

Figure 1.

* Minimum Desirable Streamflow

30 15 0 30 Miles

Kansas Water Office, February 2008

General Description

The Solomon River drains an area of 6,835 square miles of the Great Plains Physiographic Province, within north-west and north central Kansas. The [Solomon River basin](#) covers all or parts of Decatur, Norton, Phillips, Smith, Jewell, Sherman, Thomas, Sheridan, Graham, Rooks, Osborne, Mitchell, Cloud, Lincoln, Ottawa, Dickinson and Saline counties. The topography is generally flat to gently rolling hills with narrow, shallow valleys of low relief. The Solomon River is part of the Kansas River system. The basin includes subbasins with [hydrologic unit codes](#) 10260011, 10260012, 10260013, 10260014 and 10260015.⁽¹⁾

The basin is unique in that all of its drainage area is within Kansas. From the headwaters of the North and South Forks of the Solomon near the Sherman-Thomas county line, the basin extends eastward to the confluence of the Solomon with the Smoky Hill River in Dickinson County.

Surface elevations in the Solomon River Basin decline from about 3,300 feet in the western North Fork drainage to 1,150 feet at the confluence with the Smoky Hill River.

Population and Economy⁽²⁾

There were an estimated 39,900 residents in the basin in the year 2000. The total [population](#) of the 17 counties that are entirely or partially in the Solomon basin was 154,233 in the year 2000 and is projected to be 128,912 by the year 2040. The large discrepancy in estimated population and the counties total is due to the inclusion of Saline and Dickinson counties. In the past 40 years, two trends have dominated the state. Rural counties have lost population, sometimes more than 10% every decade.

As one example, Osborne County, with a population of 7,506 in 1960, had only 4,452 residents in 2000. Only one county in the basin, Thomas, gained population in this 40-year period.

In 2006 there were an estimated 8,840 farms, with 8,761,000 acres in the 17 counties with all or parts in the basin. The average farm is about 991 acres.

Agriculture is the predominant economic activity throughout the basin with irrigated agriculture taking on added significance in the semi-arid west. Irrigated [crops](#) are important in some areas of the basin.

Livestock production is an important part of the area's agriculture and economy as well. Beef cattle are the predominant livestock raised in the basin.



Ogallala Outcrop Graham County
Photo courtesy of Kansas Geological Survey

Recreation is an increasing part of the economics of the basin, as is industry. The federal reservoirs and associated recreation and wildlife areas draw hunters, fishermen and boaters to the area. In addition, the state offers fishing at Jewell State Fishing Lake, (57 acres, 6 S 2 W of Mankato), Ottawa State Fishing Lake, (138 acres, 5 N, 1 E of Bennington), Rooks State Fishing Lake, (67 acres, 2-1/2 S 2 W of Stockton) and Sheridan State Fishing Lake, (67 acres, 11 E of Hoxie).

The growing industrial contribution to the basin economy is primarily related to energy production, including ethanol. As of April 2008 one 40 million gallons per year (MGY) plant was in operation at Phillipsburg.

Opportunities for higher education in the basin are offered through the Northwest Kansas Technical College at Beloit.

Physical Characteristics

Geology and Soils

Surface geology in the Solomon basin consists of unconsolidated and consolidated rocks of sedimentary origin. The unconsolidated deposits, considered of recent origin, consist of Quaternary alluvium, loess (wind born deposits) and the Tertiary Ogallala Formation. The Quaternary alluvial deposits are widespread, primarily found in the uplands in the western and central parts of the basin. The alluvial deposits can also be found in the channels and floodplains of major streams, consisting of gravel, sand, silt and clay.

The loess deposits mainly occur in the uplands and on the valley slopes. Terrace deposits are the reworked older alluvium and Ogallala Formation.

The Ogallala Formation, found in the western third of the basin consists of silt, sand, gravel and cemented calcium carbonate beds. The Ogallala ranges from 60 feet thick in northern Phillips County to about 260 feet in central Thomas County. The Ogallala Formation lies uncomfortably on the Pierre Shale in the western and on the Niobrara Formation in the eastern part of the basin.

