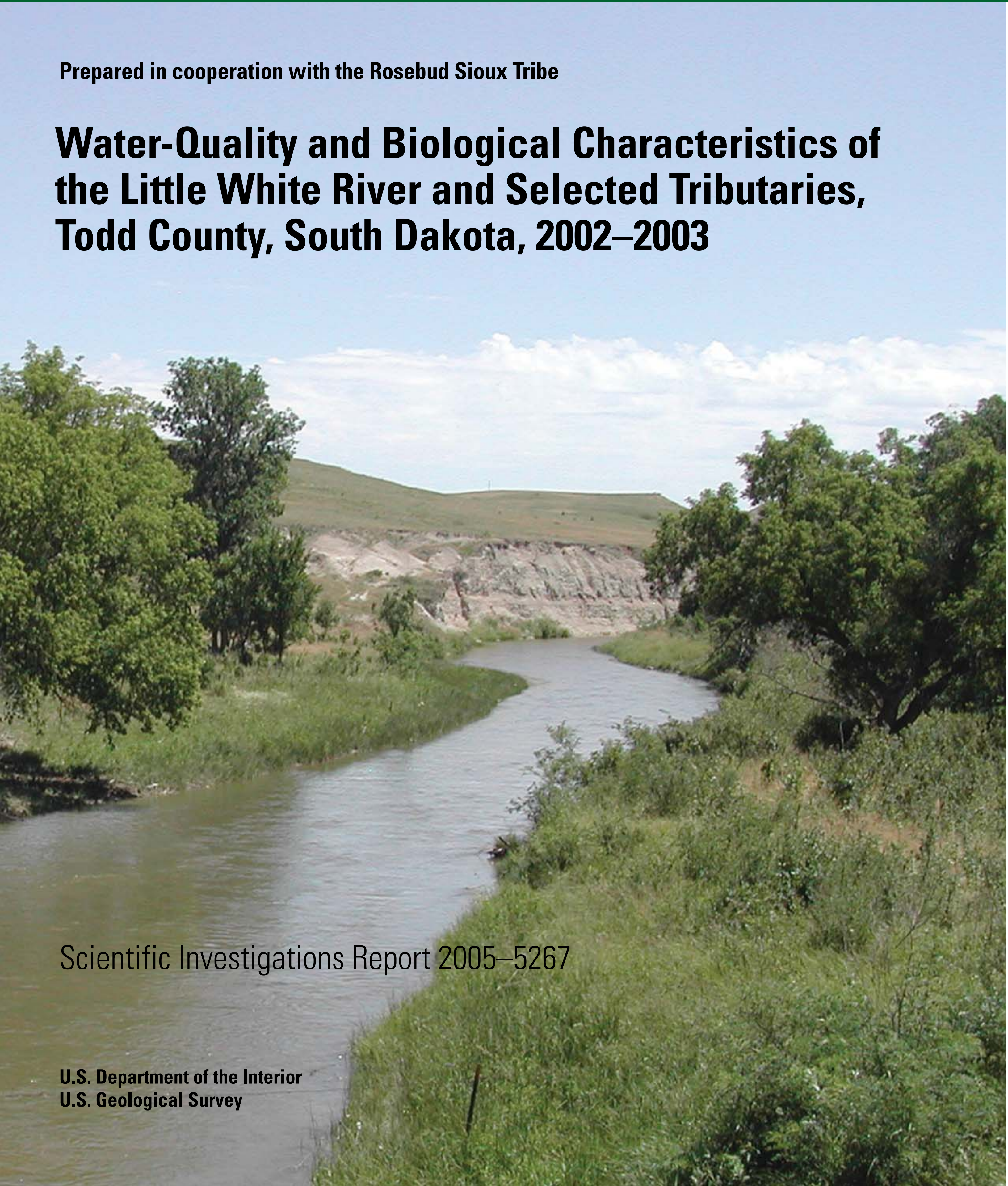
Prepared in cooperation with the Rosebud Sioux Tribe

Water-Quality and Biological Characteristics of the Little White River and Selected Tributaries, Todd County, South Dakota, 2002–2003



Scientific Investigations Report 2005–5267

U.S. Department of the Interior
U.S. Geological Survey

Front cover photograph shows the Little White River near the Todd/Mellette County line.

Water-Quality and Biological Characteristics of the Little White River and Selected Tributaries, Todd County, South Dakota, 2002–2003

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U.S. Department of the Interior
Gale A. Norton, Secretary

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Conversion Factors and Datum

Multiply	By	To obtain
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter
foot per mile (ft/mi)	0.1894	meter per kilometer
inch (in.)	2.54	centimeter
inch (in.)	25.4	millimeter
mile (mi)	1.609	kilometer
square mile (mi^2)	259.0	hectare
square mile (mi^2)	2.590	square kilometer
ton per day (ton/d)	0.9072	metric ton per day
ton per day (ton/d)	0.9072	megagram per day

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

°F = (1.8 x °C) + 32

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

°C = (°F - 32) / 1.8

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).

Horizontal coordinate information is referenced to the North American Datum of 1927 (NAVD 27).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

Water-Quality and Biological Characteristics of the Little White River and Selected Tributaries, Todd County, South Dakota, 2002–2003

By Joyce E. Williamson

Abstract

The Little White River originates in Shannon County in southwestern South Dakota and flows through Bennett County before entering Todd County. The Little White River drains approximately one-half of Todd County before entering Mellette County where it flows into the White River. The portion of the Little White River downstream from Rosebud Creek is listed as impaired in the 2004 South Dakota Integrated Report for Surface Water Quality Assessment for suspended solids.

This report presents the results of water-quality and biological sampling during 2002 and 2003 as well as analysis of streamflow and suspended-sediment data. Water-quality concentrations collected during 2002 correspond closely with historical values, indicating that the water quality within the Little White River has not changed substantially over time. Fecal coliform concentrations tend to be high during and immediately after storm runoff events, especially for some tributaries to the Little White River including Sawmill Canyon, South Fork Ironwood Creek, and Soldier Creek.

The Rosebud Sioux Tribe currently does not have approved beneficial uses and water-quality standards; however, the suspended-sediment concentrations in the Little White River within Todd County were greater than the current (2005) South Dakota standard for total suspended solids during most of the sampling period. Suspended-sediment concentrations increased from the sampling site at the Bennett/Todd County line, Little White River near Vetal, to the sampling site just upstream from Rosebud Creek, Little White River above Rosebud. Downstream from the Little White River above Rosebud, concentrations tended to be similar. Suspended-sediment concentrations exceed the current South Dakota standard for total suspended solids approximately 45 percent of the time near the Bennett/Todd County line to 82 percent of the time at the Todd/Mellette County line. This change in sediment concentrations corresponds with changes in the natural geology of the area as the stream flows through windblown sand deposits and outcrops of the Ogallala Formation.

Benthic macroinvertebrate sampling results were used to calculate a variety of metrics used as indicators of stream health. Metric results generally followed a pattern indicating decreases in stream health from the site near Vetal to the site above Rosebud and then increased stream health downstream near the Todd/Mellette County line.

Introduction

In 1972, Congress passed the Federal Water Pollution Control Act, which was amended as the Clean Water Act in 1977 (Public Law 92-500). Section 303(d) of the Clean Water Act mandates the development of total maximum daily loads (TMDLs) for all streams in the Nation. The portion of the Little White River downstream from Rosebud Creek to the mouth in Mellette County is listed as impaired in the 2004 South Dakota Integrated Report for Surface Water Quality Assessment (South Dakota Department of Environment and Natural Resources, 2004) for suspended solids. To address this concern, the U.S. Geological Survey (USGS) conducted an assessment in cooperation with the Rosebud Sioux Tribe (RST) during 2002–2003 of the water-quality and biological characteristics of the Little White River and selected tributaries in Todd County. The investigation was conceptualized by the RST and was needed to provide detailed information and to expand on existing Tribal data for surface-water quality of the Little White River Basin in Todd County. The RST currently does not have approved water-quality standards for the Little White River, but the hydrologic, water-quality, and biological data collected as part of this study will assist the RST in developing water-quality standards for the Little White River in Todd County. This information also is needed for assessment of the water quality of the Little White River upstream and downstream from Todd County by local, State, and Tribal officials. Other stakeholders involved in the assessment of the Little White River include the Bureau of Reclamation, the National Resource Conservation Service (NRCS), the Todd County Conservation District, and the South Dakota Department of Environment and Natural Resources (DENR).

The primary constituents of concern in this study were suspended sediment and fecal coliform bacteria. Samples were analyzed for additional water-quality constituents to determine current conditions and for comparison with historical sampling. Macroinvertebrate data were collected at three sites along the Little White River within Todd County.

Purpose and Scope

The purpose of this report is to describe the water-quality and biological characteristics of the Little White River and selected tributaries in Todd County. Data collected during this study (2002–2003) as well as historical streamflow (1957–2001) and water-quality (1973–2001) data were used for comparisons and analysis. Data presented in this report include water-quality results for physical properties, major ions, nutrients, trace elements, suspended sediment, bacteria, and pesticides and biological results for macroinvertebrates. Streamflow characteristics for the Little White River and selected tributaries also are described. Suspended-sediment transport is analyzed using duration analysis and simulation of sediment load using a one-dimensional flow and sediment transport model.

Description of the Study Area

The study area is the Little White River Basin within Todd County (fig. 1). The Little White River Basin is approximately 1,580 mi^2, of which approximately 560 mi^2 are within Todd County, and is the largest tributary to the White River. The Little White River originates in Shannon County in southwestern South Dakota and flows through Bennett County before entering Todd County. The river flows northeasterly across western Todd County and south-central Mellette County to the White River.

Physiography, Land Use, and Climate

The northern portion of the study area is in the Southern Plateaus physiographic province, and the southern portion of the study area is in the Sand Hills physiographic province (fig. 1). Land use within Todd County is predominately grasslands with some pasture, hay, and row crops (fig. 2). Cropland occurs primarily in areas with low topographic relief and includes both dry-land farming and irrigated areas. Most irrigation utilizes center-pivot systems that obtain water from high-production wells completed in the Ogallala aquifer and predominately occur in the southern part of the Little White River Basin. The most extensively irrigated areas are within the Rosebud Creek and Soldier Creek Basins, which are tributaries to the Little White River (fig. 2).

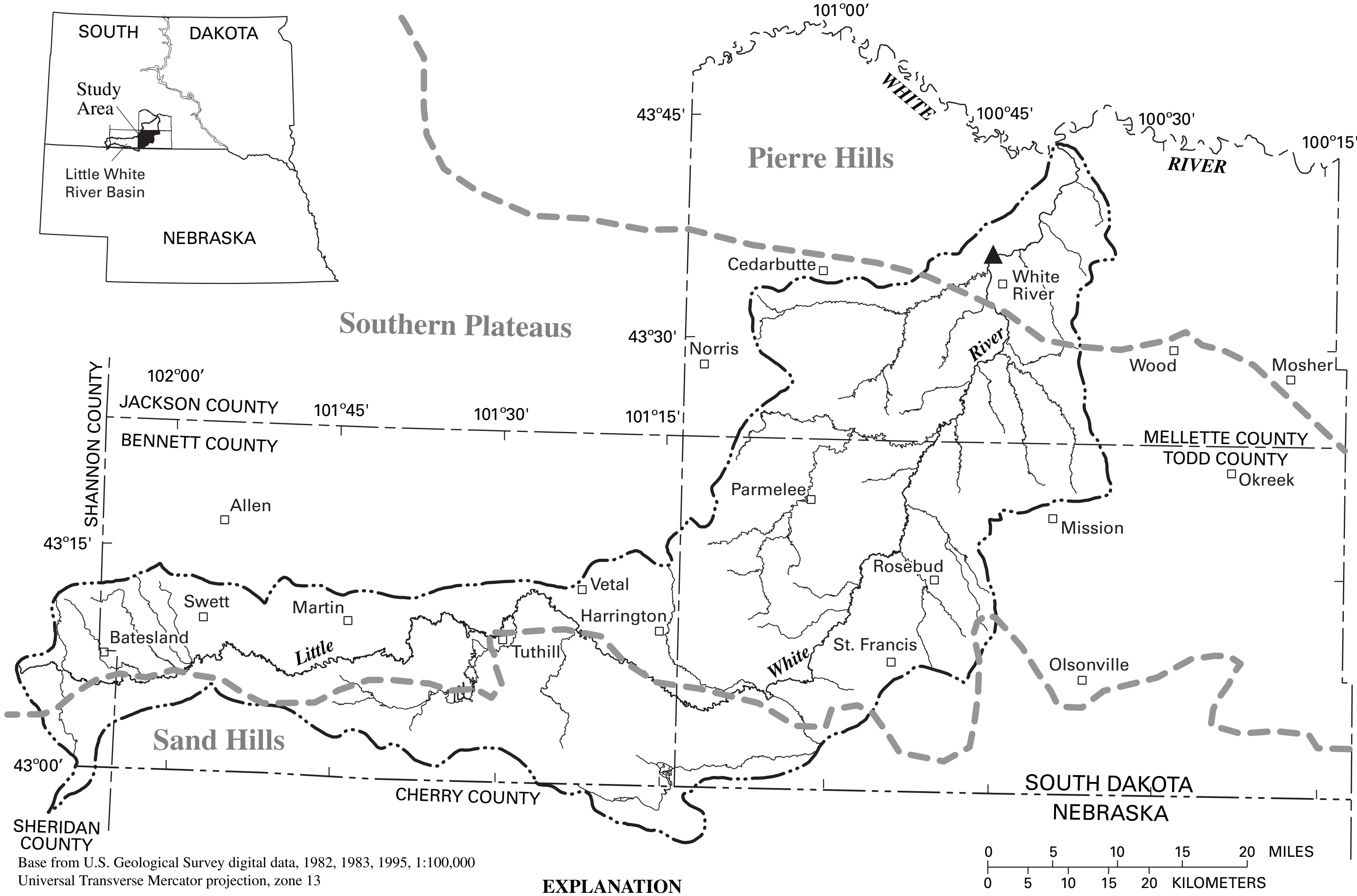
The normal annual precipitation (1971 to 2000) for Todd County is 18 to 21 in. (South Dakota State University, 2004). The majority of the precipitation falls between April and October; however, annual and seasonal precipitation vary with climatic conditions. Monthly mean temperatures range from 3.5 to 80°F (South Dakota State University, 2004).

Hydrogeology

The southernmost extent of the Little White River Basin is within Quaternary-age deposits of windblown sand (eolian deposits) and alluvium that extend into southwestern Todd County (fig. 3) and Nebraska. The windblown sand and alluvial deposits overlie the Ogallala Formation, which overlies the Arikaree Formation (Ellis and others, 1971), both of which are of Tertiary age and contain aquifers that are used extensively within Todd County. The windblown sands, Ogallala Formation, and Arikaree Formation comprise the predominant outcrops within the Little White River Basin in Todd County.

The downstream part of the Little White River flows across outcrops of the Cretaceous-age Pierre Shale. Most of the Pierre Shale is relatively impermeable although it can yield small amounts of water if fractures or sandy zones are present (Carter, 1998). Outcrops of the Tertiary-age White River Group, which is composed primarily of poorly consolidated siltstone and claystone, occur within northern Todd County and southern Mellette County. The Arikaree Formation consists of poorly consolidated, tuffaceous sandstone, siltstone, shale, and silty clay; the basal unit is composed mostly of silts and sands. The upper part of the Arikaree Formation generally is impermeable although it can yield small amounts of water from fractures, joints, and silty layers, whereas the basal unit is moderately permeable (Carter, 1998). The Ogallala Formation, which contains the Ogallala aquifer, is composed of fine- to medium-grained sandstone and some silty clay. The Ogallala Formation also is very permeable. The windblown sand deposits are very fine- to medium-grained, uniform, quartz sand and generally are very permeable (Carter, 1998). The alluvial deposits vary from clays and silts to sand and gravel. Alluvial deposits are moderately permeable along the Little White River.

Examination of streamflow characteristics summarized by Niehus (1999) indicates that flow of the Little White River near the Bennett/Todd County line is dominated by base flow originating as ground-water discharge from the Ogallala aquifer and from the windblown sand deposits. Streamflow characteristics for Spring Creek indicate that flow contributions from direct runoff are very minor because of the high infiltration capacity of the windblown sand deposits that are predominant within the drainage area (Ellis and others, 1971). Streamflow characteristics for Rosebud Creek, which is dominated by outcrops of the Ogallala Formation, indicate a large base-flow component; however, somewhat larger contributions from direct runoff are apparent, presumably resulting from influence of outcrops of the Arikaree Formation. A large base-flow component also is apparent along the main stem of the Little White River within Todd and Mellette Counties. The largest influence from direct runoff becomes more apparent farther downstream where large outcrop areas of the White River Group and Pierre Shale occur within the contributing drainage area.



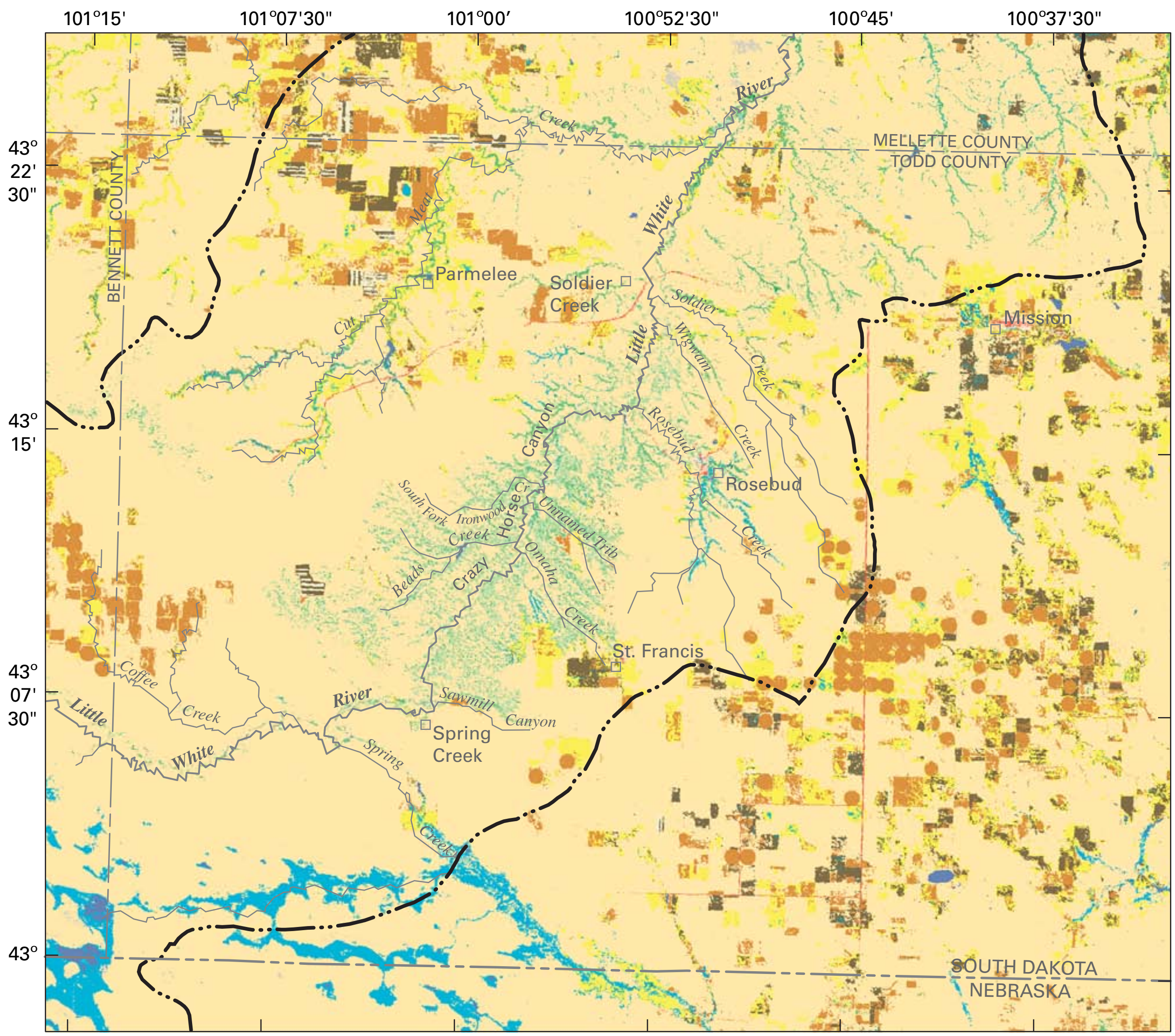
EXPLANATION

Little White River Basin boundary—Approximate location based on 1:100,000 digital coverages of Hydrologic Unit number 10140203

Physiographic division (modified from Fenneman, 1946; Flint, 1955)

U.S. Geological Survey streamflow-gaging station—Little White River below White River, site number 06450500

Figure 1. Location of the Little White River Basin, South Dakota and Nebraska.



Base from U.S. Geological Survey digital data 1:100,000, Martin, 1983, and Mission, 1982, 1:24,000
Land cover from U.S. Geological Survey, EROS Data Center raster digital data, 1992
LANDSAT Thematic Mapper, 10/11/2000
Universal Transverse Mercator projection, zone 13

0 1 2 3 4 5 6 MILES
0 1 2 3 4 5 6 KILOMETERS

EXPLANATION

National land cover classification, 1992

- Open water
- Low intensity residential
- Commercial/industrial/transportation
- Bare rock/sand/clay
- Quaries/strip mines/gravel pits
- Deciduous forest
- Evergreen forest
- Mixed forest
- Grasslands
- Pasture/hay
- Row crops
- Small grains
- Fallow
- Recreational grasses
- Woody wetlands
- Emergent herbaceous wetlands

Little White River Basin boundary

Figure 2. Land use/land cover in and near the Little White River Basin in Todd County.

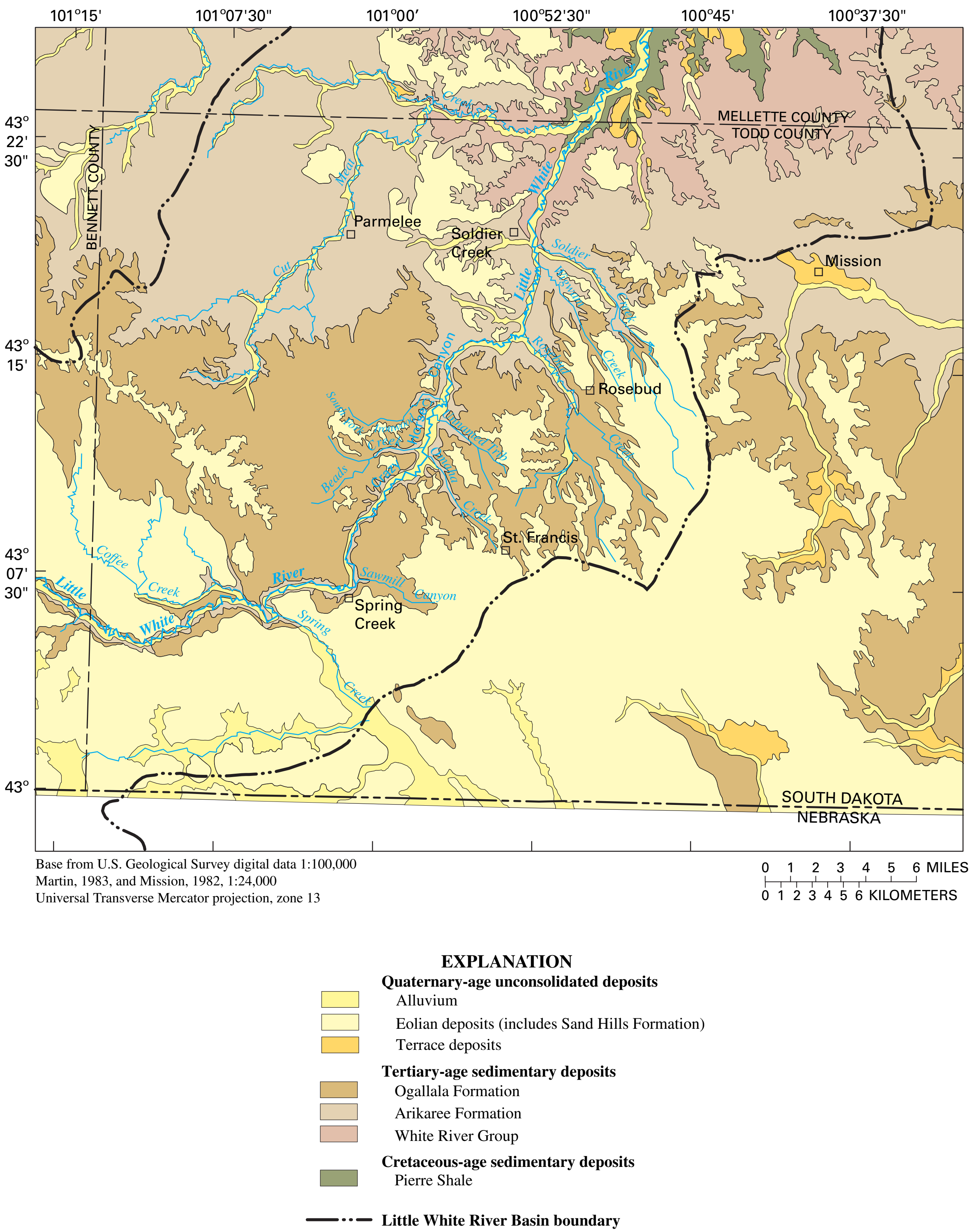


Figure 3. Generalized geologic map showing surficial geology of the Little White River Basin in Todd County (modified from Martin and others, 2004).

Discharge from these aquifers in the form of springs and seeps contribute to the base flow of the Little White River. Springflow varies with generally higher discharge during the spring when aquifer recharge and higher precipitation occurs and lower during the fall and winter (Long and others, 2003). The higher contribution during spring may be the result of a combination of shallow interflow that occurs after periods of precipitation, direct runoff, and response to rising ground-water levels. Long and others (2003) found that the flow from some springs did not vary substantially from spring to fall, whereas flow varied substantially for other springs.

Acknowledgments

The authors acknowledge the efforts of the Rosebud Sioux Tribe with the development and implementation of the study; in particular, Syed Huq, John Whiting, and Paul Leader Charge of the Office of Water Resources. Appreciation is expressed to the Bureau of Reclamation for assistance in implementation of the study and for analysis of water-quality samples. The South Dakota Department of Environment and Natural Resources provided technical assistance to the study.

Data Collection and Water-Quality Standards

Water-quality samples for this study were collected for two purposes. The first purpose was to conduct reconnaissance sampling for a wide range of constituents including physical properties, major ions, nutrients, trace elements, and pesticides. This sample set provides some indication of current conditions and provides a base from which future monitoring can be compared. The second purpose of water-quality sampling was to closely examine suspended-sediment and bacteria concentrations, which are the constituents exceeding the 2004 South Dakota stream standards for the reach below Rosebud Creek. Water-quality concentrations and/or macroinvertebrate indices may be used by the RST when setting standards and criteria for the Little White River. RST staff were involved in site selection and assisted with data collection and review throughout the study.

Sampling Sites

The reconnaissance samples were collected at 4 sites on the Little White River and 12 tributary sites during the fall of 2002 and analyzed for physical properties, major ions, nutrients, and trace elements (fig. 4, table 1). Reconnaissance pesticide samples were collected from 4 tributary sites during 2003 (fig. 4, table 1). The pesticide sampling sites were located on tributaries to the Little White River with active irrigation systems in place, with 3 sites on Rosebud Creek and 1 on Soldier Creek.

Suspended-sediment and bacteria samples were collected during 2003. For the 2003 sampling, 5 sites on the Little White River and 8 tributaries were sampled monthly from April through November (fig. 4, table 1). Streambed and streambank samples were collected at the five main stem sites in September 2003.

During the fall of 2003, macroinvertebrate samples were collected at three sites along the Little White River (fig. 4, table 1). These sites corresponded to historical sampling for macroinvertebrates by the RST (Kvame and others, 1997).

