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

Water-Quality Characteristics for Selected Streams in Lawrence County, South Dakota, 1988-92

By Joyce E. Williamson and Timothy S. Hayes

Water-Resources Investigations Report 00-4220

Prepared in cooperation with Lawrence County and the
South Dakota Department of Environment and Natural Resources

U.S. Department of the Interior

Bruce Babbitt, Secretary

U.S. Geological Survey

Charles G. Groat, Director

Rapid City, South Dakota: 2000

For additional information write to:

District Chief
U.S. Geological Survey
1608 Mt. View Road
Rapid City, SD 57702

Copies of this report can be purchased from:

U.S. Geological Survey
Information Services
Box 25286
Denver, CO 80225-0286

CONTENTS

FIGURES

FIGURES—Continued

TABLES

CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter
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

Temperature can be converted to degrees Fahrenheit (°F) or degrees Celsius (°C) by the following equations:

$$°F = 9/5\ (°C) + 32$$
$$°C = 5/9\ (°F-32)$$

Chemical concentrations: Chemical concentrations of substances in water are given in metric units of milligrams per liter (mg/L) and micrograms per liter (µg/L). Milligrams per liter is a unit expressing the concentration of chemical constituents in solution as mass (milligrams) of solute per unit volume (liter) of water. Micrograms per liter is a unit expressing the concentration of chemical constituents in solution as mass (micrograms) of solute per unit volume (liter) of water. Micrograms per liter are equivalent to milligrams per liter divided by 1,000.

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Water year: Water year is the 12-month period, October 1 through September 30, and is designated by the calendar year in which it ends. Thus, the water year ending September 30, 1992, is called the "1992 water year."

Water-Quality Characteristics for Selected Streams in Lawrence County, South Dakota, 1988-92

By Joyce E. Williamson *and* Timothy S. Hayes

ABSTRACT

During the 1980's, significant economic development and population growth began to occur in Lawrence County in the northern part of the Black Hills of western South Dakota. Rising gold prices and heap-leach extraction methods allowed the economic recovery of marginal gold-ore deposits, resulting in development of several large-scale, open-pit gold mines in Lawrence County. There was increasing local concern regarding potential impacts on the hydrologic system, especially relating to the quantity and quality of water in the numerous streams and springs of Lawrence County.

In order to characterize the water quality of selected streams within Lawrence County, samples were collected from 1988 through 1992 at different times of the year and under variable hydrologic conditions. During the time of this study, the Black Hills area was experiencing a drought; thus, most samples were collected during low-flow conditions.

Streamflow and water-quality characteristics in Lawrence County are affected by both geologic conditions and precipitation patterns. Most streams that cross outcrops of the Madison Limestone and Minnelusa Formation lose all or a large part of their streamflow to aquifer recharge. Streams that are predominantly spring fed have relatively stable streamflow, varying slightly with dry and wet precipitation cycles.

Most streams in Lawrence County generally have calcium magnesium bicarbonate type waters. The sites from the mineralized area of central Lawrence County vary slightly from other streams in Lawrence County by having higher concentrations of sodium, less bicarbonate, and more sulfate. False Bottom Creek near Central City has more sulfate than bicarbonate.

Nitrogen, phosphorous, and cyanide concentrations were at or near the laboratory reporting limits for most sites and did not exceed any of the water-quality standards. Nitrite plus nitrate concentrations at Annie Creek near Lead, Whitetail Creek at Lead, Squaw Creek near Spearfish, and Spearfish Creek below Robison Gulch were somewhat higher than at other sites. Mining activity, agricultural activity, and domestic development are possible sources of nitrogen to the streams. Increased mining activities were identified as the probable cause of increased nitrogen concentrations in Annie Creek.

In the mineralized area of the northern Black Hills, detectable concentrations of trace elements are common in stream water, occasionally exceeding beneficial-use and aquatic-life criteria. In addition, many basins have been disturbed by both historical and recent mining operations and cleanup activities. The maximum dissolved arsenic concentration at Annie Creek near Lead (48 micrograms per liter) approached the current arsenic drinking-water standard. Concentrations at or greater than 5 micrograms per liter were found in samples from Annie Creek near

Lead, Spearfish Creek above Spearfish, Whitetail Creek at Lead, and False Bottom Creek near Spearfish. Bear Butte Creek near Deadwood had one sample with a dissolved copper concentration that exceeded acute and chronic aquatic-life criteria. Bear Butte Creek near Deadwood had several manganese concentrations that exceeded the secondary maximum contaminant level of 50 micrograms per liter.

Bed-sediment and water-quality data from selected sites in small drainage basins were used to determine if factors such as pH, arsenic concentrations in bed sediments, and calcite saturation control dissolved arsenic concentrations. Arsenic solubility is controlled by adsorption, mainly on ferrihydrite. In addition, adsorption/desorption of arsenic is controlled by the pH of the stream, with high arsenic concentrations appearing only at higher pH conditions (above 8). There are significant arsenic sources available to almost all the small streams of the northern Black Hills mining area, but arsenic is less mobile in streams that are not influenced to the higher pH values by calcite. Streams where arsenic is more mobile have lower iron concentrations in their bed sediments, and they have relatively high concentrations of calcite in the bed sediment.

Additional water-quality data have been collected as part of other studies or monitoring programs by the South Dakota Department of Environment and Natural Resources, U.S. Environmental Protection Agency, U.S. Forest Service, and the U.S. Geological Survey. Summaries of selected data from these other sources are included as additional information.

INTRODUCTION

Lawrence County is located in the northern part of the Black Hills of western South Dakota (fig. 1). Settlement of the area began soon after discovery of gold by the Custer expedition in 1874. A gold rush to the southern Black Hills quickly ensued and shifted northward following discovery of richer deposits in the Deadwood-Lead area. Massive tracts of timber were cleared around Deadwood and Lead for mining uses and home building (U.S. Departments of Interior and Agriculture, 1967). Farms developed along river bottoms in the foothills to provide food for the growing population. Many water rights for irrigation of these farms preceded the statehood of South Dakota, which occurred in 1889.

By the turn of the century, the richest near-surface deposits of gold had been exploited and numerous small, underground hard-rock mines failed one by one. The Homestake Mine in Lead, however, survived to become the nation's largest underground gold producer (Gries, 1996). Economic diversification began, with timber harvest and agriculture joining gold production as dominant industries through the mid-1900's. The area began to gain popularity as a tourist attraction, with tourism and outdoor recreation emerging as one of the county's most important industries. Numerous outdoor activities such as bicycling, fishing, hiking, hunting, skiing, and snowmobiling depend upon the scenic beauty and pristine environment found in much of Lawrence County.

During the 1980's, significant economic development and population growth accelerated in Lawrence County. Rising gold prices and heap-leach extraction methods, where the ore is crushed, spread on an impervious pad, and sprayed with a cyanide solution, allowed the economic recovery of marginal gold-ore deposits, resulting in development of several large-scale, open-pit gold mines in Lawrence County (Gries, 1996). This increase in mining activity contributed to other ongoing economic and population growth in the county, resulting in increased developmental pressure in urban and suburban areas. The increase in mining activity, urbanization, and other forms of resource development created a potential conflict with activities dependent upon the scenic beauty of the Black Hills. There was increasing concern regarding potential impacts on the hydrologic system, especially relating to the quantity and quality of water in the numerous streams and springs of Lawrence County. In response to these concerns, the Lawrence County Commission, in conjunction with the South Dakota Department of Environment and Natural Resources (DENR), requested the U.S. Geological Survey (USGS) to begin an appraisal of the water resources of Lawrence County during 1988.