The Dakota Formation underlies the basin and is near the surface in Ottawa County. Other consolidated units in the basin include the Carlile Shale, Greenhorn Limestone, Graneros Shale, Kiowa Shale, Cheyenne Sandstone, Niobrara Chalk and the Pierre Shale.

Principal water bearing units include the Ogallala, Dakota formations and the valley alluvium.



Rock City- Dakota Outcrop Ottawa County
Photo courtesy Kansas Geological Survey

Table 1. Total Riparian Land Use Bank Miles for Solomon Basin

Hydro Type	Animal Prod. Area	Barren Land	Crop Land	Crop/ Tree Mix	Forest Land	Pasture/ Grass Land	Pasture/ Tree Mix	Shrub Land	Urban Land	Urban/ Tree Mix	Total
Intermittent Stream	1	8	9,759	1,533	2,618	14,922	3,557	9	108	43	32,557
Perennial Stream	0	7	50	541	1,527	156	531	10	2	6	2,829
Shoreline	0.6	20	72	10	46	983	112	5	4	2	1,256
Total	1.6	35	9,881	2,084	4191	16,061	4,200	24	114	51	36,644

A wide variety of soils are present in the Solomon basin. These include loose sands; level, productive valley alluvium; moderately heavy soils on the slopes and uplands; and friable, less acidic soils. Productivity of the soils generally increases westward.

The majority of the bottom land and terrace soils are level to slightly sloping, friable soils constituting about 14 percent of the drainage. Some bottom lands are sandy, while others are clayey and impermeable.⁽⁴⁾

In the eastern part of the basin it has thin loess soils that are generally shallow, sloping, medium acid, and easily eroded. In the west and central portion of the basin, soils range between deep moderately heavy silt loams or loess to shallow silty or stony soils over the Ogallala Formation. The friable soils in the western portion of the basin are subject to severe water and wind erosion.⁽⁴⁾



Photo courtesy of Kansas Geological Survey

In the western part of the basin, most of the river valleys contain a more granular soil type resulting from stream-laid deposits. The primary soil is the Holdrege-Ulysses Association, consisting of deep to moderately deep, dark grayish-brown silt loams and moderately deep gray clays that are gently sloping.⁽⁴⁾

Land Use/Land Cover

The Solomon basin covers approximately 4,393,538 acres. More than 52 percent (%) was cropped, while over 40% was in grass in 2005.

Of the 2.5 million acres cropped annually, about 149,734 acres were irrigated in 2006 according to annual water use reports.⁽⁷⁾ Irrigated crops are primarily corn, soybeans and alfalfa. The remaining acres area devoted to dryland crops including wheat, sorghum, corn, alfalfa, soybeans, sunflowers and hay and pasture.

The Kansas Geological Survey (KGS) categorized riparian land use in 2003. Statewide pasture/grass land is the dominant riparian land use type in Kansas, exceeding 142,000 bank miles or roughly 38% of all land use types. In this basin, the total of 35,386 bank miles varies in the type of riparian land use, with nearly 44% of the riparian cover being pasture/grass land.

Table 1 provides more detail for riparian land within one mile of streams and water bodies.⁽⁶⁾

Climate

The climate of the basin is classified as subhumid in the east and semiarid in the west. The climate characterized by moderate to low precipitation, relatively high wind velocities, high evaporation rates, a wide range of temperatures and abrupt changes in weather. Average annual total [precipitation](#) varies from 18 - 28 inches, west to east, while average annual surface runoff increases from 0.1 inches in the west to 4.0 inches in the east. Most of the precipitation occurs April through September. Annual evaporation from impoundments range from 54 inches in the east to 60 inches in the west.

Drought is a naturally recurring feature of this climate as exemplified by the Dust Bowl of the 1930's and the severe drought of 1952-1957. Kansas has been impacted by severe drought periodically. Reduced precipitation is offset by irrigation for crop production increasing the demand on the available water supply.

Flooding when it occurs, is generally the result of intense storms of short duration. The combination of limited channel capacity and flat flood plain can result in large portions of the valleys being inundated when storm intensity, coverage and duration contribute to runoff greater than the channel can handle.

