Solomon River Basin

January 2009

General Description

The Solomon River drains an area of 6,835 square miles of the Great Plains Physiographic Province, within northwest and north central Kansas. The Solomon River basin covers all or parts of Decatur, Norton, Phillips, Smith, Jewel, 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.

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.

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]

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.
[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.

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 reservoirs 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.

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 wildlife 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.

Resources

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5. US Fish and Wildlife Service. 2008. http://www.fws.gov/kirwin/
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.

Solomon River Basin Management Categories

WATER MANAGEMENT CATEGORIES

The following categories include issues identified in the Solomon basin plan as items that require attention in addition to the basin priority issues. These issues are addressed within the following management categories:

- Water Management
- Water Conservation
- Public Water Supply
- Water Quality
- Wetland and Riparian Management
- Flood Management
- Water-Based Recreation

These categories also correspond to the statewide management categories and policies of the *Kansas Water Plan* found in Volume II. These documents contain new policy issues and the existing policy and statutory framework that relate to the management categories.

ISSUE: WATER MANAGEMENT

Management of Kansas' ground and surface water fits into six statewide categories, with five of these applicable in the Solomon basin. These are:

1) River-Reservoir management;
2) Stream reaches with established Minimum Desirable Streamflow;
3) Streams outside of Minimum Desirable Streamflow protected areas;
4) The Ogallala-High Plains aquifer; and
5) Ground water outside of the Ogallala-High Plains aquifer.

Ground water is the primary water supply in the basin. The Ogallala-High Plains aquifer is a major source in the western portion of the basin where it interconnects with alluvial ground water and may have an affect on streamflow. Ground water recharge rates are generally low throughout the basin. A majority of the basin is restricted or closed for new water appropriations. The Ogallala-High Plains aquifer area of the basin is managed with the local leadership by Northwest Kansas Groundwater Management District No. 4 (GMD4). GMD4 has identified six high priority aquifer subunits. Goals and management for each are under development. Portions of two subunits are in the basin. In 2008, a computer model developed for the six priority subunits was completed through cooperation of Kansas Water Office (KWO), GMD4 and the U.S. Bureau of Reclamation (Bureau). The model will aid in development and analysis of the management strategies.

In 2006, the KWO calculated the median annual water level changes in wells from 1981 to 2005. In the northwest Ogallala aquifer area, as of 2005, there has been no statistically significant change (at a +or- 5% error level) in the rate of water level decline.[(1)] Reducing the decline rate of the Ogallala-High Plains aquifer is a basin priority issue. Additional information on this issue may be found in the Solomon Basin Ogallala decline priority issue section.

Reduced streamflow and runoff into streams has been reflected in lower water levels in Webster Reservoir, Kirwin Reservoir and Waconda Lake. These conditions and reduced availability of irrigation water stored in the reservoirs have suggested a need to take a fresh look at reservoir management. Maintaining a minimum water level in Webster Reservoir is a basin priority issue. Additional information on this issue may be found in the Solomon Basin priority issue section.

There is one minimum desirable streamflow (MDS) location in the basin, located on the Solomon River near Niles. Statistically this gage had no change in the frequency that MDS was met from 1984 to 2004 and the historical frequency (1960 to 1983).

Subbasin water budgets are under development by the Kansas Department of Agriculture-Division of Water Resources. Analysis of water resources and their use by subbasin has been completed for the upper North and South Forks Solomon River. Analyses are planned for the other subbasins to better understand and manage the resources.

Applicable *Kansas Water Plan* Objectives

- Reduce water level decline rates within the Ogallala-High Plain aquifer and implement enhanced water management in targeted areas.
- Achieve sustainable yield management of Kansas surface and ground water sources outside of the Ogallala aquifer and areas specifically exempt by regulation. Sustainable yield management would be a goal that sets water management criteria to ensure long term trends in water use will move as close as possible to stable ground water levels and maintenance of sufficient streamflows.
- Meet minimum desirable streamflow at a frequency no less than the historical achievement for the individual sites at time of enactment.

Applicable Programs

The following programs help to meet the objectives in the Water Management (quantity) category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Department of Agriculture-Division of Water Resources: Water Appropriation Program
- Kansas Geological Survey and Kansas Department of Agriculture-Division of Water Resources: Water Well Measurement
- State Conservation Commission: Water Right Transition Assistance Program
- USDA-Natural Resources Conservation Service: Environmental Quality Incentive Program (EQIP)
- USDA-Farm Services Agency: Conservation Reserve Enhancement Program
- Kansas Geological Survey: High Plains Aquifer Technical Assistance Program
- Kansas Water Office: State Water Planning Program

ISSUE: WATER CONSERVATION

Water conservation is essential for the effective management of water resources in the basin to assure that a sufficient, long-term supply of water is available for the beneficial uses of the people of the state. Conservation is defined as a careful preservation and protection of something, especially the planned management of a natural resource to prevent exploitation or destruction.

