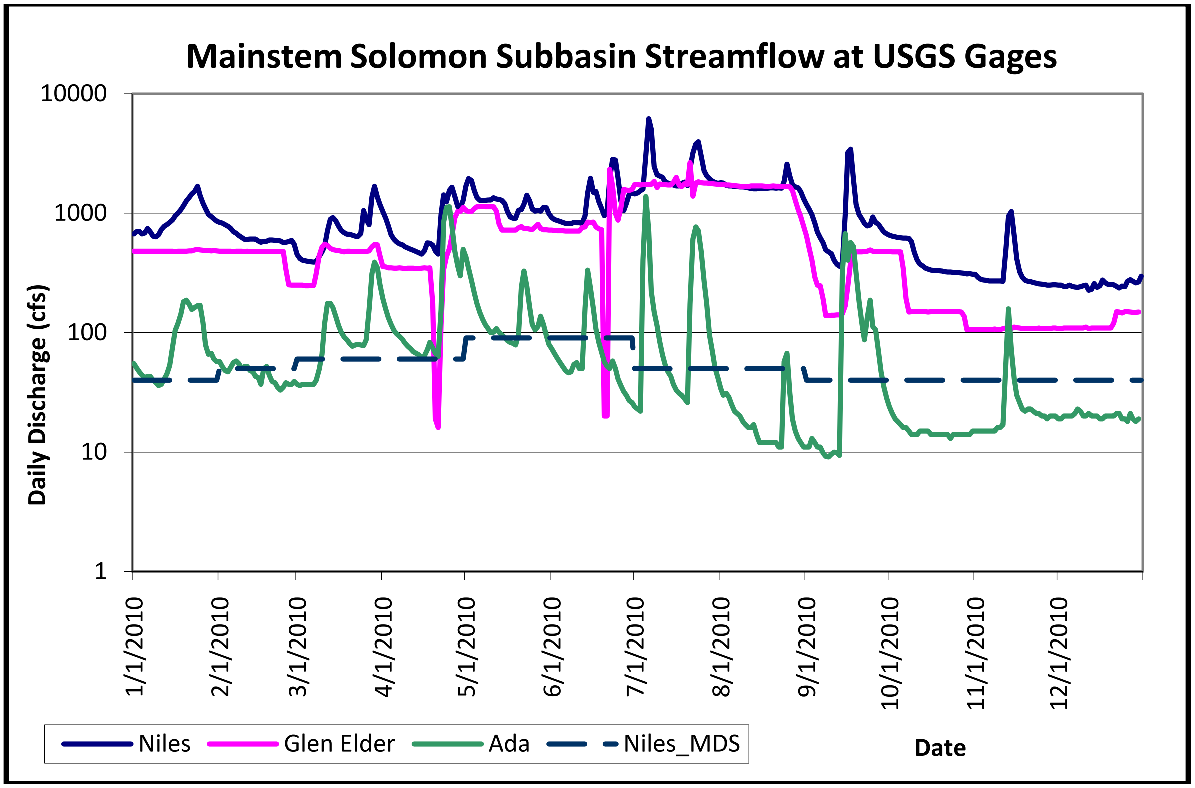

Figure 6: Daily Streamflow and MDS for Niles 2010

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 days above the MDS value. The chief engineer can prohibit the use of certain diversions for this period if they are affecting streamflow. Table 1 shows MDS by month for the Niles streamflow gage on the Solomon River.

Table 1: Minimum Desirable Streamflow (MDS)

Gage	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Niles	40	50	60	60	90	90	50	50	40	40	40	40

For the first five years, streamflow was above the MDS criteria at Niles. From 1989 until 1992 criteria was not met several times. During the 1990s when the subbasin saw higher levels of precipitation, the streamflow remained above MDS. In 2002, streamflow declined to meet MDS criteria. In 2007 and 2008, streamflow conditions improved due to above average precipitation amounts. In both 2009 and 2010, the streamflow stayed above MDS values (Figure 7).