Table 2. Climate Summary Solomon Basin

Location	Average Annual ¹		Freeze Dates (32 F.) ²		
	Precipitation (inches)	Temperature (deg. F.)	Last in Spring	First in Fall	Frost Free Days
Hoxie	21.37	52.0	Apr. 28	Oct. 5	160
Smith Center	24.65	53.8	Apr. 22	Oct. 12	171
Minneapolis	30.28	56.2	Apr. 19	Oct. 18	183

¹ Source: National Climatic Data Center (1971-2000 data)

² Source: KSU Weather Data Library (1961-1990 data)

Wildlife and Habitat

Key wildlife habitat includes cropland, good and excellent rangeland, weedy and brushy fence rows and ungrazed areas, riparian areas, streams, and wetlands. Key wildlife species include ring-necked pheasants, greater prairie chicken, bobwhite quail, and whitetail and mule deer.⁽¹¹⁾

Three wildlife areas are maintained by state or federal agencies near each of the federal reservoirs.

Kirwin National Wildlife Refuge is located in the rolling hills of the narrow North Fork of the Solomon River valley in southeastern Phillips County. The Kirwin Refuge lies in a transition zone between the tall grass prairies of the east and the short grass plains of the west. As a result, grasses and wildlife common to both areas are found on the Refuge.⁽⁴⁾ The water in the Refuge, along with Kirwin Lake is considered an Outstanding National Resource Water and a Special Aquatic Life Use Water.

Webster Wildlife Area encompasses 7,622 acres of public hunting surrounding 1,678 surface acres of water. A variety of wildlife habitats are developed and maintained to enhance wildlife.

Glen Elder Wildlife Area encompasses almost 13,200 land acres surrounding the 12,500 acre Glen Elder Reservoir.

Numerous threatened or endangered species have range within the basin. These include the bald eagle, snowy plover, piping plover, whooping crane, peregrine falcon and Topeka shiner (historic range).⁽¹¹⁾

Water Resources

The major streams in the basin are the Solomon River and its major tributaries, the North Fork Solomon and the South Fork Solomon, both originating near the Thomas-Sherman county line. Major tributaries include Bow and Salt creeks. Three U.S. Bureau of Reclamation (Bureau) dam/reservoir projects regulate streamflow in the Solomon basin. These are Kirwin on the North Fork, Webster on the South Fork and Glen Elder/Waconda at the confluence of North and South Forks of the Solomon River. Principal aquifers include the Ogallala Formation of the High Plains aquifer in the west, the Dakota in the east and alluvial/terrace deposits along major streams.

The streams include 32,557 intermittent stream miles and 2,829 perennial stream miles.⁽⁶⁾ Drainage density is 0.41 mile in the basin (perennial streams only).

The Ogallala-High Plains [aquifer](#) region of the Solomon basin is located in the extreme western extent of the basin. The Ogallala-High Plains aquifer consists of several hydraulically connected aquifers, the largest of which is the Ogallala. The Ogallala-High Plains aquifer is distinctive from other aquifers in Kansas in that it has generally lower annual recharge.

The majority of ground water used, other than the Ogallala-High Plains aquifer is alluvial ground water. A portion of the natural recharge that reaches the alluvial aquifer contributes to streamflow through base flow.

Ground water is the principal water supply source in the Solomon basin, accounting for about 93 percent of reported water use. The North and South Forks and the main stem of the Solomon River are surface sources of water supply in the basin.

Irrigation is the predominant use of water in the basin accounting for 95% of [all reported water use](#) in 2006. There are 2,417 water rights in the basin that reported use of a total of 175,084 acre feet in 2006 from surface and ground water sources. Surface sources accounted for 23,646 acre feet while the majority, 151,438 acre feet was reported use from ground water.⁽⁷⁾

The second largest use, at more than 6,331 acre feet, was for municipal water use (communities and rural water districts). The quantities used for recreation, industrial and domestic uses are very small, so appear as less than one percent of the water used in the Solomon basin in 2006 (Figure 2).

There were 47 [public water suppliers](#) in the basin in 2006 providing water to urban and rural areas.