The general objectives of the Lawrence County study were to: (1) describe and characterize bedrock aquifers; (2) quantify surface-water resources; and (3) characterize the water quality of selected streams within the county. During 1992, the Lawrence County

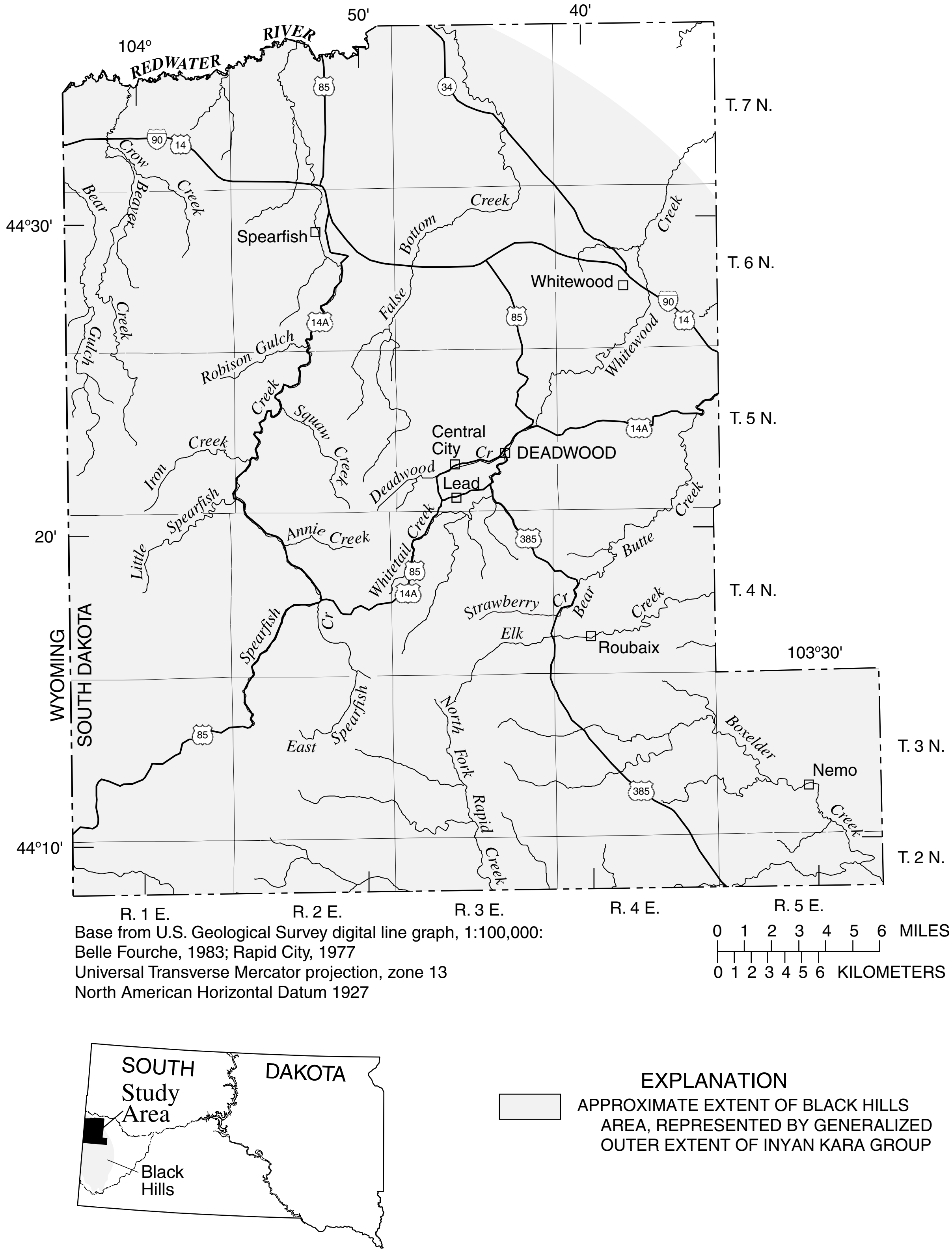


Figure 1. Location of study area in Lawrence County.

study was incorporated into the Black Hills Hydrology Study, which has a purpose of investigating the regional hydrogeologic characteristics of the Black Hills area. Thus, accomplishment of the first objective of the original Lawrence County study is being fulfilled under the Black Hills Hydrology Study. A variety of relevant information has previously been presented by Driscoll and Bradford (1994), Driscoll and others (1996), Strobel and others (1999), and Driscoll and others (2000). Much of the second objective also has been accomplished in a variety of ways. Precipitation and streamflow data have been published annually in Water Resources Data for South Dakota (U.S. Geological Survey, 1989-2000). Results of a spring inventory for the Black Hills area, including Lawrence County, were presented by Wenker (1997). Streamflow characteristics have been described by Miller and Driscoll (1998), and streamflow losses have been quantified by Hortness and Driscoll (1998).

Purpose and Scope

This report focuses on summarizing water-quality data collected from selected streams within Lawrence County during 1988-92 and characterizing the general stream-water quality within the county. Additional water-quality data have been collected at a variety of locations in Lawrence County since 1992, with results presented by Driscoll and Bradford (1994), Driscoll and others (1996), and Driscoll and others (2000). This report considers the consistent data set collected during 1988-92.

Data prior to resource development, including gold and silver mining, are not available; thus, effects of early resource development on water quality cannot be assessed. However, the data sets presented do provide a baseline against which future changes can be compared. Relations between variability of constituent concentrations and streamflow are examined, and spatial variability of water quality, which primarily results from differences in geology, is described. Water-quality characteristics related to mining, including relations between water and sediment chemistry, are examined for the mineralized area to evaluate patterns that may help to discern geochemical processes. Summaries of water-quality data collected by other agencies also are presented.

Description of the Study Area

The Black Hills of South Dakota and Wyoming are a large domal uplift formed during the Laramide orogeny (Late Cretaceous-Paleocene age). Lawrence County covers an area slightly over 800 mi^2 and is located in the northern portion of the Black Hills (fig. 1).

Physiography and Climate

The climate in Lawrence County is influenced by land-surface elevation, which ranges from just under 3,000 ft above sea level in the extreme northeastern corner of the county to in excess of 7,000 ft in the higher elevations. Mean annual air temperature decreases with increasing elevation, ranging from 46.9°F at Spearfish (elevation, 3,640 ft) to 44.2°F at Lead (elevation, 5,240 ft). Temperature extremes ranging from less than -30°F to in excess of 100°F are common. Annual precipitation increases with elevation, ranging from an average of about 21 in. at Spearfish to 29 in. at Lead (U.S. Department of Commerce, 1988-94). Generally, most of the annual precipitation falls between March and August, and most runoff generally occurs between March and June (Addison, 1991).

Land Use

Major land uses within Lawrence County include mining, timber production, agriculture, urban and suburban areas, and tourism and outdoor recreation. Gold mining has been the most important industry in the overall development of the area. During the initial gold rush, numerous mining claims were staked in the more mineralized portions of what is now Lawrence County. Placer mining, small surface pits, and shallow underground mines were common through the late 1800's. Underground gold mining at the Homestake Mine in Lead constituted most of the mining activity in the northern Black Hills from the late 1800's through about 1980, although numerous small mines also existed within the area (Gries, 1996). Since then, development of heap-leach recovery methods for low-grade gold ores has led to development of several new large-scale, open-pit gold mines.