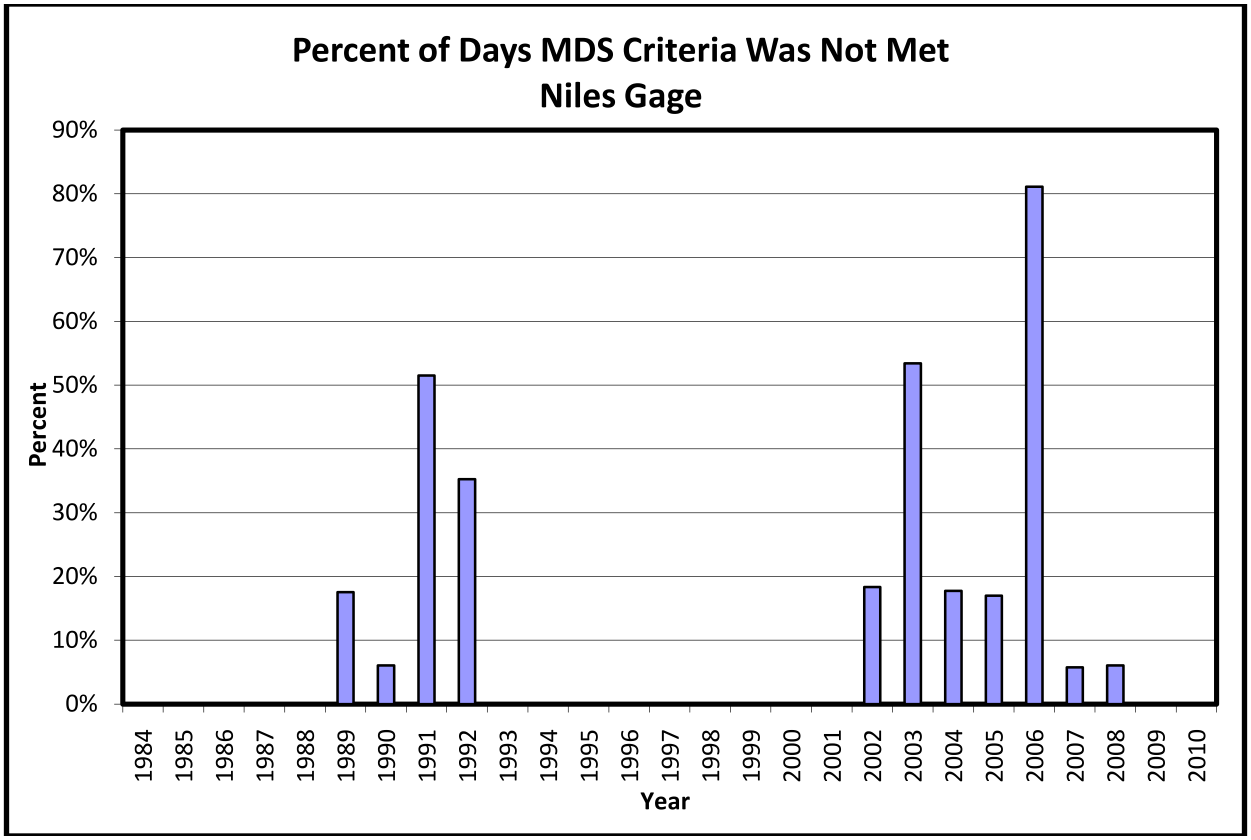

Figure 7: Percent of days MDS was not met at Niles USGS gage

IV. Groundwater

The Kansas Department of Agriculture, Division of Water Resources (KDA-DWR) measures monitoring wells for groundwater levels in the Mainstem of the Solomon River subbasin. There are nine monitoring wells used for these measurements, all of which were drilled in the alluvial aquifer system (Figure 8). The wells are monitored on a tri-annual basis in winter, spring and fall. Only the winter measurements, taken in December, January or February, are used for the monitoring well water level charts, since those measurements are considered to be the least influenced by irrigation well pumping. Figure 9 charts groundwater levels in all the monitoring wells and also the five-year rolling averages of those wells. Legal descriptions are available in the appendix. The y-axis is labeled DBLS (feet). The DBLS stands for depth below land surface.