Water conservation activities apply to all uses; irrigation, municipal, industrial, and others, and from all sources. In 2006, irrigation accounted for nearly 95% of all reported water pumped or diverted in the basin. Municipal use accounted for four percent of water used in the basin, with stock water at one percent and industry, recreation, domestic and other uses at less than one percent each.

Of the 616 public water suppliers that have an approved conservation plan in place as of December 31, 2008, 38 plans have been approved in the Solomon basin. As of August 2006, 139 conservation plans had been approved for irrigation water rights in the basin. The number of diversion points in Kansas that reported irrigation application rates over the regional average fluctuated from about 3,700 to less than 500 from 1991 to 2005. Of the total number of individual points of diversions that reported diversion of a measurable quantity of water in Kansas in 2006, more than 45% reported a metered quantity at least once during that year in the Solomon basin. (Source: DWR-Water Right Info. System).

Applicable *Kansas Water Plan* Objectives

- Reduce the number of public water suppliers with excessive unaccounted for water by first targeting those with 30% or more unaccounted for water.
- Reduce the number of irrigation points of diversion for which the amount of water applied in acre feet per acre (AF/A) exceeds an amount considered reasonable for the area.
- All non-domestic points of diversion meeting predetermined criteria will be metered, gaged, or otherwise measured.
- Conservation plans will be required for water rights meeting priority criteria under K.S.A. 82a-733 if it is determined that such a plan would result in significant water management improvement.

Applicable Programs

The following programs help to meet the objectives in the Water Conservation category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Department of Agriculture-Division of Water Resources: Water Appropriation Program
- Kansas State University Research and Extension: Water Conservation and Management Program
- State Conservation Commission: Water Resources Cost-Share Program
- State Conservation Commission: Water Right Transition Assistance Program
- Kansas Water Office: Water Conservation Program
- USDA-Natural Resources Conservation Service: Environmental Quality Incentive Program (EQIP)
- USDA-Farm Services Agency: Conservation Reserve Program

ISSUE: PUBLIC WATER SUPPLY

The primary approach to addressing public water supply issues in the basin focuses on ensuring that there are adequate supplies of surface and ground water within the basin to meet future water demands, reducing the number of public water supply systems that are vulnerable to drought, and ensuring that systems have the technical, financial and managerial capacity to meet future needs for water quality and quantity.

In 2006, there were 49 public water supplies in the Solomon basin. Ground water is the primary source for most public water supplies, accounting for over 95% of the total supply, principally from the Ogallala-High Plains and Dakota aquifers and alluvial deposits along major streams. The City of Beloit obtains their water from surface flow in the Solomon River below Waconda Lake.

Among the state's major river basins, the percentage of drought vulnerable public water suppliers in 2006 ranged from three percent (Neosho Basin) to 42% (Solomon basin). Comparison of the KWO 2000 and 2006 lists show a significant increase in the number of drought vulnerable public water suppliers in most western river basins including the Solomon. There were 20 public suppliers considered drought vulnerable in the Solomon basin in 2006.

Applicable *Kansas Water Plan* Objectives

- Ensure that sufficient surface water storage is available to meet projected year 2040 public water supply needs for areas of Kansas with current or potential access to surface water storage.
- Less than five percent of public water suppliers will be drought vulnerable.
- Ensure that all public water suppliers have the technical, financial and managerial capability to meet their needs and to meet Safe Drinking Water Act requirements.

Applicable Programs

The following programs help to meet the objectives in the Public Water Supply category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Department of Agriculture-Division of Water Resources: Water Appropriation Program

- Kansas Department of Health and Environment: Public Water Supply Program
- Kansas Department of Health and Environment: Kansas Public Water Supply Loan Fund
- Kansas Water Office: State Water Planning Program
- Kansas Water Office: Water Conservation Program

ISSUE: WATER QUALITY

Water quality and related water resource issues are addressed through a combination of watershed restoration and protection efforts utilizing voluntary, incentive-based approaches, as well as regulatory programs.

All the counties within the basin have a sanitarian funded by the Local Environmental Protection Program (LEPP). All conservation districts in the basin have adopted nonpoint source pollution management plans. Buffer coordinators have also been employed in three counties in the basin to facilitate enrollment of stream buffers in the continuous Conservation Reserve Program (CRP) and State Water Quality Buffer Initiative.

The federal Clean Water Act requires states to conduct Total Maximum Daily Load (TMDL) studies and develop TMDLs for water bodies identified on the state's List of Impaired Waters (Section 303(d) List). TMDLs are quantitative objectives and strategies needed to achieve the state's surface water quality standards. There are 21 approved TMDLs within the Solomon Basin. Dissolved oxygen on Limestone Creek is a high priority for implementation. There are three lakes in the basin listed as water quality impaired. Streams are sampled at 15 locations within the basin with dissolved oxygen, total suspended solids (TSS), and total phosphorous (TP) identified as the cause of the greatest number of impairments. Other pollutants limiting use of Solomon basin streams include arsenic, biological stressors, copper, E. coli bacteria and sulfate. TMDL development for bacteria total suspended solids and total phosphorous are anticipated in 2009.