The timber industry, which primarily harvests ponderosa pine (Orr, 1959), evolved in support of the mining industry. Timber harvest was first concentrated near the mining centers, but spread to serve developing farms and towns in surrounding areas. The Black Hills

Forest Reserve was established in 1897 and in 1905 transferred to the U.S. Forest Service (USFS), an agency of the U.S. Department of Agriculture, for management of forested lands in the Black Hills (U.S. Forest Service, 1994). It was renamed the Black Hills National Forest in 1907. Privately held lands, including active mining claims, foothills ranches, and meadows and bottom lands along numerous streams, were excluded from the Black Hills National Forest, which constitutes about 53 percent of Lawrence County.

The agriculture industry also initially developed in support of the mining industry. A number of irrigated vegetable farms are still located along Spearfish Creek; however, cattle production currently is the largest component of the agriculture industry, with most crops produced as cattle fodder. Private and USFS lands in the higher elevations are used as summer pasture; however, most cattle are wintered in the lower elevations, where the majority of crop production takes place. Irrigation withdrawals along Spearfish Creek and the Redwater River reduce the flow of these streams during dry summer months.

Spearfish and the Deadwood-Lead area, with 1996 populations of about 8,000 and 3,000 respectively, are the primary urban areas in Lawrence County. Total population of the county was about 21,000 in 1990. Various suburban areas have developed near the urban areas and numerous individual residences are located on small plots of private land within the forested, higher elevations of the county.

Tourism and outdoor-recreation activities have gained popularity over the years to become important industries in Lawrence County. Tourist attractions around the area have been popular with summer vacationers for many years. Outdoor recreation, including bicycling, fishing, hiking, hunting, skiing, and snowmobiling have become increasingly popular in recent years. Dominant sport wildlife species include elk, deer, and turkeys. Various streams support naturally reproducing populations of brook and brown trout, as well as put-and-take rainbow trout fisheries. Numerous campgrounds and trail systems have been developed for outdoor enthusiasts.

Hydrogeology

The geology of Lawrence County is extremely complex, with exposures of igneous, metamorphic, and sedimentary rocks and unconsolidated sediments ranging in age from Precambrian to Quaternary. A stratigraphic section for Lawrence County is presented in figure 2, and a generalized hydrogeologic unit map of the study area is presented in figure 3. The central core of the Black Hills, which extends southward from central Lawrence County, consists largely of Precambrian igneous and metamorphic rocks and Tertiary igneous rocks. The Precambrian metamorphic rocks and Tertiary igneous rocks are referred to as the mineralized area in this report because of the presence of gold, silver, and other ores. A series of sedimentary formations is exposed in roughly concentric rings around the fringe of the Black Hills and progress from older at the higher elevations to younger at the lower elevations. These formations typically dip away from the uplifted Black Hills at angles that approach or exceed 20 degrees near the outcrops and decrease with distance from the uplift (Carter and Redden, 1999a, 1999b, 1999c). The youngest sedimentary rocks of the sequence are exposures of Cretaceous marine shales, limestone, and sandstone, including the Belle Fourche Shale in the northeastern corner of the county. Sand and gravel terrace deposits of Tertiary (?) age are found in central and east-central Lawrence County and relatively modern alluvial and terrace deposits of unconsolidated Quaternary sand and gravel are found in several parts of the county.

Thousands of feet of sedimentary rocks have been eroded from much of central Lawrence County exposing a variety of Precambrian igneous and metamorphic rocks. Precambrian rocks underlie the Deadwood Formation of Cambrian and Ordovician age, which is the basal sedimentary unit. A wide variety of intrusive rocks of Tertiary age are found near the contact between the Precambrian rocks and the Deadwood Formation. The Tertiary intrusions generally are more mineralized than the Precambrian rocks and Deadwood Formation, and in many cases, deposits of gold ore and various other ores are associated with the intrusive rocks.

The Precambrian igneous and metamorphic rocks generally have low permeability, with ground-water flow systems primarily restricted to weathered zones or localized fracture systems. Limited ground water is obtained from relatively shallow wells (typically less than several hundred feet deep), many of which may be hydraulically connected to nearby streams. The quality of water from wells within the igneous and metamorphic rocks is known to vary significantly by location, dependent upon the local mineralogy.

ERATHEM	SYSTEM	ABBREVIATION FOR STRATIGRAPHIC INTERVAL	GEOLOGIC FORMATION	SUBSURFACE THICKNESS, IN FEET[1]	DESCRIPTION
CENOZOIC	QUATERNARY & TERTIARY (?)	Qa, Qc, Qg	UNDIFFERENTIATED SANDS AND GRAVELS	[2]0-60	Sand, gravel, and boulders
CENOZOIC	QUATERNARY & TERTIARY (?)	Tw	WHITE RIVER GROUP	[3]0-150	Light colored clays with sandstone channel fillings and local limestone lenses.
CENOZOIC	TERTIARY	Tui	INTRUSIVE IGNEOUS ROCKS	---	Includes rhyolite, latite, trachyte, and phonolite.
MESOZOIC	CRETACEOUS	Kps	GRANEROS GROUP: BELLE FOURCHE SHALE	[2]150-850	Gray shale with scattered limestone concretions. Clay spur bentonite at base.
MESOZOIC	CRETACEOUS	Kps	GRANEROS GROUP: MOWRY SHALE	[2]125-230	Light-gray siliceous shale. Fish scales and thin layers of bentonite.
MESOZOIC	CRETACEOUS	Kps	GRANEROS GROUP: MUDDY SANDSTONE (DYNNESON; NEWCASTLE)	[2]0-100	Brown to light yellow and white sandstone.
MESOZOIC	CRETACEOUS	Kps	GRANEROS GROUP: SKULL CREEK SHALE	[2]150-270	Dark gray to black siliceous shale.
MESOZOIC	CRETACEOUS	Kik	INYAN KARA GROUP: FALL RIVER FORMATION	[4]10-200	Massive to slabby sandstone.
MESOZOIC	CRETACEOUS	Kik	INYAN KARA GROUP: LAKOTA FM (Fuson Shale; Minnewaste Limestone)	[4]30-300	Coarse gray to buff cross-bedded conglomeratic sandstone, interbedded with buff, red, and gray clay, especially toward top. Local fine-grained limestone.
MESOZOIC	JURASSIC	Ju	MORRISON FORMATION	[2]0-150	Green to maroon shale. Thin sandstone.
MESOZOIC	JURASSIC	Ju	UNKPAPA SS	[2]0-275	Massive fine-grained sandstone.
MESOZOIC	JURASSIC	Ju	SUNDANCE FORMATION (Redwater Member; Lak Member; Hulett Member; Stockade Beaver Mem.; Canyon Spr Member)	[2]250-475	Greenish-gray shale, thin limestone lenses. Glauconitic sandstone; red sandstone near middle.
MESOZOIC	JURASSIC	Ju	GYPSUM SPRING FORMATION	[2]0-125	Red siltstone, gypsum, and limestone.
MESOZOIC	TRIASSIC	TRPs	SPEARFISH FORMATION (Goose Egg Equivalent)	[2]375-800	Red sandy shale, soft red sandstone and siltstone with gypsum and thin limestone layers. Gypsum locally near the base.
PALEOZOIC	PERMIAN	Pmk	MINNEKAHTA LIMESTONE	[3]35-50	Thin to medium-bedded finely-crystalline, purplish gray laminated limestone.
PALEOZOIC	PERMIAN	Po	OPECHE SHALE	[2]25-150	Red shale and sandstone.
PALEOZOIC	PERMIAN / PENNSYLVANIAN	PIPm	MINNELUSA FORMATION	[5]350-650	Yellow to red cross-bedded sandstone, limestone, and anhydrite locally at top. Interbedded sandstone, limestone, dolomite, shale, and anhydrite. Red shale with interbedded limestone and sandstone at base.
PALEOZOIC	MISSISSIPPIAN	MDm	MADISON (PAHASAPA) LIMESTONE	[6]350-1000	Massive light-colored limestone. Dolomite in part. Cavernous in upper part.
PALEOZOIC	DEVONIAN	MDm	ENGLEWOOD FORMATION	[4]40-75	Pink to buff limestone. Shale locally at base.
PALEOZOIC	ORDOVICIAN	Ou	WHITEWOOD (RED RIVER) FORMATION	[2]0-150	Buff dolomite and limestone.
PALEOZOIC	ORDOVICIAN	Ou	WINNIPEG FORMATION	[2]0-110	Green shale with siltstone.
PALEOZOIC	ORDOVICIAN / CAMBRIAN	OЄd	DEADWOOD FORMATION	[3]300-500	Massive to thin-bedded buff to purple sandstone. Greenish glauconitic shale flaggy dolomite and flat-pebble limestone conglomerate. Sandstone, with conglomerate locally at the base.
PRECAMBRIAN		pЄu	UNDIFFERENTIATED METAMORPHIC AND IGNEOUS ROCKS		Schist, slate, quartzite, and arkosic grit. Intruded by diorite, metamorphosed to amphibolite, and by granite and pegmatite.