Sampling and Analysis Methods

Prior to sampling, all water-sampling equipment was presoaked in Liquinox solution, thoroughly scrubbed, rinsed with tap water, and then rinsed with deionized water. At the sampling site, samples were collected and processed using methods described in Ward and Harr (1990). Field measurements of streamflow, air and water temperature, pH, dissolved oxygen, and specific conductance were taken. When more than one site was sampled during a given day, equipment was cleaned between sites with a deionized water rinse and a thorough rinse with stream water at the new sites. After samples were collected, processed through a 0.45-μm (micrometer) filter if applicable, and preserved, they were shipped to the appropriate laboratory.

Suspended-sediment samples were collected with a handheld depth-integrated sampler. For samples on the Little White River and when tributaries had high flows, the equal-width integrated (EWI) method was used (Edwards and Glysson, 1998); tributary flows typically were collected as a single point, depth-integrated sample. Streambed and streambank sediment samples were collected to a depth of 6 to 8 in. using a hand-held core sampler (Edwards and Glysson, 1998) at the five main stem sites. A single core was collected from the right bank, the left bank, and main channel bed. Macroinvertebrate sampling was conducted following the U.S. Environmental Protection Agency (USEPA) Western Pilot Environmental Monitoring and Assessment Program (EMAP) protocols (U.S. Environmental Protection Agency, 2005).

Quality assurance/quality control (QA/QC) samples were collected for water-quality samples. QA/QC samples included replicates (samples collected immediately following the scheduled sample), splits (larger volume of water collected and then split during processing of the sample), and blanks (deionized water processed through sampling equipment or bottles and preserved). Results of 2002 QA/QC water-quality samples are provided in table 14 in the Supplemental Data section at the end of the report. Replicate and split sample results generally differed by less than 10 percent or had concentration differences of less than 0.08 mg/L (milligrams per liter). Blanks analyzed for fecal coliform bacteria all reported non-detectable concentrations. Suspended-sediment sample replicate results are presented in table 15 in the Supplemental Data section and had concentration differences ranging from 1 to 40 percent. Much of this difference can be attributed to the constant change in sediment load in the Little White River, and differences generally increased as streamflow and sediment concentration increased.

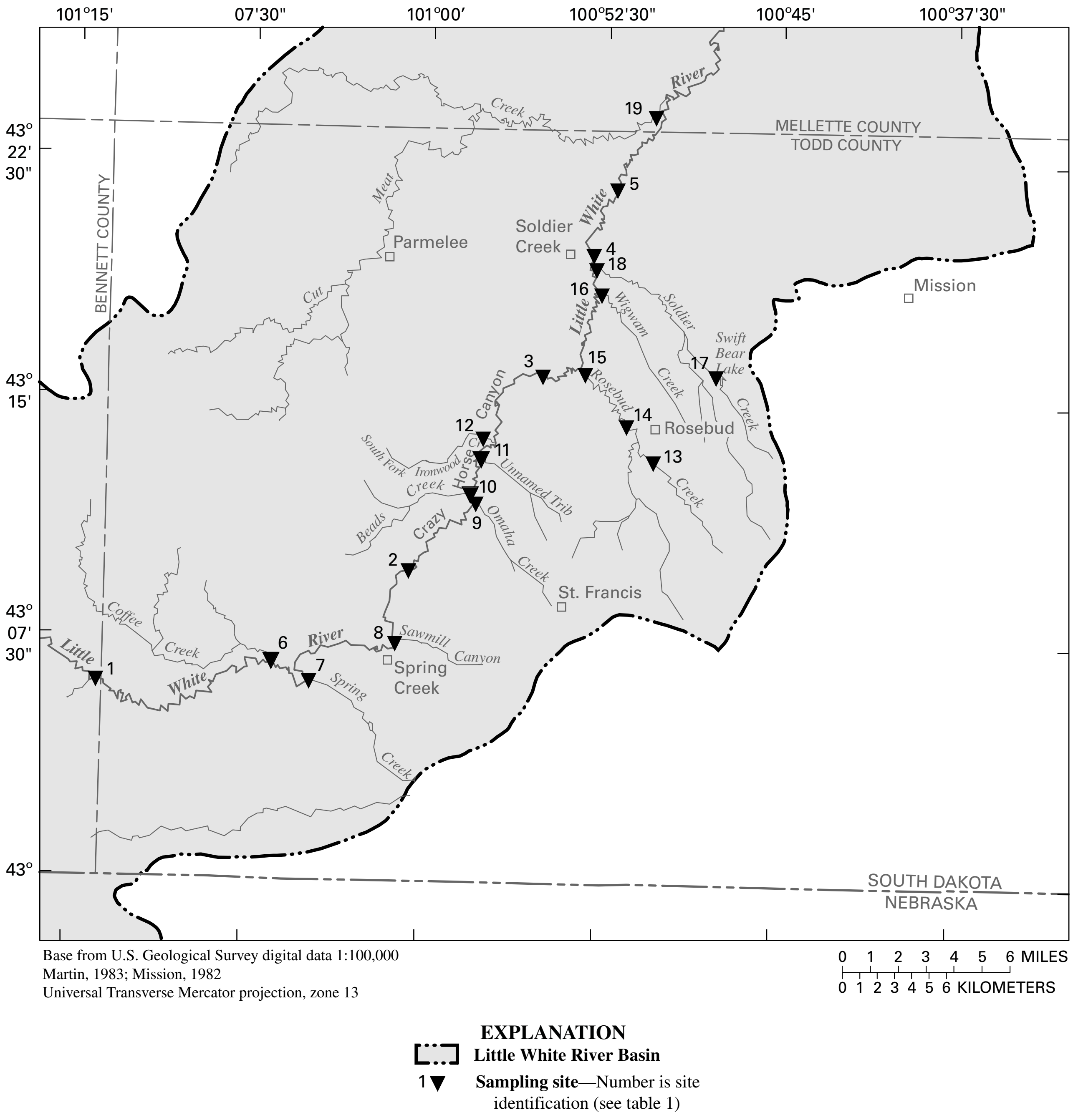


Figure 4. Water-quality sampling sites on or near the Little White River.

Table 1. Site information for selected streamflow-gaging stations and water-quality sampling sites.

[Site type: C, continuous-record streamflow; M, miscellaneous-record streamflow; R, reconnaissance; S, suspended sediment and bacteria; P, pesticides; B, biological/macroinvertebrate]

Map number (fig. 4)	Site number	Site name	Site type	Latitude	Longitude
		Main stem sites			
1	06449100	Little White River near Vetal	C, R, S, B	43 06 03	101 13 49
2	430939101003500	Little White River, Valandra Bridge, near Spring Creek	M, R, S, B	43 09 39	101 00 35
3	06449300	Little White River above Rosebud	C, S	43 15 47	100 55 02
4	06449500	Little White River near Rosebud	C, R, S	43 19 32	100 53 00
5	432136100520700	Little White River near Todd/Mellette County line	M, R, S, B	43 21 36	100 52 07
		Tributaries			
6	430647101062100	Coffee Creek above Spring Creek	M, R	43 06 47	101 06 21
7	430610101044300	Spring Creek near St. Francis	M, R, S	43 06 10	101 04 43
8	430724101010200	Sawmill Canyon near Spring Creek	C, R, S	43 07 24	101 01 02
9	431146100574900	Omaha Creek near Rosebud	M, R, S	43 11 46	100 57 49
10	431205100580200	Beads Creek near Rosebud	M, R	43 12 05	100 58 02
11	431312100573600	Unnamed tributary Crazy Horse Canyon near Rosebud	M, R	43 13 12	100 57 36
12	431343100571700	South Fork Ironwood Creek near Rosebud	M, R, S	43 13 43	100 57 17
13	431310100501600	East tributary Rosebud Creek near Rosebud	M, P	43 13 10	100 50 16
14	06449400	Rosebud Creek at Rosebud	C, R, S, P	43 14 14	100 51 26
15	431600100533600	Rosebud Creek at Little White River confluence, below Rosebud	M, R, S, P	43 16 00	100 53 36
16	431823100523400	Wigwam Creek near Soldier Creek	M, R	43 18 23	100 52 34
17	431552100473600	Soldier Creek above Swift Bear Lake, near Rosebud	M, P	43 15 52	100 47 36
18	431911100525200	Soldier Creek near Rosebud	M, R, S	43 19 11	100 52 52
19	432358100502600	Cut Meat Creek near confluence Little White River, below Soldier Creek	C, R, S	43 23 58	100 50 26

The majority of the samples were sent to the Bureau of Reclamation Laboratory in Bismarck, N. Dak. Sample analyses included major ions, nutrients, trace elements, and suspended sediment. USEPA standard methods were used for all analyses and are presented in table 16 in the Supplemental Data section. For suspended sediment, a modification to the USEPA standard method was used to correspond with the USGS method. Because it is difficult to keep a sample with high sediment concentrations well mixed, analyzing the entire sample ensures more consistent sample results (Gray and others, 2000). QA/QC suspended-sediment samples were analyzed at the USGS Sediment Laboratory in Iowa City, Iowa (Knott and others, 1993). QA/QC replicate samples include laboratory methods differences (residue at 180°C at USGS Sediment Laboratory and residue at 105°C at Bureau of Reclamation Laboratory) as well as actual variability within the stream. Streambed and streambank sediment samples were analyzed for grain-size distribution at the USGS Sediment Laboratory in Iowa City, Iowa. Bacteria samples were sent to the South Dakota State Health Laboratory in Pierre, S. Dak., and were analyzed using method 9222D outlined in the 19th edition of Standard Methods for the Examination of Water and Wastewater (Eaton and others, 1995). Pesticide and macroinvertebrate samples were sent to the USGS National Water Quality Laboratory in Denver, Colo., for analyses. References for analytical procedures used by NWQL can be found at URL http://nwql.usgs.gov/Public/ref_list.html (accessed May 10, 2005).

Water-Quality Standards

In an effort to control water pollution, Congress passed the Federal Water Pollution Control Act (Public Law 92-500) in 1972. Congress amended the law in 1977, changing the name to the Clean Water Act, which requires the classification of surface waters with regard to beneficial use and to establish water-quality standards to meet those uses (South Dakota Department of Water and Natural Resources, 1987). The Clean Water Act also requires that these standards be reviewed and revised every 3 years.

The State of South Dakota has beneficial uses and water-quality standards for streams in South Dakota. The RST has the authority to designate beneficial uses and the corresponding water-quality standards for the streams within the legal boundaries of the Rosebud Indian Reservation. The Tribe currently (2005) does not have approved beneficial uses and standards. As part of the South Dakota 3-year review and ambient monitoring of streams, the section of the Little White River from the Todd/Mellette County line to the confluence with the White River has been listed in the South Dakota 305-B report because it is not meeting current standards for total suspended solids (TSS). Fecal coliform bacteria concentrations also have been exceeding standards for this section of the stream.

Because the RST currently does not have approved beneficial uses and standards, the beneficial uses and standards currently in place for the State of South Dakota are used as a reference (table 2). It is important to note that because of anti-degradation rules, the State and the Tribe must be able to meet the standards established by one another for stream reaches on the Little White River as well as other streams that cross State and reservation boundaries.

All streams in South Dakota have the designated uses of wildlife propagation and stock watering and irrigation waters. The Little White River has additional beneficial uses of a warmwater semi-permanent fishery and limited contact water. Spring Creek, Rosebud Creek, and Soldier Creek have beneficial uses of coldwater marginal fisheries and limited contact waters. Cut Meat Creek and Ironwood Creek have beneficial uses of warmwater marginal fisheries and limited contact waters.

The South Dakota standard for TSS is a concentration determined by standard methods where 100 mL (milliliters) of a sample is analyzed for the suspended materials. Sediment samples in this study were analyzed for suspended-sediment concentration (SSC), where the entire sample is analyzed for suspended material. The biggest difference between TSS and SSC methods is that SSC values tend to be larger than TSS values. This is because it is very difficult to keep heavier sediment well mixed within the sample so that a representative subsample can be obtained. By analyzing the entire sample, the concentration typically is more representative of concentrations within the stream (Gray and others, 2000). However, the State criterion and listing of the Little White River is based on TSS concentrations so results from this sampling may be higher than historical data collected by the State.

Table 2. South Dakota surface-water-quality standards for selected physical properties and constituents by beneficial use.

[Standards from South Dakota Department of Environment and Natural Resources (2004b). All constituents in milligrams per liter unless otherwise noted. µS/cm, microsiemens per centimeter at 25 degrees Celsius; mL, milliliter; °F, degrees Fahrenheit; °C, degrees Celsius; ≥, greater than or equal to; <, less than; --, no data available]

Property or constituent	Coldwater marginal fisheries	Warmwater semi-permanent fisheries	Warmwater marginal fisheries	Limited contact waters	Wildlife propagation and stock-watering waters	Irrigation waters
Specific conductance (µS/cm)	--	--	--	--	[1]4,000/7,000	[1]2,500/4,375
pH (standard units)	6.5–8.8	6.5–9	6.5–9	--	6–9.5	--
Temperature (°F) (maximum)	75 (24°C)	90 (32°C)	90 (32°C)	--	--	--
Dissolved oxygen	≥5.0	≥5.0	≥4.0	≥5.0	--	--
Total suspended solids	[1]90/158	[1]90/158	[1]150/263	--	--	--
Total dissolved solids	--	--	--	--	[1]2,500/4,375	--
Sodium adsorption ratio	--	--	--	--	--	10
Nitrate (as N)	--	--	--	--	[1]50/88	--
Fecal coliform (colonies per 100 mL (May 1 - September 30)	--	--	--	<2,000	--	--

[1]30-day average/daily maximum.

Streamflow Characteristics

Numerous springs occur along the Little White River in the southwestern portion of Todd County. Ground-water discharge from the Ogallala and the Arikaree aquifers as springflow provides as much as 50 percent of the base flow to the Little White River, especially during the winter months (Carter, 1998). A summary of streamflow statistics in the Little White River is given in table 3. High-flow events typically occur during late-winter, spring, or early summer when snowmelt and more frequent rainfall occur. Severe thunderstorms in the summer and fall also can result in high-flow events.

Summary statistics of 2002–2003 flow measurements at selected tributaries to the Little White River are presented in table 4. Measured streamflow from the various tributaries ranged from 0 to 25 ft^3/s. Many of the tributaries upstream from and including Rosebud Creek provide very constant sources of flow to the Little White River (fig. 5). Tributaries along the lower reach, such as Wigwam Creek, Soldier Creek, and Cut Meat Creek, tend to decrease in flow over the summer and often go dry.

Table 3. Streamflow data and summary statistics for selected gaging stations on the Little White River.

[Water year, October 1 through September 30; mi^2, square miles; ft^3/s, cubic feet per second]

Station number	Station name	Period of record (water year)	Drainage area (mi^2)	Contributing drainage area (mi^2)	Minimum daily flow (ft^3/s)	Median daily flow (ft^3/s)	Maximum instantaneous flow (ft^3/s)
06449100	Little White River near Vetal	1960–2003	590	415	9	45	3,540
06449300	Little White River above Rosebud	1982–2000	890	630	20	101	2,190
06449500	Little White River near Rosebud	1944–2003	1020	760	10	95	4,640
[1]06450500	Little White River below White River	1950–2003	1,570	1,310	7	97	13,700

[1]This site is located outside of Todd County in Mellette County near the town of White River but is used for additional information and comparison.

Table 4. Summary statistics of streamflow measurements during 2002–2003 at selected tributaries to the Little White River.

Site number	Site name	Number of measurements	Discharge, in cubic feet per second		
			Minimum	Median	Maximum
430647101062100	Coffee Creek above Spring Creek	2	4.4	4.7	4.9
430610101044300	Spring Creek near St. Francis	11	3.6	4.1	25
430724101010200	Sawmill Canyon near Spring Creek	12	.93	1.3	1.7
431146100574900	Omaha Creek near Rosebud	11	.54	1.1	1.3
431205100580200	Beads Creek near Rosebud	2	1.3	1.7	2.1
431312100573600	Unnamed tributary Crazy Horse Canyon near Rosebud	2	.1	.25	.36
431343100571700	South Fork Ironwood Creek near Rosebud	11	1.0	1.9	2.2
06449400	Rosebud Creek at Rosebud	10	5.9	9.7	11
431600100533600	Rosebud Creek at Little White River confluence, below Rosebud	10	6.0	9.8	11
431823100523400	Wigwam Creek near Soldier Creek	1	.2	.2	.2
431911100525200	Soldier Creek near Rosebud	11	.0	1.7	7.1
432358100502600	Cut Meat Creek near confluence Little White River, below Soldier Creek	9	.0	.0	7.7

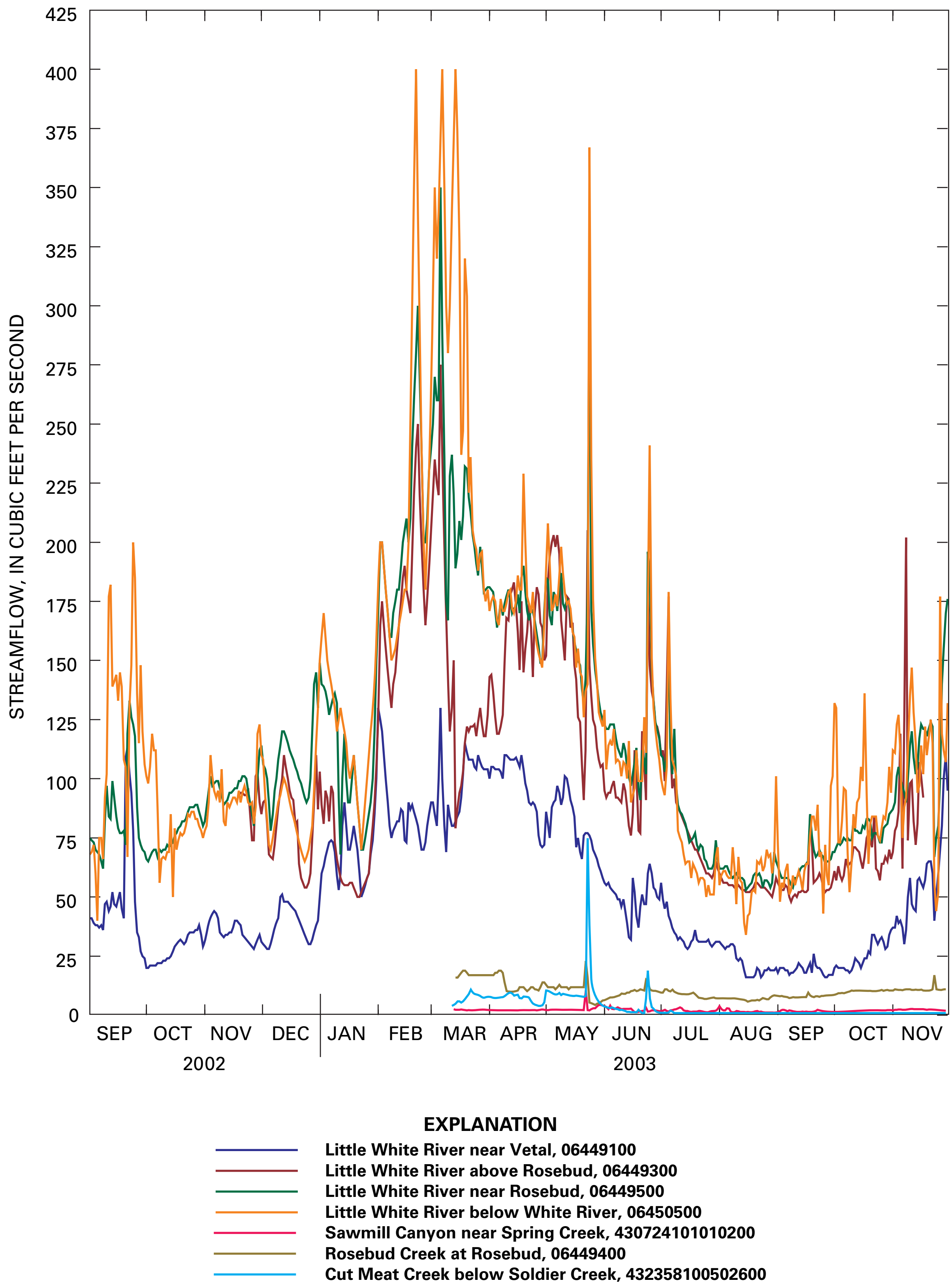


Figure 5. Hydrograph for continuous streamflow monitoring sites, September 1, 2002, through November 30, 2003.

Annual mean flow for four selected gaging stations on the Little White River is presented in figure 6. The highest annual mean flow at all four sites occurred during 1997 when much of South Dakota received above-normal precipitation. The lowest mean flows typically occurred during the 1970s or early 1980s. The three upstream sites have less variability in annual mean flow than the downstream site (fig. 1), primarily as a result of the perennial tributary inflows that occur along outcrops of the Ogallala and Arikaree Formations. Variability in annual mean flow is evident at Little White River below White River, which is indicative of the larger drainage basin being influenced by intermittent tributary inflows.

Figure 7 presents the monthly mean flow for the period of record for the four selected sites on the Little White River. Flow typically is low during the fall and winter months with higher flows occurring as a result of snowmelt and spring runoff, generally during late February through June. Flows decrease again during July and through the summer and fall. The highest monthly mean flows typically are in March and April.

Daily-duration hydrographs present the percentage of time that daily mean streamflow is exceeded for a specific day (fig. 8). The duration hydrographs show the maximum and minimum daily flows and the 25-, 50-, and 75-percent non-exceedance values for the period of record for the four sites presented in table 3. For example, based on historical data, there is a 50-percent chance that the flow at the Little White River near Vetal (06449100) will be less than 60 ft^3/s and a 75-percent chance that the flow will be less than 105 ft^3/s on June 1 of any year. On the same day, there is a 50-percent chance that flow at Little White River near Rosebud (06449500) will be less than 69 ft^3/s and 75-percent chance it will be less than 82 ft^3/s. The longer the period of record for a site, the more reliable the duration hydrograph is at representing flows because a wider range of conditions has been monitored. The daily duration hydrographs display the strong influence of the base flows along the Little White River with relatively consistent flows in the 25- to 75-percent ranges and minimums that typically are greater than 10 ft^3/s. Daily mean flows less than 10 ft^3/s occurred only 4 times at the site near Vetal (06449100) in 44 years of record and only 6 times at the site below White River (06450500) in 54 years of record.

Duration curves of daily mean flow are presented in figure 9. These curves present the percentage of time that a daily mean flow was equaled or exceeded. For example, daily mean flows exceed 200 ft^3/s only 2 percent of the time at the site near Vetal (06449100), 11 percent of the time above Rosebud (06449300), 11 percent of the time near Rosebud (06449500), and 14 percent of the time below White River (06450500). There is less than a 1-percent chance that flows will exceed 1,000 ft^3/s at any of the sites (0.01–0.8 percent) and more than a 92-percent chance that flows will be greater than 20 ft^3/s (93–99.9 percent). Generally, high-flow conditions typically occur less than 10 percent of the time, and low-flow conditions are exceeded more than 90 percent of the time (fig. 9).

Water-Quality Characteristics

Water-quality samples were collected for two purposes: (1) to conduct reconnaissance sampling for a variety of constituents including physical properties, major ions, nutrients, trace elements, and pesticides; and (2) to closely examine suspended-sediment concentrations and bacteria densities, the two constituents with concentrations exceeding the current (2004) South Dakota stream standards in the reach below Rosebud Creek. Reconnaissance samples provide information on current conditions and provide a base which results from future monitoring can be compared. The suspended-sediment and bacteria sampling address current concerns and the need for more detailed information.

Reconnaissance Sampling

During the fall of 2002, samples were collected at 4 main stem sites and 12 tributary sites (table 1, fig. 4). This sampling was done to provide base-line data for future comparisons, to compare 2002 concentrations with historical concentrations (1973–2001) where possible, and to ensure that fecal coliform bacteria and suspended sediment are the only constituents with concentrations that approach or exceed water-quality standards. Results from this sampling are provided in table 14; summary tables with comparisons are provided in table 16. Pesticide data were collected in 2003 as part of the reconnaissance sampling, and results are provided in the table 17 in the Supplemental Data section.

Three sites along the Little White River have historical water-quality data, with the exception of pesticide data, for comparisons—Little White River near Vetal, Little White River above Rosebud, and Little White River near Rosebud. From the reconnaissance sampling, all concentrations were within ranges previously reported for samples from the Little White River. Concentrations from the sampled tributaries also were within ranges found for the Little White River. None of the concentrations were at levels of concern (table 2) with the exception of suspended sediment and fecal coliform bacteria, which are discussed in more detail later in this report. Nutrient concentrations from reconnaissance sampling at Little White River near Vetal and Little White River above Rosebud generally were greater than historical medians, and dissolved ammonia, nitrate, and nitrite concentrations were near the maximum historical values. Arsenic concentrations in ground water in Todd County and the surrounding area occasionally are greater than the current (2004) USEPA drinking-water standard of 10 µg/L (micrograms per liter) (Carter 1998; Carter and others, 1998). Some historical concentrations for dissolved arsenic in the Little White River also were greater than the 10-µg/L standard, but concentrations from the reconnaissance sample for the Little White River and tributaries were less than 9 µg/L.

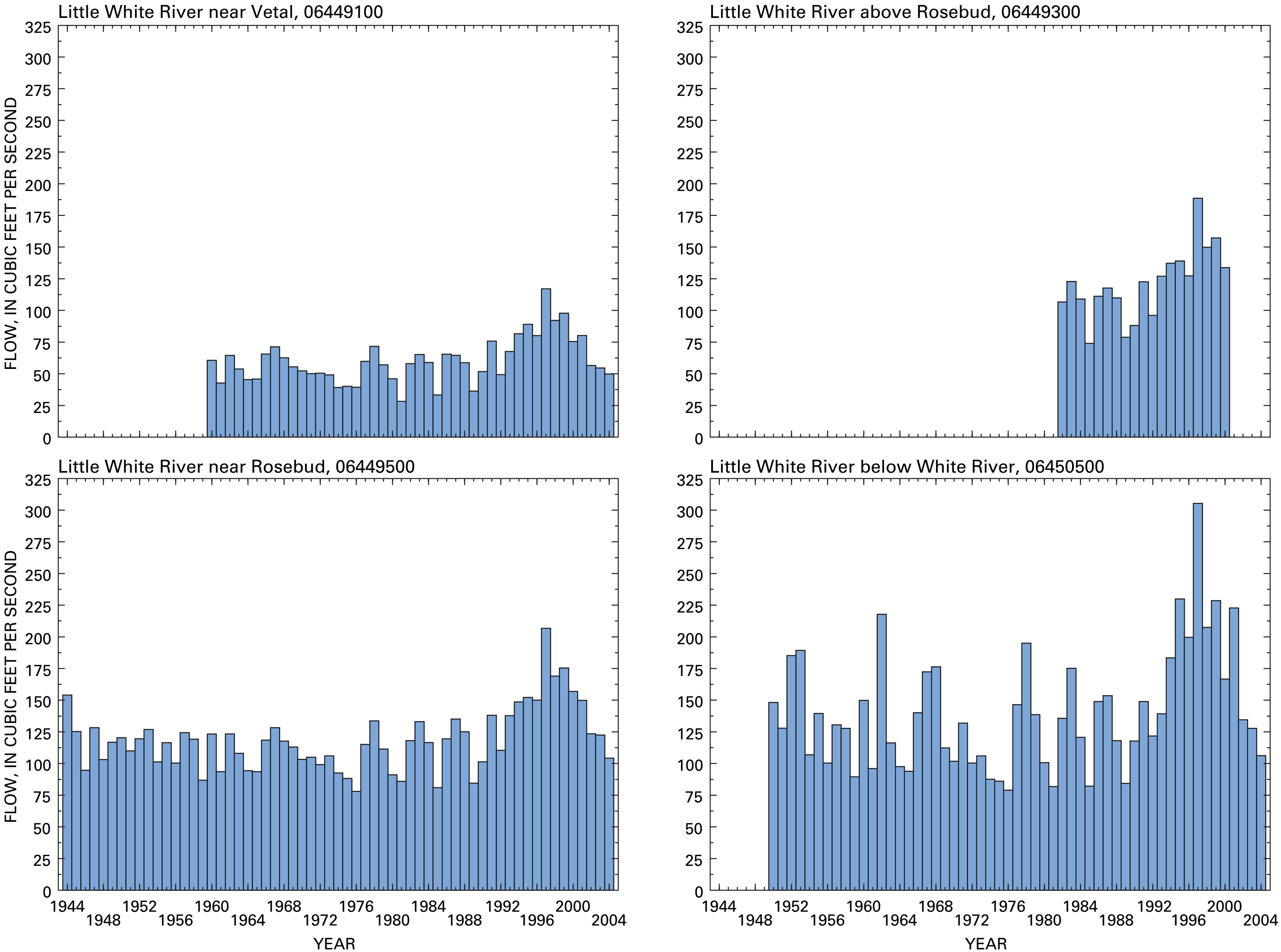


Figure 6. Annual mean flow for selected sites on the Little White River.