Kansas Watershed Restoration and Protection Strategy (WRAPS) is a planning and management framework that engages stakeholders within a watershed in a process to:

- Identify watershed restoration and protection needs.
- Establish watershed management goals.
- Create a cost-effective action plan to achieve goals.
- Implement the action plan.

As of March 2008, there were 44 active WRAPS projects located throughout Kansas. One project is in the Solomon basin and includes the watersheds above Glen Elder Dam/Waconda Lake.

Applicable *Kansas Water Plan* Objectives

- Reduce the average concentration of bacteria, biochemical oxygen demand, solids, metals, nutrients, pesticides and sediment that adversely affect the water quality of Kansas lakes and streams.
- Ensure that water quality conditions are maintained at a level equal to or better than year 2000 conditions.
- Reduce the average concentration of dissolved solids, metals, nitrates, pesticides and volatile organic chemicals that adversely affect the water quality of Kansas ground water.
- Maintain, enhance, or restore priority wetlands and riparian areas.
- Nutrient reduction goals will be included in all WRAPS projects within the basin.
- All public water suppliers will complete and implement a source water protection plan.

Applicable Programs

The following programs help to meet the objectives in the Water Quality category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Department of Health and Environment: State Water Plan Program (Contamination Remediation)
- Kansas Corporation Commission: Conservation Division Programs

- Kansas Department of Health and Environment: Local Environmental Protection Program
- Kansas Department of Health and Environment: Watershed Management Program/WRAPS
- Kansas Department of Health and Environment: Watershed Planning Section/TMDL Program
- State Conservation Commission: Nonpoint Source Pollution Control Program
- State Conservation Commission: Water Resources Cost-Share Program

ISSUE: WETLAND & RIPARIAN MANAGEMENT

The primary approach to wetland and riparian management in the basin focuses on providing technical and financial assistance to landowners to protect and restore these resources in priority watersheds through the implementation of best management practices.

Riparian lands in the Solomon basin have been impacted by infestation of non-native phreatophytes, although not to the degree as in other western basins. Of greatest concern are the effects tamarisk (salt cedar) and Russian olive on native riparian ecosystems. A biological control project releasing leaf eating beetles occurred in the basin in 2005 and 2006. It was determined that the timing of the release limited success.

Applicable *Kansas Water Plan* Objectives

- Maintain, enhance or restore priority wetlands and riparian areas.

Applicable Programs

The following programs help to meet the objectives in the Wetland and Riparian Management category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Forest Service: Forest Stewardship Program and Conservation Tree Planting Program
- State Conservation Commission: Riparian and Wetland Protection Program
- Kansas Water Office: State Water Planning Program
- Kansas Department of Wildlife and Parks: State Parks and Wildlife Areas Planning and Development Program
- Kansas Department of Wildlife and Parks: Wildlife Habitat Improvement Program

ISSUE: FLOOD MANAGEMENT

Flooding is a natural, recurring event associated with streams and rivers that has resulted in the formation of natural floodplains over time. While this inundation provided benefits under natural conditions, encroachment of urban and agricultural development onto floodplains has resulted in the potential for flood damage. In addition, the Solomon basin is prone to flash flooding which is characterized by a rapid rise in water level, fast-moving water and much flood debris.

Kansas Water Plan flood management guidance has targeted watershed dam construction assistance to priority watersheds, encouraged National Flood insurance participation and updating floodplain maps for priority communities.

Significant flooding was experienced during 1903, 1908, 1915, 1919, 1935, 1941 and 1973 on the Solomon River. Three federal projects; Kirwin, Glen Elder and Webster dams contribute to flood control in the basin. There is one organized watershed district in the basin. Two watershed dam projects are complete in the basin. Financial assistance from the State Water Plan Fund has been provided for flood mapping as part of the 1993 Kansas Department of Agriculture-Division of Water Resources, Kansas Flood Mapping Initiative in Ottawa County in the basin.

Applicable *Kansas Water Plan* Objectives

- Reduce the vulnerability to damage from floods within identified priority communities or areas.

Applicable Programs

The following programs help to meet the objectives in the Flood Management category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Department of Agriculture-Division of Water Resources: Water Structures Program/Floodplain Management
- Kansas Department of Agriculture-Division of Water Resources: Water Structures Program/Dam Safety
- Kansas Division of Emergency Management: Hazard Mitigation Grants Program
- State Conservation Commission: Watershed Dam
- Construction Program
- State Conservation Commission: Watershed Planning Assistance Program
- FEMA: National Flood Insurance Program

ISSUE: WATER-BASED RECREATION

The Solomon basin has a wide variety of public water recreation sites on state and federal land. There is a demand for more consistent water levels to provide access to water-based recreation facilities for area residents and recreational income by attracting sportsmen and women to the area.