A number of the monitoring wells have been measured since the late 1950s to the early 1960s, and more wells were added to the network in 2001 and 2003. The wells display large seasonal fluctuations due to precipitation recharge and seepage from the river due to releases or spills from Waconda (Glen Elder Dam). Ongoing observation of water levels is critical to understanding the fluctuations that may occur over time. Historical records can provide a hydrologic outlook on the long-term sustainability or decline of an area.

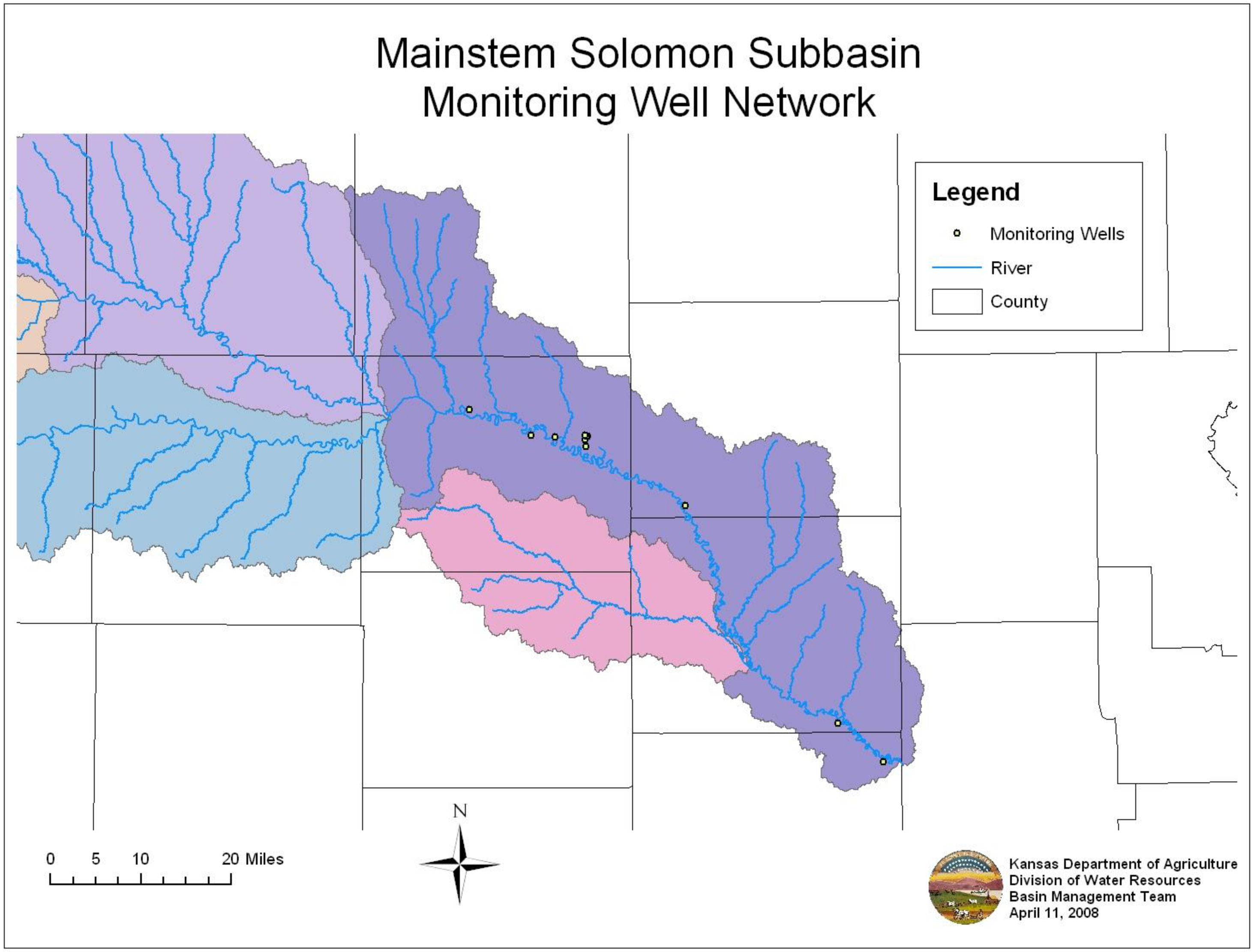

Figure 8: Mainstem Monitoring Wells