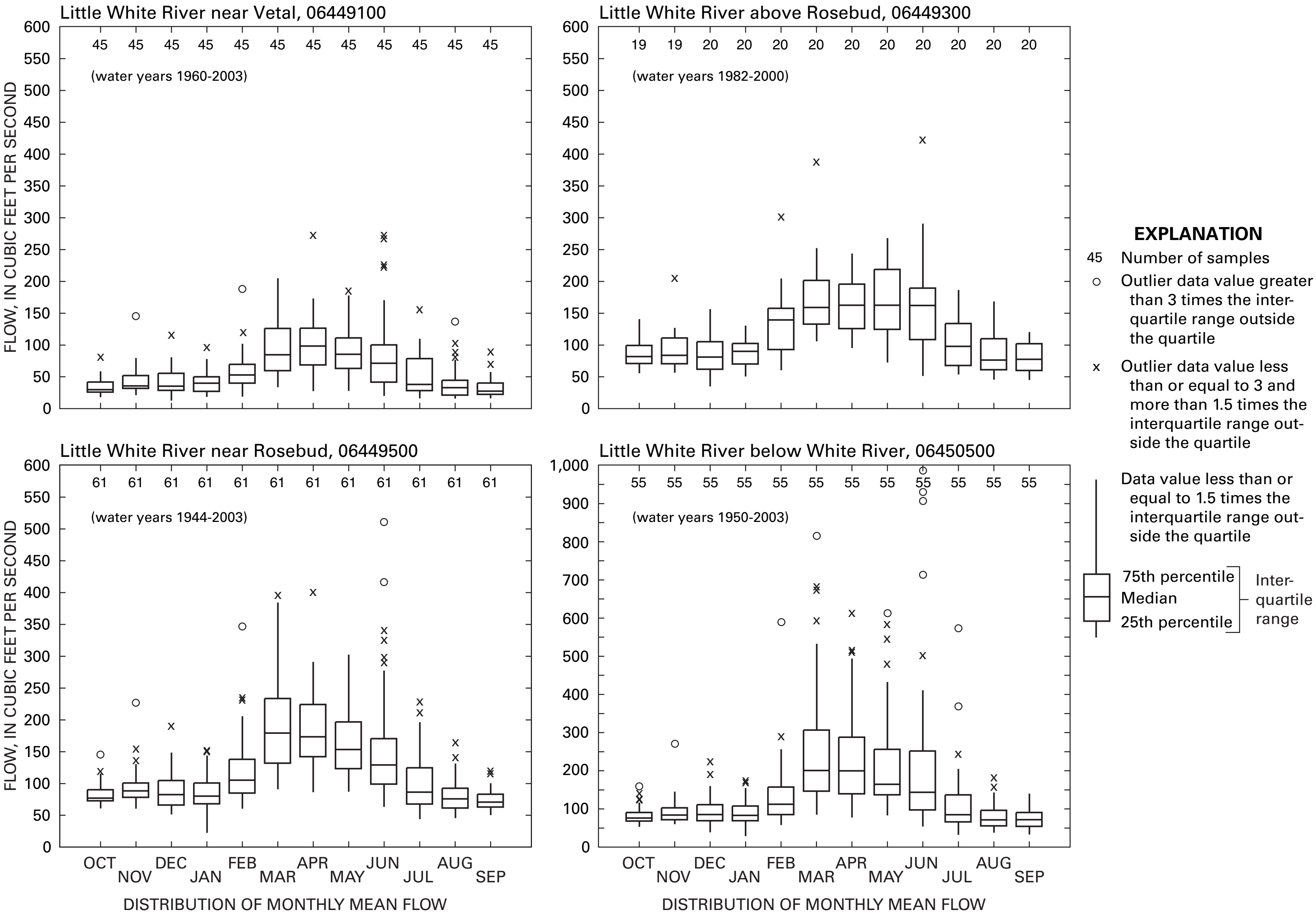


Figure 7. Distribution of monthly mean flows for selected sites on the Little White River.

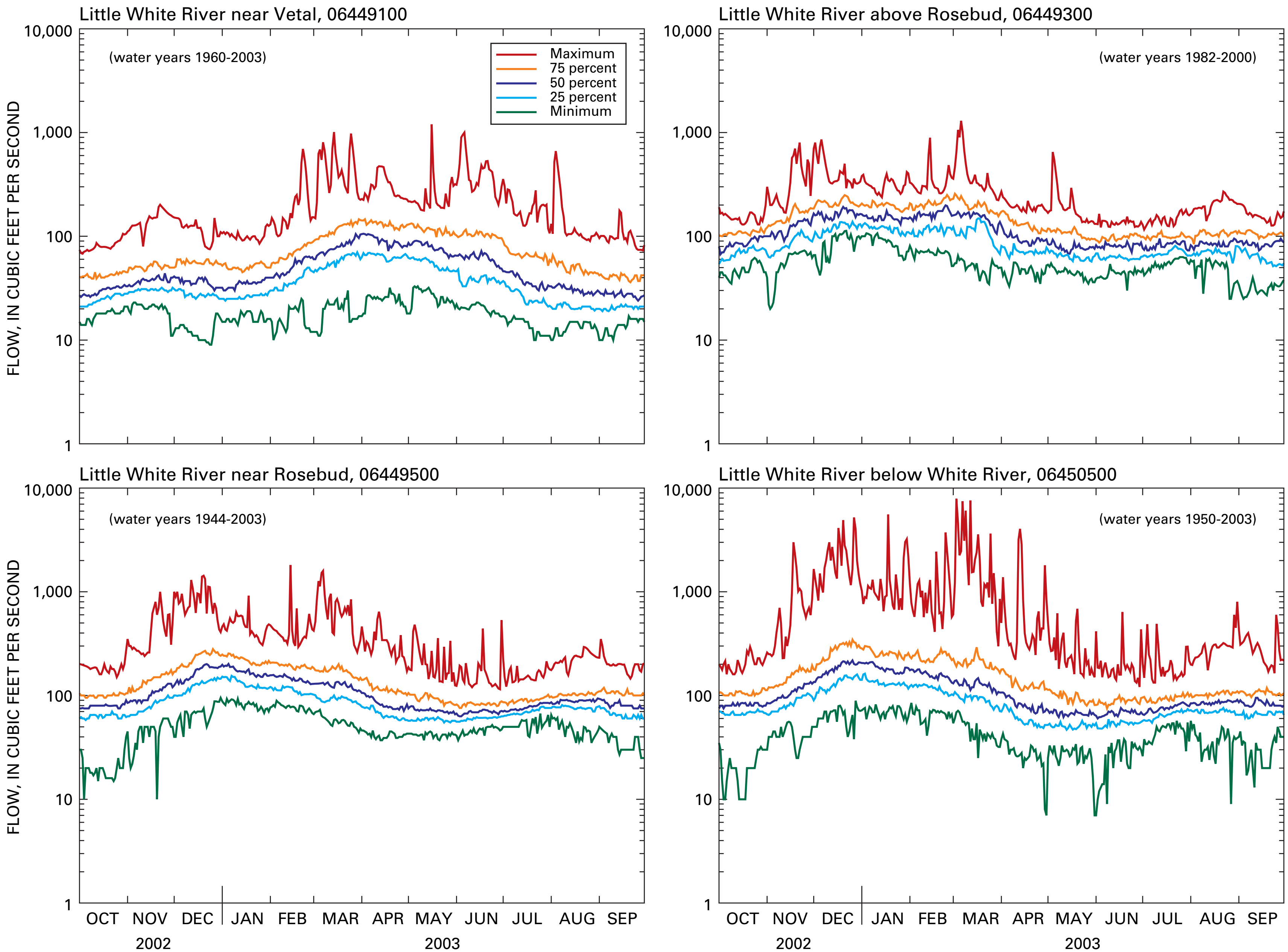


Figure 8. Duration hydrographs of daily mean flow for selected sites on the Little White River.

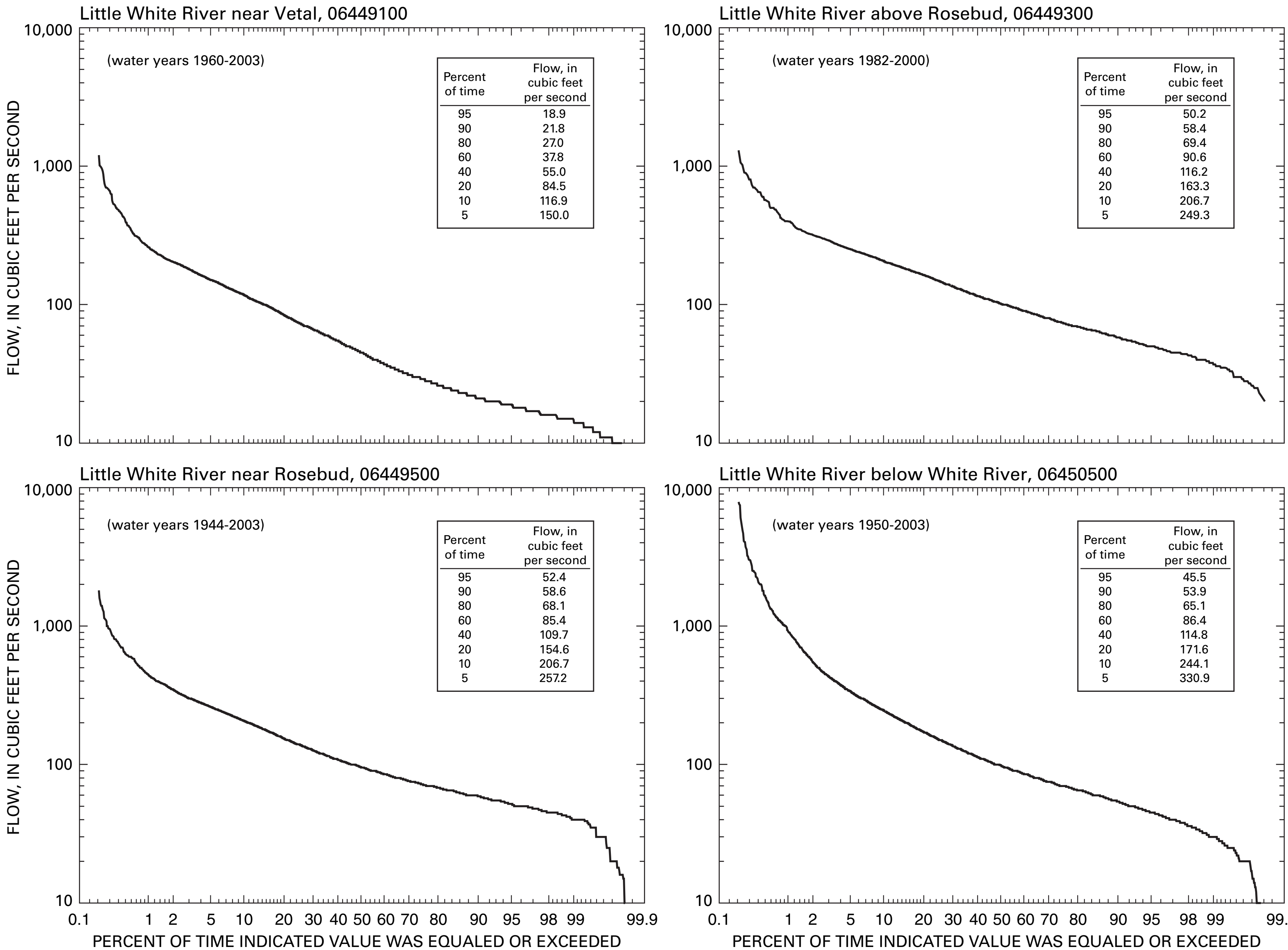


Figure 9. Duration curve of daily mean flow for selected sites on the Little White River.

Pesticide samples were collected during the fall of 2003 at four tributary sites to the Little White River (table 1, fig. 4). Tributaries were selected for sampling from drainages close to the intense farming and irrigation lands in the south-central portion of Todd County. All pesticide concentrations were less than laboratory reporting levels with the exception of two constituents from the sample from Soldier Creek above Swift Bear Lake (table 17). A concentration of 0.01 μg/L for atrazine and an estimated concentration of 0.005 μg/L for 2-chloro-4-isopropylamino-6-amino-s triazine (a transformation product of deethyl-atrazine) were reported. Atrazine was not detected in any of the historical samples along the Little White River. Additional sampling for pesticides in tributaries draining this area may provide better indications of seasonal or climatic effects in pesticide concentrations in surface waters in the basin.

Bacteria and Suspended Sediment

Intensive sampling for fecal coliform bacteria and suspended sediment occurred between April and November 2003. Samples were collected monthly with an additional sample collected in September. Bacteria and suspended-sediment concentrations from the reconnaissance sampling and historical USGS streamflow and suspended-sediment data (1957–2001) were included in comparisons and analyses.

Fecal Coliform Bacteria

Fecal coliform bacteria concentrations often are highest during and immediately after storm events. Streamflow during April and May generally was high because of snowmelt and spring rainfall with a storm event in late May. Storm events also occurred in late June and early July. The July samples were collected immediately after the storm events and prior to streamflow declines that occurred during July and August. Additional rainfall resulted in high flows in September and October. Fecal coliform bacteria concentrations were less than the State's limited contact standard of 2,000 col/100 mL (colonies per 100 milliliters) on the Little White River with the exception of June and July when storm events occurred. A fecal coliform bacteria concentration of 9,500 col/100 mL was reported at the Little White River near Vetal in June (table 5). Concentrations of 4,200 col/100 mL and 3,200 col/100 mL were reported for the Little White River near Rosebud and near the Todd/Mellette County line, respectively, in July (table 5). Samples from several tributaries had concentrations greater than 2,000 col/100 mL during the sampling period including Sawmill Canyon, South Fork Ironwood Creek, and Soldier Creek. The large concentrations in Sawmill Canyon continued past August into September. Soldier Creek had a large concentration (5,500 col/100 mL) during the reconnaissance sampling in September 2002 (table 5).

Possible sources of fecal coliform bacteria include wildlife, livestock, and septic systems. More detailed sampling is needed to determine where the fecal coliform concentrations increase within the tributary reach. More storm-event sampling is needed to determine the full concentration range and the time-frame necessary for concentrations to return to safe levels.

Suspended Sediment

Streams that originate in or flow through southwestern South Dakota, including the White River and Little White River, often carry large suspended-sediment loads. Sediment transport within these basins is driven largely by the geology of the area where fine-grained sands and clays are readily available. The surficial deposits within the Little White River Basin within Todd County are dominated by windblown sand deposits (eolian), the Ogallala Formation, and the Arikaree Formation (fig. 3), which provide a substantial supply of fine sands and clay for transport.

For a stream to be determined as not meeting the beneficial uses assigned to a specific reach, several criteria need to be met (South Dakota Department of Environment and Natural Resources, 2004a). Generally, only data collected during the past 5 years are examined. This ensures that current conditions are evaluated. In addition, a minimum number of observations or samples are required. For streams, 20 samples for any one constituent usually are necessary unless more than 25 percent of the samples exceed the water-quality standard, and then the requirement is decreased to 10 samples. A sampling site for which concentrations in more than 10 percent of the 20 or more samples exceed a water-quality standard is considered a stream segment that is water-quality limited or nonsupporting. This percentage increases to 25 percent if fewer than 20 samples are available. Data collected for this study fall in this latter category. Table 6 presents a summary of suspended-sediment concentrations for the Little White River between September 2002 and November 2003 and percentage of samples that did not meet current water-quality standards based on the State's criteria. Complete results from the 2003 suspended-sediment sampling are presented in table 15.

Table 5. Fecal-coliform bacteria concentration from selected sites in the Little White River Basin.

[Data in colonies per 100 milliliters. <, less than; --, no data]

Site Number	Site Name	Sept. 23–25, 2002	Nov. 4–7, 2002	Apr. 21–22, 2003	May 6–8, 2003	June 17–19, 2003	July 8–9, 2003	Aug. 11–12, 2003	Sept. 2–4, 2003	Sept. 22–23, 2003	Oct. 20–22, 2003	Nov. 17–19, 2003
	Main stem sites											
06449100	Little White River near Vetal	400	70	60	100	9,500	310	40	30	130	130	180
430939101003500	Little White River, Valandra Bridge, near Spring Creek	60	10	10	50	590	460	10	100	30	110	180
06449300	Little White River above Rosebud	--	30	40	30	700	--	50	70	<10	40	30
06449500	Little White River near Rosebud	290	<10	<10	20	100	4,200	20	70	60	<10	420
432136100520700	Little White River near Todd/Mellette County line	130	20	10	20	390	3,200	40	50	60	70	80
	Tributaries											
430647101062100	Coffee Creek above Spring Creek	380	50	--	--	--	--	--	--	--	--	
430610101044300	Spring Creek near St. Francis	170	120	<10	<10	180	580	730	160	230	40	60
430724101010200	Sawmill Canyon near Spring Creek	930	170	70	20	1,000	--	2,400	3,700	1,600	70	80
431146100574900	Omaha Creek near Rosebud	50	30	<10	90	60	130	50	120	20	80	<10
431205100580200	Beads Creek near Rosebud	50	20	--	--	--	--	--	--	--	--	--
431312100573600	Unnamed tributary Crazy Horse Canyon near Rosebud	380	10	--	--	--	--	--	--	--	--	--
431343100571700	South Fork Ironwood Creek near Rosebud	440	150	10	20	2,200	6,300	420	1,400	1,000	280	100
06449400	Rosebud Creek at Rosebud	--	<10	<10	10	110	--	30	10	50	<10	10
431600100433600	Rosebud Creek at Little White River confluence, below Rosebud	60	40	<10	20	150	--	90	70	--	90	<10
431823100523400	Wigwam Creek near Soldier Creek	--	80	--	--	--	--	--	--	--	--	
431911100525200	Soldier Creek near Rosebud	5,500	170	330	<10	2,500	6,700	no flow	no flow	no flow	60	130
432358100502600	Cut Meat Creek near confluence Little White River, below Soldier Creek	--	--	30	10	90	420	no flow	no flow	no flow	no flow	no flow

Table 6. Summary of 2002–2003 suspended-sediment concentrations compared to the South Dakota standard of 158 milligrams per liter for warmwater semi-permanent fisheries.

[mg/L, milligrams per liter]

Site Number	Site Name	Number of samples	Range of concentrations (mg/L)	Number exceeding criterion	Percentage of exceedances
06449100	Little White River near Vetal	11	17–427	5	45
430939101003500	Little White River, Valandra Bridge, near Spring Creek	11	87–1,185	7	64
06449300	Little White River above Rosebud	10	118–856	7	70
06449500	Little White River near Rosebud	11	87–1,530	7	64
432136100520700	Little White River near Todd/Mellette County line	11	112–2,660	9	82

Based on the samples collected during 2002–2003, the Little White River within Todd County exceeds the State standard for suspended sediment 45 to 82 percent of the time. Because sampling occurred during a relatively dry year and because the suspended-sediment concentration increases with increased streamflow, these percentages of exceedance are conservative. The relation between historical (1957–2001) suspended-sediment concentration and streamflow provides a broader indication of exceedances (fig. 10). Using historical data and comparing those concentrations to the current State standard, 50 percent of the samples from the Little White River near Vetal exceeded the State standard, 88 percent of the samples from the Little White River above Rosebud exceeded the State standard, 89 percent of the samples from the Little White River near Rosebud exceeded the State standard, and 100 percent of the samples from the Little White River below White River exceeded the State standard.

To further examine the percentage of time the stream is exceeding standards, an estimate of suspended sediment can be generated based on regression analysis of measured streamflow and suspended-sediment concentrations (1957–2003). Table 7 provides the regression equations for selected sites on the Little White River, and the R^2 value is the amount of variation described by the regression equation. The R^2 value for the site with the most data, Little White River above Rosebud (06449300), indicates that streamflow (the independent variable) describes 86 percent of the variation in suspended-sediment concentration. The other 14 percent may be related to factors such as the intensity of the storm, location of the storm (widespread or localized), time between storms, and snowmelt/spring storm combination. Using the regression equations in table 7 and applying them to historical daily mean discharge data (1944–2002), suspended-sediment concentrations in the Little White River near Vetal (06449100) would exceed current State suspended-solids criterion 46 percent of the time. Suspended-sediment concentrations in the Little White River above Rosebud (06449300) and the Little White River near Rosebud (06449500) always would exceed the criterion. Data collected during 2002–2003 at the Little White River near Vetal show a similar percentage of exceedance, whereas data from Little White River above Rosebud and Little White River near Rosebud show lower percentages of exceedance.

Historical daily suspended-sediment data are available for the Little White River near Vetal and the Little White River near Rosebud for the 1991 water year (Oct. 1, 1990, to Sept. 30, 1991). Streamflow during this water year was near normal with the exception of one high-flow event on May 16, 1991. This high flow is the record peak flow for the Little White River near Vetal. Monthly mean streamflow values are near normal for the site near Vetal and only slightly above normal for the site near Rosebud. Figure 11 presents a graph of the daily suspended-sediment concentrations in water year 1991 in relation to the current State standard for TSS. Suspended-sediment concentrations exceeded the standard 170 days during the year (46 percent of the time) for the Little White River near Vetal, and 320 days of the year (88 percent of the time) for the Little White River near Rosebud. These percentages are higher than those for the 2002–2003 data; however, all of the various methods to estimate exceedances indicate that the Little White River near Vetal exceeds the current State standard 45 to 50 percent of the time, whereas the two downstream sites generally exceed the standard 70 to 100 percent of the time.

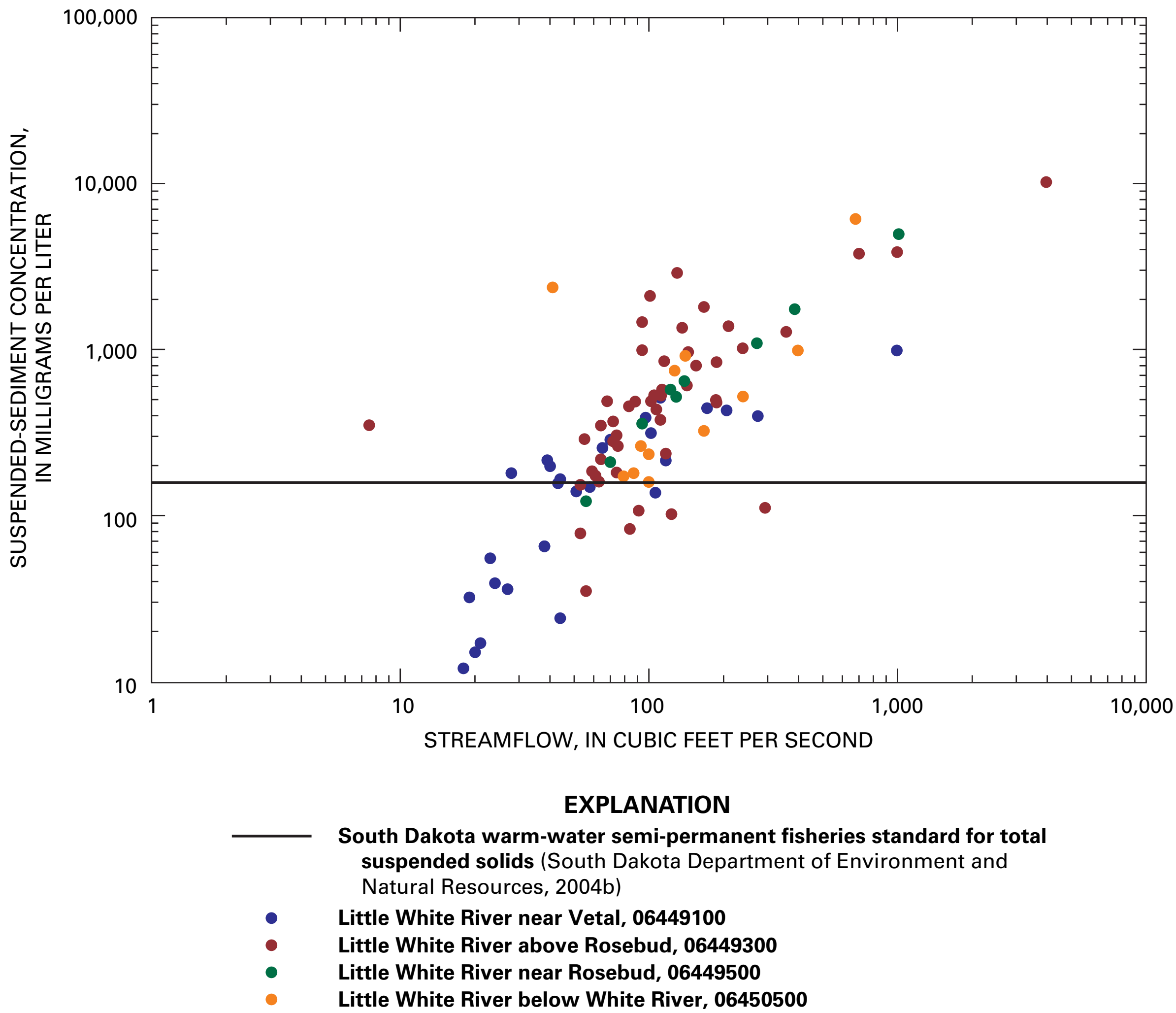


Figure 10. Relation between historical suspended-sediment concentrations and streamflow for selected sites on the Little White River, 1957–1995.

Table 7. Regression analysis of suspended-sediment concentration and streamflow for selected sites on the Little White River.

[SSC, suspended-sediment concentration; Q, streamflow]

Station number	Station name	Number of samples	Regression equation	R^2
06449100	Little White River near Vetal	38	SSC = 110 + 0.995*Q	0.68
06449300	Little White River above Rosebud	57	SSC = 329 + 2.62*Q	.86
06449500	Little White River near Rosebud	19	SSC = -121 + 4.96*Q	.92

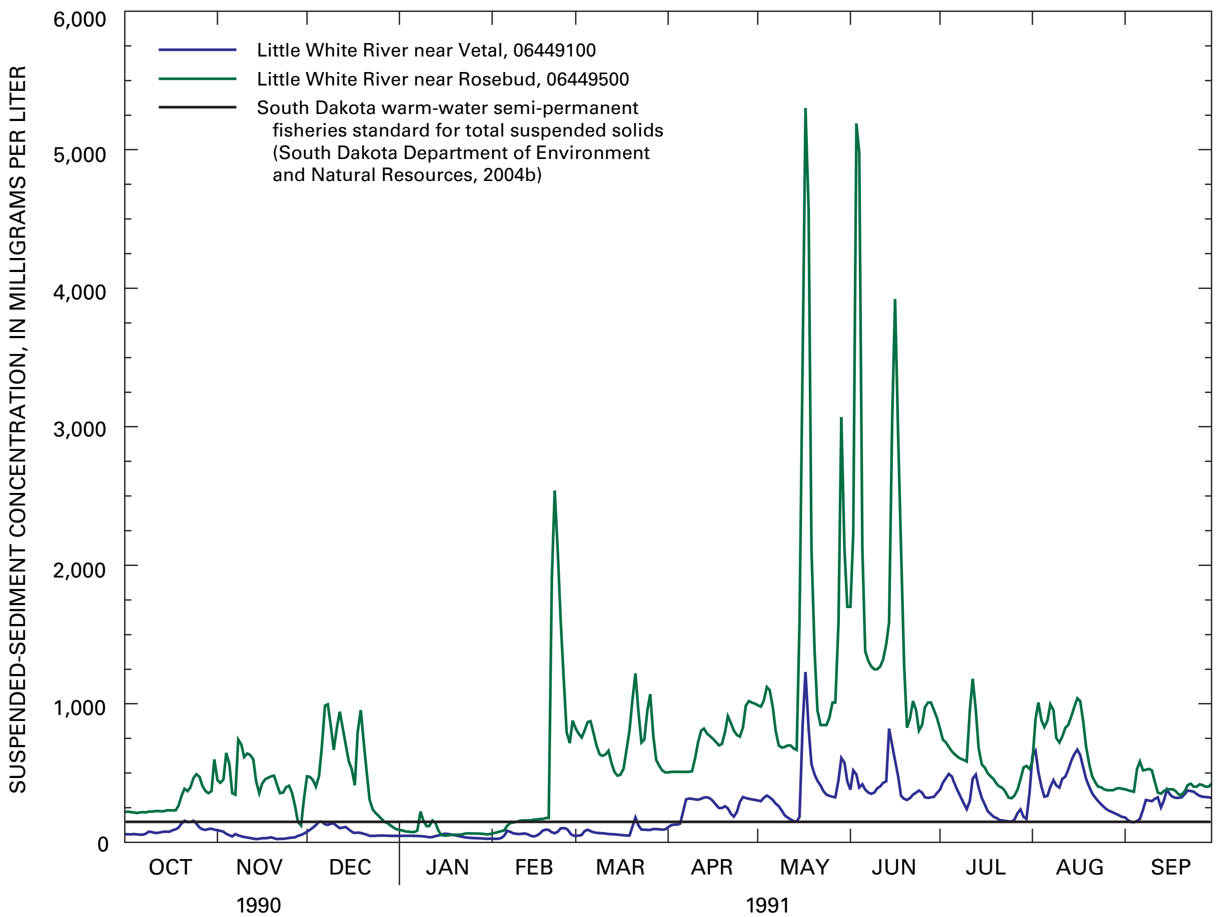


Figure 11. Daily mean suspended-sediment concentration for selected sites on the Little White River for October 1, 1990, through September 30, 1991.