Modified from information furnished by the Department of Geology and Geological Engineering, South Dakota School of Mines and Technology (written commun., January 1994)

1 The subsurface thickness was modified from several references to provide a range that was the most specific to the study area.

2 DeWitt and others, 1989.

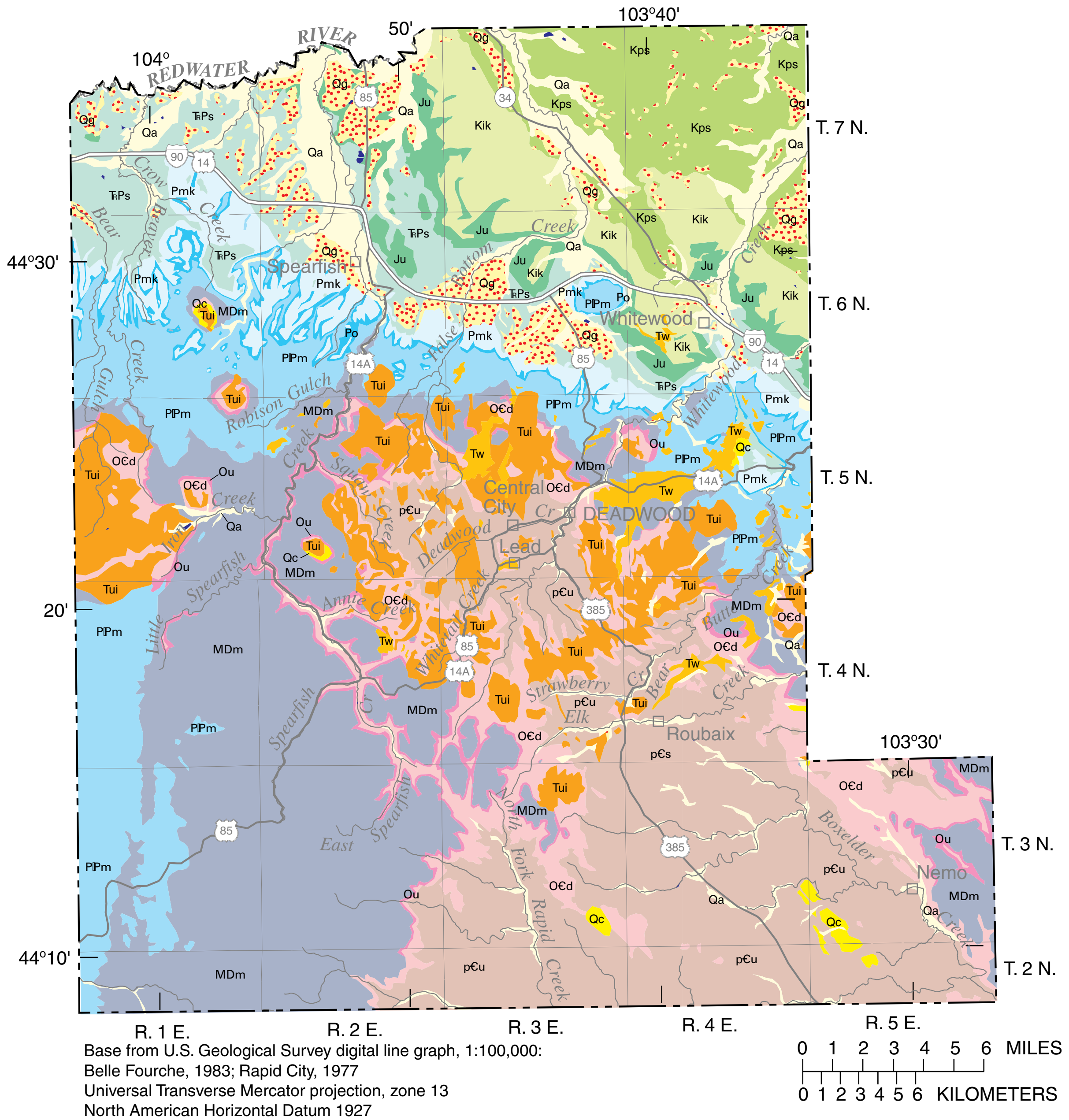
3 Robinson and others, 1964.

4 Kyllonen and Peter, 1987.

5 Thickness estimated from subtracting surfaces created from structure contours of Madison Limestone and Minnelusa Formation tops (Carter and Redden, 1999b, and Carter and Redden, 1999a).

6 Thickness estimated from subtracting surfaces created from structure contours of Deadwood Formation and Madison Limestone tops (Carter and Redden, 1999c, and Carter and Redden, 1999b). The subsurface thicknesses of the Madison Limestone greater than 700 feet are in the northeast part of the study area.

Figure 2. Stratigraphic section for Lawrence County.



EXPLANATION

QUATERNARY UNITS

- Qa — Alluvium
- Qc — Colluvium
- Qg — Gravel deposits

TERTIARY UNITS

- Tw — White River Group
- Tui — Undifferentiated intrusive igneous rocks

MESOZOIC UNITS

- Kps — Belle Fourche Shale to Skull Creek Shale, undifferentiated
- Kik — Inyan Kara Group

MESOZOIC UNITS-cont.

- Ju — Morrison Formation to Sundance and Gypsum Spring Formation, undifferentiated
- ŦPs — Spearfish Formation

PALEOZOIC UNITS

- Pmk — Minnekahta Limestone
- Po — Opeche Shale
- PIPm — Minnelusa Formation
- MDm — Madison Limestone and Englewood Formation
- Ou — Whitewood Formation and Winnipeg Formation
- O€d — Deadwood Formation

PRECAMBRIAN UNIT

- p€u — Precambrian igneous and metamorphic units

WATER BODIES

Figure 3. Generalized hydrogeologic units of Lawrence County (modified from Strobel and others, 1999).