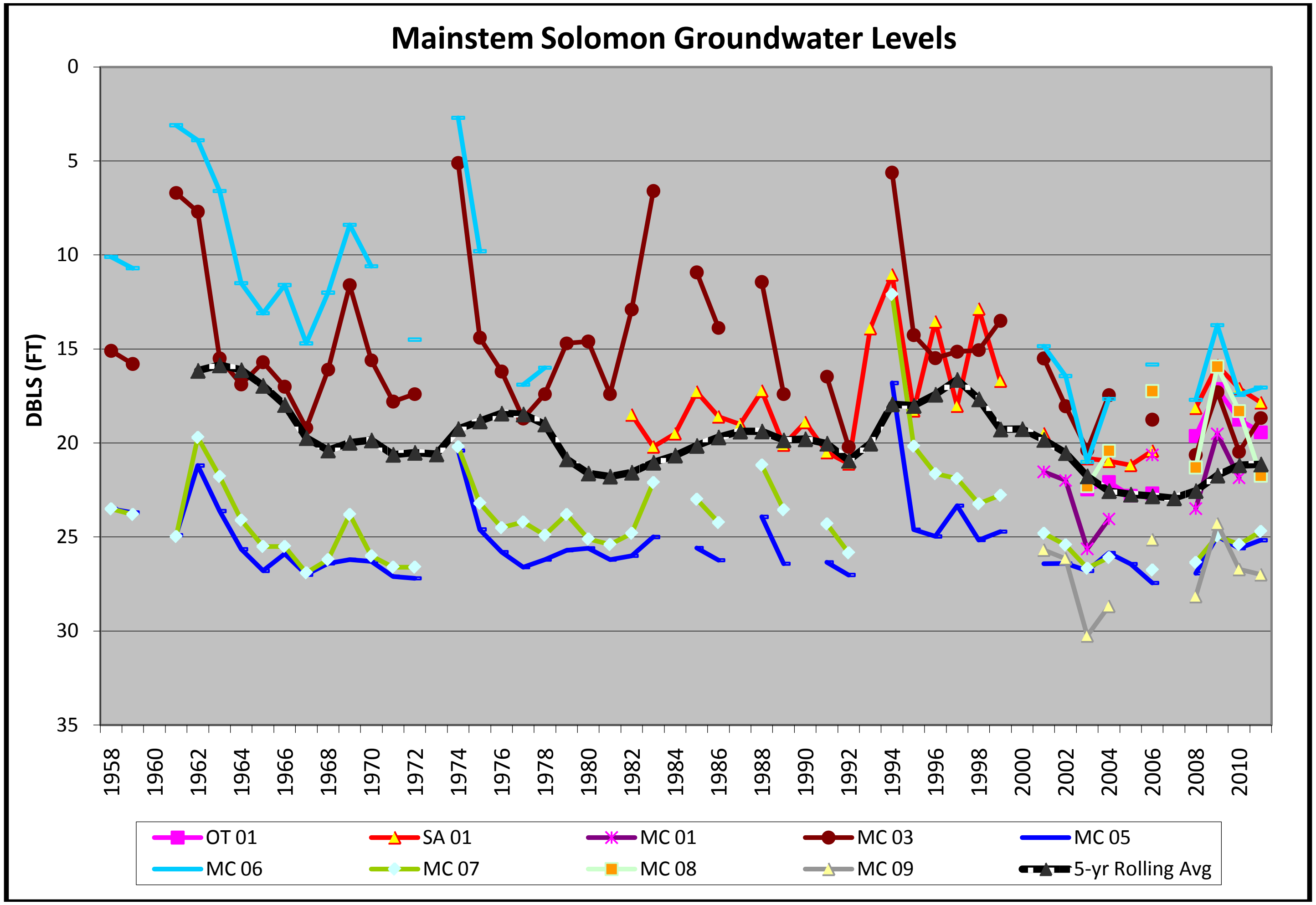

Figure 9: Monitoring wells located in the Mainstem Solomon Subbasin

There are nine monitoring wells in the Mainstem Solomon subbasin. The Mainstem has monitoring wells in three counties: Saline, Mitchell and Ottawa counties. The average change in the water levels from 2010 to 2011 is a decline of 0.23 feet. Change in water levels ranged from a decline of 3.44 feet (MC08) to an increase of 1.80 feet (MC03). The five-year rolling average does show a cyclical pattern with a declining trend from 1998 until 2007. The 5-year rolling average increased slightly in 2011 (Figure 9).