One observation that remains consistent through the analysis is that the suspended-sediment concentrations tend to increase between the site near Vetal and the site above Rosebud, and then remain fairly constant from the site above Rosebud to the site near Rosebud (fig. 12). Land-use patterns do not change substantially between the site near Vetal and the site above Rosebud (fig. 2), and the riparian health along the Little White River is very good with grassy banks and large shrubs and trees providing bank stabilization and canopy cover (fig. 13). However, the geology does change within this reach, specifically from windblown sand deposits to outcrops of the Ogallala Formation (fig. 3). The slight change in sediment concentration from the site above Rosebud to the site near Rosebud indicates that the Arikaree Formation does not contribute as much sediment as the Ogallala Formation. Tributary concentrations follow a similar pattern (fig. 12) with higher sediment concentrations from tributaries upstream from the site above Rosebud.

Sediment transport and the ability of the stream to carry a load are driven not only by the discharge/velocity but also the size of the sediment being transported. Generally, as the sediment size increases, a greater velocity is needed to transport the sediment downstream. One measure of sediment size is the percent of fines (sediment diameter less than 0.062 μm). Figure 14 presents the percentage of fines for selected sites on the Little White River. The pattern inversely follows the general trend in suspended-sediment concentrations with the percentage of fines decreasing from the site near Vetal to the Valandra Bridge site and percentages staying somewhat constant from the Valandra Bridge site to the site near the Todd/Mellette County line (fig. 14). The decrease in fines corresponds with an increase in sand particle size within the sediment. The increase in sediment size also corresponds with the presence of outcrops of the Ogallala Formation. Availability of sediment for transport throughout the basin (fig. 15) is evident by suspended-sediment concentrations exceeding the current State TSS standard 45 to 50 percent of the time at the site near Vetal. The outcrop of the Ogallala Formation appears to be a major factor in sediment concentration and size for the Little White River.

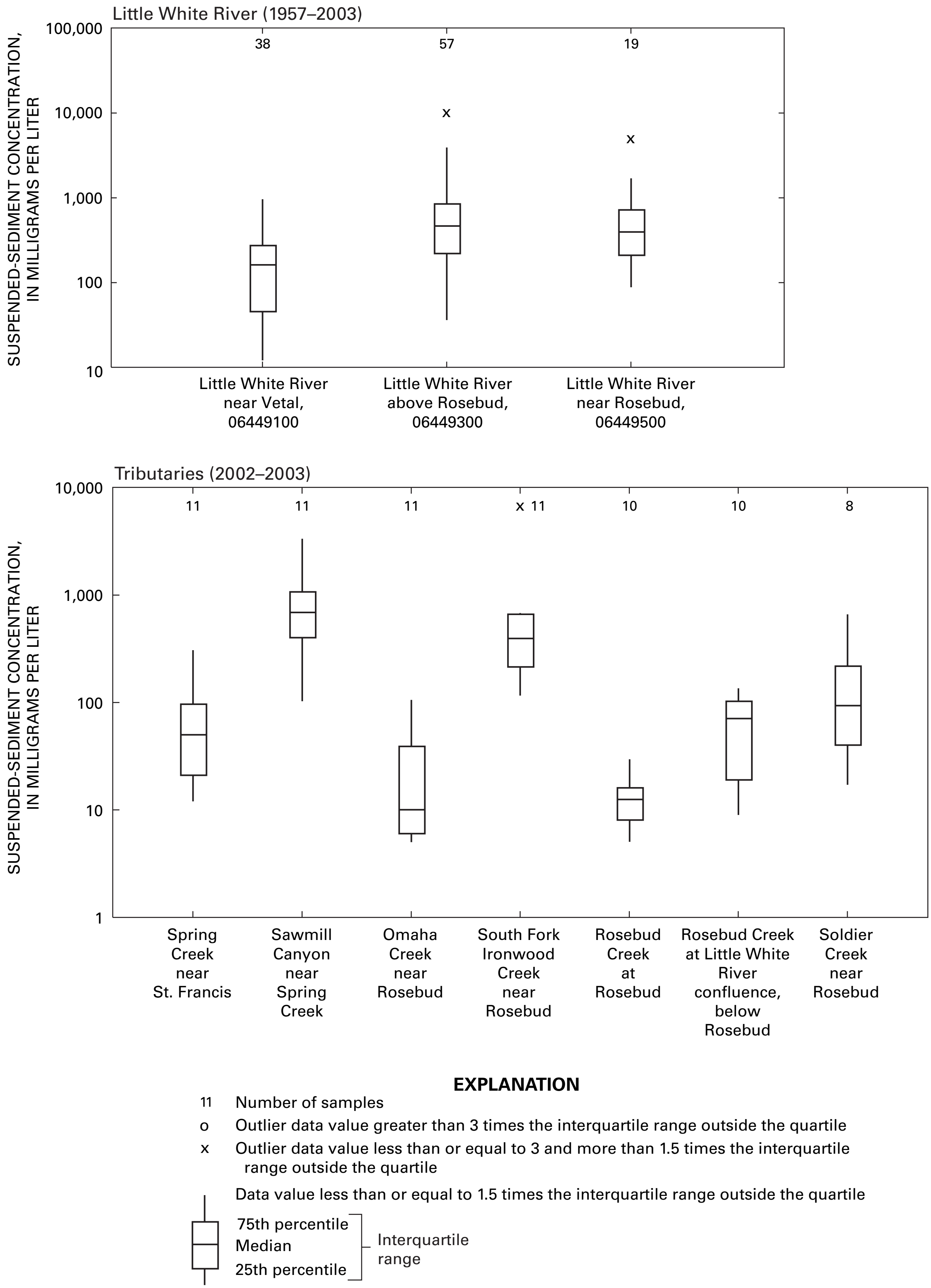


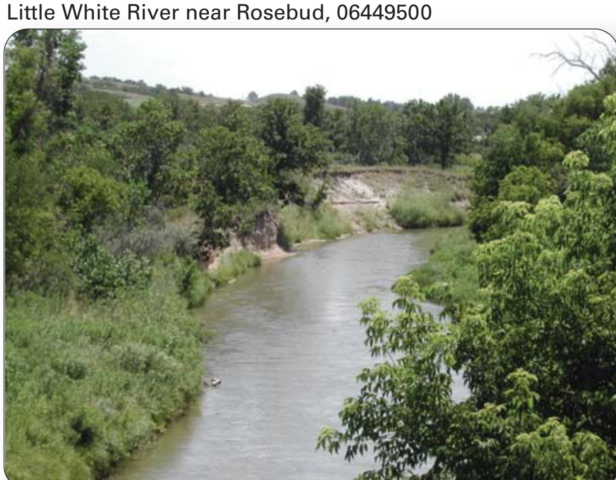
Figure 12. Boxplots of suspended-sediment concentration for the Little White River and tributaries.

Little White River near Vetal, 06449100

Little White River, Valandra Bridge, near Spring Creek, 430939101003500

Little White River above Rosebud, 06449300

Little White River near Rosebud, 06449500



Little White River near Todd/Mellette County line, 432136100520700

Figure 13. Photographs of riparian areas along the Little White River, Todd County.

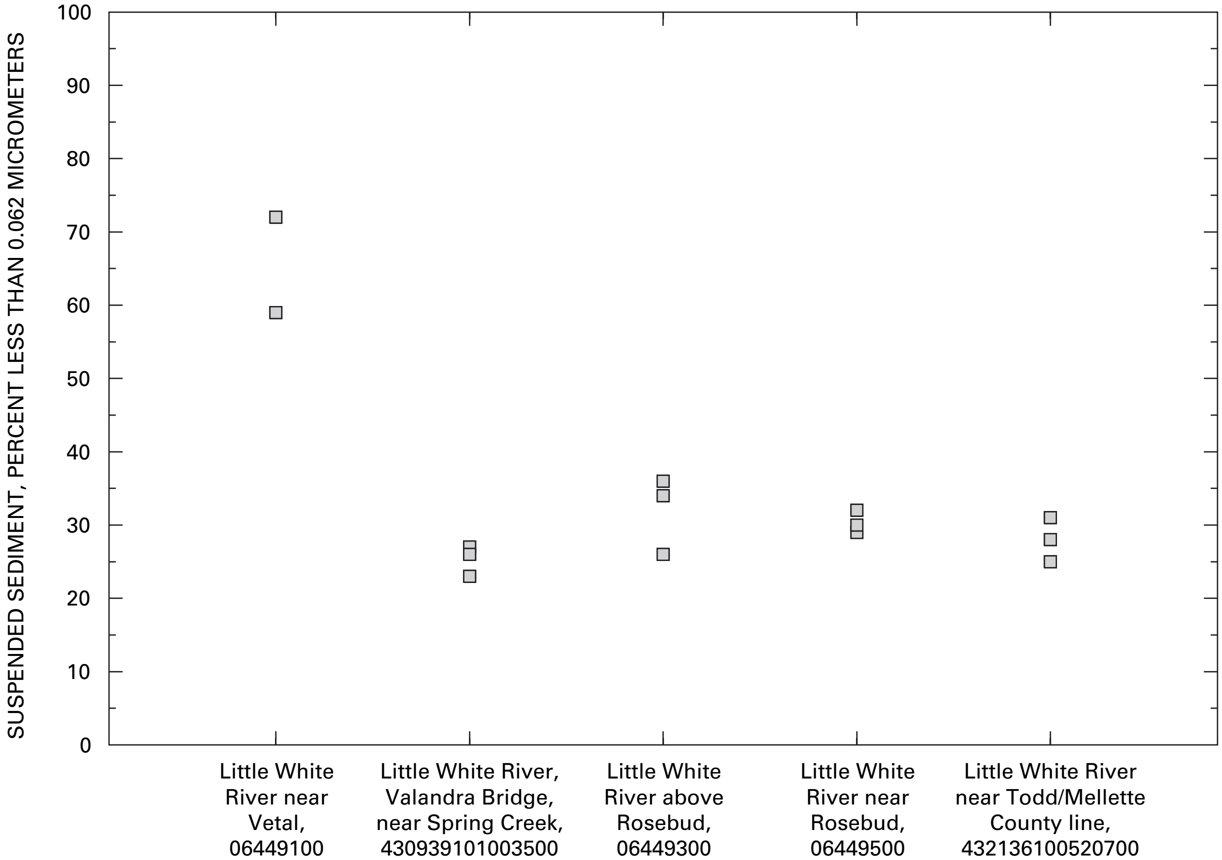


Figure 14. Suspended-sediment size for selected sites on the Little White River, Todd County.

Slope within a basin is another variable that can influence sediment transport and is a driver of the stream velocities. Table 8 presents a summary of elevation changes between sites on the Little White River. The site Little White River near Martin, 06447500, is outside the study area in Jackson County, and provides information for comparison. The river slope in the Little White River changes from 6.9 ft/mi (near Martin to near Vetal) to 9.4 ft/mi (near Vetal to above Rosebud), and the mean suspended-sediment concentration (based on period of record) increased from 199 to 867 mg/L. The reach from near Vetal to above Rosebud flows through the part of the basin where outcrops of the Ogallala Formation are present (fig. 3). The reach from above Rosebud to near Rosebud also has a substantial increase in slope (9.4 to 13 ft/mi), but the suspended-sediment concentration did not increase (867 to 769 mg/L). This section of the river flows through the part of the basin where outcrops of the Arikaree Formation are present (fig. 3). Typically, when river slope increases, stream velocities increase, and sediment transport capabilities increase. Because mean suspended-sediment concentrations did not increase in the reach from above Rosebud to near Rosebud when river slope increased, this indicates that the Arikaree Formation is not contributing substantially to the total sediment load in the Little White River.

Sand road near Little White River, approximately 30 feet from river.

Streambank available for collapse and movement downstream during higher flows.

Sand transport after a storm from bank near bridge crossing where roadway construction disturbed existing grasses.

Figure 15. Photographs representing examples of high-sand areas or where sand movement has taken place along the Little White River.

Table 8. Decrease in elevation between selected sites on the Little White River.

[mi, mile; ft, feet; mg/L, milligrams per liter; NA, not available]

Little White River site				Distance between sites (mi)	Decrease in elevation between sites (ft)	Slope (ft/mi)	Mean suspended-sediment concentration at downstream site (mg/L)
Upstream site		Downstream site					
06447500	Little White River near Martin	06449100	Little White River near Vetal	38	264	6.9	199
06449100	Little White River near Vetal	06449300	Little White River above Rosebud	39	365	9.4	867
06449300	Little White River above Rosebud	06449500	Little White River near Rosebud	9	121	13	769
06449500	Little White River near Rosebud	06450500	Little White River below White River	31	382	12	NA

Duration Analysis

One of the factors for setting a stream's criteria is to examine natural and anthropogenic influences. Duration graphs of concentrations or loads associated with a constituent can be used to visually examine when the constituent is exceeding current or target criteria (fig. 16). The x-axis for each plot is the flow duration determined from the period of record (table 3) at each site. The y-axis is the suspended-sediment load calculated by multiplying the measured streamflow and suspended-sediment concentration from the samples collected at each site (1957–2003) by a conversion factor (0.0027). Each dot in figure 16 corresponds to a suspended-sediment load and the streamflow when the sample was collected. The solid curve on each plot corresponds to the calculated load based on the current State standard for warmwater semi-permanent fisheries of 158 mg/L for total suspended solids multiplied by historical daily mean flow values. Samples plotting above the curve that were collected during low-flow or dry conditions (flow exceedances greater than 60 percent) indicate point-source influences; samples plotting above the curve that were collected during average-flow or moist conditions (flow exceedances between 60 and 10 percent) indicate poor riparian health; and samples plotting above the curve that were collected during high-flow or wet conditions (flow exceedances less than 10 percent) indicate streambank erosion (Bruce Cleland, America's Clean Water Foundation, written commun., 2004).

During high-flow conditions, measured suspended-sediment loads are greater than this curve at all three sites; during average-flow conditions, measured suspended-sediment loads are near the curve at the site near Vetal and greater than the curve at the other two sites; and during low-flow conditions, the measured suspended-sediment load is less than the curve at the site near Vetal and near the curve at the other two sites (fig. 16). Based on Bruce Cleland's discussions (America's Clean Water Foundation, written commun., 2004), improving land-use practices such as contour strips and conservation tillage, improving riparian health, and increasing buffer zones along the streams may reduce the suspended-sediment load measured during the average-flow periods; however, many of these practices are already in place within Todd County.

Both the Little White River above Rosebud and near Rosebud have concentration exceedances throughout the range of flows. This indicates that with no known point sources of sediment other than the natural geology and with existing good riparian health, a decrease in the sediment load to meet the current standards likely is unattainable.

With a goal of less than 10 percent exceedance of a standard, the RST may need to establish a standard with a higher concentration than the current State standard for the Little White River. This is one option that the State currently (2005) is investigating for the reach of the Little White River within Mellette County (Robert Smith, South Dakota Department of Environment and Natural Resources, oral commun., 2005). One option would be to have a standard similar to the current standard, which is constant throughout the flow regime. Another option would be to have a standard that varies with flow such as a stepped standard. The advantage of the latter option is that it may restrict future degradation at low flows. This type of standard would be more restrictive for all flows and would require measured discharge with all suspended-sediment sampling. Examples of possible scenarios for higher or different standards

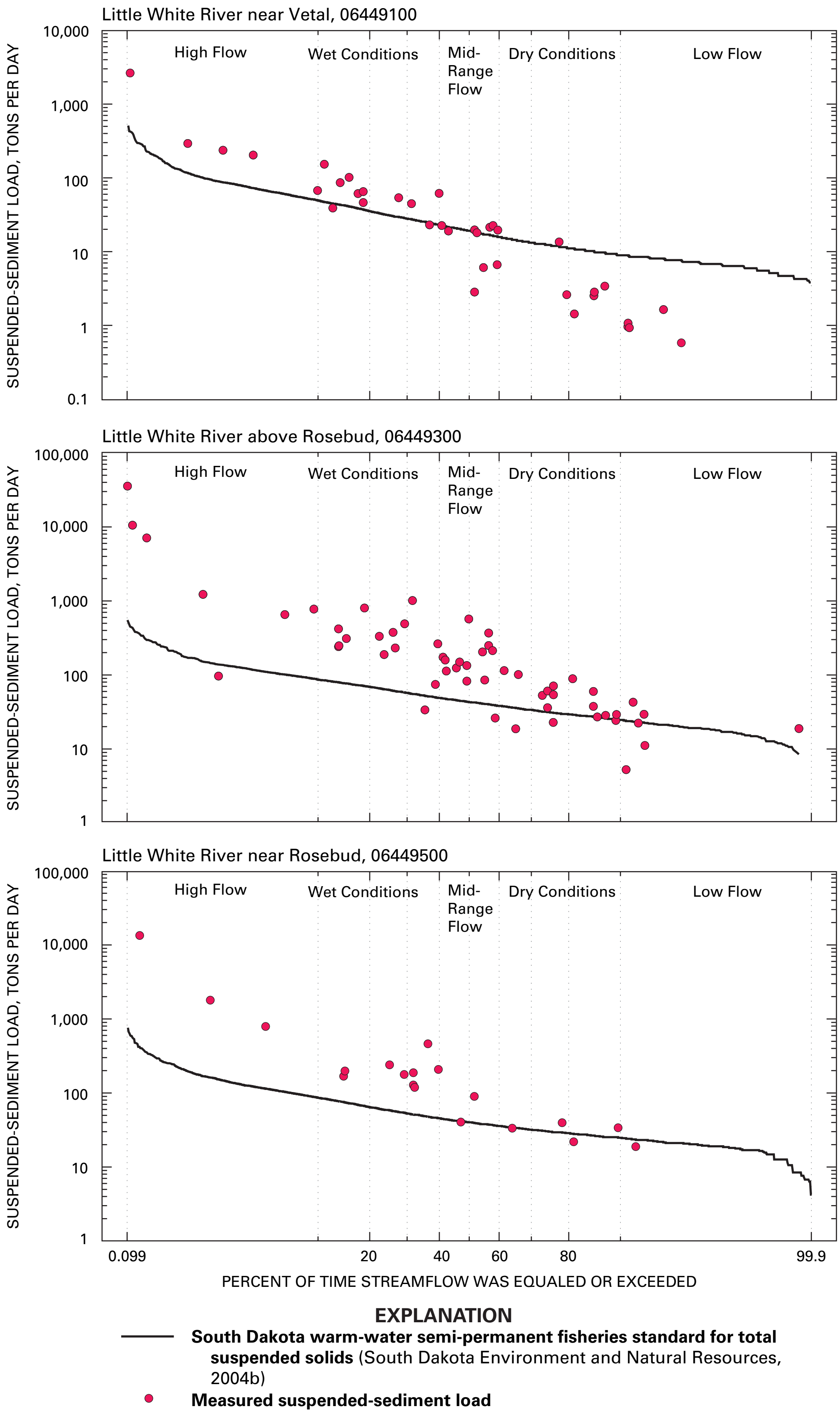


Figure 16. Suspended-sediment load duration curves for selected sites on the Little White River.

are provided in figure 17. The Little White River sites above Rosebud and near Rosebud have similar ranges of flow and suspended-sediment concentrations; however, more data are available for the site above Rosebud and this may be a better site from which to make decisions. For example, if the site near Rosebud was used to establish a stepped standard for the reach of the Little White River within Todd County, then more than 10 percent exceedance would likely take place in all flow regimes. A stepped standard established on the basis of the site above Rosebud likely would be attainable for all sites within Todd County. Data collected by the State downstream from the Todd/Mellette County line may have lower concentrations because of the differences in laboratory methods as previously described in the Sampling and Analysis Methods section. It would be beneficial for RST and State staff to work together to establish a new standard. A lower standard likely would be more appropriate for the Little White River upstream from the outcrop of the Ogallala Formation than downstream from this outcrop.

Simulated Flow and Sediment Transport

To further examine sediment transport within the Little White River within Todd County, this portion of the Little White River was simulated using the one-dimensional flow and sediment transport model CONCEPTS (Conservational Channel Evolution and Pollutant Transport System). CONCEPTS was developed by the National Sedimentation Laboratory, U.S. Department of Agriculture, to simulate open-channel hydraulics, sediment transport, and channel morphology (Langendoen, 2000). CONCEPTS predicts response of flow and sediment transport to instream hydraulic structures and computes channel evolution including elevation changes, channel widening, basal scour, and mass wasting. Flow is computed as a function of time and sediment transport rates account for sediment size fractions. Sediment transport is further defined with adjustments for fluvial erosion or entrainment of bank material and bank mass failure due to gravity.

Simulation of sediment transport can assist with determination of the maximum load a stream can receive without exceeding allowable limits, identification and assessment of point and nonpoint sources of sediment, and development and evaluation of load reduction scenarios. For the Little White River in Todd County, where sediment concentrations already exceed the current (2004) State standard on a regular basis, the model can be used to help evaluate appropriate sediment concentration for development of a standard and could be used in the evaluation of load reduction scenarios.

For CONCEPTS, flow is assumed to be one dimensional along the centerline of the channel and neglects cross-stream variations that are common in a stream reach including debris or rocks, constrictions or expansions, riffles, and point bars. CONCEPTS can model hydraulic changes that take place at structures including bridges, culverts, drop structures, and generic structures for which a rating curve can be developed. The stream corridor is represented as a straight channel with reaches that connect cross sections. A reach is a stream segment that connects two cross sections. The cross sections provide detail to characterize the channel and flow-carrying capacity. Cross sections represent locations throughout the stream corridor where substantial changes occur. For accurate results, cross sections should occur whenever the stream changes in bed slope, shape, and flow-resistance characteristics.

Channel elevations were surveyed for three sites along the Little White River where USGS gaging stations were located (06449100, Little White River near Vetal; 06449300, Little White River above Rosebud; 06449500, Little White River near Rosebud). Other channel cross sections were estimated using digital-elevation data for the area. Cross-section estimates based on digital-elevation data also were determined for the three surveyed sites to check how closely they represent actual field conditions, and differences generally were less than 2 ft. Bridges and culverts were not modeled. To be able to add these structures to the model, surveying of the cross sections above and below each structure would be necessary as would exact measurements of the structures themselves. Cross sections near bridges and culverts were estimated using digital-elevation data.

Because of the limitations of the data collected as part of this study, some general assumptions and estimated model inputs were used. Table 9 presents a summary of the values assigned to the CONCEPTS model for the Little White River. All values assigned to parameters were calculated from data collected along the Little White River, were based on author's best judgment from knowledge of the basin, or were from examples and documents provided by Eddy J. Langendoen (U.S. Department of Agriculture, Agriculture Research Service, National Sedimentation Laboratory, Oxford, Mississippi, written commun., March 26, 2004). Many of the parameters that affect sediment transport were estimated because collection of these data was beyond the scope of this study. For parameters such as friction angles, changes in shear strength, porosity, and hiding coefficients, values associated with sand channels, provided within the manual and training for CONCEPTS (U.S. Department of Agriculture, 2005), were used. CONCEPTS model example input files are provided at the end of the Supplemental Data section for the main input run file and the cross-section file for cross-section 001 (Little White River near Vetal).

The sediment load fraction sizes at the upstream end of the channel were based on two historical analyses of sediment-size distribution for suspended and bed sediment. Bed and bank sediment-size analysis collected as part of this study at the five main stem sites and used for simulation of sediment transport are provided in table 10. An average water temperature of 14°C was selected because temperature ranged from around 6°C to 23°C during the simulated period (April through October 2003).

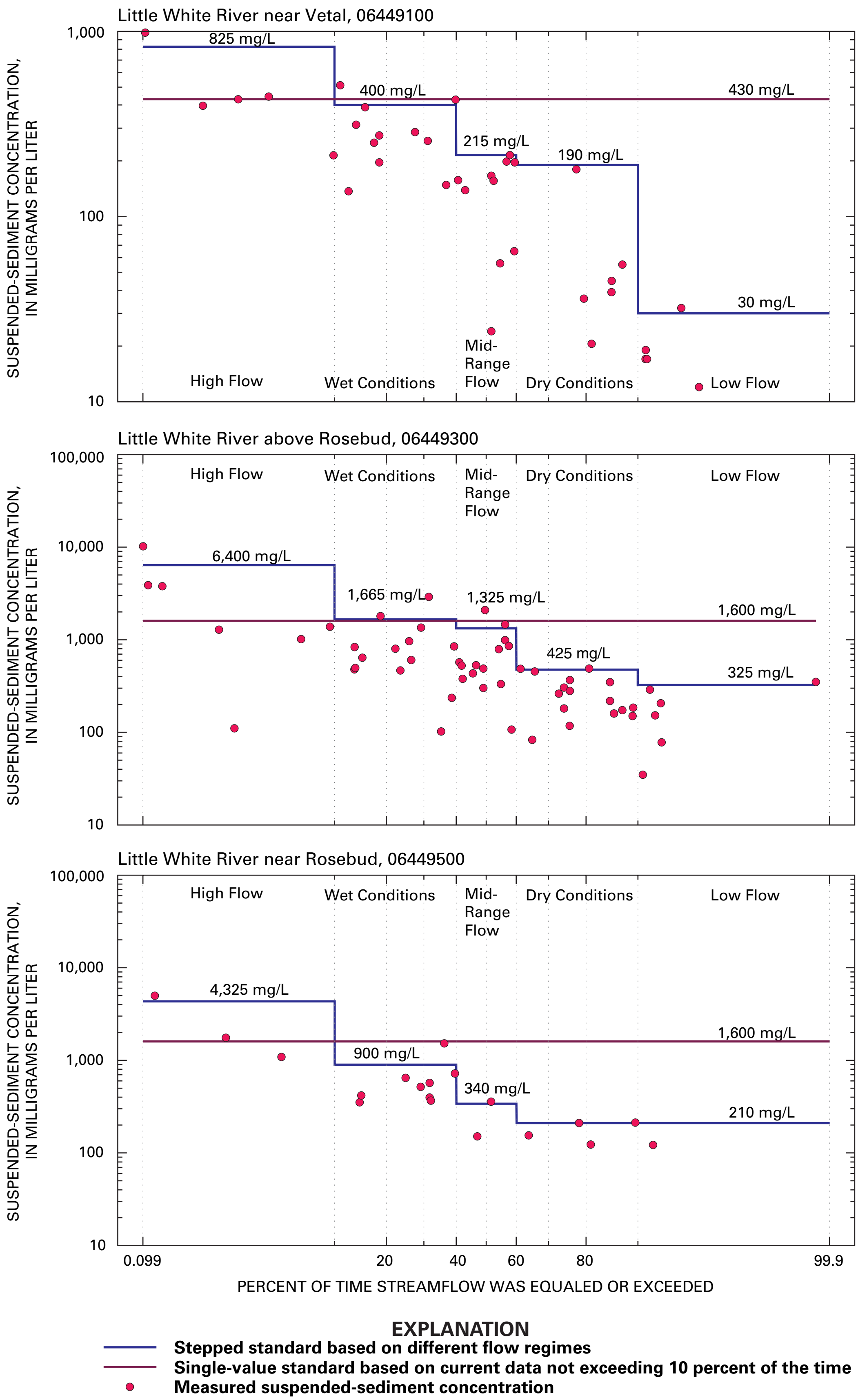


Figure 17. Possible higher suspended-sediment standard examples for selected sites on the Little White River.