The federal dam projects include Kirwin Reservoir, Waconda Lake and Webster Reservoir and associated recreation and wildlife areas that draw hunters, fishermen and boaters to the area. Public hunting areas include Kirwin National Wildlife Refuge, Webster Wildlife Area and Glen Elder Wildlife Area. The state also offers fishing at Jewell, Ottawa, Rooks, and Sheridan state fishing lakes. In addition, Antelope Lake-Graham County and Logan City Lake are community lakes supported by Kansas Department of Wildlife and Parks Community Lakes Assistance Program.

Maintaining a minimum water level in Webster Reservoir is a basin priority issue. Additional information on this issue may be found in the Solomon Basin Webster Water Level priority issue section.

Applicable *Kansas Water Plan* Objectives

- Increase public recreational opportunities at Kansas lakes and streams.

Applicable Programs

The following programs help to meet the objectives in the Water-Based Recreation category. For more information on the programs and associated policies, see the Programs Manual.

- Kansas Department of Wildlife and Parks: Rivers and Stream Access
- Kansas Department of Wildlife and Parks: State Parks

ISSUES FOR FUTURE ACTION

Irrigation Districts needs if any.

Solomon Basin High Priority Issue
Ogallala-High Plains Aquifer Declines
January 2009

Issue

Long-term management of the Ogallala-High Plains and alluvial aquifers to extend and conserve the life of the aquifer, while meeting area needs.

Vision

Sufficient water resources in western Kansas to support healthy, economically strong communities and rural lifestyles, today and for future generations.

Goal

Extend and conserve the life of the Ogallala–High Plains aquifer.

Description

The Ogallala portion of the High Plains aquifer (Ogallala-High Plains aquifer) underlies western portions of the Solomon River basin. Within the basin, the Ogallala underlies Thomas, Sheridan and Graham counties, along with parts of Norton, Phillips and Rooks counties, and southern Smith County. Thomas and Sheridan counties and part of Graham County are in Northwest Kansas Groundwater Management District No. 4 (GMD4). The aquifer fringe outside GMD4 is managed by Kansas Department of Agriculture-Division of Water Resources (DWR).

Ground water supplies significant appropriations (95% in 2006) of municipal, irrigation, industrial and domestic water in the basin from the alluvial and Ogallala-High Plains aquifers. The Ogallala-High Plains aquifer has been developed so extensively that the amount of water withdrawn annually is significantly more than the recharge, resulting in ground water declines. Some areas are already experiencing shortages in meeting demand. As ground water levels decline, the aquifer loses hydraulic connection with the overlying alluvial aquifers and rivers and no longer contributes much, if any, base stream flow. Since the 1950s (predevelopment), Ogallala water levels have declined as much as 45 percent in Thomas, Sheridan and Graham Counties. Water levels have been reduced up to 50 feet in the majority of those portions of Thomas and Sheridan counties located in the basin.

More recently, water levels have declined up to 30 feet over the ten-year period from 1996-2006. The greatest decline is centered south of Hoxie in Sheridan County. Generally, Thomas and Sheridan county areas in the basin have declined by 5-20 feet in the ten-year period. The overall decline has contributed to a progressive reduction in flow during the past several decades in the upper North Fork and upper South Fork of the Solomon River.[(1)]

Water users in parts of Thomas, Sheridan and Graham counties are already experiencing shortages in meeting demand. To extend and conserve the life of the Ogallala–High Plains aquifer, GMD4 and DWR are defining priority areas to reduce aquifer declines. Federal and State voluntary incentive programs to reduce water use have been developed and targeted to priority areas.

A 2006 Kansas Water Office (KWO) analysis of water level data from 1981-2005 indicated that the aquifer decline rate had not been reduced by a statistically significant amount between two time periods: pre-1993, and 1993-2005.[(4)]

Ground Water Appropriations

Total appropriations in the basin from the Ogallala-High Plains aquifer and overlying alluvium are

approximately 249,860 acre feet for all beneficial uses in the Solomon basin. This represents 1,100 active water rights from 1,211 wells.[6]

The majority of the producing wells in the Ogallala-High Plains aquifer and associated alluvium, about 1,044 wells, are within the GMD4. These appropriations total 243,827 acre feet, or nearly 98% of the Ogallala appropriations in the basin.

Water Use

The 2006 reported ground water use from the Ogallala-High Plains aquifer area was 132,778 acre feet. Reported water use for 2006 within GMD4 was 129,635 acre feet from 1,010 wells. Irrigation use is 98% of the Ogallala-High Plains reported use in the basin.[7]

Annual irrigation water use reported and quantified by township for 2002-2006 is provided in Table 1 below, based on data analysis by DWR.[6] (Note some townships have water use in more than one area, such as a GMD and the fringe, therefore the sum of the number of townships analyzed for each area is not the same as those included in "ALL" in the table.) The majority of a township may be in another basin or have no access to the Ogallala–High Plains aquifer.