V. Water Use

The Mainstem Solomon subbasin has a total of 303 water rights with an authorized quantity of 42,536 acre-feet. Most of the water rights and authorized quantities are for appropriated surface water rights (Table 2). The following map shows the points of diversion for the subbasin (Figure 10). Some water rights have more than one point of diversion associated with it. Irrigation, stock, domestic, recreation, industrial and municipal water rights are used for this water use analysis.

Table 2: Water Rights in the Mainstem Solomon Subbasin

Type	Source	Number of Rights	Authorized Quantity
Vested	Surface Water	9	867
Appropriated	Surface Water	123	27,750
Vested	Groundwater	8	598
Appropriated	Groundwater	163	13,322

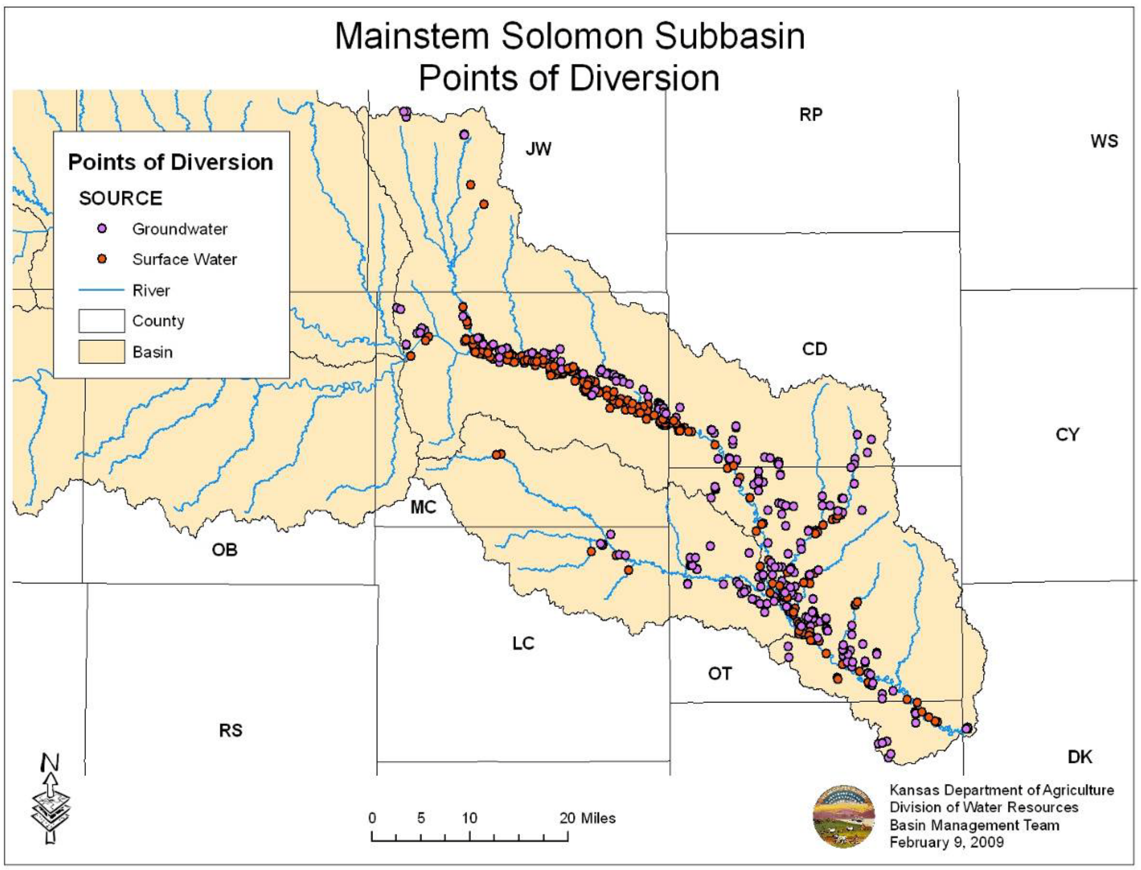

Figure 10: Mainstem Points of Diversion

The water use ranges from 29,072 acre-feet in 2002 to 2,673 acre-feet in 1993. The average water use for the subbasin from 1989-2009 was 14,742 acre-feet. Water use in 2009, the most recent year for which complete records are available, was 21,781 acre-feet, which is more use than 2008 and the historical average for the subbasin (Figure 11).