Table 9. Summary of values assigned to the CONCEPTS model for the Little White River.

[m, meters; km, kilometers; m^3/s, cubic meters per second; kPa, kiloPascals; Pa, Pascals; m/sPa, meters per second Pascals; N, newton; GIS, geographic information system]

Parameter	Model values assigned	Description	Detail/source
Main run file			
Discharge file	Discharge.txt	Streamflow time-series data at the upstream boundary of the modeled reach (m^3/s).	Daily mean discharge from gaging station Little White River near Vetal, 06449100.
Upstream sediment discharge option and rates	0 1 3 700.65 0.092 11.36 700.93 1.0154 4.312 701.61 2.989 2.775	Rate of lateral inflow (m^3/s), downstream boundary flag (0 or 1), number of rating curve segments (integer). Rating curve variables for h (stage, in m), α (coefficient), and β (exponent) for the downstream boundary site.	Lateral inflow was set to 0, inflows were defined in reach descriptions. Downstream boundary flag is either set to 0 (loop-rating curve) or 1 (user-defined rating curve). Rating curve parameters were set based on breaks in power-curve through actual measured stage/discharge values at the Little White River near Rosebud, 06449500.
Fraction of fines in a cohesive bed	0 0.9 0.3 0.1 0.9 0.3 0.1 0 0 0 0 0 0 0 0	Flag indicating how sediment load is imposed at the upstream boundary (0 or 1); fraction of load carried in each of 13 grain-size classes (real from 0 to 1.0)	Fractions set based on sediment-size distribution data from gaging station Little White River near Vetal, 06449100.
Bed control at downstream boundary	1	Indication of when the bed can be assumed cohesive or cohesionless (0 or 1).	A value of 1 assumes that the bed is always cohesionless.
Bank-failure analysis options	7 5 10	Level of complexity of the stability analysis (integer, 1-7), number of possible elevations at which the slip surface may intersect the bank profile (mass wasting) (integer), the frequency of application of the bank-stability analysis algorithm (integer).	All processes were used: positive pore-water pressure, confining pressures, and matric suction; common slip surface intersections and algorithm counts were used.
Type of bed resistance formulation	1	Flag to use friction-factor relations or to use user-defined Manning n values (0 or 1).	Used user-defined Manning n values.
Water temperature	14	Water temperature (degrees Celsius).	Average water temperature over the modeled time frame.
Sediment and streambank mechanics options	1 1 1	Flags for sediment routing and bed adjustment (0 or 1), streambank fluvial erosion (0 or 1), and streambank mass-wasting (0 or 1).	Simulated all three processes.
Simulation times	04/01/2003 12:00 to 11/30/2003 12:00 with a time step of 86400 seconds (1 day)	Start and end time for the simulation and the time step (seconds).	Simulated time period of sampling during 2003.
Number of links	1	The number of links simulated (integer).	The stream was simulated as one single link with 12 cross sections.

Table 9. Summary of values assigned to the CONCEPTS model for the Little White River.—Continued

[m, meters; km, kilometers; m^3/s, cubic meters per second; kPa, kiloPascals; Pa, Pascals; m/sPa, meters per second Pascals; N, newton; GIS, geographic information system]

Parameter	Model values assigned	Description	Detail/source
		Cross-section files	
River kilometer	Varies by cross section	Location of the cross section; distance from upstream boundary (km).	Based on GIS data to get stream reach between cross sections.
Friction factor	Varies by cross section	Manning n for the total cross section (real).	Author's judgment and knowledge of the site.
Tributary inflow	0 or 1 followed by tributary file name (varies by cross section)	Value set to 0 for those stream segments/cross sections without any tributary inflow, otherwise set to 1 followed by the tributary inflow file name. Tributary inflow in m^3/s.	Most cross sections had tributary inflow files; a few from actual measured streamflow, all others were estimated.
		Floodplain variables (left and right)	
Friction factor	Varies by cross section	Manning n value for the left floodplain (real).	Authors judgment and knowledge of the site.
Streambank coordinates	Varies by cross section	Number of points, station (x) and elevation (y) coordinates in meters.	Cross section 1, 9, and 11 were surveyed, balance of cross sections were calculated based on GIS elevation data.
		Bank variables (left and right)	
Number of soil layers	1	Number of soil layers in the stream bank (integer).	Assumed that soil layer is consistent throughout the soil layer and that core samples are representative of entire bank material.
Elevation of layer top	Varies by cross section	The elevation of the top of the soil layer (meters).	Generally given as the top elevation of the floodplain.
c'	0	Effective cohesion (kPa).	Typical values for rounded sand.
ϕ	27	Friction angle/angle of internal friction (degrees).	Typical values for rounded sand.
ϕ^b	15	Angle indicating increase in shear strength for an increase in matric suction (degrees).	Typical values for rounded sand.
γ_s	18,000	Specific weight of sediment (N/m^3).	Typical values for rounded sand.
Bank erodibility	10	Critical shear stress (Pa).	Used values from example input files with similar streambed and bank sediment fractions data.
Sediment composition	Varies by cross section	Sediment composition based on 13 size fractions.	Sediment fractions based on sediment-size distribution results from streambank sediment core samples. Fractions from non-measured locations were set to match next closest site or to match site with closest geological outcrops.

Table 9. Summary of values assigned to the CONCEPTS model for the Little White River.—Continued

[m, meters; km, kilometers; m^3/s, cubic meters per second; kPa, kiloPascals; Pa, Pascals; m/sPa, meters per second Pascals; N, newton; GIS, geographic information system]

Parameter	Model values assigned	Description	Detail/source
		Bank variables (left and right)—Continued	
Ground-water table	Varies by cross section	Elevation of ground-water table (m).	Used values that were approximately halfway up the stream bank.
Friction factor	Varies by cross section	Manning n value for the left streambank (real).	Author's judgment and knowledge of the site.
		Channel bed	
Bed coordinates	Varies by cross section	Number of points, station (x) and elevation (y) coordinates (m).	Cross section 1, 9, and 11 were surveyed, balance of cross sections were calculated based on GIS elevation data.
Bedrock elevation	0	Elevation of bedrock below the streambed (m).	Used a value of 0 which allowed for unlimited bed cutting and movement.
λ	0.40	Porosity (real).	Average of typical values for fine- to medium-grained sand sediments.
Hiding factors	0.25 0.95 0.70	Hiding factors for silt, sand, and gravel (real).	Used values from example input files with similar streambed and bank sediment fractions data.
Number bed layers	1	Number of soil/sediment layers in the streambed (integer).	Assumed that soil layer is consistent throughout the soil layer and that core samples are representative of entire bed material.
Bed composition	Varies by cross section	Sediment composition based on 13 size fractions.	Sediment fractions based on sediment-size distribution results from bed sediment core samples. Fractions from non-measured locations were set to match next closest site or to match site with closest geological outcrops.
τ_d	0.10	Critical shear stress to deposit sediment particles (Pa).	Used values from example input files with similar streambed and bank sediment fractions data.
τ_e	7.05	Critical shear stress to entrain sediment particles (Pa).	Used values from example input files with similar streambed and bank sediment fractions data.
Erodibility Coefficient	$3.40E^{-07}$	Erodibility coefficient (m/sPa).	Used values from example input files with similar streambed and bank sediment fractions data.
Channel friction factor	Varies by cross section	Manning n value for the channel.	Author's judgment and knowledge of the site.

Table 10. Results of bed and bank sediment analysis for selected sites on the Little White River.

Site	06449100 Little White River near Vetal			430939101003500 Little White River, Valandra Bridge, near Spring Creek		
Sieve size (micrometers)	Left bank (percent less than)	Bed (percent less than)	Right bank (percent less than)	Left bank (percent less than)	Bed (percent less than)	Right bank (percent less than)
0.002	2	0	1	2	0	2
0.004	2	0	1	2	0	2
0.008	2	0	1	3	0	3
0.016	3	0	1	4	0	3
0.031	7	0	3	7	0	6
0.063	21	0	11	17	0	18
0.125	37	2	29	44	3	38
0.25	84	29	55	84	43	72
0.5	99	88	87	97	85	96
1	100	97	99	100	94	100
2	100	98	100	100	95	100
4	100	99	100	100	97	100
8	100	100	100	100	97	100
Site	**06449300 Little White River above Rosebud**			**06449500 Little White River near Rosebud**		
Sieve size (micrometers)	**Left bank (percent less than)**	**Bed (percent less than)**	**Right bank (percent less than)**	**Left bank (percent less than)**	**Bed (percent less than)**	**Right bank (percent less than)**
0.002	8	0	8	9	0	4
0.004	8	0	9	11	0	4
0.008	10	0	11	13	0	5
0.016	12	0	13	19	0	6
0.031	25	0	27	26	0	12
0.063	66	1	67	47	1	28
0.125	89	5	93	66	6	63
0.25	92	41	99	88	38	94
0.5	99	91	100	97	83	100
1	100	99	100	98	97	100
2	100	99	100	100	98	100
4	100	100	100	100	98	100
8	100	100	100	100	99	100

Table 10. Results of bed and bank sediment analysis for selected sites on the Little White River.—Continued

Site	432136100520700 Little White River near Todd/Mellette County line		
Sieve size (micrometers)	Left bank (percent less than)	Bed (percent less than)	Right bank (percent less than)
0.002	5	0	4
0.004	6	6	4
0.008	6	0	4
0.016	8	0	5
0.031	16	0	10
0.063	46	0	34
0.125	80	1	77
0.25	92	23	97
0.5	98	76	100
1	98	94	100
2	100	97	100
4	100	99	100
8	100	100	100

Continuous streamflow at Sawmill Canyon, Rosebud Creek, and Soldier Creek was used to estimate daily tributary inflows from other sites along the Little White River. Regression relations were used to estimate flow, which was then checked and adjusted on the basis of measured streamflow. This method allowed changes to reflect localized storms within selected basins. Some of the variation within the model output is attributed to lack of continuous streamflow at additional tributaries. Storms can be localized within the basin and can produce a high enough volume to change model results. Sediment loading from the tributaries is relatively minor in comparison to the transport within the Little White River; however, it should be acknowledged that intense storms within a tributary basin can produce large sediment loads.

The model was calibrated by first simulating streamflow, with all variables for sediment transport turned off. Initially the simulation was run as one stream reach with a cross section at the upstream boundary (Little White River near Vetal, 06449100) and a cross section at the most-downstream gaging station (Little White River near Rosebud, 06449500). Next, the additional cross sections and tributary inflows were added. The stage-discharge relation necessary for the downstream boundary was based on measured values from the Little White River near Rosebud, 06449500. Simulated and measured streamflow through the Little White River Basin are presented in figure 18. The lack of fit for the May 25, 2003, event for Little White River near Rosebud is attributed to sparse tributary inflow information. A site visit at the South Fork of Ironwood Creek in June 2003 provided evidence of a large, localized storm, with high flows and high sediment transport. Gaps between the measured and simulated streamflow also are attributed to sparse tributary inflow information. The lack of detailed information on hydraulic structures also may account for differences between simulated and measured streamflow.

Once streamflow calibration was complete, sediment transport variables were included, based on best knowledge, actual data collected, and estimates. In an effort to model the sediment transport within the system, estimated values were varied within ranges often reported for sand-dominated stream channels. Five storms were simulated using the 2003 data—April 29 to May 19, May 21 to June 2, June 16 to July 10, September 16–25, and October 16–24. The May 21 event was the largest single event during 2003. The April period represents snowmelt and early spring rainfall, the May and June periods are a sequence of storm events over a 3-week period, and the September and October periods are relatively small storm events. Sediment load results for selected locations on the river are presented in table 11 and figure 19. Regression-based load results were calculated from continuous streamflow values for the storm event period and regression equations presented in table 7.

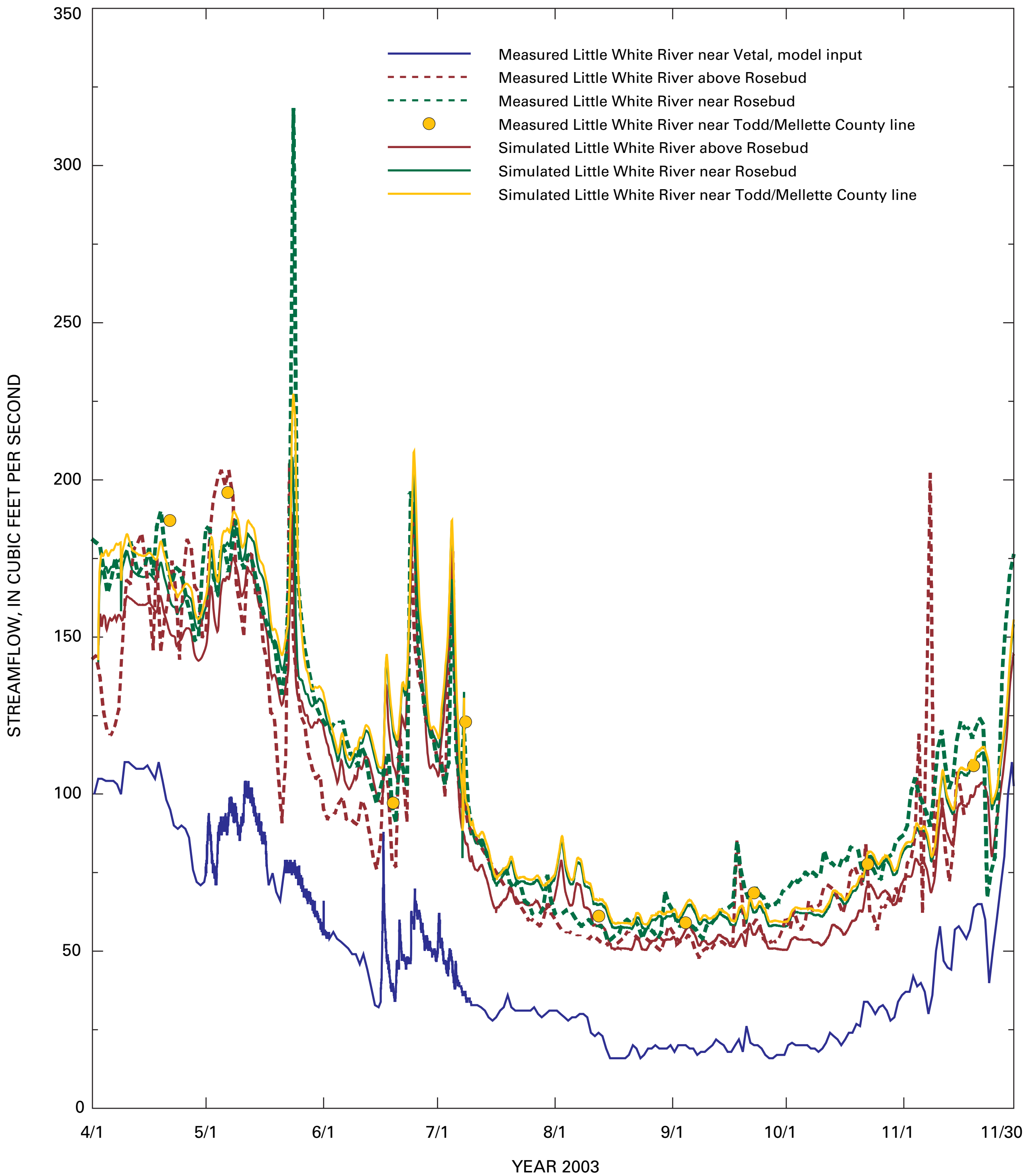


Figure 18. Measured and simulated streamflow for selected sites on the Little White River.

Table 11. Simulated sediment load compared to regression-based sediment load for selected storms and sites on the Little White River, 2003.

[--, no data]

Storm event dates	06449100 Little White River near Vetal			06449300 Little White River above Rosebud			06449500 Little White River near Rosebud		
	Simulated load (tons per event)	Regression-based load (tons per event)	Percent difference between simulated load and regression-based load estimate	Simulated load (tons per event)	Regression-based load (tons per event)	Percent difference between simulated load and regression-based load estimate	Simulated load (tons per event)	Regression-based load (tons per event)	Percent difference between simulated load and regression-based load estimate
04-29-2003 to 05-19-2003	120	952	87	341	7,305	95	550	6,910	92
05-21-2003 to 06-02-2003	536	420	28	1,420	2,730	48	2,360	3,950	40
06-16-2003 to 07-10-2003	1,710	507	240	2,360	4,880	52	4,620	4,010	15
09-16-2003 to 09-25-2003	490	70	600	546	797	31	936	431	120
10-16-2003 to 10-24-2003	390	141	180	635	1,210	48	897	732	22
Average sediment load, per day	41	--	--	68	--	--	116	--	--

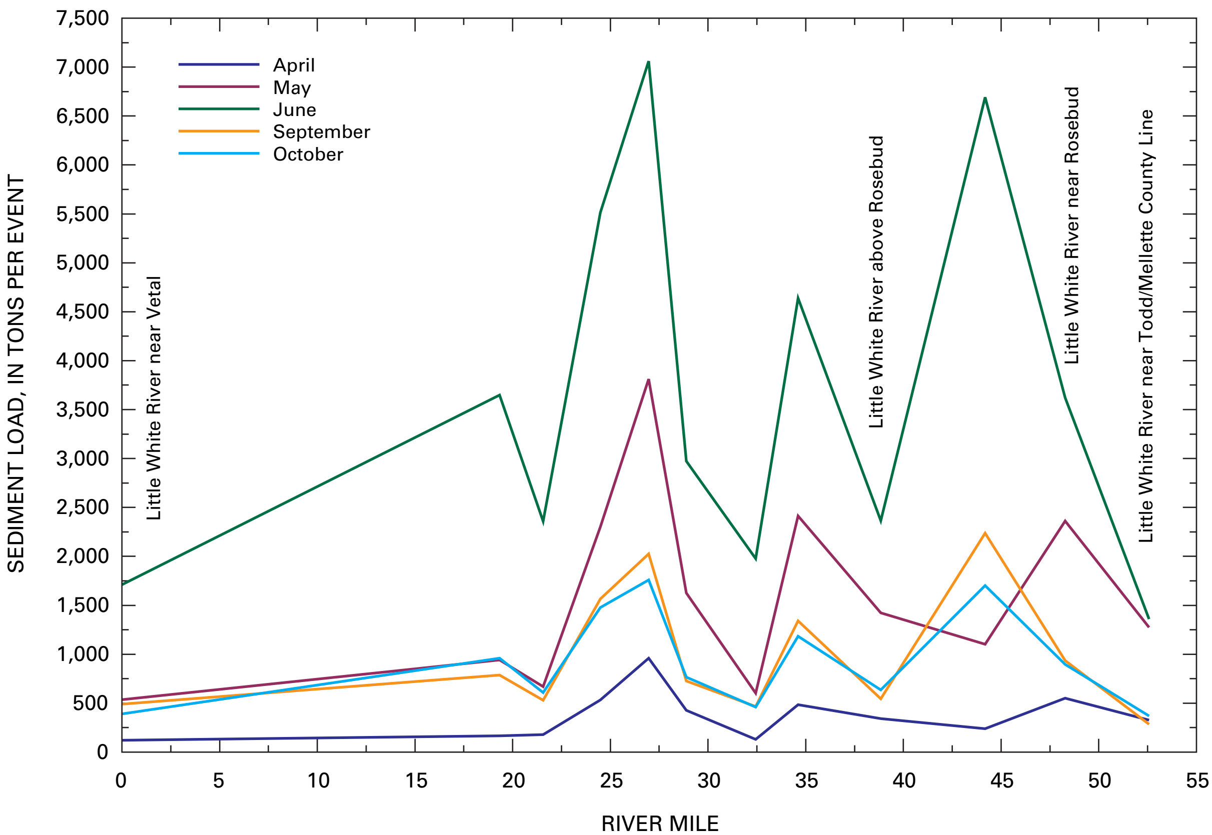


Figure 19. Simulated storm-event sediment load on the Little White River.

The CONCEPTS model was calibrated and produced reasonable results with the data available for this effort. The model can be used to simulate changes in sediment transport including the response of the system to increases or decreases in sediment load upstream of the study area and any response to increased sediment contributions from a tributary within the study area. Additional sampling would be necessary to quantify and correctly adjust the model to reflect those changes. The model would provide more accurate simulation results with additional details for all hydraulic structures including the various bridges and culverts along the stream, more accurate continuous tributary inflow particularly during storm events, and basin-specific measurements to address the streambank properties for cohesion, friction angle, and critical shear stress.

The simulated sediment load for the April snowmelt/early spring rainfall were considerably less than the regression-based load. The season and intensity of a storm are just a couple of the factors that affect the sediment transported. A steady runoff, which would be typical in the early spring, generally would result in less sediment transport than would a summer thunderstorm. Because the regression equations are derived from point samples and are not inclusive of an entire storm hydrograph, the simulated load results probably are more representative of actual sediment load. For this type of event, the model probably provides a better estimate of the sediment transport. Results are similar for the May storm event, which was more intense than the April event. The simulated sediment load generally was lower than the regression-based load; however, the simulated streamflows also were less than the measured streamflows, and that would account for much of this variability. The simulated and regression-based loads for the sequence of storms in June and July also were most similar at each of the two downstream sites, with differences attributed to the simulated streamflow varying from measured streamflow. Loads for the September and October storms were most similar at each of the two downstream sites.

Figure 19 shows how simulated loads change through the river reach from the Bennett/Todd County line to near the Todd/Mellette County line for each simulated storm event. The simulation results indicate that the largest sediment loads occurred between river mile 20 and river mile 27 and between the Little White River above Rosebud (river mile 38) and river mile 45 for most events. These results could change considerably with changes in the model bank parameters that characterize bank stability. Based on simulated sediment loads, the Little White River near Vetal averages 41 ton/d, the Little White River above Rosebud averages 68 ton/d, and the Little White River near Rosebud averages 116 ton/d (table 11).

The model also can simulate other results such as change in thalweg or lowest point in the channel, streambed and bank changes, and peak discharge. For the data collected as part of this study, the change in riverbed was minimal (inches); however, the model did predict streambank failures at the Little White River near Vetal site during April and May. The accuracy of these results would likely increase with more accurate input values for the model streambank material parameters.

Biological Characteristics

Benthic macroinvertebrates were sampled in August 2003 at three sites as part of this study. The RST also sampled for macroinvertebrates in 1996 at the same three sites. Table 12 presents the RST data, and table 13 presents the results of the 2003 sampling efforts. Benthic macroinvertebrates typically are abundant in most streams, are reasonably easy to collect, and are good indicators of localized conditions. Results can be used in comparisons with index or reference sites, for comparing and assessing sites within the same stream, and for comparisons from one year to another. This report uses the two latter comparisons. Because macroinvertebrates have limited migration patterns, they are well suited for assessing site-specific conditions. With complex life cycles of about 1 year, macroinvertebrates integrate the effects of environmental variations and can respond quickly to stressors.

Different metrics can be used as indicators of aquatic health. Number of individuals, number of taxa found, and number of individuals in specific taxa can provide indications of the richness or diversity at a site. Typically, these numbers decrease when the site is disturbed or impaired. Actual counts also will vary with sampling methods so comparisons from one year to another may not be valid if the sampling methods are not similar. Smaller counts are present in the RST 1996 data when compared to the USGS 2003 data. This may be a result of different sampling methods within the stream. Methods used by the RST followed their Standard Operating Procedures at the time, which were developed from USEPA methodology (Kvame and others, 1997). The USGS collection methods followed current USEPA EMAP protocols (U.S. Environmental Protection Agency, 2005). Although the richness metrics can not be compared between 1996 and 2003 data, comparisons can be made between sites.

In 1996, the number of individuals decreased from upstream to downstream, but the number of taxa stayed consistent. The number of ephemeroptera, plecoptera, and trichoptera (EPT) increased from site 1 (near Vetal) to site 2 (Valandra Bridge near Spring Creek) and then decreased from site 2 to site 5 (near Todd/Mellette County line) with similar numbers at site 1 and site 5. For the 2003 data, total number of individuals increased from upstream to downstream and the number of taxa stayed constant at all three sites. The number of EPT taxa again increased from site 1 to site 2 and then decreased from site 2 to site 5. Decreases in the EPT count may be an indication of impairment or disturbance between the sites. The dominate species in 1996 had functional feeding designations of filter/collector and gatherer/collector. The dominate species in 2003 had functional feeding designations of predator for site 1 and gatherer/collector for sites 2 and 5.

Other metrics provide an indication of the presence of tolerant species. These species typically will remain at a site that is impaired when less tolerant species are not present. The Family Biotic Index (FBI) is a sum of the number of individuals in a family times a tolerance factor, divided by the total number of individuals. Tolerance scales range from 10 to 0, with 10 indicating poor condition and 0 indicating healthy conditions. In 1996, site 1 had the highest FBI of 5.19, site 5 was next with a FBI of 4.37, and site 2 was the healthiest with a FBI of 3.47. In 2003, the same pattern was present and numbers were very comparable at 5.26 (site 1), 3.02 (site 2), and 4.51 (site 5). The percentage of dominant taxa (total number of the dominant taxa divided by the total number of individuals) generally increases with impairment or disturbance within a stream. In 1996, the percentages decreased from site 1 to site 2 and then increased from site 2 to site 5, following the same general trend as the FBI. In 2003, the percentages decreased from site 1 through site 5 and were less than the percentages calculated for the 1996 data. The percentage of total organisms that are considered to be tolerant followed the same trend as the FBI for both 1996 and 2003. All of the tolerance metrics indicate that the biological health of the stream improves from site 1 to site 2 but decreases again from site 2 to site 5, with site 1 and site 5 having similar metrics.

Composition metrics generally are percentages of selected taxa or groups of taxa compared to the total number of individuals and, depending on the taxa, increase or decrease with stream health. Percent Diptera and percent Chironomidae typically increase and percent EPT typically decreases with disturbance. The 1996 and 2003 composition metrics generally follow the same trends of stream health as the tolerance metrics, with percentages indicating an increase in stream health from site 1 to site 2 and then a decrease in stream health from site 2 to site 5.

Feeding measures represent the percentage of the macroinvertebrates that feed a particular way. For example, grazers and scrapers graze or scrape upon periphyton. Results are variable for most feeding measures with the exception of percent shredders, which decrease with perturbation. Percent collectors decreased slightly from site 1 to site 2 for the 1996 data and increased from upstream to downstream for the 2003 data. The percent shredders increased from site 1 to site 2 then decreased from site 2 to site 5 for the 1996 data with the exact opposite trend in 2003. The 1996 shredder data follow the same general trend observed in most of the other biological metrics.

Table 12. Results of macroinvertebrate sampling in 1996 by the Rosebud Sioux Tribe and selected metric calculations.