There has been widespread adoption of more efficient irrigation systems in the Kansas High Plains, shifting from flood and center pivot irrigation to center pivot with drop nozzles.[8] A study by Kansas State University in 2006 found that the number of acres irrigated is a more important determinant of changes in water use than the adoption of more efficient irrigation systems.[2] The authors concluded that if the irrigated acres are held steady after conversion to a more efficient irrigation system, net water use would, on average, change little; it is with a decrease in irrigated acres that a reduction in water use is assured.

Aquifer Declines

Average water levels in the aquifer within the groundwater management districts have continued to decline over the past ten years.

The overall average water table (top of ground water) decline in the High Plains region over the 2005 calendar year was 0.57 feet, which was somewhat more than the average decline during 2004 (0.15 feet) but less than the average annual decline rate over the five years since the 2001 measurements (approximately 0.98 feet/year).

Figure 2 is an estimated projection of the years until the High Plains aquifer reaches a point where wells will only be able to produce 400 gallons per minute (gpm) if ground water level trends from 1996 to 2006 repeat continuously and unchanged into the future.[10] This methodology is best suited to the Ogallala portion of the Ogallala-High Plains aquifer because of the relatively extensive data sets for the Ogallala. The variability of the system is the biggest drawback.

Activities and Progress

Various programs and activities have been initiated to reduce the decline rate of the Ogallala-High Plains aquifer and to extend and conserve the aquifer. Tools such as ground water and surface water models and more detailed aquifer characterization have been developed. In the Solomon basin, the determination of Ogallala subunit priority areas, setting subunit goals and developing management plans to reach these goals has been the responsibility of GMD4 along with DWR for areas outside the district.

Good data is essential to the determination of decline rates. Data development includes calibration of the ground water model or models to better understand the aquifer and subunits. Water flowmeters, now required on almost all wells, provide improved information on withdrawals. All wells in GMD4 should be metered by December 31, 2009. Annual water level measurements from "index" wells as well as weather station data to quantify precipitation provide information contributing to more accurate models.

GMD4 has identified six high priority subunits within their area, portions of which are in the Solomon basin. The GMD4 board is in the process of establishing preliminary water use goals and enhanced management actions for the high priority aquifer sub-units.[5]

The state and GMD4 have modeled management scenarios for six high priority subunits shown in Figure 4. Based on hydrologic conditions, corresponding economic estimates were produced for the cropping changes anticipated to occur as ground water levels change, based on historical farm decision triggers determined by K-State. The study considered a variety of water conservation policies aimed at achieving a 30% reduction in current ground water consumption levels. The economic effects of various water conservation policies on producer gross profits and regional economy were estimated.[3]

Voluntary programs have been targeted to areas determined by GMD4 within district boundaries and by DWR in the fringe areas. Federal Ground and Surface Water Programs of the Environmental Quality Incentive Program (EQIP) were focused for two years on these areas with projects selected annually. GMD4 utilized all resources allocated for their areas for incentive payments of $100 per acre annually for three years on eligible acres that convert irrigated land to non-irrigated land.

State programs have offered incentives to retire water rights in some areas, however that opportunity has not been provided to the Solomon basin through 2008. GMD4 high priority subunits may be eligible in the future. Regulatory programs have included special assistance by DWR to irrigators that have pumped in excess of their water rights and the area average.

Progress toward reducing the aquifer decline rate was evaluated by the Kansas Water Office in 2006 using water level data from 1981 to 2005. The median annual water level changes were calculated for each region and standardized or indexed to antecedent moisture conditions using the Palmer Drought Severity Index (PDSI) for the appropriate region. The comparison of pre-1993 and 1993-2005 periods concluded that there was no discernable change in the rate of water level declines in the Ogallala–High Plains region. It also concluded that in the northwest Ogallala aquifer area (GMD4 and DWR fringe areas), as of 2005, there has been no statistically significant change (at a five percent error level) in the rate of decline.[4]

It should be noted that the percentage of total water use that has been reduced through voluntary and regulatory programs is small. A reduction of decline rates will likely take many years or decades to be recognizable unless participation and reductions are greater.

Priority Aquifer Subunits: Priority aquifer subunit maps are used to guide state and federal efforts on water conservation. The priority aquifer subunit areas are being further defined by the groundwater management districts inside each district, and the Division of Water Resources for areas of the Ogallala-High Plains aquifer outside of the district, with input from the public. Currently, Figure 5 illustrates priorities. This will be used until new priority aquifer subunit maps are defined and approved. Specific target areas are defined for areas eligible for enrollment in EQIP quick response areas and the Water Transition Assistance Program (WTAP).