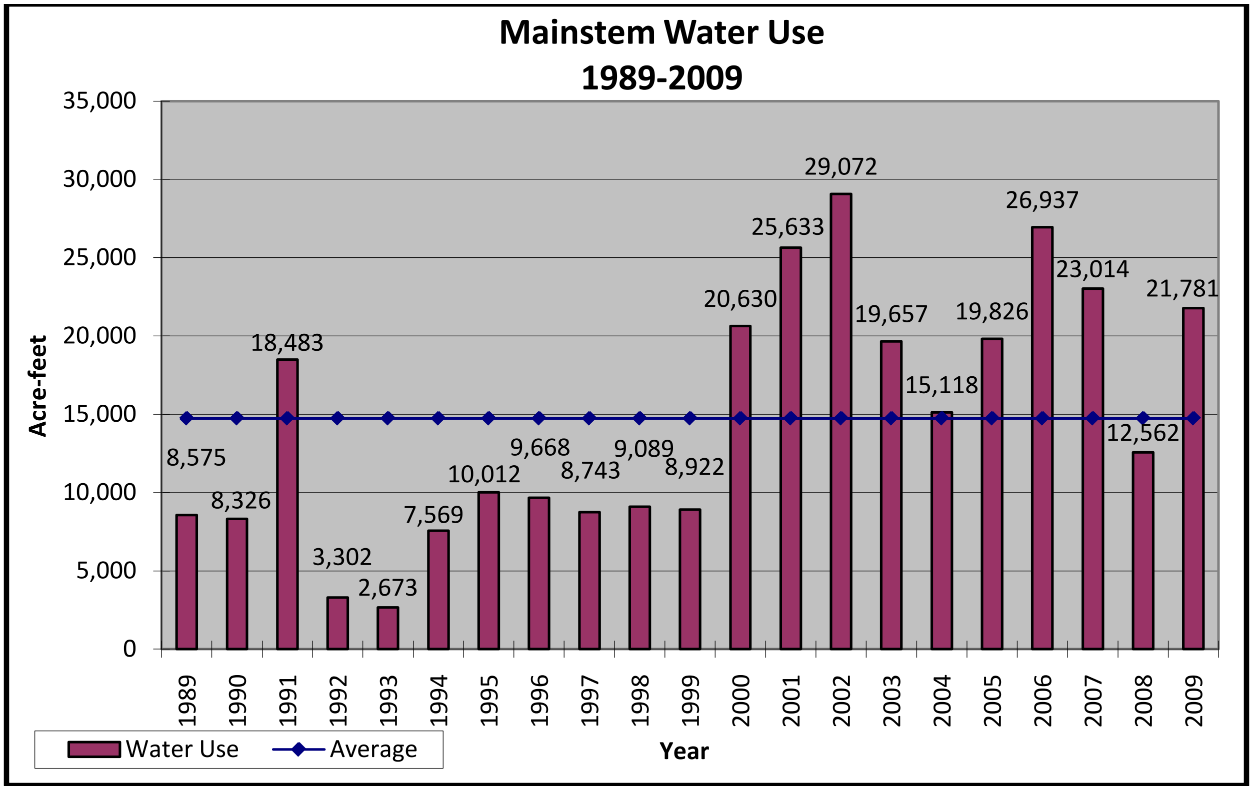

Figure 11: Ground and surface water use by year

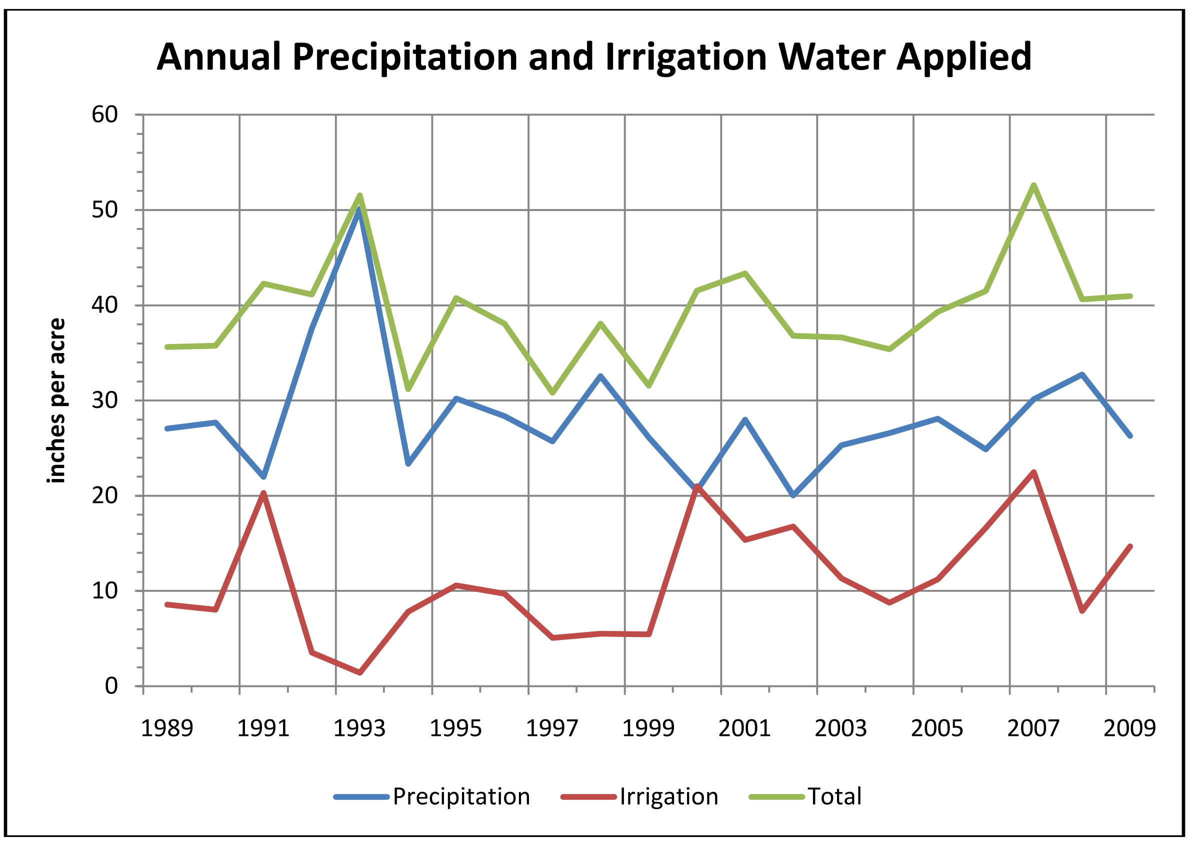

Figure 12: Annual Precipitation and Irrigation (inches per acre) 1989-2009

Since 1989, the Mainstem subbasin averaged 28.3 inches in precipitation and 11.1 inches of irrigation pumping (Figure 12), but there is significant variability in both of these figures. Irrigators in the subbasin pump more water in drier years to compensate for the lack of precipitation. In 2009, the subbasin received 26.3 inches in precipitation and pumped 14.7 inches. Irrigation season precipitation averages 20.6 inches, which is more than seven inches below the annual average (Figure 13).