Solomon Basin
2006 Reported Water Use by Type

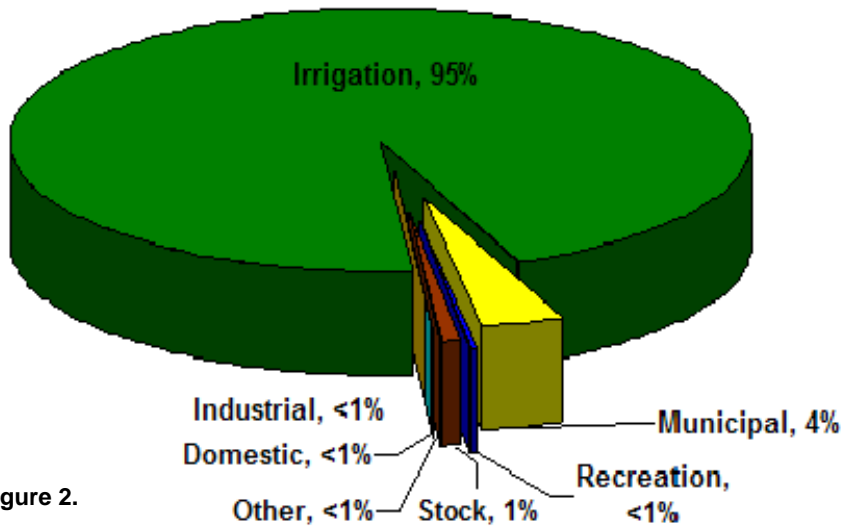


Figure 2.

Water Management

Northwest Kansas Groundwater Management District No. 4 (GMD4) is a water management entity in the basin, where it overlies the Ogallala-High Plains aquifer in Thomas, Sherman and Graham counties (Figure 3). GMD4, formed in 1976, is pro-active in developing local water policy compatible with state laws.

Water appropriations and use are overseen by the Kansas Department of Agriculture-Division of Water Resources. All of the streams and alluvial corridors in the basin are either closed to new appropriations or new appropriations are restricted. Minimum desirable streamflow has been set at one site on the Solomon River at Niles. Generally, the Ogallala-High Plains aquifer has no new appropriations available, but in limited cases a new water appropriation for ground water limited to quantities under 15 acre feet can be obtained by meeting some very specific criteria within GMD4.

States generally have the responsibility to determine the management of the water resources in that state. The exception to this is the management of federal reservoirs by a federal agency. In the Solomon basin the three federal reservoirs are managed by the Bureau, with some releases coordinated by the U.S. Army Corps of Engineers (Corps). The State of Kansas has not purchased any water supply storage in the federal reservoirs in the basin.

Three irrigation districts (Kirwin Irrigation District No. 1, Webster Irrigation District No. 4 and Glen Elder Irrigation District No. 8) operate using releases from the three res-

ervoirs Kirwin, Webster and Waconda, respectively. When water is available from storage in the lakes the districts are authorized to irrigate up to 25,394 acres.

Watershed districts may be formed to construct, operate and maintain works of improvement needed to provide for water management. The primary function is to develop a comprehensive general plan for a watershed that will provide flood protection for the residents and landowners. One watershed district is organized in the basin, Salt Creek Watershed Joint District No. 46 (Figure 3).⁽⁹⁾ In 2005 there was a second organized watershed district, Fisher & Criss Creek Watershed District No. 67.

Numerous other entities related to water resources may exist in the basin to address one or more water related issues.

Each county has a county conservation district responsible for the conservation of soil, water, and related natural resources within that county boundary. Multiple county groups may form Resource Conservation and Development areas (RC&Ds) to also address conservation of natural resources. Parts of three RC&Ds cover the Solomon basin. In addition, drainage districts may also be formed to reclaimed and protected land from the effects of water.

Addressing water quality is one Watershed Restoration and Protection (WRAPS) program that covers a part of the basin. The Waconda Reservoir WRAPS began development in SFY2007. Project goal: develop stakeholder leadership team to lead WRAPS effort; compile watershed information.