The priority rank shown on this map outside GMD4 is based on an area's total score from two databases: estimated usable lifetime and density of ground water use. Useable lifetime is defined as the ability to support a 400 gpm well yield, on every quarter section, pumping for 90 days. Rank 1 indicates areas with a short estimated usable lifetime and a history of higher ground water usage. Rank 4, the lowest concern areas, have a relatively long useable lifetime and low total water use.

Recommended Actions

1. DWR should identify priority subunits. In their areas of responsibility, GMD4 and DWR should identify priority aquifer subunits or areas and develop specific goals and management strategies to extend and conserve the life of the aquifer.

2. GMD4 and DWR should manage aquifer subunits to maintain economic health while ensuring sufficient water resources for future generations of western Kansas communities and rural populations and chosen lifestyles.

3. Provide opportunities to permanently or temporarily reduce water use through voluntary programs (state, federal, and local).

4. Educate water users, decision makers and the general public on the condition of the aquifer and methods and opportunities to reduce water use.

5. Support research for high value, low water use crops.

6. Seek crop insurance option for limited irrigation crops from USDA Risk Management Agency.

In order to implement the actions stated above, the following specific activities are recommended:

- Provide technical support, including hydrologic modeling, if appropriate, to project current and future aquifer conditions. Identify and implement activities to promote local conservation to extend the life of the aquifer that accrues to the aquifer subunit or region where water savings has occurred.
- Recognize the benefit of aquifer subunit planning. Management of the aquifer by subunit can benefit the local community's economic well-being and social connectedness, reduce over pumping and well shut offs from impairments.
    - Encourage ownership in one's aquifer subunit; promote local leadership.
    - Form subunit teams for local leadership of aquifer subunits or other methods of managing local areas/subunits for reduced consumptive water use.
    - Target incentive based programs to aquifer subunits that have a long-term vision and plan.
    - Implement aquifer subunit plans that assure water into the future to help attract industry, thus contributing to the economic health of the subunit and area.
- Consider the long term impact of climatic change on the water demands for the region.
- Consider interstate discussions on water conservation and planning where aquifer subunits cross state boundaries, and are not directly impacting an existing surface water compact.

Resources

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Solomon Basin High Priority Issue
Subbasin Water Management
January 2009

Issue

Solomon River water resources management by subbasins to stabilize hydrologic systems and improve reliability of water availability to water users.

Description

The Solomon River drains an area of 6,835 square miles including all or parts of Decatur, Norton, Phillips, Smith, Jewel, Sherman, Thomas, Sheridan, Graham, Rooks, Osborne, Mitchell, Cloud, Lincoln, Dickinson and Saline counties. The basin includes subbasins with hydrologic unit codes 10260011-upper North Fork Solomon River, 10260012-lower North Fork Solomon River, 10260013-upper South Fork Solomon River, 10260014-lower South Fork Solomon River and 10260015-mainstem Solomon River (Figure 1).

The present allocations and operation of water resources and the associated problems varies by watershed within the Solomon basin. Three U.S. Bureau of Reclamation dam/reservoir projects regulate streamflow in the Solomon basin. These are; Kirwin along the North Fork Solomon, Webster along the South Fork Solomon, and Glen Elder/Waconda at the confluence of North and South Forks of the Solomon River. Streamflow is dependent on runoff and climatic factors that cannot be regulated and vary widely year to year.

Ground water depletion due to pumping occurs in the Solomon River basin in the Ogallala-High Plains and the alluvial aquifers. Low stream flows have occurred in recent years as well. Stream flow has a direct effect on ground water recharge, especially in the alluvial aquifer.

The Ogallala-High Plains aquifer occurs in the western third of the basin. The alluvial/stream systems interact with the Ogallala-High Plains in the upper North and South Forks of the Solomon River. Alluvial ground water supplies depend on recharge from runoff and stream flow from water released from the reservoir storage.

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 reservoirs. These reservoirs are Kirwin, Webster and Waconda respectively. When water is available from storage in the lakes, the irrigation districts are authorized to irrigate up to 25,394 acres. Water storage in the reservoirs has often been well below levels needed to meet water allocations in recent years.

Water appropriations by sub-basin are shown in Table 1. Almost 425,000 acres are authorized for irrigation in the Solomon basin from surface and ground water sources.(1)

The major water use in the basin is irrigation. Ground water is the source for the upper North and South Forks and the lower North Fork, while surface water is the main source for the lower South Fork and the Solomon River subbasins.