[Functional feeding groups: FC, filter/collector; GC, gatherer/collector; PR, predator; SC, scraper; SH, shredder. EPT, Ephemeroptera, Plecoptera, and Trichoptera; FBI, Family Biotic Index. --, no data or not applicable]

Phylum	Class	Order	Family	Little White River near Vetal (site 1)	Little White River near Valandra Bridge (site 2)	Little White River near Todd/Mellette County line (site 5)	Benthic tolerance[1]	Functional feeding designations
Annelida	Oligochaeta	Tubificida	--	--	--	--	10	GC
Anthropoda	Insecta	Coleoptera	Dytiscidae	1	--	--	5	PR
Anthropoda	Insecta	Coleoptera	Elmidae	1	1	1	4	GC
Anthropoda	Insecta	Coleoptera	Hydrophilidae	1	--	--	5	PR
Anthropoda	Insecta	Diptera	Anthericidae	--	--	6	7	
Anthropoda	Insecta	Diptera	Chironomidae	24	12	8	6	GC
Anthropoda	Insecta	Diptera	Simuliidae	101	7	13	6	FC
Anthropoda	Insecta	Ephemeroptera	Baetidae	26	21	45	4	GC
Anthropoda	Insecta	Ephemeroptera	Caenidae	17	8	--	7	GC
Anthropoda	Insecta	Ephemeroptera	Heptageniidae	9	13	3	4	SC
Anthropoda	Insecta	Ephemeroptera	Oligoneuriidae	4	22	--	0	GC
Anthropoda	Insecta	Ephemeroptera	Tricorythidae	13	10	5	4	GC
Anthropoda	Insecta	Gastropoda	Physidae	--	1	--	8	SC
Anthropoda	Insecta	Hemiptera	Gerridae	1	--	--	5	PR
Anthropoda	Insecta	Odonata	Calopterygidae	--	1	--	0	PR
Anthropoda	Insecta	Odonata	Gomphidae	9	8	2	1	PR
Anthropoda	Insecta	Plecoptera	Chloroperlidae	--	--	2	1	PR
Anthropoda	Insecta	Plecoptera	Perlidae	--	2	--	1	PR
Anthropoda	Insecta	Plecoptera	Pteronarcyidae	--	3	--	0	SH
Anthropoda	Insecta	Trichoptera	Hydropsychidae	4	33	27	4	FC
Anthropoda	Insecta	Trichoptera	Hydroptilidae	--	--	5	4	--
Anthropoda	Insecta	Trichoptera	Leptopceridae	3	2	1	0	--

Table 12. Results of macroinvertebrate sampling in 1996 by the Rosebud Sioux Tribe and selected metric calculations.—Continued

[Functional feeding groups: FC, filter/collector; GC, gatherer/collector; PR, predator; SC, scraper; SH, shredder. EPT, Ephemeroptera, Plecoptera, and Trichoptera; FBI, Family Biotic Index. --, no data or not applicable]

Phylum	Class	Order	Family	Little White River near Vetal (site 1)	Little White River near Valandra Bridge (site 2)	Little White River near Todd/Mellette County line (site 5)	Benthic tolerance[1]	Functional feeding designations
Category	Metric							
	Total number of individuals			215	144	118	--	--
	Dominant species			Simuliidae	Hydropsychidae	Baetidae	--	--
Richness	Number of taxa			15	15	12	--	--
Richness	Number of EPT taxa			76	114	88	--	--
Tolerance	FBI			5.19	3.47	4.37	--	--
Tolerance	Percent dominant taxa			46.98	22.92	38.14	--	--
Tolerance	Percent tolerant organisms			67.91	19.44	22.88	--	--
Composition	Percent Diptera			58.14	13.19	22.88	--	--
Composition	Percent Chironomidae			11.16	8.33	6.78	--	--
Composition	Percent EPT			35.35	79.17	74.58	--	--
Feeding	Percent collectors			88.84	79.17	83.90	--	--
Feeding	Percent filterers			48.84	27.78	33.90	--	--
Feeding	Percent scrapers			4.19	9.72	2.54	--	--
Feeding	Percent shredders			0	2.08	0	--	--
Feeding	Percent predators			5.58	7.64	3.39	--	--

[1]U.S. Environmental Protection Agency, 2005.

Table 13. Results of macroinvertebrate sampling in 2003 and selected metric calculations.

Functional feeding groups: FC, filter/collector; GC, gatherer/collector; PR, predator; SC, scraper; SH, shredder. Life stage: A, adult; L, larvae, P, pupae. EPT, Ephemeroptera, Plecoptera, and Trichoptera; FBI, Family Biotic Index. --, no data or not applicable]

Phylum	Class	Order	Family	Revised Taxa	Little White River near Vetal (site 1)	Little White River near Valandra Bridge (site 2)	Little White River near Todd/Mellette County line (site 5)	Benthic tolerance[1]	Functional feeding designation	Life stage
Nematoda	--	--	--	Nematoda	4	2	--	5	PA	--
Annelida	Oligochaeta	Tubificida	Naididae	Naididae	20	4	10	--	GC	--
Annelida	Oligochaeta	Tubificida	Tubificidae	Tubificidae	8	4	52	10	GC	--
Arthropoda	Insecta	Ephemeroptera	--	Ephemeroptera	--	--	6	--	GC	L
Arthropoda	Insecta	Ephemeroptera	Caenidae	Caenis sp.	4	10	34	7	GC	L
Arthropoda	Insecta	Ephemeroptera	Caenidae	Cercobrachys sp.	36	12	2	7	GC	L
Arthropoda	Insecta	Ephemeroptera	Leptohyphidae	Tricorythodes sp.		92	46	5	GC	L
Arthropoda	Insecta	Ephemeroptera	Baetidae	Baetidae	6	40	26	4	GC	L
Arthropoda	Insecta	Ephemeroptera	Baetidae	Centroptilum/Procloeon sp.	4	--	--	--	OM	L
Arthropoda	Insecta	Ephemeroptera	Baetidae	Acentrella sp.	--	16	90	4	GC	L
Arthropoda	Insecta	Ephemeroptera	Baetidae	Acentrella insignificans (McDunnough)	--	2	6	4	GC	L
Arthropoda	Insecta	Ephemeroptera	Baetidae	Camelobaetidius sp.	--	72	22	2	GC	L
Arthropoda	Insecta	Ephemeroptera	Baetidae	Fallceon quilleri (Dodds)	6	60	14	--	GC	L
Arthropoda	Insecta	Ephemeroptera	Baetidae	Paracloeodes minutus (Daggy)	32	6	4	--	SC	L
Arthropoda	Insecta	Ephemeroptera	Baetidae	Plauditus sp.	--	--	12	--	--	L
Arthropoda	Insecta	Ephemeroptera	Oligoneuriidae	Homoeoneuria sp.	80	90	20	--	--	L
Arthropoda	Insecta	Odonata	Coenagrionidae	Coenagrionidae	2	2	--	6	PR	L
Arthropoda	Insecta	Odonata	Gomphidae	Gomphidae	6	72	9	1	PR	L
Arthropoda	Insecta	Odonata	Gomphidae	Ophiogomphus sp.	--	1	--	1	PR	L
Arthropoda	Insecta	Hemiptera	Corixidae	Corixidae	138	--	--	10	PR	L
Arthropoda	Insecta	Hemiptera	Corixidae	Trichocorixa sp.	4	--	--	--	PR	A

Table 13. Results of macroinvertebrate sampling in 2003 and selected metric calculations.—Continued

Functional feeding groups: FC, filter/collector; GC, gatherer/collector; PR, predator; SC, scraper; SH, shredder. Life stage: A, adult; L, larvae, P, pupae. EPT, Ephemeroptera, Plecoptera, and Trichoptera; FBI, Family Biotic Index. --, no data or not applicable]

Phylum	Class	Order	Family	Revised Taxa	Little White River near Vetal (site 1)	Little White River near Valandra Bridge (site 2)	Little White River near Todd/Mellette County line (site 5)	Benthic tolerance[1]	Functional feeding designation	Life stage
Arthropoda	Insecta	Trichoptera	Hydroptilidae	Hydroptilidae	--	2	--	4	--	A
Arthropoda	Insecta	Trichoptera	Hydroptilidae	Hydroptilidae	--	--	4	4	--	L
Arthropoda	Insecta	Trichoptera	Hydroptilidae	Hydroptila sp.	--	2	--	6	SC	L
Arthropoda	Insecta	Trichoptera	Hydroptilidae	Mayatrichia sp.	--	2	4	6	SC	L
Arthropoda	Insecta	Trichoptera	Hydroptilidae	Mayatrichia sp.	--	--	2	6	SC	P
Arthropoda	Insecta	Trichoptera	Hydroptilidae	Mayatrichia ayama Mosely	--	--	2	--	SC	P
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychidae	--	6	--	4	GC	L
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsyche sp.	--	12	2	4	GC	L
Arthropoda	Insecta	Trichoptera	Brachycentridae	Brachycentrus occidentalis Banks	2	--	--	1	GC	L
Arthropoda	Insecta	Trichoptera	Leptoceridae	Leptoceridae	--	2	--	4	GC	L
Arthropoda	Insecta	Trichoptera	Leptoceridae	Oecetis sp.	--	--	4	8	PR	L
Arthropoda	Insecta	Coleoptera	Elmidae	Elmidae	--	6	2	4	GC	L
Arthropoda	Insecta	Coleoptera	Elmidae	Dubiraphia sp.	12	--	4	4	GC	L
Arthropoda	Insecta	Coleoptera	Elmidae	Microcylloepus sp.	--	--	2	4	GC	L
Arthropoda	Insecta	Coleoptera	Elmidae	Zaitzevia parvula (Horn)	2	--	--	4	GC	A
Arthropoda	Insecta	Diptera	Ceratopogonidae	Ceratopogonidae	10	--	4	6	PR	L
Arthropoda	Insecta	Diptera	Ceratopogonidae	Atrichopogon sp.	--	4	--	6	PR	L
Arthropoda	Insecta	Diptera	Chironomidae	Chironomidae	2	2	8	6	GC	P
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	8	4	10	6	GC	P
Arthropoda	Insecta	Diptera	Chironomidae	Chironomini	2	--	4	6	GC	L
Arthropoda	Insecta	Diptera	Chironomidae	Axarus sp.	--	2	4	--	GC	L

Table 13. Results of macroinvertebrate sampling in 2003 and selected metric calculations.—Continued

Functional feeding groups: FC, filter/collector; GC, gatherer/collector; PR, predator; SC, scraper; SH, shredder. Life stage: A, adult; L, larvae, P, pupae. EPT, Ephemeroptera, Plecoptera, and Trichoptera; FBI, Family Biotic Index. --, no data or not applicable]

Phylum	Class	Order	Family	Revised Taxa	Little White River near Vetal (site 1)	Little White River near Valandra Bridge (site 2)	Little White River near Todd/Mellette County line (site 5)	Benthic tolerance[1]	Functional feeding designa-tion	Life stage
Arthropoda	Insecta	Diptera	Chironomidae	Chernovskiia sp.	32	2	4	6	GC	L
Arthropoda	Insecta	Diptera	Chironomidae	Chironomus sp.	2	--	--	10	GC	L
Arthropoda	Insecta	Diptera	Chironomidae	Cryptochironomus sp.	10	--	6	8	PR	L
Arthropoda	Insecta	Diptera	Chironomidae	Cryptotendipes sp.	2	--	4	6	GC	L
Arthropoda	Insecta	Diptera	Chironomidae	Paracladopelma sp.	10	--	6	7	GC	L
Arthropoda	Insecta	Diptera	Chironomidae	Paralauterborniella nigrohalterale (Malloch)	10	--	4	--	--	L
Arthropoda	Insecta	Diptera	Chironomidae	Polypedilum sp.	10	6	48	6	SH	L
Arthropoda	Insecta	Diptera	Chironomidae	Robackia sp.	14	10	32	--	GC	L
Arthropoda	Insecta	Diptera	Chironomidae	Saetheria sp.	--	--	12	--	GC	L
Arthropoda	Insecta	Diptera	Chironomidae	Stictochironomus sp.	4	2	--	9	OM	L
Arthropoda	Insecta	Diptera	Chironomidae	Pseudochironomus sp.	--	--	2	5	GC	L
Arthropoda	Insecta	Diptera	Chironomidae	Cladotanytarsus sp.	50	10	20	7	GC	L
Arthropoda	Insecta	Diptera	Chironomidae	Rheotanytarsus sp.	2	--	2	6	FC	L
Arthropoda	Insecta	Diptera	Chironomidae	Stempellinella sp.	34	--	68	4	GC	L
Arthropoda	Insecta	Diptera	Chironomidae	Stempellinella sp.	--	--	4	4	GC	P
Arthropoda	Insecta	Diptera	Chironomidae	Tanytarsus sp.	14	--	--	6	FC	L
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	--	12	4	5	GC	L
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae	--	--	12	5	GC	P
Arthropoda	Insecta	Diptera	Chironomidae	Cricotopus/Orthocladius sp.	--	--	4	6	GC	L
Arthropoda	Insecta	Diptera	Chironomidae	Cricotopus sp.	--	--	12	7	SH	L
Arthropoda	Insecta	Diptera	Chironomidae	Cricotopus bicinctus group	--	--	2	6.7	OM	L

Table 13. Results of macroinvertebrate sampling in 2003 and selected metric calculations.—Continued

Functional feeding groups: FC, filter/collector; GC, gatherer/collector; PR, predator; SC, scraper; SH, shredder. Life stage: A, adult; L, larvae, P, pupae. EPT, Ephemeroptera, Plecoptera, and Trichoptera; FBI, Family Biotic Index. --, no data or not applicable]

Phylum	Class	Order	Family	Revised Taxa	Little White River near Vetal (site 1)	Little White River near Valandra Bridge (site 2)	Little White River near Todd/Mellette County line (site 5)	Benthic tolerance[1]	Functional feeding designa-tion	Life stage
Arthropoda	Insecta	Diptera	Chironomidae	Lopescladius sp.	2	--	--	6	GC	L
Arthropoda	Insecta	Diptera	Chironomidae	Parakiefferiella sp.	--	2	--	6	GC	L
Arthropoda	Insecta	Diptera	Chironomidae	Rheocricotopus sp.	--	2	--	6	GC	L
Arthropoda	Insecta	Diptera	Chironomidae	Rheosmittia sp.	--	6	--	--	GC	L
Arthropoda	Insecta	Diptera	Chironomidae	Rheosmittia sp.	6	--	--	--	GC	P
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae	--	2	--	7	PR	P
Arthropoda	Insecta	Diptera	Chironomidae	Pentaneura sp.	--	4	2	6	PR	L
Arthropoda	Insecta	Diptera	Chironomidae	Procladius sp.	14	--	--	9	PR	L
Arthropoda	Insecta	Diptera	Simuliidae	Simuliidae	8	50	36	6	FC	L
Arthropoda	Insecta	Diptera	Simuliidae	Simuliidae	--	6	--	6	FC	P
Arthropoda	Insecta	Diptera	Simuliidae	Simulium sp.	--	4	--	6	FC	L
Arthropoda	Insecta	Diptera	Simuliidae	Simulium sp.	--	6	--	6	FC	P
Arthropoda	Insecta	Diptera		Brachycera	2	--	--	--	--	A
Arthropoda	Insecta	Diptera	Athericidae	Atherix variegata Walker	--	4	2	2	PR	L
Category		Metric								
	Total number of individuals				614	657	695	--	--	--
	Dominant taxa				Corixidae	Tricorythodes sp.	Acentrella sp.	--	--	--
Richness	Number of taxa				47	47	47	--	--	--
Richness	Number of EPT taxa				170	426	300	--	--	--
Tolerance	FBI				5.26	3.02	4.51	--	--	--
Tolerance	Percent dominant taxa				22.48	14.00	12.95	--	--	--

Table 13. Results of macroinvertebrate sampling in 2003 and selected metric calculations.—Continued

Functional feeding groups: FC, filter/collector; GC, gatherer/collector; PR, predator; SC, scraper; SH, shredder. Life stage: A, adult; L, larvae, P, pupae. EPT, Ephemeroptera, Plecoptera, and Trichoptera; FBI, Family Biotic Index. --, no data or not applicable]

Phylum	Class	Order	Family	Revised Taxa	Little White River near Vetal (site 1)	Little White River near Valandra Bridge (site 2)	Little White River near Todd/Mellette County line (site 5)	Benthic tolerance[1]	Functional feeding designation	Life stage
Tolerance	Percent tolerant organisms				60.91	37.14	48.06	--	--	--
Composition	Percent Diptera				40.39	21.31	45.47	--	--	--
Composition	Percent Chironomidae				37.13	10.05	39.42	--	--	--
Composition	Percent EPT				27.69	64.84	43.17	--	--	--
Feeding	Percent collectors				46.25	68.49	79.42	--	--	--
Feeding	Percent filterers				3.91	10.05	5.47	--	--	--
Feeding	Percent scrapers				5.21	1.52	1.73	--	--	--
Feeding	Percent shredders				1.63	0.91	8.63	--	--	--
Feeding	Percent predators				29.97	14.46	4.17	--	--	--

[1]U.S. Environmental Protection Agency, 2005.

Summary

The Little White River Basin in south-central South Dakota is the largest tributary to the White River with a drainage area of approximately 1,590 mi^2, and approximately 560 mi^2 within Todd County. The flow of the Little White River near the Bennett/Todd County line is dominated by base flow originating as ground-water discharge from the Ogallala aquifer and from windblown sand deposits. A large base-flow component also is apparent along the main stem of the Little White River within Todd and Mellette Counties. The State currently (2004) lists the section of the Little White River below Rosebud to the confluence of the White River as impaired because it does not meet the existing State warmwater semi-permanent fisheries beneficial-use standards for fecal coliform bacteria and total suspended solids.

The U.S. Geological Survey, in cooperation with the Rosebud Sioux Tribe, conducted an assessment during 2002–2003 of the water-quality and biological characteristics of the Little White River and selected tributaries in Todd County. Reconnaissance sampling was conducted in 2002 along the Little White River and selected tributaries, and samples were analyzed for physical properties, major ions, nutrients, and trace elements. Reconnaissance pesticide samples were collected during the summer of 2003. This sample set provides some indication of current conditions and provides a base from which future monitoring can be compared. More detailed sampling was conducted in 2003 to examine fecal coliform bacteria and suspended-sediment concentrations. Macroinvertebrate sampling was conducted in 2003 and indicies examined for indications of stream health.

Results from reconnaissance sampling generally were within ranges previously reported for samples from the Little White River, with similar concentrations for tributaries to the Little White River. Nutrient concentrations were slightly higher than historical medians and near the previous maximum concentrations for dissolved ammonia, dissolved nitrite, and dissolved nitrate. Arsenic concentrations were less than the current (2005) drinking-water standard of 10 µg/L (micrograms per liter). All pesticide concentrations in samples collected from tributary sites were less than laboratory reporting levels with the exception of atrazine (0.01 µg/L) and 2-chloro-4-isopropylanino-6-amino-s triazine (estimated concentration of 0.005 µg/L). Atrazine was not detected in historical (1973–2001) samples. More extensive pesticide sampling would be beneficial to provide better indications of seasonal or climatic effects in pesticide concentrations in surface waters in the basin.

Fecal coliform bacteria concentrations generally were less than the State's limited contact standard of 2,000 col/100 mL (colonies per 100 milliliters) within the Little White River with the exception of immediately after storm events. A fecal coliform bacteria concentration of 9,500 col/100 mL was reported at the Little White River near Vetal in June, and 4,200 col/100 mL and 3,200 col/100 mL were reported for the Little White River near Rosebud and near the Todd/Mellette County line, respectively, in July. Several tributaries had higher concentrations than the standard during this same time period, including Sawmill Canyon, South Fork Ironwood Creek, and Soldier Creek. High concentrations in Sawmill Canyon also occurred in August and September. More detailed sampling during and after storm events would be beneficial to determine exactly where high concentrations originate within tributaries and how long concentrations of concern might persist.

The Rosebud Sioux Tribe currently (2005) does not have approved beneficial uses and corresponding standards for the streams on the Reservation. Using the current South Dakota standards for comparison purposes for the samples collected during 2002–2003, suspended-sediment concentrations exceed the State total suspended-solids standard 45 to 82 percent of the time. Sampling took place during a relatively dry year, so these results may be conservative. Review of historical (1957–2001) daily suspended-sediment concentrations indicates that the Little White River near Vetal (Bennett/Todd County line) exceeded the State standard 50 percent of the time, and the Little White River near Rosebud exceeded the standard 89 percent of the time. Although slightly higher, these numbers are similar to the 2002–2003 data. Analysis of suspended-sediment data does show an increase in concentration and consequently exceedances of the standard between the Bennett/Todd County line and upstream from Rosebud Creek. Land-use patterns do not change substantially between these sites, and riparian health along the Little White River is very good. However, the geology does change within this reach, specifically from windblown sand deposits to outcrops of the Ogallala Formation. Suspended sediment in the tributaries to the Little White River followed similar trends with higher concentrations within the tributary basins with outcrops of the Ogallala Formation. In addition, the percentage of fine sediment decreases in this same reach. The slope of the river between these two sites is 9.4 ft/mi, and downstream slope is 13 ft/mi. The downstream section with the greater slope does not have a corresponding increase in sediment concentration, and this may indicate that the Arikaree Formation does not contribute as much sediment as the Ogallala Formation. With little indication of land use or riparian health causing sediment concentrations, the Rosebud Sioux Tribe may need to establish a standard with a higher concentration than the current State standard for the Little White River.

Sediment transport was simulated using the one-dimensional flow and sediment transport model CONCEPTS (Conservational Channel Evolution and Pollutant Transport System). Model results were similar to estimates of sediment load from sediment concentrations and flows collected during the study. This effort was limited to the data already collected as part of this study and would benefit from further refinement. Based on the simulation of several storms during the spring and summer of 2003, the Little White River averages 41 ton/d of sediment near the Bennett/Todd County line and 116 ton/d downstream from the confluence of Rosebud Creek.

Benthic macroinvertebrate sampling results were used to calculate a variety of metrics to be used as indicators of stream health. Historical data collected in 1996 by the Rosebud Sioux Tribe also were used for comparisons within the stream. Benthic macroinvertebrates have limited migration patterns and complex life cycles of about 1 year so they can respond quickly to stressors in their environment. The Family Biotic Index is a sum of the number of individuals in a family times a tolerance factor, divided by the total number of individuals. Tolerance scales range from 10 to 0, with 10 indicating poor conditions and 0 indicating healthy conditions. In the 1996 Rosebud Sioux Tribe data, the Family Biotic Index was 5.19 at site 1 (near Vetal), 3.47 at site 2 (Valandra Bridge near Spring Creek), and 4.37 at site 5 (near Todd/Mellette County line). In the 2003 data, the same pattern was present with an index of 5.26 at site 1, 3.02 at site 2, and 4.51 at site 5. Generally, the majority of the metrics displayed the same pattern with increases in stream health between site 1 near the Bennett/Todd County line and site 2 downstream from Sawmill Canyon, followed by an decrease in stream health from site 2 to site 5 near the Todd/Mellette County line. Metrics at the upstream site near the Bennett/Todd County line and the downstream site were comparable.

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Supplemental Data

Table 14. Results from reconnaissance sampling during September and November 2002 for selected sites on or tributaries to the Little White River.

[ft³/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; mg/L, milligrams per liter; col/100 mL, colonies per 100 milliliters; µg/L, micrograms per liter; --, no data; <, less than]

Station number	Station name	Date	Time	Discharge (ft^3/s)	Air temperature (°C)
06449100	Little White River near Vetal	09-23-2002	1055	88	11.0
06449100	Little White River near Vetal	11-04-2002	1015	40	8.0
06449100[1]	Little White River near Vetal	11-04-2002	1015	40	8.0
430939101003500	Little White River, Valandara Bridge, near Spring Creek	09-23-2002	1450	115	22.0
430939101003500	Little White River, Valandara Bridge, near Spring Creek	11-07-2002	1040	75	11.0
06449300	Little White River above Rosebud	11-07-2002	0935	96	10.0
06449500	Little White River near Rosebud	09-25-2002	1230	122	13.0
06449500[1]	Little White River near Rosebud	09-25-2002	1230	122	13.0
06449500	Little White River near Rosebud	11-04-2002	1230	100	9.0
06449500[1]	Little White River near Rosebud	11-04-2002	1230	100	9.0
432136100520700	Little White River near Todd/Mellette County line	09-25-2002	1345	128	13.0
432136100520700	Little White River near Todd/Mellette County line	11-07-2002	1200	108	2.0
430647101062100	Coffee Creek above Spring Creek	09-23-2002	1340	4.4	15.5
430647101062100	Coffee Creek above Spring Creek	11-06-2002	0800	4.9	12.0
430610101044300	Spring Creek near St. Francis	09-24-2002	1045	4.1	13.0
430610101044300	Spring Creek near St. Francis	11-06-2002	0915	4.2	5.0
430724101010200	Sawmill Creek near Spring Creek	09-25-2002	0820	1.2	9.0
430724101010200	Sawmill Creek near Spring Creek	11-06-2002	1020	1.3	12.0
431146100574900	Omaha Creek near Rosebud	09-24-2002	1220	.82	20.0
431146100574900	Omaha Creek near Rosebud	11-06-2002	1105	1.2	12.0
431205100580200	Beads Creek near Rosebud	09-25-2002	0900	1.3	12.0
431205100580200	Beads Creek near Rosebud	11-06-2002	1145	2.1	16.0
431312100573600	Unnamed tributary Crazy Horse Canyon near Rosebud	09-24-2002	1300	.13	22.0
431312100573600	Unnamed tributary Crazy Horse Canyon near Rosebud	11-06-2002	1215	.36	11.0
431343100573100	South Fork Ironwood Creek near Rosebud	09-24-2002	1330	1.8	20.0
431343100573100	South Fork Ironwood Creek near Rosebud	11-06-2002	1250	1.9	13.0
06449400	Rosebud Creek at Rosebud	11-07-2002	1240	11	18.0
431600100533600	Rosebud Creek at Little White River confluence, below Rosebud	09-24-2002	1350	7.9	23.0
431600100533600	Rosebud Creek at Little White River confluence, below Rosebud	11-07-2002	0800	11	7.0
431823100523400	Wigwam Creek near Soldier Creek	11-04-2002	1415	.18	8.0
431911100525200	Soldier Creek near Rosebud	09-25-2002	1015	1.1	13.0
431911100525200	Soldier Creek near Rosebud	11-04-2002	1230	3.9	8.0
Field equipment[2]	Field equipment	09-23-2002	1050	--	--

Water temperature (°C)	Dissolved oxygen (mg/L)	Conductivity (μS/cm)	pH (standard units)	Dissolved calcium (mg/L)	Dissolved magnesium (mg/L)	Dissolved potassium (mg/L)	Dissolved sodium (mg/L)	Alkalinity (mg/L as $CaCO_3$)	Dissolved chloride (mg/L)
11	7.6	334	7.6	36	5	9.6	19	145	3.6
1	15.7	287	7.1	33	5	7	18	120	3
1.4	15.7	287	7.1	33	5	7.3	18	120	3.1
15	9.1	309	7.6	33	5	8.6	16	133	2.9
5.0	11.4	261	7.8	31	4	6.1	15	113	2.1
3.5	11.7	271	8.3	33	5	6.8	16	122	2.1
13.0	10.3	307	7.8	35	5	8.8	17	143	2.4
13.4	10.3	307	7.8	36	5	8.4	17	136	2.5
2.0	14.2	284	7.7	36	5	6.7	16	131	2.6
2.4	14.2	284	7.7	35	5	6.6	15	132	2.5
14.0	9.1	310	7.8	35	5	8.7	17	146	2.6
6.0	12.4	286	8.4	36	5	6.4	16	135	2.4
13.5	9.9	276	7.9	37	6	4.6	5	132	.8
6.0	11.8	270	7.5	39	7	5.2	6	130	1.3
10.0	9.0	208	7.1	26	5	6.1	7	93	1.6
6.0	11.9	202	7.4	28	3	6.6	8	94	1.2
9.5	11.0	304	7.5	44	5	5.8	9	149	.8
5.5	13.0	302	7.7	45	5	6.1	10	144	1.5
11	9.5	403	7.6	54	7	7.3	15	196	2.9
3.5	13.9	396	8.0	58	8	7.1	15	191	4.1
12	10.2	312	7.3	35	6	10.6	18	150	1.5
5.0	12.5	308	7.7	36	7	7.3	18	146	1.9
11.5	9.2	424	8.1	55	5	8.1	25	208	1.6
1.8	16.2	405	7.7	56	5	7.2	25	195	2.1
12.5	9.2	308	7.9	44	5	5.8	8	144	1.7
5.8	13.4	301	7.9	48	5	5.2	9	149	1.8
6.2	13	336	8.7	53	6	5.8	9	169	2.2
15.8	8.9	334	7.9	46	5	6.3	10	164	2.4
3.2	12.2	353	8.1	54	6	6.3	11	176	2.8
4.2	15.4	532	7.4	70	8	10.2	34	264	5.9
10.6	11	348	7.7	45	7	9.3	14	171	2.4
0.0	15.2	380	7.6	54	7	8.9	14	188	3.9
--	--	--	--	<1	<1	<1	<1	<10	.7