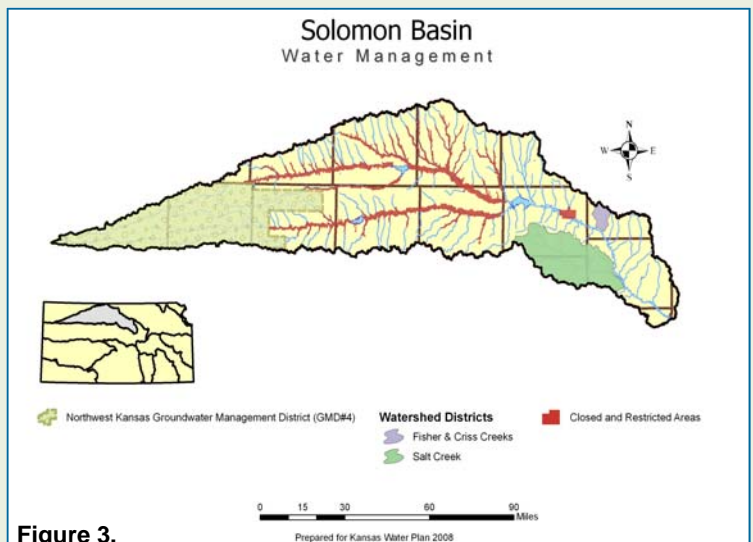


Figure 3.

Resources

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2. U.S. census data, 2000.
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6. Wilson, Brownie. 2003. http://hercules.kgs.ku.edu/geohydro/ofr/2003_55/riparian/ofr_2003_55e.htm. Kansas Geological Survey.
7. Kansas Department of Agriculture-Division of Water Resources. WRIS database, December 13, 2007.
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9. State Conservation Commission. 2008. <http://scc.ks.gov/dmdocuments/Kansas%20Watershed%20and%20Drainage%20District%20Directory%20WORD%20for%20ACROBAT.pdf>
10. U.S. Department of Agriculture. 2008. <http://www.ks.nrcs.usda.gov/partnerships/rcd/>
11. Kansas Department of Wildlife and Parks. 2008. http://www.kdwp.state.ks.us/news/other_services/threatened_and_endangered_species/threatened_and_endangered_species/range_maps Most of information from previous *Kansas Water Plan* sections.



Kirwin Terrace, Phillips County
Photo courtesy of Kansas Geological Survey

Irrigation and Recreation Storage

Surface water supplies account for about seven percent of water authorized for use in the basin which includes storage in the three federal reservoirs. Storage in the reservoirs include storage for irrigation and municipal use. Recreation is a side-benefit of the water stored in the lakes.

Webster Reservoir, on the South Fork of the Solomon River in Rooks County, was built to include providing irrigation water for 8,500 acres in Rooks and Osborne counties. Fewer acres are irrigated due to shortages of water in storage. Some years no irrigation occurs from District storage in Webster. Sedimentation has reduced conservation pool storage to 71,926 acre feet.

Kirwin Reservoir, on the North Fork of the Solomon River in Phillips County, was built to include irrigation on 11,435 acres in Phillips, Smith and Osborne counties. Often, fewer acres are irrigated due to shortages of water in storage. Some years no irrigation occurs from the District storage in Kirwin.⁽³⁾ Sedimentation has reduced conservation pool storage to 89,639 acre-feet.

Waconda Lake is on the main stem of the Solomon River, west of Glen Elder. The Glen Elder Dam was completed in 1969, providing storage of 196,400 acre-feet of water in the conservation pool of Waconda Lake. Sedimentation has reduced conservation pool storage to 193,183 acre-feet. Glen Elder Dam is a multiple purpose dam and reservoir constructed by the Bureau of Reclamation in Osborne and Mitchell counties. The dam and reservoir authorization are for the purposes of flood protection, irrigation, recreation, fish and wild-life and water supply. Irrigation from the lake serves 21,000 acres of valley land.

Glen Elder Irrigation District No. 8 is authorized for 15,170 acre feet of water. In 2005 the District reported using 10,187 acre feet on 6,509 acres.

Water supply for Beloit includes up to 2,000 acre feet from Waconda Lake storage.



Glen Elder Dam. Photo courtesy of U.S. Bureau of Reclamation