Upper Solomon subbasins (above Kirwin and Webster reservoirs) annual water use average ranged from 66,461 acre-feet in 1993 to 246,868 acre-feet in 1998. The average water use for the subbasins from 1987-2006 was 147,004 acre-feet.(2)

The average annual water use in the lower Solomon subbasins (Kirwin and Webster reservoirs to the confluence of the North and South Forks) ranged from 5,384 acre-feet in 1993 to 30,821 acre-feet in 2000. Average water use for the subbasins from 1987-2006 was 19,911 acre-feet.(3)

Mainstem Solomon subbasin (below Glen Elder) annual water use ranged from 2,990 acre-feet in 1993 to 30,326 acre feet in 2002. Average water use for the subbasin from 1987-2006 was 14,503 acre feet.(4)

In the upper North and South Fork Solomon, streamflow observations at U.S. Geological Survey (USGS) gages at Glade (North Fork), Bow Creek at Stockton and above Webster Reservoir on the upper South Fork have been in operation since at least 1952. The average streamflow for their periods of record were 25 cubic feet per second (cfs), 12 cfs and 49 cfs respectively. During the 1990s flow was higher, averaging 38 cfs, 17 cfs and 55 cfs. Reduced flows averaging 7 cfs, 6 cfs and 13 cfs have occurred in the 2000s.

On the lower North and South Fork of the Solomon, streamflow observations at USGS gages at Portis and Osborne indicate average flows have declined from the 1990s flows of 175 cfs and 168 cfs, respectively. Declines in flows since records began in the 1940s, averaging 115 cfs and 105 cfs, respectively, are also documented. Averages for the 2000s, so far, are 33 cfs and 20 cfs. Ground water in these subbasins displays seasonal fluctuations which are affected by the operations of surface water delivery systems through the Kirwin and Webster irrigation districts. Overall ground water levels were down throughout the subbasin in 2007.

In the mainstem Solomon subbasin, streamflow observations at USGS gages located below Glen Elder Reservoir, downstream from Niles and on Salt Creek at Ada, indicate average flows over their periods of record were 219 cfs, 539 cfs and 64 cfs, respectively. (The period of record varies for each gage, but includes at least 1965 through present.) During the 1990s streamflow levels were higher averaging 468 cfs below Glen Elder, 883 cfs at Niles and 108 cfs on Salt Creek. Reduced flows occurred in the 2000s averaging 58 cfs, 154 cfs and 23 cfs respectively.

The Niles gage has minimum desirable streamflow (MDS) set in 1984. Most of the time MDS criteria is met at Niles, although in 2002 MDS was not met.

Ground water measurements indicate an average decline of 0.78 feet from 2006 to 2008. The five-year rolling average shows a cyclical pattern with a declining trend since 1998.

Recommended Actions

1. Complete the refinement of water balance of subbasins within the Solomon basin.

2. Continue modeling of upper North and South Fork with scenarios of possible future water use patterns.

3. Develop management operations to improve reliability of water available to water right holders.

4. Work with federal agencies to make appropriate reservoir storage and operation changes to meet sustainable yield management and other goals of *Kansas Water Plan*.

Resources

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Solomon Basin High Priority Issue
Minimum Water Levels in Webster Reservoir
January 2009

Issue

Increase water levels in Webster Reservoir for improved recreational opportunities.

Description

Webster Dam and Reservoir are located on the South Fork Solomon River in Rooks County approximately eight miles west of Stockton. It is a modified, homogenous, earth-filled embankment with a structural height of 154 feet above the streambed and a crest length of 10,720 feet. Top of the conservation pool is elevation 1,892.45 feet above mean sea level. The dam, which impounds Webster Reservoir, was completed in June 1956.

Webster Reservoir was built by the U.S. Bureau of Reclamation (Bureau) for irrigation, flood control, recreation and fish and wildlife purposes. The Webster Reservoir has afforded recreation as a byproduct of storage space in the lake for other purposes. The State of Kansas may have the opportunity to acquire storage for recreation. The space has become available as a result of a decision by the Webster Irrigation District No. 4 to negotiate the possible sale or lease of a portion of its storage in the reservoir. The Kansas Water Appropriation Act limits the consumptive use of the hydrologic system to the historic amounts. Any changes to the water rights and use of the reservoir would require that the consumptive use of the system be at or below present levels. Capacity of Webster Reservoir is 400,422 acre feet for dead, inactive, conservation and flood control storage. The conservation storage capacity is 76,157 acre feet.

When the reservoir is at the top of the conservation pool, water backs upstream approximately five miles from the dam. At this level, the reservoir has a shoreline length of approximately 45 miles with a water surface area of 3,739 acres. The total controlled storage of Webster Reservoir is 259,510 acre feet. The lake capacity includes 1,256 acre feet of dead storage, 6,096 acre feet of inactive storage, 71,926 acre feet of active storage, and 183,353 acre feet for flood control.

The Bureau is required by the Reclamation Act of 1956 to provide irrigation districts holding long-term water service contracts the first right to a stated share of the available water supply. The available water supply to the Webster Irrigation District No.4 is the natural flows of the South Fork of the Solomon River and the storage waters available for release above the established reservoir shutoff elevation.