Table 14. Results from reconnaissance sampling during September and November 2002 for selected sites on or tributaries to the Little White River.—Continued

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; mg/L, milligrams per liter; col/100 mL, colonies per 100 milliliters; µg/L, micrograms per liter; --, no data; <, less than]

Station Number	Station Name	Date	Dissolved sulfate (mg/L)	Dissolved ammonia (mg/L as N)	Dissolved nitrate (mg/L as N)
06449100	Little White River near Vetal	09-23-2002	19.3	0.02	0.35
06449100	Little White River near Vetal	11-04-2002	25.4	.05	1.09
06449100[1]	Little White River near Vetal	11-04-2002	27.7	.05	1.03
430939101003500	Little White River, Valandara Bridge, near Spring Creek	09-23-2002	13	<.02	.55
430939101003500	Little White River, Valandara Bridge, near Spring Creek	11-07-2002	15	.06	1.03
06449300	Little White River above Rosebud	11-07-2002	14.4	.06	.88
06449500	Little White River near Rosebud	09-25-2002	15	.03	.55
06449500[1]	Little White River near Rosebud	09-25-2002	14.3	.08	.45
06449500	Little White River near Rosebud	11-04-2002	14.4	.06	.94
06449500[1]	Little White River near Rosebud	11-04-2002	13.7	.04	.90
432136100520700	Little White River near Todd/Mellette County line	09-25-2002	14.7	.05	.52
432136100520700	Little White River near Todd/Mellette County line	11-07-2002	14.2	.06	.82
430647101062100	Coffee Creek above Spring Creek	09-23-2002	5.9	.03	.64
430647101062100	Coffee Creek above Spring Creek	11-06-2002	5.2	.08	.91
430610101044300	Spring Creek near St. Francis	09-24-2002	6.2	<.02	.58
430610101044300	Spring Creek near St. Francis	11-06-2002	6.2	.04	.74
430724101010200	Sawmill Creek near Spring Creek	09-25-2002	7.7	.04	.87
430724101010200	Sawmill Creek near Spring Creek	11-06-2002	9.3	.08	.95
431146100574900	Omaha Creek near Rosebud	09-24-2002	10	.03	.23
431146100574900	Omaha Creek near Rosebud	11-06-2002	11.3	.09	.49
431205100580200	Beads Creek near Rosebud	09-25-2002	10.3	.06	.75
431205100580200	Beads Creek near Rosebud	11-06-2002	12.3	.08	.24
431312100573600	Unnamed tributary Crazy Horse Canyon near Rosebud	09-24-2002	11.6	.04	.12
431312100573600	Unnamed tributary Crazy Horse Canyon near Rosebud	11-06-2002	16.9	.08	.13
431343100573100	South Fork Ironwood Creek near Rosebud	09-24-2002	6.5	.02	.63
431343100573100	South Fork Ironwood Creek near Rosebud	11-06-2002	8	.08	.69
06449400	Rosebud Creek at Rosebud	11-07-2002	8.2	.08	.70
431600100533600	Rosebud Creek at Little White River confluence, below Rosebud	09-24-2002	7.6	<.02	.38
431600100533600	Rosebud Creek at Little White River confluence, below Rosebud	11-07-2002	8.8	.07	.58
431823100523400	Wigwam Creek near Soldier Creek	11-04-2002	18.6	.08	<.10
431911100525200	Soldier Creek near Rosebud	09-25-2002	6.7	.05	.16
431911100525200	Soldier Creek near Rosebud	11-04-2002	9.6	.09	.14
Field equipment[2]	Field equipment	09-23-2002	<5	<.02	<.10

Dissolved nitrite (mg/L as N)	Dissolved ortho-phosphate (mg/L as P)	Total phosphate (mg/L as P)	Total ammonia plus organic nitrogen (mg/L as N)	Suspended solids (mg/L at 105°C)	Suspended solids (mg/L at 550°C)	Dissolved solids (mg/L)	Sodium adsorption ratio	Hardness (mg/L as $CaCO_3$)
<0.02	0.15	0.29	1.3	274	255	180	0.78	111.2
<.02	.17	.19	<1	56	50	164	.78	100.9
<.02	.17	.12	<1	--	--	166	.77	100.9
<.02	.14	.22	<1	432	415	160	.7	103.7
<.02	.12	.1	<1	204	198	143	.68	94.9
<.02	.11	.09	<1	333	324	150	.68	100.4
<.02	.11	.26	1.6	396	380	170	.72	109.7
<.02	.1	.28	1	396	380	166	.72	110.7
<.02	.08	.1	<1	151	144	159	.65	108.5
<.02	.15	.08	<1	--	--	158	.64	107.5
<.02	.11	.19	<1	442	424	171	.69	108.2
<.02	.09	.11	<1	306	296	161	.66	108.7
<.02	.09	.14	<1	31	26	140	.22	118.1
<.02	.09	.05	<1	10	8	142	.22	124
<.02	.1	.14	<1	12	10	107	.36	76.9
<.02	.1	.09	<1	21	20	110	.37	81.8
<.02	.07	.16	<1	401	388	163	.36	128.1
<.02	.08	.13	<1	103	99	164	.37	132
<.02	.07	.12	<1	40	38	214	.49	164.4
<.02	.05	.06	<1	9	7	218	.48	177.2
.07	<.01	.13	<1	19	16	172	.073	112.2
<.02	.04	.08	<1	24	22	170	.71	116.7
<.02	.11	.12	<1	2	1	230	.86	156.4
<.02	.08	.04	<1	5	4	229	.86	160.7
<.02	.14	.15	<1	214	200	158	.32	127.8
<.02	.09	.1	<1	296	287	167	.35	140.4
<.02	.02	.04	<1	13	12	186	.31	157.4
<.02	<.01	.09	<1	73	69	176	.37	137.1
<.02	<.01	<.01	<1	69	65	196	.38	161
<.02	.1	.05	<1	30	27	305	1.01	207
<.02	<.01	.14	1.1	50	44	187	.51	139.6
<.02	.01	.05	<1	118	110	211	.47	165.2
<.02	<.01	.12	<1	--	--	5	--	<10

Table 14. Results from reconnaissance sampling during September and November 2002 for selected sites on or tributaries to the Little White River.—Continued

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; mg/L, milligrams per liter; col/100 mL, colonies per 100 milliliters; µg/L, micrograms per liter; --, no data; <, less than]

Station Number	Station Name	Date	Fecal coliform (col/ 100 mL)	Dissolved silver (µg/L)	Dissolved aluminum (µg/L)
06449100	Little White River near Vetal	09-23-2002	400	<25	<25
06449100	Little White River near Vetal	11-04-2002	70	<25	<25
06449100[1]	Little White River near Vetal	11-04-2002	--	--	--
430939101003500	Little White River, Valandara Bridge, near Spring Creek	09-23-2002	60	<25	<25
430939101003500	Little White River, Valandara Bridge, near Spring Creek	11-07-2002	10	<25	<25
06449300	Little White River above Rosebud	11-07-2002	30	<25	<25
06449500	Little White River near Rosebud	09-25-2002	290	<25	<25
06449500[1]	Little White River near Rosebud	09-25-2002	250	<25	<25
06449500	Little White River near Rosebud	11-04-2002	<10	<25	<25
06449500[1]	Little White River near Rosebud	11-04-2002	--	<25	<25
432136100520700	Little White River near Todd/Mellette County line	09-25-2002	130	<25	<25
432136100520700	Little White River near Todd/Mellette County line	11-07-2002	20	<25	<25
430647101062100	Coffee Creek above Spring Creek	09-23-2002	380	<25	<25
430647101062100	Coffee Creek above Spring Creek	11-06-2002	50	<25	<25
430610101044300	Spring Creek near St. Francis	09-24-2002	170	<25	30
430610101044300	Spring Creek near St. Francis	11-06-2002	120	<25	<25
430724101010200	Sawmill Creek near Spring Creek	09-25-2002	930	<25	28
430724101010200	Sawmill Creek near Spring Creek	11-06-2002	170	<25	<25
431146100574900	Omaha Creek near Rosebud	09-24-2002	50	<25	<25
431146100574900	Omaha Creek near Rosebud	11-06-2002	30	<25	<25
431205100580200	Beads Creek near Rosebud	09-25-2002	50	<25	<25
431205100580200	Beads Creek near Rosebud	11-06-2002	20	<25	<25
431312100573600	Unnamed tributary Crazy Horse Canyon near Rosebud	09-24-2002	380	<25	<25
431312100573600	Unnamed tributary Crazy Horse Canyon near Rosebud	11-06-2002	10	<25	<25
431343100573100	South Fork Ironwood Creek near Rosebud	09-24-2002	440	<25	<25
431343100573100	South Fork Ironwood Creek near Rosebud	11-06-2002	40	<25	<25
06449400	Rosebud Creek at Rosebud	11-07-2002	<10	<25	<25
431600100533600	Rosebud Creek at Little White River confluence, below Rosebud	09-24-2002	60	<25	<25
431600100533600	Rosebud Creek at Little White River confluence, below Rosebud	11-07-2002	150	<25	<25
431823100523400	Wigwam Creek near Soldier Creek	11-04-2002	80	<25	<25
431911100525200	Soldier Creek near Rosebud	09-25-2002	5,500	<25	<25
431911100525200	Soldier Creek near Rosebud	11-04-2002	170	<25	<25
Field equipment[2]	Field equipment	09-23-2002	--	<25	<25

Dissolved arsenic (µg/L)	Dissolved boron (µg/L)	Dissolved barium (µg/L)	Dissolved beryllium (µg/L)	Dissolved cadmium (µg/L)	Dissolved cobalt (µg/L)	Dissolved chromium (µg/L)	Dissolved copper (µg/L)
8.4	43.7	123	<5	<10	<10	<10	<10
6.0	36.4	107	<5	<10	<10	<10	<10
--	--	--	--	--	--	--	--
8.8	37.0	116	<5	<10	<10	<10	<10
6.0	28.4	102	<5	<10	<10	<10	<10
5.5	23.8	107	<5	<10	<10	<10	<10
7.4	36.1	122	<5	<10	<10	<10	<10
7.9	43.7	123	<5	<10	<10	<10	<10
5.6	32.9	118	<5	<10	<10	<10	<10
4.9	29.5	116	<5	<10	<10	<10	<10
6.8	36.1	120	<5	<10	<10	<10	<10
6.0	28.4	119	<5	<10	<10	<10	<10
2.4	<25	97.0	<5	<10	<10	<10	<10
3.3	<25	102	<5	<10	<10	<10	<10
3.2	<25	59	<5	<10	<10	<10	<10
3.6	<25	63	<5	<10	<10	<10	<10
4.1	<25	113	<5	<10	<10	<10	<10
4.2	<25	114	<5	<10	<10	<10	<10
3.5	29.3	167	<5	<10	<10	<10	<10
4.1	27.2	176	<5	<10	<10	<10	<10
3.2	37.0	133	<5	<10	<10	<10	<10
2.9	31.8	129	<5	<10	<10	<10	<10
<2	46.3	188	<5	<10	<10	<10	<10
4.8	36.3	185	<5	<10	<10	<10	<10
2.4	<25	134	<5	<10	<10	<10	<10
2.4	<25	141	<5	<10	<10	<10	<10
3.5	<25	167	<5	<10	<10	<10	<10
3.6	<25	168	<5	<10	<10	<10	<10
3.4	<25	182	<5	<10	<10	<10	<10
8.3	48.8	238	<5	<10	<10	<10	<10
3.1	39.5	220	<5	<10	<10	<10	<10
3.7	23.8	222	<5	<10	<10	<10	<10
<2	<25	<25	<5	<10	<10	<10	<10

Table 14. Results from reconnaissance sampling during September and November 2002 for selected sites on or tributaries to the Little White River.—Continued

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; mg/L, milligrams per liter; col/100 mL, colonies per 100 milliliters; µg/L, micrograms per liter; --, no data; <, less than]

Station Number	Station Name	Date	Dissolved iron (µg/L)	Dissolved lithium (µg/L)	Dissolved manganese (µg/L)
06449100	Little White River near Vetal	09-23-2002	<25	<25	<25
06449100	Little White River near Vetal	11-04-2002	<25	<25	<25
06449100[1]	Little White River near Vetal	11-04-2002	--	--	--
430939101003500	Little White River, Valandara Bridge, near Spring Creek	09-23-2002	<25	<25	<25
430939101003500	Little White River, Valandara Bridge, near Spring Creek	11-07-2002	<25	<25	<25
06449300	Little White River above Rosebud	11-07-2002	<25	<25	<25
06449500	Little White River near Rosebud	09-25-2002	<25	<25	<25
06449500[1]	Little White River near Rosebud	09-25-2002	<25	<25	<25
06449500	Little White River near Rosebud	11-04-2002	<25	<25	<25
06449500[1]	Little White River near Rosebud	11-04-2002	<25	<25	<25
432136100520700	Little White River near Todd/Mellette County line	09-25-2002	<25	<25	<25
432136100520700	Little White River near Todd/Mellette County line	11-07-2002	<25	<25	<25
430647101062100	Coffee Creek above Spring Creek	09-23-2002	<25	<25	<25
430647101062100	Coffee Creek above Spring Creek	11-06-2002	<25	<25	<25
430610101044300	Spring Creek near St. Francis	09-24-2002	<25	<25	<25
430610101044300	Spring Creek near St. Francis	11-06-2002	<25	<25	<25
430724101010200	Sawmill Creek near Spring Creek	09-25-2002	<25	<25	<25
430724101010200	Sawmill Creek near Spring Creek	11-06-2002	<25	<25	<25
431146100574900	Omaha Creek near Rosebud	09-24-2002	<25	<25	<25
431146100574900	Omaha Creek near Rosebud	11-06-2002	<25	<25	<25
431205100580200	Beads Creek near Rosebud	09-25-2002	<25	<25	<25
431205100580200	Beads Creek near Rosebud	11-06-2002	<25	<25	<25
431312100573600	Unnamed tributary Crazy Horse Canyon near Rosebud	09-24-2002	<25	<25	<25
431312100573600	Unnamed tributary Crazy Horse Canyon near Rosebud	11-06-2002	<25	<25	<25
431343100573100	South Fork Ironwood Creek near Rosebud	09-24-2002	<25	<25	<25
431343100573100	South Fork Ironwood Creek near Rosebud	11-06-2002	<25	<25	<25
06449400	Rosebud Creek at Rosebud	11-07-2002	<25	<25	<25
431600100533600	Rosebud Creek at Little White River confluence, below Rosebud	09-24-2002	<25	<25	<25
431600100533600	Rosebud Creek at Little White River confluence, below Rosebud	11-07-2002	<25	<25	<25
431823100523400	Wigwam Creek near Soldier Creek	11-04-2002	<25	<25	<25
431911100525200	Soldier Creek near Rosebud	09-25-2002	<25	<25	<25
431911100525200	Soldier Creek near Rosebud	11-04-2002	<25	<25	<25
Field equipment[2]	Field equipment	09-23-2002	<25	<25	<25

[1]Quality-assurance/quality-control split sample.

[2]Quality-assurance/quality-control laboratory field blank.

Dissolved molybdenum (µg/L)	Dissolved nickel (µg/L)	Dissolved lead (µg/L)	Dissolved antimony (µg/L)	Dissolved selenium (µg/L)	Dissolved thallium (µg/L)	Dissolved vanadium (µg/L)	Dissolved zinc (µg/L)
<10	<25	3.8	<25	<1	<25	<25	<25
<10	<25	<2	25	<2.6	<25	<25	<25
--	--	--	--	--	--	--	--
<10	<25	<2	<25	<1	<25	<25	<25
<10	<25	<2	<25	<2.6	<25	<25	<25
<10	<25	<2	30	<2.6	<25	<25	<25
<10	<25	<2	<25	<1	<25	<25	<25
<10	<25	<2	<25	<1	<25	<25	<25
<10	<25	3.8	<25	<2.6	<25	<25	<25
<10	<25	2.7	<25	<2.6	<25	<25	<25
<10	<25	<2	<25	<1	<25	<25	<25
<10	<25	2.5	<25	<2.6	<25	<25	<25
<10	<25	<2	<25	<1	<25	<25	<25
<10	<25	<2	28	<2.6	<25	<25	<25
<10	<25	<2	33	<1	<25	<25	<25
<10	<25	5.6	28	<2.6	<25	<25	<25
<10	<25	3.1	<25	<1	<25	<25	<25
<10	<25	<2	<25	<2.6	<25	<25	<25
<10	<25	<2	<25	<1	<25	<25	<25
<10	<25	5.5	30	<2.6	<25	<25	<25
<10	<25	4.7	<25	<1	<25	<25	<25
<10	<25	<2	31	<2.6	<25	<25	<25
<10	<25	<2	<25	<1	<25	<25	<25
<10	<25	<2	31	<2.6	<25	<25	<25
<10	<25	<2	<25	<1	<25	<25	<25
<10	<25	<2	31	<2.6	<25	<25	<25
<10	<25	<2	33	<2.6	<25	<25	<25
<10	<25	<2	<25	<1	<25	<25	<25
<10	<25	<2	31	<2.6	<25	<25	<25
<10	<25	4.2	37	<2.6	<25	<25	<25
<10	<25	<2	<25	<1	<25	<25	<25
<10	<25	7.8	<25	<2.6	<25	<25	<25
<10	<25	<2	<25	<1	<25	<25	<25

Table 15. Results from 2003 suspended-sediment and bacteria sampling of selected sites on the Little White River and tributaries.

[ft³/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; QA/QC, quality assurance/quality control; mg/L, milligrams per liter; µm, micrometers; mL, milliliters; col/100 mL, colonies per 100 milliliters; --, no data; <, less than; >, greater than]

Date	Discharge (ft^3/s)	Specific conductance (µS/cm)	Dissolved oxygen (mg/L)	pH	Suspended sediment (mg/L at 105°C)	Suspended sediment (mg/L at 550°C)	Suspended sediment QA/QC (mg/L at 180°C)	Fine (percent <0.062 µm)	Fecal coliform bacteria (col/100 mL)
Little White River near Vetal, 06449100									
04-22-2003	88	298	12.5	7.0	196	179	--	--	60
05-06-2003	90	319	10.7	7.8	251	229	--	59	100
06-17-2003	54	280	9.2	6.6	427	301	--	--	9,500
07-08-2003	37	362	7.8	7.9	196	174	--	--	310
08-11-2003	24	281	8.5	7.8	45	40	--	--	40
09-02-2003	20	301	8.5	8.2	17	15	15	--	30
09-22-2003	21	315	11.9	7.6	19	18	--	--	130
10-20-2003	26	340	14.8	7.7	21	18	--	--	130
11-17-2003	54	308	10.6	6.9	157	141	153	72	180
Little White River, Valandra Bridge, near Spring Creek, 430939101003500									
04-22-2003	136	279	12.6	8.2	387	368	--	--	10
05-07-2003	143	301	10.3	8.6	444	425	--	29	50
06-17-2003	107	307	9.5	7.6	1,185	1,127	--	--	590
07-09-2003	72	318	7.8	8.0	311	291	--	--	460
08-11-2003	53	250	7.4	8.2	130	120	--	--	10
09-03-2003	51	271	7.8	8.2	88	85	89	32	100
09-23-2003	57	277	11.5	8.1	87	83	--	--	[1]30
10-21-2003	61	280	12.5	8.2	138	134	--	--	110
11-18-2003	92	284	13.0	7.3	267	252	295	30	180
Little White River above Rosebud, 06449300									
04-21-2003	150	286	13.1	6.9	467	449	--	--	40
05-06-2003	180	309	10.4	8.3	641	618	--	23	30
06-18-2003	96	314	10.6	8.2	792	741	--	--	700
07-08-2003	93	318	6.2	8.2	856	792	--	--	late sample
08-11-2003	55	256	7.9	8.5	152	143	153	--	50
09-04-2003	53	270	9.3	8.0	206	199	--	27	70
09-23-2003	60	287	10.7	8.2	150	146	--	--	[1]<10
10-21-2003	72	294	12.7	8.4	118	115	--	--	40
11-18-2003	102	294	14.1	8.0	301	289	361	26	30

Table 15. Results from 2003 suspended-sediment and bacteria sampling of selected sites on the Little White River and tributaries.—Continued

[ft3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; QA/QC, quality assurance/quality control; mg/L, milligrams per liter; µm, micrometers; mL, milliliters; col/100 mL, colonies per 100 milliliters; --, no data; <, less than; >, greater than]

Date	Discharge (ft^3/s)	Specific conductance (µS/cm)	Dissolved oxygen (mg/L)	pH	Suspended sediment (mg/L at 105°C)	Suspended sediment (mg/L at 550°C)	Suspended sediment QA/QC (mg/L at 180°C)	Fine (percent <0.062 µm)	Fecal coliform bacteria (col/100 mL)
Little White River near Rosebud, 06449500									
04-21-2003	178	296	12.6	6.9	419	400	--	--	<10
05-06-2003	180	315	9.8	8.7	351	334	--	36	20
06-18-2003	109	326	13.3	8.1	721	676	--	--	100
07-08-2003	114	256	7.7	7.8	1,530	1,380	--	--	4,200
08-12-2003	60	301	8.9	8.4	212	203	--	--	20
09-02-2003	56	277	6.1	8.3	87	84	122	26	70
09-22-2003	67	294	11.5	8.3	123	120	--	--	60
10-20-2003	81	303	14.2	8.2	155	150	--	--	<10
11-17-2003	121	307	10.8	6.8	322	308	368	34	420
Little White River near Todd/Mellette County line, 432136100520700									
04-21-2003	187	293	11.6	6.7	534	512	--	--	10
05-06-2003	196	313	9.8	8.8	524	504	--	28	20
06-19-2003	97	286	11.3	8.1	831	784	--	--	390
07-08-2003	123	265	7.6	7.7	2,660	2,440	--	--	3,200
08-12-2003	61	308	8.0	8.4	166	156	--	--	40
09-04-2003	59	282	9.5	7.1	155	148	149	31	50
09-22-2003	69	296	11.1	8.0	112	107	--	--	60
10-22-2003	78	309	10.7	8.3	187	181	--	--	70
11-19-2003	109	305	13.8	7.2	304	286	424	25	80
Spring Creek near St. Francis, 430610101044300									
04-22-2003	16	302	11.7	7.3	97	93	--	--	<10
05-07-2003	25	318	10.1	8.3	313	306	--	--	<10
06-17-2003	6.0	255	9.3	7.8	48	41	--	--	180
07-09-2003	7.6	262	8.3	7.2	137	128	--	--	580
08-11-2003	3.9	182	7.9	8.0	58	55	--	--	730
09-03-2003	3.8	209	8.8	7.7	37	35	--	--	160
09-23-2003	3.7	214	11.1	7.7	50	47	--	--	[1]230
10-21-2003	3.8	180	12.0	6.8	15	14	--	--	40
11-18-2003	3.8	187	11.5	6.3	71	68	--	--	60

Table 15. Results from 2003 suspended-sediment and bacteria sampling of selected sites on the Little White River and tributaries.—Continued

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; QA/QC, quality assurance/quality control; mg/L, milligrams per liter; µm, micrometers; mL, milliliters; col/100 mL, colonies per 100 milliliters; --, no data; <, less than; >, greater than]

Date	Discharge (ft^3/s)	Specific conductance (µS/cm)	Dissolved oxygen (mg/L)	pH	Suspended sediment (mg/L at 105°C)	Suspended sediment (mg/L at 550°C)	Suspended sediment QA/QC (mg/L at 180°C)	Fine (percent <0.062 µm)	Fecal coliform bacteria (col/100 mL)
Sawmill Canyon near Spring Creek, 430724101010200									
04-22-2003	1.3	310	10.4	8.1	627	610	--	--	70
05-07-2003	1.4	292	11.2	7.4	1,070	1,060	--	--	20
06-17-2003	1.1	315	9.5	6.8	2,300	2,230	--	--	1,000
07-09-2003	1.4	318	8.6	7.1	3,380	3,270	--	--	lab error
08-11-2003	1	243	7.8	8.0	740	709	--	--	2,400
09-03-2003	.9	211	8.5	7.6	672	649	--	--	3,700
09-23-2003	1.1	291	12.2	8.1	877	855	--	--	[1]1,600
10-21-2003	1.4	288	12.4	7.8	367	355	--	--	70
11-18-2003	1.7	308	12.5	7.2	690	679	--	--	80
Omaha Creek near Rosebud, 431146100574900									
04-22-2003	1.1	399	13.7	7.7	39	36	--	--	<10
05-07-2003	1.2	391	11.6	8.1	25	21	--	--	90
06-17-2003	.92	400	10.3	7.2	107	97	--	--	60
07-09-2003	1.3	415	7.7	7.3	15	12	--	--	130
08-11-2003	.54	339	8.0	8.0	8	6	--	--	50
09-03-2003	.59	388	8.2	8.0	6	4	--	--	120
09-23-2003	.87	403	11.6	8.2	6	4	--	--	[1]20
10-21-2003	1.1	399	12.0	8.0	10	8	--	--	80
11-18-2003	1.3	399	13.6	7.6	5	4	--	--	<10
South Fork Ironwood Creek near Rosebud, 431343100571700									
04-22-2003	2.2	309	14.2	7.5	131	125	--	--	10
05-07-2003	2.1	312	10.6	8.4	116	109	--	--	20
06-18-2003	1.7	302	11.4	7.1	6,712	6,579	--	--	2,200
07-09-2003	1.9	296	7.6	7.3	677	641	--	--	6,300
08-11-2003	1.3	276	7.1	8.2	518	499	--	--	420
09-03-2003	1.0	314	7.6	8.1	420	404	--	--	1,400
09-23-2003	1.7	309	10.4	8.2	394	378	--	--	[1]1,000
10-21-2003	1.9	325	11.1	8.0	277	265	--	--	280
11-18-2003	20	319	13.6	7.7	667	657	--	--	100

Table 15. Results from 2003 suspended-sediment and bacteria sampling of selected sites on the Little White River and tributaries.—Continued

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; QA/QC, quality assurance/quality control; mg/L, milligrams per liter; µm, micrometers; mL, milliliters; col/100 mL, colonies per 100 milliliters; --, no data; <, less than; >, greater than]

Date	Discharge (ft^3/s)	Specific conductance (µS/cm)	Dissolved oxygen (mg/L)	pH	Suspended sediment (mg/L at 105°C)	Suspended sediment (mg/L at 550°C)	Suspended sediment QA/QC (mg/L at 180°C)	Fine (percent <0.062 µm)	Fecal coliform bacteria (col/100 mL)
Rosebud Creek at Rosebud, 06449400									
04-21-2003	10	338	14.0	7.1	14	12	--	--	<10
05-06-2003	11	345	12.4	7.9	12	10	--	--	10
06-18-2003	10	350	10.3	7.8	30	27	--	--	110
07-08-2003	10	337	6.4	7.8	25	17	--	--	late sample
08-12-2003	5.9	330	7.2	8.0	11	9	--	--	30
09-03-2003	7.3	328	7.9	7.9	7	5	--	--	10
09-22-2003	7.7	340	11.2	8.2	5	4	--	--	50
10-21-2003	10	342	13.0	8.5	16	14	--	--	<10
11-18-2003	10	343	15.4	7.8	8	7	--	--	10
Rosebud Creek at Little White River confluence, below Rosebud, 431600100533600									
04-22-2003	11	339	12.6	8.6	136	126	--	--	<10
05-08-2003	10	365	10.0	8.6	102	94	--	--	20
06-18-2003	10	350	16.2	7.9	39	33	--	--	150
07-08-2003	11	338	6.9	8.2	131	120	--	--	late sample
08-12-2003	6.0	332	8.5	8.2	14	12	--	--	90
09-04-2003	6.2	306	9.1	8.2	19	17	--	--	70
09-23-2003	no access	--	--	--	--	--	--	--	--
10-22-2003	10	358	10.5	7.9	9	8	--	--	90
11-19-2003	10	361	13.9	7.6	94	87	--	--	<10
Soldier Creek near Rosebud, 431911100525200									
04-21-2003	7.1	381	12	7.2	674	612	--	--	330
05-06-2003	4.7	394	9.7	8.0	173	155	--	--	<10
06-18-2003	1.8	352	15.7	7.4	74	64	--	--	2,500
07-08-2003	3.1	305	7.5	7.3	274	239	--	--	6,700
08-12-2003	0	--	--	--	--	--	--	--	--
09-04-2003	0	--	--	--	--	--	--	--	--
09-23-2003	0	--	--	--	--	--	--	--	--
10-22-2003	1.2	387	10.3	8.1	32	29	--	--	60
11-17-2003	1.7	395	10.0	7.8	17	15	--	--	130

Table 15. Results from 2003 suspended-sediment and bacteria sampling of selected sites on the Little White River and tributaries.—Continued

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; QA/QC, quality assurance/quality control; mg/L, milligrams per liter; µm, micrometers; mL, milliliters; col/100 mL, colonies per 100 milliliters; --, no data; <, less than; >, greater than]

Date	Discharge (ft^3/s)	Specific conductance (µS/cm)	Dissolved oxygen (mg/L)	pH	Suspended sediment (mg/L at 105°C)	Suspended sediment (mg/L at 550°C)	Suspended sediment QA/QC (mg/L at 180°C)	Fine (percent <0.062 µm)	Fecal coliform bacteria (col/100 mL)
Cut Meat Creek near confluence Little White River, below Soldier Creek, 432358100502600									
04-21-2003	6.9	498	11.0	6.8	92	80	--	--	30
05-07-2003	7.7	524	10.3	8.3	--	--	--	--	10
06-19-2003	.55	326	13.3	8.2	41	33	--	--	90
07-08-2003	.83	542	7.9	8.0	122	107	--	--	420
08-12-2003	0	--	--	--	--	--	--	--	--
09-04-2003	0	--	--	--	--	--	--	--	--
09-23-2003	0	--	--	--	--	--	--	--	--
10-22-2003	0	--	--	--	--	--	--	--	--
11-19-2003	0	--	--	--	--	--	--	--	--

[1]Fecal coliform bacteria samples collected on September 23, 2003, were not received at the laboratory within the required 24-hour period. Values determined may not reflect actual concentrations on the date of the sample.