Many of the sedimentary rocks have higher permeability than the underlying igneous and metamorphic rocks. Regionally, the sedimentary rock units form a complex series of aquifers that are separated by various confining units. These aquifers generally are unconfined in outcrop areas, where recharge occurs. Aquifers in the Madison Limestone, Minnelusa Formation, and Inyan Kara Group are utilized across considerable distances beyond the Black Hills area. Aquifers in the Deadwood Formation and Minnekahta Limestone also extend beyond the Black Hills area but generally are utilized only near the outcrop areas. Localized aquifers exist in numerous other sedimentary units within Lawrence County. The quality of water within the various sedimentary aquifers varies considerably, both spatially within the aquifers, as well as between aquifers (Peter, 1985; Kyllonen and Peter, 1987). Concentrations of dissolved constituents generally increase substantially with increasing distance from recharge areas.

Streamflow within Lawrence County is affected by topography and geology. The base flow of most streams originates in the higher elevations, where relatively high precipitation and low evaporation rates result in more water being available for flows of springs and streams. Large and consistent springs occur from large outcrops of the Madison Limestone in the headwaters of Spearfish Creek (Wenker, 1997; Miller and Driscoll, 1998). Most streams in Lawrence County, with the exception of Whitewood Creek, generally lose all or part of their flow as they cross outcrops of the Madison Limestone and Minnelusa Formation (Hortness and Driscoll, 1998). A number of large, artesian springs in northwestern Lawrence County, which originate from upward leakage from the Madison Limestone and Minnelusa Formation (Klemp, 1995), provide a large and consistent source of streamflow in several tributaries to the Redwater River (Miller and Driscoll, 1998).

Acknowledgments

The authors acknowledge the Lawrence County Commissioners and DENR for their insight, advice, and cooperation provided for this study. The authors also thank the U.S. Environmental Protection Agency (EPA) for assistance in obtaining water-quality data from other sources summarized in this report.

DATA COLLECTION

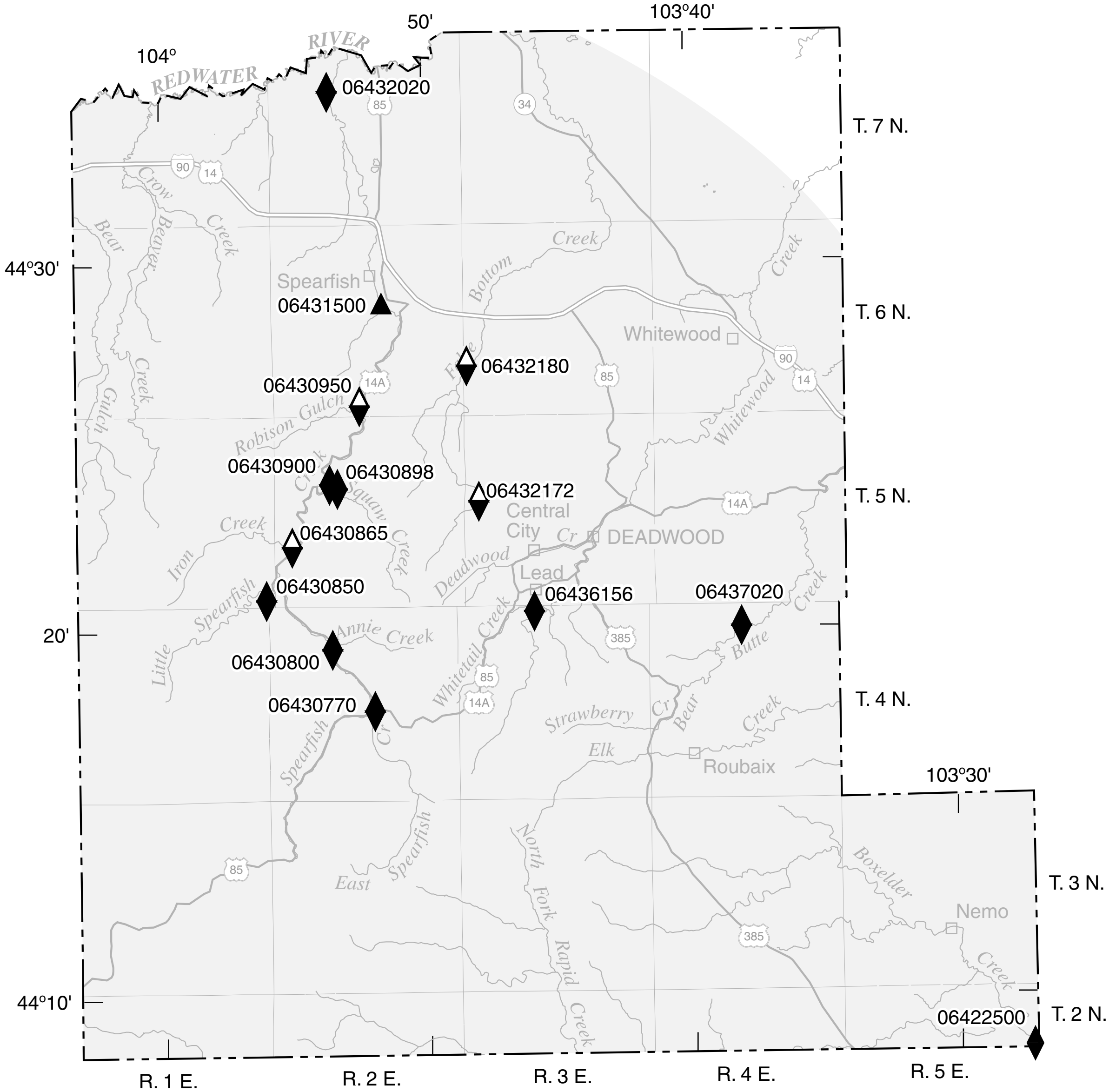
Sampling Sites

Water-quality samples for this study were collected during 1988-92 at 13 surface-water sites within Lawrence County (fig. 4). Sampling sites were selected along streams that were most likely to be influenced by future resource and urban development. Some sites were sampled as frequently as four times per year to quantify seasonal variations in water quality. Sites with low variability were sampled less frequently. Site information is presented in table 1. Information for streamflow-gaging station Spearfish Creek at Spearfish (06431500), which has no water-quality data but is used for hydrologic characterization, also is presented in table 1.

Sampling Methods

Prior to sampling, all water-sampling equipment was presoaked in a 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 on a given day, equipment cleaning between sites consisted of a deionized water rinse and thorough rinsing with stream water at the new site. After samples were collected, processed through a 0.45-micrometer (µm) filter if applicable, and preserved, they were shipped to the USGS National Water Quality Laboratory (NWQL) in Denver, Colorado, for analysis.

Previous studies (Fuller and others, 1988) found that the dissolved arsenic concentration from a 0.45-µm filter is essentially equal to the total arsenic concentration under base-flow conditions. A significant portion of the dissolved arsenic concentration is associated with colloidal material, and to get a true measure of dissolved arsenic, a smaller filter pore size was recommended (0.05 to 0.10 µm). Most of the samples collected along Whitewood Creek by USGS (1987 to present) were collected with a smaller pore-size filter, but the data presented in most sections of this report were obtained using the more standard filter size of 0.45 µm.