The normal irrigation season for Webster Irrigation District No.4 is from May 1 to September 30. Irrigation water can be released any time during this period. The District has a water right to store water in Webster Reservoir. The District also has a storage use right in Webster Reservoir and a natural flow water right for irrigation from the South Fork Solomon River of 158 cfs (23,607 acre feet per year). There are 8,537 irrigable acres within the District. Water is initially released into the South Fork Solomon River and diverted into the Osborne Canal approximately 19 miles downstream at Woodston Diversion Dam 1.5 miles west of Woodston (Figure 1). Bypasses are made at the request of the state for senior water rights.

The diversion control system includes one 8-foot by 18-foot radial sluiceway gate and one 84-inch by 78-inch canal outlet gate to the Osborne Canal. Fifty-four acres of the Woodston Diversion Dam land area is operated and maintained by the Webster Irrigation District No. 4. The Kansas Department of Wildlife and Parks (KDWP) under a lease with the Bureau, is responsible for wildlife management on the remaining 210 acres of land surrounding the diversion dam. KDWP also manages 54 acres reserved for operation and maintenance purposes.[(2)]

The *Solomon River Basin Resource Management Assessment and Environmental Assessment/Finding of No Significant Impact* was completed in May 2002 to analyze the conversion of the Webster Irrigation District No. 4's long-term water service contract to a repayment contract. Specifically, the alternative contract provides for

minimum pool elevations at Webster Reservoir, which results in secondary benefits to fisheries and recreation by providing carryover irrigation storage. In addition, the alternative provides for an increased delivery efficiency of nine percent for Webster Irrigation District No. 4 and to increase collective on-farm irrigation efficiency by five percent. [1]

The preferred alternative identified in the assessment provides for the inclusion of specific environmental measures in the District's operating plans. Those related to water level include:

- Continue irrigation with specified water conservation goals and practices to be outlined in the Irrigation District's Water Conservation Plan. There is a minimum pool elevation at Webster Reservoir of 1,863.0 feet above mean sea level (msl) (7,352 acre feet). The annual shutoff elevation for Webster Reservoir would be established according to the Webster Irrigation District Operating Plan.

- Establish policies to maintain reservoir levels.

The effect of ground water depletion on base streamflow and farm conservation practices have greatly reduced inflow to the Reservoir. Since the mid 1950s, the surface water supply in the river basin has decreased significantly. The 10-year moving average inflow to Webster Reservoir has decreased from 81,800 acre feet in 1955, to 44,200 acre feet in 1970, to 12,700 acre feet in 1985, to 11,700 acre feet in 1992. This decrease in reservoir inflow has drastically changed District operations. The reduced inflow has created lower pool levels. Greater water surface fluctuation at these lower pool levels (Figure 2).

The Webster Irrigation District No. 4 is in negotiation with the state to establish a cooperative partnership between the two parties to achieve a minimum conservation pool in the lake. This pool would provide suitable habitat for fisheries production, safe access to the lake by anglers and boaters, and habitat for water fowl and other wildlife more consistently.

Discussions include the possible state purchase or lease of the water rights/storage or maintenance of minimum water levels. Although recreation is an authorized use, no storage space in the lake has been dedicated to that purpose.

Recreation at Webster Reservoir includes on-lake boating and fishing as well as activities on federal land and Webster State Park. The state park offers five boat ramp lanes and three courtesy docks that provide boaters ample launching facilities at conservation level.

Raising the water level in the lake is considered to aid fisheries management at Webster Reservoir. Rising or stable water levels during the spring promote reproduction, survival and growth of various fish species by providing quality spawning habitat and nursery cover and enhancing primary productivity.

In a study conducted by the KDWP for the U.S. Bureau of Reclamation [3], the total estimated economic value of the Webster fishery (stilling basin included) was $11,129,238 during the 20-month period of evaluation. Past visitation records at Webster State Park show that the higher the water level, the higher the visitation. Activities enhanced by the higher, more stable lake levels are fishing, boating, skiing, swimming, and camping. These activities increase park customer satisfaction, which increases visitation and optimizes the economic benefits associated with the state park and the local economy.

The boat ramps within the state park and the wildlife area are usable when water levels are maintained at a higher level. As water levels decline to five feet below conservation level, the ramp on the Wildlife Area becomes unusable and ramp access to the water becomes more difficult and often unusable.

Recommended Actions

1. Establish a cooperative partnership between the Webster Irrigation District No. 4 and the State of Kansas to achieve the highest possible conservation pool water level in the Webster Reservoir.

2. Consider/negotiate water right acquisition in Webster Reservoir.

3. Obtain rights to water by (in order of preference):
   a. Purchase of Webster Irrigation District's water rights and convert storage in Webster Reservoir for fish, wildlife, and recreation purposes;
   b. Negotiation of a long-term lease; or
   c. Negotiation of a partial purchase of Webster Irrigation District water rights and conversion to fish, wildlife and recreation storage.

Note: Purchase of water rights and associated storage is preferred.

4. Maintain consumptive use of the stream/aquifer/ reservoir system at or below present historical levels.

Resources

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