Table 16. U.S. Environmental Protection Agency Standard Method Codes and equipment used for water-quality analysis by the Bureau of Reclamation Laboratory, Bismark, N.Dak.

[ICP, inductively coupled plasma; FIA, fluid injection analysis; AA, atomic absorption]

Constituent	Equipment	U.S. Environmental Protection Agency Standard Method Code
Dissolved calcium	ICP Emission	200.7
Dissolved magnesium	ICP Emission	200.8
Dissolved potassium	ICP Emission	200.9
Dissolved sodium	ICP Emission	200.10
Alkalinity	Titrator	310.1
Dissolved chloride	FIA	325.2
Dissolved sulfate	FIA	375.4
Dissolved ammonia	FIA	350.1
Dissolved nitrate	FIA	353.2
Dissolved nitrite	FIA	353.2
Dissolved orthophosphate	FIA	365.1
Total phosphate	FIA	365.4
Total ammonia plus organic nitrogen	FIA	350.1
Dissolved silver	ICP Emission	200.7
Dissolved aluminum	ICP Emission	200.7
Dissolved arsenic	Graphite Furnace AA	206.2
Dissolved boron	ICP Emission	200.7
Dissolved barium	ICP Emmission	200.7
Dissolved beryllium	ICP Emmission	200.7
Dissolved cadmium	ICP Emmission	200.7
Dissolved cobalt	ICP Emmission	200.7
Dissolved chromium	ICP Emmission	200.7
Dissolved copper	ICP Emmission	200.7
Dissolved iron	ICP Emmission	200.7
Dissolved lithium	ICP Emmission	200.7
Dissolved manganese	ICP Emmission	200.7
Dissolved molybdenum	ICP Emmission	200.7
Dissolved nickel	ICP Emmission	200.7
Dissolved lead	Graphite Furnace AA	239.2
Dissolved antimony	ICP Emmission	200.7
Dissolved selenium	Graphite Furnace AA	270.2
Dissolved thallium	ICP Emmission	200.7
Dissolved vanadium	ICP Emmission	200.7
Dissolved zinc	ICP Emmission	200.7

Table 17. Summary statistics comparing historical physical properties and constituent concentrations to results from reconnaissance sampling on the Little White River.

[Constituents are dissolved fraction unless otherwise noted; ft^3/s, cubic feet per second; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; µg/L, micrograms per liter; --, no data; <, less than]

Property/constituent	Historical samples (1973–2001)					Reconnaissance samples	
	Number of samples	Number less than laboratory reporting level	Minimum value or concentration	Median value or concentration	Maximum value or concentration	September 2002	November 2002
Little White River near Vetal, 06449100							
Discharge, ft^3/s	322	0	12	46	992	88	40
Dissolved oxygen, mg/L	31	0	7.1	9.4	18.1	7.7	15.7
pH, standard units	33	0	7.8	8.2	8.6	7.6	7.1
Specific conductance, µS/cm	311	0	117	340	670	334	287
Air temperature, °C	288	0	-22.0	15.0	38.5	11.0	8.0
Water temperature, °C	319	0	0.0	10	30.5	11.0	1.4
Hardness, mg/L	31	0	96.0	120	140	111	101
Calcium, mg/L	31	0	29	36	41	36	33
Magnesium, mg/L	32	0	4.5	6.3	8.3	5	5
Potassium, mg/L	32	0	7.0	11	16	9.6	7.0
Sodium adsorption ratio	31	0	0.8	1	1	0.8	0.8
Sodium, mg/L	32	0	19	26.5	36	19	18
Alkalinity, mg/L	30	0	128	159	187	145	120
Chloride, mg/L	32	0	2.2	3.2	4.4	3.6	3.0
Fluoride, mg/L	11	0	0.4	0.5	0.6	--	--
Silica, mg/L	32	0	34	46.5	57	--	--
Sulfate, mg/L	32	0	11	21	37	19.3	25.4
Dissolved solids, sum of constituents, mg/L	31	0	207	249	286	180	164
Dissolved solids, mg/L	20	0	218	268	296	--	--
Ammonia, mg/L	11	0	0.01	0.02	0.06	0.02	0.05
Nitrate, mg/L	10	0	0.3	0.62	1.19	0.35	1.09
Nitrite, mg/L	32	22	<0.01	<0.01	0.02	<0.02	<0.02
Ortho phosphate, mg/L	29	0	0.22	0.61	1.38	0.15	0.17
Total phosphate, mg/L	4	0	0.89	0.98	1.2	0.29	0.19
Aluminum, µg/L	0	0	--	--	--	<25	<25
Antimony, µg/L	18	3	<1	2	21	<25	25.2
Arsenic, µg/L	19	0	7	9	13	8.4	6
Barium, µg/L	18	0	94	108	150	123	107
Beryllium, µg/L	19	17	<0.5	<0.5	<10	<5	<5

Table 17. Summary statistics comparing historical physical properties and constituent concentrations to results from reconnaissance sampling on the Little White River.—Continued

[Constituents are dissolved fraction unless otherwise noted; ft^3/s, cubic feet per second; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; µg/L, micrograms per liter; --, no data; <, less than]

Property/constituent	Historical samples (1973–2001)					Reconnaissance samples	
	Number of samples	Number less than laboratory reporting level	Minimum value or concentration	Median value or concentration	Maximum value or concentration	September 2002	November 2002
Little White River near Vetal, 06449100—Continued							
Boron, µg/L	20	0	30	50	60	43.7	36.4
Cadmium, µg/L	19	15	<1	<1	<10	<10	<10
Chromium, µg/L	18	17	<1	<1	1	<10	<10
Cobalt, µg/L	16	16	<3	<3	<50	<10	<10
Copper, µg/L	21	4	<1	4	22	<10	<10
Iron, µg/L	20	1	<3	29.5	100	<25	<25
Lead, µg/L	20	16	<1	<5	5	3.8	<2
Lithium, µg/L	0	0	--	--	--	<25	<25
Manganese, µg/L	21	2	<1	7	69	<25	<25
Molybdenum, µg/L	0	0	--	--	--	<10	<10
Nickel, µg/L	18	5	<1	1.5	7	<25	<25
Selenium, µg/L	31	27	<1	<1	<1	<1	<2.6
Thallium, µg/L	16	16	<1	<1	<1	<25	<25
Vanadium, µg/L	0	0	--	--	--	<25	<25
Zinc, µg/L	31	2	<3	8	100	<25	<25
Little White River above Rosebud, 06449300							
Discharge, ft^3/s	207	0	7.50	101	1,550	--	95
Dissolved oxygen, mg/L	97	0	6.7	9.6	14.2	--	11.7
pH, standard units	111	0	7.1	8.1	9.4	--	8.3
Specific conductance, µS/cm	202	0	219	310	580	--	271
Air temperature, °C	193	0	-18.0	14.0	38.0	--	10.0
Water temperature, °C	209	0	-1.0	11.4	31.0	--	3.5
Hardness, mg/L	60	0	66	110	130	--	100
Calcium, mg/L	60	0	21	36.5	43	--	33
Magnesium, mg/L	62	0	3.4	5.7	7.5	--	5
Potassium, mg/L	62	0	5.8	9.4	14	--	6.8
Sodium adsorption ratio	60	0	0.5	0.9	1	--	0.7
Sodium, mg/L	62	0	10	21	31	--	16
Alkalinity, mg/L	105	0	65	147	195	--	122
Chloride, mg/L	62	0	0.8	3.2	17	--	2.1

Table 17. Summary statistics comparing historical physical properties and constituent concentrations to results from reconnaissance sampling on the Little White River.—Continued

[Constituents are dissolved fraction unless otherwise noted; ft^3/s, cubic feet per second; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; µg/L, micrograms per liter; --, no data; <, less than]

Property/constituent	Historical samples (1973–2001)					Reconnaissance samples	
	Number of samples	Number less than laboratory reporting level	Minimum value or concentration	Median value or concentration	Maximum value or concentration	September 2002	November 2002
Little White River above Rosebud, 06449300—Continued							
Fluoride, mg/L	27	0	0.3	0.5	0.7	--	--
Silica, mg/L	23	0	38	49	56	--	--
Sulfate, mg/L	61	0	6.4	15	30	--	14.4
Dissolved solids, sum of constituents, mg/L	58	0	114	194	269	--	150
Dissolved solids, mg/L	61	0	151	232	292	--	--
Ammonia, mg/L	41	1	<0.01	0.02	0.11	--	0.06
Nitrate, mg/L	22	0	0.11	0.47	1.59	--	0.88
Nitrite, mg/L	62	39	<0.01	<0.01	0.05	--	<0.02
Ortho phosphate, mg/L	59	0	0.049	0.54	1.44	--	0.11
Total phosphate, mg/L	12	0	0.009	0.54	1.56	--	0.09
Aluminum, µg/L	33	0	20	90	1,500	--	<25
Antimony, µg/L	19	3	<1	2	20	--	29.6
Arsenic, µg/L	60	0	2.9	8	13	--	5.5
Barium, µg/L	51	1	<2	100	180	--	107
Beryllium, µg/L	19	17	<0.5	<0.5	<10	--	<5
Boron, µg/L	57	0	30	40	80	--	23.8
Cadmium, µg/L	60	55	<1	<10	<10	--	<10
Chromium, µg/L	19	18	<1	<1	1	--	<10
Cobalt, µg/L	16	16	<3	<3	<50	--	<10
Copper, µg/L	62	11	<1	3	29	--	<10
Iron, µg/L	62	2	5	32	1,100	--	<25
Lead, µg/L	59	46	<1	<1	20	--	<2
Lithium, µg/L	33	1	<4	20	50	--	<25
Manganese, µg/L	62	2	1	4	48	--	<25
Molybdenum, µg/L	1	0	1.8	--	1.8	--	<10
Nickel, µg/L	18	10	<1	<1	5	--	<25
Selenium, µg/L	96	84	<1	<1	<3	--	<2.6
Thallium, µg/L	16	16	<1	<1	<1	--	<25
Vanadium, µg/L	1	1	9	--	9	--	<25
Zinc, µg/L	82	16	<3	<10	150	--	<25

Table 17. Summary statistics comparing historical physical properties and constituent concentrations to results from reconnaissance sampling on the Little White River.—Continued

[Constituents are dissolved fraction unless otherwise noted; ft^3/s, cubic feet per second; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; µg/L, micrograms per liter; --, no data; <, less than]

Property/constituent	Historical samples (1973–2001)					Reconnaissance samples	
	Number of samples	Number less than laboratory reporting level	Minimum value or concentration	Median value or concentration	Maximum value or concentration	September 2002	November 2002
Little White River near Rosebud, 06449500							
Discharge, ft^3/s	289	0	43	106	1,060.0	122	100
Dissolved oxygen, mg/L	0	0	--	--	--	10.3	14.2
pH, standard units	0	0	--	--	--	7.8	7.7
Specific conductance, µS/cm	248	0	180.0	325	580.0	307	284
Air temperature, °C	285	0	-30.0	16.0	39.5	13.0	9.0
Water temperature, °C	285	0	0.0	11.5	31.5	13.4	2.4
Hardness, mg/L	--	--	--	--	--	110	108
Calcium, mg/L	--	--	--	--	--	--	--
Magnesium, mg/L	--	--	--	--	--	--	--
Potassium, mg/L	--	--	--	--	--	--	--
Sodium adsorption ratio	--	--	--	--	--	--	--
Sodium, mg/L	--	--	--	--	--	--	--
Alkalinity, mg/L	--	--	--	--	--	--	--
Chloride, mg/L	--	--	--	--	--	--	--
Fluoride, mg/L	--	--	--	--	--	--	--
Silica, mg/L	--	--	--	--	--	--	--
Sulfate, mg/L	--	--	--	--	--	--	--
Dissolved solids, sum of constituents, mg/L	--	--	--	--	--	--	--
Dissolved solids, mg/L	--	--	--	--	--	--	--
Ammonia, mg/L	--	--	--	--	--	--	--
Nitrate, mg/L	--	--	--	--	--	--	--
Nitrite, mg/L	--	--	--	--	--	--	--
Ortho phosphate, mg/L	--	--	--	--	--	--	--
Total phosphate, mg/L	--	--	--	--	--	--	--
Aluminum, µg/L	--	--	--	--	--	--	--
Antimony, µg/L	--	--	--	--	--	--	--
Arsenic, µg/L	--	--	--	--	--	--	--
Barium, µg/L	--	--	--	--	--	--	--
Beryllium, µg/L	--	--	--	--	--	--	--
Boron, µg/L	--	--	--	--	--	--	--

Table 17. Summary statistics comparing historical physical properties and constituent concentrations to results from reconnaissance sampling on the Little White River.—Continued

[Constituents are dissolved fraction unless otherwise noted; ft^3/s, cubic feet per second; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; µg/L, micrograms per liter; --, no data; <, less than]

Property/constituent	Historical samples (1973–2001)					Reconnaissance samples	
	Number of samples	Number less than laboratory reporting level	Minimum value or concentration	Median value or concentration	Maximum value or concentration	September 2002	November 2002
Little White River near Rosebud, 06449500—Continued							
Cadmium, µg/L	--	--	--	--	--	--	--
Chromium, µg/L	--	--	--	--	--	--	--
Cobalt, µg/L	--	--	--	--	--	--	--
Copper, µg/L	--	--	--	--	--	--	--
Iron, µg/L	--	--	--	--	--	--	--
Lead, µg/L	--	--	--	--	--	--	--
Lithium, µg/L	--	--	--	--	--	--	--
Manganese, µg/L	--	--	--	--	--	--	--
Molybdenum, µg/L	--	--	--	--	--	--	--
Nickel, µg/L	--	--	--	--	--	--	--
Selenium, µg/L	--	--	--	--	--	--	--
Thallium, µg/L	--	--	--	--	--	--	--
Vanadium, µg/L	--	--	--	--	--	--	--
Zinc, µg/L	--	--	--	--	--	--	--

Table 18. Results from 2003 pesticide sampling of selected tributaries to the Little White River.

[ft^3/s, cubic feet per second; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; E, estimated; <, less than]

	Soldier Creek above Swift Bear Lake, near Rosebud, 431552100473600	East tributary Rosebud Creek near Rosebud, 431310100501600	Rosebud Creek at Rosebud, 06449400	Rosebud Creek at Little White River confluence, below Rosebud, 431600100533600
Date	08-12-2003	08-12-2003	08-12-2003	08-12-2003
Time	1030	0650	1400	0930
Discharge, ft^3/s	0.37	3.0	5.9	6.0
Dissolved oxygen, mg/L	6.2	8.4	7.2	8.5
pH, standard units	7.8	7.7	8.0	8.2
Specific conductance, µS/cm	325	335	330	332
Temperature, air, °C	26.0	21.5	19.5	24.0
Temperature, water, °C	22.6	15.0	21.0	19.8
2,6-Diethylaniline, mg/L	<.006	<.006	<.006	<.006
2-Chloro-4-isopropylamino-6-amino-s-triazine, mg/L	E.005	<.006	<.006	<.006
Acetochlor, mg/L	<.006	<.006	<.006	<.006
Alachlor, mg/L	<.004	<.004	<.004	<.004
alpha-HCH, mg/L	<.005	<.005	<.005	<.005
alpha-HCH-d6, surrogate, percent recovery	78.9	88.4	77.9	84.8
Atrazine, mg/L	0.01	<.007	<.007	<.007
Azinphos-methyl, mg/L	<.050	<.050	<.050	<.050
Benfluralin, mg/L	<.010	<.010	<.010	<.010
Butylate, mg/L	<.002	<.002	<.002	<.002
Carbaryl, mg/L	<.041	<.041	<.041	<.041
Carbofuran, mg/L	<.020	<.020	<.020	<.020
Chlorpyrifos, mg/L	<.005	<.005	<.005	<.005
cis-Permethrin, mg/L	<.006	<.006	<.006	<.006
Cyanazine, mg/L	<.018	<.018	<.018	<.018
DCPA, mg/L	<.003	<.003	<.003	<.003
Desulfinyl fipronil, mg/L	<.004	<.004	<.004	<.004
Diazinon, mg/L	<.005	<.005	<.005	<.005
Diazinon-d10, surrogate, percent recovery	101	101	94.7	103
Dieldrin, mg/L	<.005	<.005	<.005	<.005
Disulfoton, mg/L	<.02	<.02	<.02	<.02
EPTC, mg/L	<.002	<.002	<.002	<.002
Ethalfluralin, mg/L	<.009	<.009	<.009	<.009
Ethoprop, mg/L	<0.005	<0.005	<0.005	<0.005

Table 18. Results from 2003 pesticide sampling of selected tributaries to the Little White River.—Continued

[ft^3/s, cubic feet per second; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; E, estimated; <, less than]

	Soldier Creek above Swift Bear Lake, near Rosebud, 431552100473600	East tributary Rosebud Creek near Rosebud, 431310100501600	Rosebud Creek at Rosebud, 06449400	Rosebud Creek at Little White River confluence, below Rosebud, 431600100533600
Desulfinylfipronil amide, mg/L	<.009	<.009	<.009	<.009
Fipronil sulfide, mg/L	<.005	<.005	<.005	<.005
Fipronil sulfone, mg/L	<.005	<.005	<.005	<.005
Fipronil, mg/L	<.007	<.007	<.007	<.007
Fonofos, mg/L	<.003	<.003	<.003	<.003
Lindane, mg/L	<.004	<.004	<.004	<.004
Linuron, mg/L	<.035	<.035	<.035	<.035
Malathion, mg/L	<.027	<.027	<.027	<.027
Methyl parathion, mg/L	<.006	<.006	<.006	<.006
Metolachlor, mg/L	<.013	<.013	<.013	<.013
Metribuzin, mg/L	<.006	<.006	<.006	<.006
Molinate, mg/L	<.002	<.002	<.002	<.002
Napropamide, mg/L	<.007	<.007	<.007	<.007
p,p'-DDE, mg/L	<.003	<.003	<.003	<.003
Parathion, mg/L	<.010	<.010	<.010	<.010
Pebulate, mg/L	<.004	<.004	<.004	<.004
Pendimethalin, mg/L	<.022	<.022	<.022	<.022
Phorate, mg/L	<.011	<.011	<.011	<.011
Prometon, mg/L	<.01	<.01	<.01	<.01
Pronamide, mg/L	<.004	<.004	<.004	<.004
Propachlor, mg/L	<.010	<.010	<.010	<.010
Propanil, mg/L	<.011	<.011	<.011	<.011
Propargite, mg/L	<.02	<.02	<.02	<.02
Simazine, mg/L	<.005	<.005	<.005	<.005
Tebuthiuron, mg/L	<.02	<.02	<.02	<.02
Terbacil, mg/L	<.034	<.034	<.034	<.034
Terbufos, mg/L	<.02	<.02	<.02	<.02
Thiobencarb, mg/L	<.005	<.005	<.005	<.005
Triallate, mg/L	<.002	<.002	<.002	<.002
Trifluralin, mg/L	<.009	<.009	<.009	<.009

CONCEPTS (Conservational Channel Evolution and Pollutant Transport System) Model Example Input Files

Main Input File

```
!
! Main Input File
!
! case name lw with tributary input, gw inflow, and various N values
lws
! project title
Little White River
!------------------------ Run Control Data -------------------------
! upstream flow discharge file
discharge.txt
! lateral inflow and downstream boundary condition
 0.0  1  3  700.65 .092  11.3636 700.93 1.0154 4.3120 701.61  2.989 2.7746
! sediment discharge at upstream end of the channel
 0 0.9 0.3 0.1 0.9 0.3 0.1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
! silt fraction and downstream bed control
 1.0 1.0 1.0
! bank failure analysis
 7  5  10
! type of flow resistance formulation
 1
! water temperature
 14.0
! sediment and streambank mechanics options
 1  1  1
!------------------------ Simulation Times -------------------------
!        start                  end        time step
  04/01/2003 12:00:00  11/30/2003 12:00:00  86400
!--------------------- Makeup of Modeling Reach --------------------
! number of links
1
! linktypes for the above number of links
1
!---------------------------- Link 1 -------------------------------
! REACH: number of cross sections and their data filename
12
xs01.txt
xs02.txt
xs03.txt
xs04.txt
xs05.txt
xs06.txt
xs07.txt
xs08.txt
xs09.txt
xs10.txt
xs11.txt
xs12.txt
!---------------------------- Output -------------------------------
! single point and time
```

```
  12
   50183
 1  1
   4
  05/19/2003 12:00:00
  06/02/2003 12:00:00
  07/10/2003 12:00:00
  09/25/2003 12:00:00
   50183
 1  2
   4
  05/19/2003 12:00:00
  06/02/2003 12:00:00
  07/10/2003 12:00:00
  09/25/2003 12:00:00
   50183
 1  3
   4
  05/19/2003 12:00:00
  06/02/2003 12:00:00
  07/10/2003 12:00:00
  09/25/2003 12:00:00
   50183
 1  4
   4
  05/19/2003 12:00:00
  06/02/2003 12:00:00
  07/10/2003 12:00:00
  09/25/2003 12:00:00
   50183
 1  5
   4
  05/19/2003 12:00:00
  06/02/2003 12:00:00
  07/10/2003 12:00:00
  09/25/2003 12:00:00
   50183
 1  6
   4
  05/19/2003 12:00:00
  06/02/2003 12:00:00
  07/10/2003 12:00:00
  09/25/2003 12:00:00
   50183
 1  7
   4
  05/19/2003 12:00:00
  06/02/2003 12:00:00
  07/10/2003 12:00:00
  09/25/2003 12:00:00
   50183
 1  8
   4
  05/19/2003 12:00:00
  06/02/2003 12:00:00
  07/10/2003 12:00:00
```

```
  09/25/2003 12:00:00
   50183
 1  9
   4
  05/19/2003 12:00:00
  06/02/2003 12:00:00
  07/10/2003 12:00:00
  09/25/2003 12:00:00
   50183
 1  10
   4
  05/19/2003 12:00:00
  06/02/2003 12:00:00
  07/10/2003 12:00:00
  09/25/2003 12:00:00
   50183
 1  11
   4
  05/19/2003 12:00:00
  06/02/2003 12:00:00
  07/10/2003 12:00:00
  09/25/2003 12:00:00
   50183
 1  12
   4
  05/19/2003 12:00:00
  06/02/2003 12:00:00
  07/10/2003 12:00:00
  09/25/2003 12:00:00
!   single point, continuosly in time
  3
  725517
 1  9
  1
  04/02/2003 12:00:00  11/30/2003 12:00:00
  725517
 1  11
  1
  04/02/2003 12:00:00  11/30/2003 12:00:00
  725517
 1  12
  1
  04/02/2003 12:00:00  11/30/2003 12:00:00
!  profile at specific time points
 1
 255
 1  1   1  12
6
  05/19/2003 12:00:00
  06/02/2003 12:00:00
  07/10/2003 12:00:00
  09/25/2003 12:00:00
  10/28/2003 12:00:00
  11/13/2003 12:00:00
```

Input File of Cross Section 001

```
!
! Input file of cross section 001
!
! Name of cross section and model kilometer (km)
Cross Section 1: Little White Near Vetal
     0.000
! Friction factor
     0.060
!Tributary inflow info
 0
!--------------------- Left FloodPlain -----------------------
! number of points
   4
! station and elevation for above number of coordinates in (m)
     0.000    850.93
     5.49     850.31
     6.71     850.00
     9.14     849.53
! Friction factor
     0.065
!------------------------ Left Bank -------------------------
! number of points
   3
! station and elevation for above number of coordinates in (m)
     9.14     849.53
    11.58     849.10
    11.89     849.01
! Soil layer data
! number of soil layers in the bank
  1
! layer 1: elevation of layer top
     851
! layer 1: strength parameters (c,phi,phib,gamma_s)
   0.0  27.0  15.0  18000.0
! layer 1: erodibility, i.e. critical shear stress (Pa)
   10.00
! layer 1: sediment composition
    2.50
    4.90
   13.40
   63.60
   14.30
    1.30
    0.00
    0.00
    0.00
    0.00
    0.00
    0.00
    0.00
    0.00
! groundwatertable
    849
! Friction factor
```

```
     0.050
!----------------------- Channel Bed -------------------------
! number of points
   8
! station and elevation for above number of coordinates in (m)
    11.890   849.010
    13.410   848.210
    14.630   848.050
    16.150   848.050
    17.070   848.010
    18.290   848.250
    19.510   848.570
    20.42    848.000
! Elevation of bedrock (m)
   0.00
! Porosity
  0.40
! Hiding factors
  0.25     0.95     0.70
! Surface layer and substratum data
! Number of sediment layers composing the bed
   1
! Layer 1: layer depth below bed surface
    0.00
! Layer 1: composition
    0.00
    0.00
    0.40
   29.00
   58.90
   10.00
    0.80
    0.70
    0.20
    0.00
    0.00
    0.00
    0.00
    0.00
! Critical shear stresses for deposition on and erosion of cohesive beds,
! and erodibility coefficient
    0.100    7.050  3.40E-07
! Friction factor
     0.025
!------------------------ Right Bank -------------------------
! number of points
   2
! station and elevation for above number of coordinates in (m)
    20.420   849.000
    21.340   849.530
! Soil layer data
! number of soil layers in the bank
  1
! layer 1: elevation of layer top
     850.00
! layer 1: strength parameters (c,phi,phib,gamma_s)
```

```
   0.0  27.0  15.0  18000.0
! layer 1: erodibility, i.e. critical shear stress (Pa)
   10.00
! layer 1: sediment composition
    1.10
    2.10
    8.10
   40.10
   35.60
   13.00
    0.00
    0.00
    0.00
    0.00
    0.00
    0.00
    0.00
    0.00
! groundwatertable
    849
! Friction factor
     0.05
!--------------------- Right FloodPlain -----------------------
! number of points
   3
! station and elevation for above number of coordinates in (m)
    21.340   849.530
    34.380   850.080
    54.860   850.110
! Friction factor
     0.065
```

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