Base from U.S. Geological Survey digital line graph, 1:100,000:
Belle Fourche, 1983; Rapid City, 1977
Universal Transverse Mercator projection, zone 13
North American Horizontal Datum 1927

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

EXPLANATION

Station Number	Station Name
06422500	Boxelder Creek near Nemo
06430770	Spearfish Creek near Lead
06430800	Annie Creek near Lead
06430850	Little Spearfish Creek near Lead
06430865	Iron Creek near Lead
06430898	Squaw Creek near Spearfish
06430900	Spearfish Creek above Spearfish
06430950	Spearfish Creek below Robison Gulch, near Spearfish
06431500	Spearfish Creek at Spearfish
06432020	Spearfish Creek below Spearfish
06432172	False Bottom Creek near Central City
06432180	False Bottom Creek near Spearfish
06436156	Whitetail Creek at Lead
06437020	Bear Butte Creek near Deadwood

06431500 ▲ CONTINUOUS-RECORD STREAMFLOW-GAGING STATION--Number is station number

06432180 ▼ WATER-QUALITY SAMPLING SITE--Number is station number

06430865 △ MISCELLANEOUS-RECORD STREAMFLOW-GAGING STATION--Number is station number

Figure 4. Location of selected streamflow-gaging stations and water-quality sampling sites.

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

[Station types: C, continuous-record streamflow; M, miscellaneous-record streamflow; WQ, water-quality sampling site. N, north; W, west]

Station number (fig. 4)	Station type	Station name	Latitude	Longitude	Drainage area (square miles)
			(degrees, minutes, seconds)		
06422500	C, WQ	Boxelder Creek near Nemo	44 08 38 N	103 27 16 W	96
06430770	C, WQ	Spearfish Creek near Lead	44 17 56 N	103 52 02 W	63.5
06430800	C, WQ	Annie Creek near Lead	44 19 37 N	103 53 38 W	3.55
06430850	C, WQ	Little Spearfish Creek near Lead	44 20 58 N	103 56 08 W	25.8
06430865	M, WQ	Iron Creek near Lead	44 22 25 N	103 55 07 W	undetermined
06430898	C, WQ	Squaw Creek near Spearfish	44 24 04 N	103 53 35 W	6.95
06430900	C, WQ	Spearfish Creek above Spearfish	44 24 06 N	103 53 40 W	139
06430950	M, WQ	Spearfish Creek below Robison Gulch, near Spearfish	44 26 14 N	103 52 32 W	undetermined
06431500	C	Spearfish Creek at Spearfish	44 28 57 N	103 51 40 W	168
06432020	C, WQ	Spearfish Creek below Spearfish	44 34 48 N	103 53 37 W	204
06432172	M, WQ	False Bottom Creek near Central City	44 23 28 N	103 47 58 W	undetermined
06432180	M, WQ	False Bottom Creek near Spearfish	44 27 09 N	103 48 22 W	undetermined
06436156	C, WQ	Whitetail Creek at Lead	44 20 36 N	103 45 57 W	6.15
06437020	C, WQ	Bear Butte Creek near Deadwood	44 20 08 N	103 38 06 W	16.6

Analytical Results

Constituents analyzed in samples submitted to the NWQL include major ions, nutrients, and trace elements. Methods of analysis are described in Fishman and Friedman (1989). Analytical results and field measurements are presented in tables 8-10 in the Supplemental Data section at the end of this report. Of all water samples collected, 99 percent had total anion and cation milliquivalent concentrations that balanced within 5 percent difference. Summary statistics, including the minimum, median, maximum, and number of observations for most of the parameters sampled, are presented in table 2.

GENERAL WATER-QUALITY CHARACTERISTICS

In-stream water quality can be highly variable and can be influenced by a number of factors. In addition to effects of geology and land use, water quality can be influenced by variations in streamflow. The following sections present applicable beneficial-use and water-quality criteria, examine streamflow characteristics, and describe general water-quality characteristics in Lawrence County.

Beneficial Uses and Water-Quality Criteria

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. The Clean Water Act requires states to classify streams with regard to beneficial use and to establish water-quality criteria that define acceptable properties or constituent concentrations to meet those uses (South Dakota Department of Water and Natural Resources, 1987). The Clean Water Act also requires states to review and revise these criteria every 3 years. A summary of the beneficial-use categories applicable to the streams sampled in the study is presented in table 3; the current criteria for those uses are presented in table 4. All streams in the state are classified based on a beneficial use. The beneficial-use criteria are designed to protect human health and ensure that a stream can support the specified beneficial uses.

Table 2. Summary statistics for selected physical properties and constituents at sampling sites in Lawrence County

[N, number of observations; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mm, millimeters; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; --, no data available]

WATSTORE[1] parameter code	Physical property/ constituent	Statistic	Station number												
			06422500	06430770	06430800	06430850	06430865	06430898	06430900	06430950	06432020	06432172	06432180	06436156	06437020
00061	Discharge (cubic feet per second)	Minimum	0.56	11	0.01	11	1.1	0.26	34	2.1	6.8	0.28	2.7	0.68	0.46
		Median	2.7	15	0.16	14	1.5	0.64	41	2.5	39	0.41	--	1.1	1.45
		Maximum	12	20	6.5	16	3.2	12	74	7.5	57	13	20	7	15
		N	8	9	21	9	9	17	9	43	11	9	2	15	16
00095	Specific conductance (µS/cm)	Minimum	230	430	122	447	310	120	370	329	553	110	140	290	170
		Median	336	437	349	465	412	322	418	382	635	335	--	427	291.5
		Maximum	385	450	400	500	426	376	431	446	930	380	194	509	352
		N	7	8	18	9	9	17	9	42	10	8	2	16	16
00400	Field pH (standard units)	Minimum	8.1	8.4	8.2	8.3	7.9	7.7	8.2	7.7	7.5	7.6	7.7	7.6	7.4
		Median	8.5	8.6	8.45	8.4	8.6	8.4	8.6	8.6	8.4	8.2	--	8.4	8.3
		Maximum	8.6	8.6	8.8	8.7	8.7	8.8	8.6	8.8	8.6	8.2	8.3	9.3	8.7
		N	8	9	20	9	9	17	9	42	11	9	2	17	16
00020	Air temperature (degrees Celsius)	Minimum	0	-3	-4.5	-10	-3	-10	-5	-18	-5	-12	5	-5	-5
		Median	13	13.5	9	7	13	10	13.5	13	10.5	12	--	11	8
		Maximum	27	26	30	30	23	28	28	35.5	25	22.5	20	29	28
		N	8	9	21	9	9	17	9	43	11	9	2	17	16
00010	Water temperature (degrees Celsius)	Minimum	1	1	0	4	2	0	1.5	0	2	0	5	0	0
		Median	7.5	7.5	2	7	8	9.5	8	8	8.5	6.5	--	5.5	8.75
		Maximum	15.5	11.5	16	12	11	18	12	19	17.5	16	11	16.5	20
		N	8	9	21	9	9	17	9	43	11	9	2	17	16
00076	Turbidity (nephelometric turbidity units)	Minimum	0.3	0.1	0.2	0.1	0.1	0.1	0.2	--	0.3	0.3	8.5	0.5	0.2
		Median	1.65	0.4	0.65	0.4	0.3	0.4	0.4	--	0.4	6.5	--	0.9	0.6
		Maximum	6.5	1	12	0.7	2.4	3.7	1.3	--	1.1	46	15	10	7.5
		N	8	9	18	9	9	17	9	0	11	9	2	17	16
00025	Air pressure (mm of mercury)	Minimum	642	622	625	629	636	638	643	648	669	628	655	625	634
		Median	645	628	632.5	634	638	648	648	658.5	680	638	--	632	640
		Maximum	657	636	642	642	646	654	656	685	686	646	663	645	649
		N	7	9	18	9	9	17	9	42	11	9	2	16	15