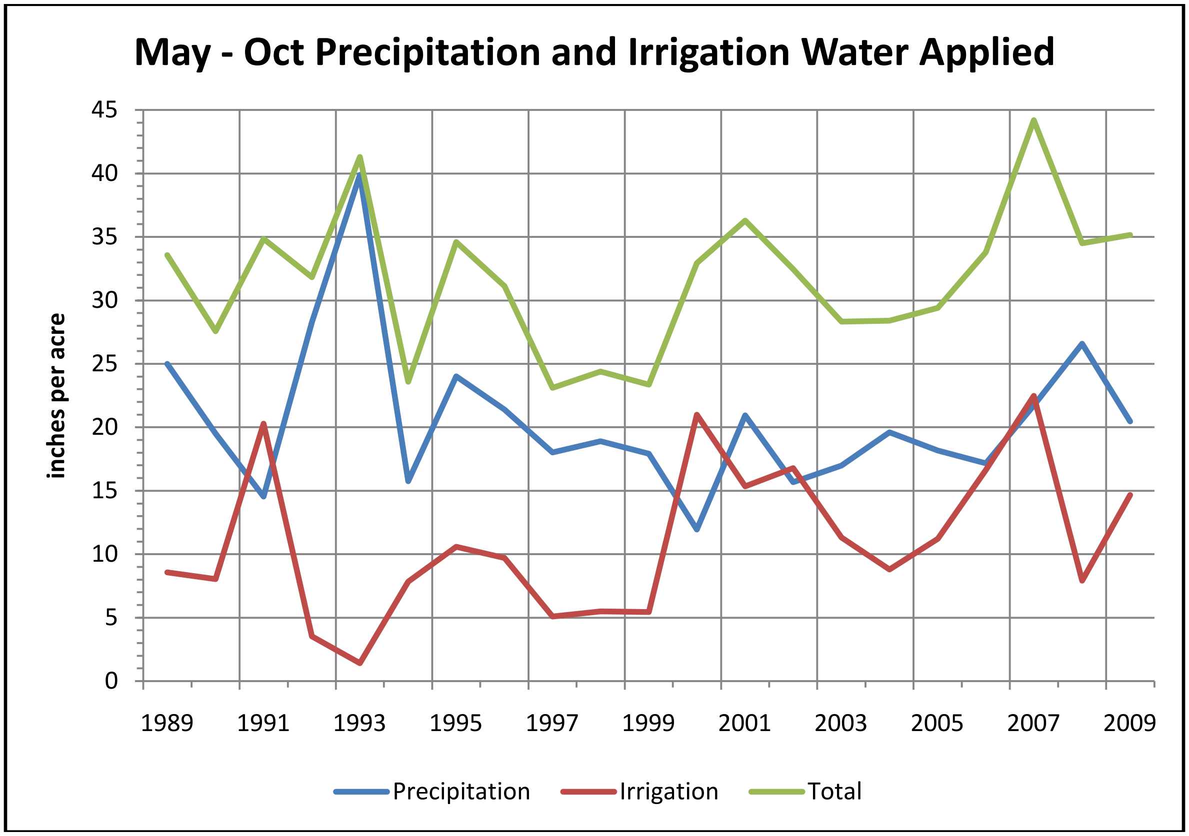

Figure 13: May - October Precipitation and Irrigation (inches per acre) 1989-2009

VI. Conclusions

Precipitation in the Mainstem subbasin was just below average in 2010. MDS values were met 100 percent of the time at the Niles USGS gage during 2010. The five-year rolling average trend increased slightly in 2010, but the annual water levels had both increases and decreases. Water use increased in 2009 from 2008 levels and was also above the subbasin average. It is important to continue to increase our understanding of the impacts of pumping, how fast the system recovers after recharge events, and other characteristics of the hydrologic system in order to evaluate the long-term effects of water usage on this subbasin, protect property rights, and ensure the benefits of these water resources to future generations.

VII. Appendix

Monitoring Well ID	Legal Description	Subbasin
MC01	07 06W 17 CCD	Mainstem
MC03	07 06W 29 BBB	Mainstem
MC05	07 07W 18 DDA	Mainstem
MC06	07 06W 19 ADA	Mainstem
MC07	07 07W 22 ABB	Mainstem
MC08	07 06W 17 CCD,7	Mainstem
MC09	07 06W 17 CCB,2	Mainstem
OT01	12S 02W 26 DDC	Mainstem
SA01	13 01W 23 BCB,2	Mainstem