Table 2. Summary statistics for selected physical properties and constituents at sampling sites in Lawrence County–Continued

[N, number of observations; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mm, millimeters; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; --, no data available]

WATSTORE[1] parameter code	Physical property/ constituent	Statistic	Station number												
			06422500	06430770	06430800	06430850	06430865	06430898	06430900	06430950	06432020	06432172	06432180	06436156	06437020
00300	Dissolved oxygen (mg/L)	Minimum	8.3	9.3	8.6	10.1	9.5	7.4	10	9.2	9.6	8.1	9.2	8	8.2
		Median	10.7	10.2	10.3	10.8	10.9	9.8	10.4	11.2	10.8	10.7	--	10.5	9.9
		Maximum	11.9	11.7	15.6	13.4	13	14.1	12.3	13.4	13.7	13.8	11.2	13.2	13.6
		N	8	9	18	9	9	17	9	43	11	9	2	16	15
00301	Dissolved oxygen (percent of saturation)	Minimum	92	99	94	102	98	91	101	78	97	97	98	95	95
		Median	100	102.5	102	103	105	102	103	108	104	100	--	102	100
		Maximum	113	105	114	126	112	117	117	151	131	161	101	118	125
		N	7	8	15	9	9	17	9	41	10	9	2	15	15
00900	Total hardness (mg/L as $CaCO_3$)	Minimum	120	260	55	250	170	59	210	180	300	48	55	130	65
		Median	185	260	190	270	240	170	240	220	360	160	--	220	140
		Maximum	210	260	220	280	250	190	260	240	530	180	95	230	170
		N	8	9	19	7	9	17	9	43	11	9	2	17	16
90410	Lab alkalinity (mg/L as $CaCO_3$)	Minimum	105	219	58	216	167	44	193	174	202	23	46	100	44
		Median	173.5	237	181	246	204	121	214	197	228	72	--	160	87.5
		Maximum	200	255	207	268	231	138	239	224	244	90	60	186	123
		N	8	9	21	9	9	17	9	43	11	9	2	17	16
70300	Dissolved solids, residue at 180 degrees Celsius (mg/L)	Minimum	137	190	83	147	154	81	182	--	334	81	105	173	120
		Median	186	238	197	246	234	192	223	--	409	220	--	252	177
		Maximum	212	256	257	258	285	230	242	--	660	253	130	287	208
		N	8	9	21	9	9	17	9	0	11	9	2	17	16
70301	Dissolved solids, sum of constituents (mg/L)	Minimum	140	243	76	237	178	79	215	191	331	83	92	177	105
		Median	201	256	210	262	239	200	240	218	418	225	--	254	177.5
		Maximum	228	261	237	276	247	232	256	244	605	250	141	289	220
		N	8	9	19	7	9	17	9	43	11	9	2	17	16
00530	Suspended solids, unfilterable residue at 105 degrees Celsius (mg/L)	Minimum	<1	<1	<1	<1	<1	<1	<1	--	<1	<1	5	<1	<1
		Median	2.5	1	6.5	3	<1	1	2	--	<1	6	--	3	6.5
		Maximum	5	16	23	10	7	10	21	--	9	180	7	20	20
		N	8	9	18	9	9	17	9	0	11	9	2	17	16

Table 2. Summary statistics for selected physical properties and constituents at sampling sites in Lawrence County–Continued

[N, number of observations; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mm, millimeters; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; --, no data available]

WATSTORE[1] parameter code	Physical property/ constituent	Statistic	Station number												
			06422500	06430770	06430800	06430850	06430865	06430898	06430900	06430950	06432020	06432172	06432180	06436156	06437020
00915	Dissolved calcium (mg/L)	Minimum	30	58	14	63	45	16	51	40	77	14	17	38	17
		Median	42.5	61	49	68	60	42	56	47	94	44	--	58	39.5
		Maximum	44	64	54	70	64	49	61	53	140	51	28	61	47
		N	8	9	19	7	9	17	9	43	11	9	2	17	16
00925	Dissolved magnesium (mg/L)	Minimum	11	24	4.8	23	15	4.6	21	19	27	3.2	3	9.3	5.4
		Median	19	25	18	24	22	14	24	24	32	11	--	17	10.5
		Maximum	25	27	20	25	23	16	26	26	44	13	6.1	19	13
		N	8	9	19	7	9	17	9	43	11	9	2	17	16
00930	Dissolved sodium (mg/L)	Minimum	2.9	1.1	1.9	0.8	1	1.7	1.9	2.5	3.1	3.3	4	5.5	3.5
		Median	3.85	1.3	3.6	0.9	1.2	2.8	2	2.9	3.9	5.8	--	8.8	4.8
		Maximum	4.1	1.9	5.4	1.3	2.2	4.6	2.1	3.7	6.4	6.7	7.2	14	7.8
		N	8	9	19	7	9	17	9	43	11	9	2	17	16
00932	Sodium (percent of cations)	Minimum	4	1	3	1	1	3	2	2	2	7	8	5	6
		Median	4	1	5	1	1	4	2	3	2	8	--	8	6.5
		Maximum	6	2	7	1	3	6	2	4	3	12	22	12	12
		N	8	9	19	7	9	17	9	43	11	9	2	17	16
00931	Sodium-adsorption ratio[2]	Minimum	0.1	0	0.1	0	0	0.1	0	0.1	0.1	0.2	0.2	0.2	0.2
		Median	0.1	0	0.1	0	0	0.1	0.1	0.1	0.1	0.2	--	0.3	0.2
		Maximum	0.1	0	0.2	0	0.1	0.1	0.1	0.1	0.1	0.2	0.4	0.4	0.3
		N	8	9	19	7	9	17	9	43	11	9	2	17	16
00935	Dissolved potassium (mg/L)	Minimum	1.7	0.5	0.6	0.4	0.5	1.3	0.5	0.6	0.8	1.8	1.6	1.2	1.4
		Median	2.1	0.7	0.9	0.6	0.6	1.8	0.8	0.8	1.4	3.9	--	1.7	2.75
		Maximum	2.8	0.7	1.4	4.6	0.7	2.4	0.8	1.2	1.8	4.2	1.8	1.9	3.5
		N	8	9	19	8	9	17	9	43	11	9	2	17	16
--	Calculated bicarbonate (mg/L)	Minimum	128	267	71	263	204	54	235	212	246	28	56	122	54
		Median	212	289	221	300	249	148	261	240	278	88	--	195	107
		Maximum	244	311	252	327	282	168	291	273	297	110	73	227	150
		N	8	9	21	9	9	17	9	43	11	9	2	17	16

Table 2. Summary statistics for selected physical properties and constituents at sampling sites in Lawrence County–Continued

[N, number of observations; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mm, millimeters; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; --, no data available]

WATSTORE[1] parameter code	Physical property/ constituent	Statistic	Station number												
			06422500	06430770	06430800	06430850	06430865	06430898	06430900	06430950	06432020	06432172	06432180	06436156	06437020
00945	Dissolved sulfate (mg/L)	Minimum	13	2.8	5	1.8	1.9	12	4	3.9	90	26	19	27	29
		Median	16	3	11	2.1	2	42	4.2	9	120	90	--	38	43.5
		Maximum	18	3.9	22	3.6	3	69	20	17	260	100	44	54	73
		N	8	9	21	9	9	17	9	43	11	9	2	17	16
00940	Dissolved chloride (mg/L)	Minimum	1.5	0.6	0.5	0.8	0.3	0.2	0.9	1.2	2.1	1.1	1.8	5.5	4.1
		Median	2.8	1	2.6	2.7	0.5	1.3	1.3	3.1	3.8	1.7	--	17	6.3
		Maximum	4.4	2.7	7.5	3.9	2.7	5.7	11	10	6.6	3.1	4.8	40	12
		N	8	9	21	9	9	17	9	43	11	9	2	17	16
00950	Dissolved fluoride (mg/L)	Minimum	<0.1	<0.1	<0.1	<0.1	<0.1	0.5	0.1	<0.1	<0.1	0.3	0.4	0.2	0.1
		Median	0.2	0.1	0.2	0.1	0.1	1.1	0.2	0.3	0.2	1.1	--	0.45	0.3
		Maximum	0.2	0.2	0.4	0.2	0.2	1.3	0.3	0.4	0.6	1.3	0.5	0.6	0.5
		N	8	9	21	9	9	17	9	43	11	9	2	16	16
00955	Dissolved silica (mg/L)	Minimum	9.4	9.8	11	8.6	9.7	12	9.6	9.2	8.4	15	14	12	11
		Median	10	10	12	9.1	10	13	9.9	10	10	20	--	14	12
		Maximum	12	11	15	9.2	11	17	11	12	13	22	16	15	14
		N	8	9	20	7	9	17	9	43	11	9	2	17	16
00613	Nitrite nitrogen (mg/L)	Minimum	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		Median	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	--	<0.01	<0.01
		Maximum	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.09	0.02	<0.01	<0.01	0.02	0.02
		N	8	9	18	8	9	14	9	38	9	9	2	14	13
00631	Dissolved nitrite + nitrate nitrogen (mg/L)	Minimum	<0.1	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
		Median	<0.1	0.17	1.2	0.15	0.11	<0.1	0.1	<0.1	0.3	<0.1	--	0.36	<0.1
		Maximum	0.2	0.2	4.3	0.2	0.21	0.84	0.19	0.17	0.56	0.3	<0.1	1.4	0.16
		N	8	9	19	9	9	14	9	39	9	9	2	14	13
00608	Ammonia nitrogen (mg/L)	Minimum	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		Median	<0.01	<0.01	0.02	0.02	0.01	<0.01	0.01	<0.01	0.01	<0.01	--	0.01	<0.01
		Maximum	0.03	0.09	0.16	0.08	0.07	0.06	0.06	0.06	0.05	0.07	<0.01	0.05	0.05
		N	8	9	19	9	9	14	9	39	9	9	2	14	13

Table 2. Summary statistics for selected physical properties and constituents at sampling sites in Lawrence County–Continued

[N, number of observations; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mm, millimeters; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; --, no data available]

WATSTORE[1] parameter code	Physical property/ constituent	Statistic	Station number												
			06422500	06430770	06430800	06430850	06430865	06430898	06430900	06430950	06432020	06432172	06432180	06436156	06437020
00623	Ammonia + organic nitrogen (mg/L)	Minimum	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	--	<0.2	<0.2	<0.2	<0.2	<0.2
		Median	<0.2	<0.2	<0.2	0.2	<0.2	<0.2	<0.2	--	<0.2	<0.2	--	<0.2	<0.2
		Maximum	0.4	0.3	0.5	0.5	0.4	0.6	0.3	--	0.3	0.7	0.4	0.6	0.3
		N	8	9	17	9	9	14	9	0	10	9	2	15	14
00666	Dissolved phosphorus (mg/L as P)	Minimum	<0.01	<0.01	0.018	<0.01	0.01	<0.01	<0.01	--	<0.01	<0.01	0.01	<0.01	<0.01
		Median	<0.01	0.01	0.03	0.01	0.02	0.1	0.01	--	<0.01	<0.01	--	0.01	<0.01
		Maximum	0.02	0.02	0.04	0.1	0.03	0.02	0.02	--	0.02	0.11	0.02	0.02	0.04
		N	8	9	19	9	9	14	9	0	10	9	2	15	14
00671	Orthophosphate phosphorus (mg/L as P)	Minimum	<0.001	0.006	0.005	<0.001	0.001	<0.001	<0.002	<0.01	<0.001	<0.001	0.011	<0.001	<0.001
		Median	0.002	0.009	0.0215	0.01	0.011	0.003	0.007	<0.01	<0.001	0.001	--	0.0035	0.001
		Maximum	0.01	0.03	0.04	0.02	0.014	0.012	0.011	0.02	0.003	0.106	0.035	0.014	0.016
		N	8	9	18	9	9	14	9	39	9	9	2	14	13
00720	Total cyanide (mg/L)	Minimum	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	--	<0.01	<0.01
		Median	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	--	<0.01	<0.01
		Maximum	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		N	5	5	14	5	5	14	6	41	7	6	1	13	11
00723	Dissolved cyanide (mg/L)	Minimum	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		Median	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	--	<0.01	<0.01
		Maximum	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		N	8	9	18	9	9	17	8	41	11	9	2	17	15
01095	Dissolved antimony (µg/L)	Minimum	<1	<1	<1	<1	<1	<1	<1	--	<1	<1	<1	<1	<1
		Median	<1	<1	2	<1	<1	<1	<1	--	<1	<1	--	2	<1
		Maximum	<1	2	7	<1	1	2	<1	--	1	<1	1	4	<1
		N	8	9	19	7	9	17	9	0	11	9	2	17	16
01002	Total arsenic (µg/L)	Minimum	<1	<1	15	<1	<1	3	2	<1	2	2	--	7	<1
		Median	<1	<1	28.5	1	1	3.5	4	1	2	2.5	--	14.5	<1
		Maximum	1	1	50	1	1	4	5	10	4	4	4	20	2
		N	5	5	14	4	5	12	5	9	6	4	1	12	10

Table 2. Summary statistics for selected physical properties and constituents at sampling sites in Lawrence County–Continued

[N, number of observations; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mm, millimeters; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; --, no data available]

WATSTORE[1] parameter code	Physical property/ constituent	Statistic	Station number												
			06422500	06430770	06430800	06430850	06430865	06430898	06430900	06430950	06432020	06432172	06432180	06436156	06437020
01000	Dissolved arsenic (µg/L)	Minimum	<1	<1	6	<1	<1	<1	2	1	2	<1	2	7	<1
		Median	<1	1	32	1	1	3	4	3	2	2	--	13	1
		Maximum	1	1	48	1	2	4	5	4	3	3	5	20	2
		N	8	9	19	7	9	17	9	43	11	9	2	17	16
01005	Dissolved barium (µg/L)	Minimum	26	74	66	94	65	33	80	--	78	40	46	82	27
		Median	31	82	100	97	86	62	84	--	85	55	--	92	41
		Maximum	43	85	140	100	90	88	88	--	110	75	59	100	46
		N	8	9	19	7	9	17	9	0	11	9	2	17	16
01020	Dissolved boron (µg/L)	Minimum	<10	<10	<10	<10	<10	<10	<10	--	10	<10	<10	10	<10
		Median	15	<10	<10	<10	<10	<10	<10	--	20	10	--	20	15
		Maximum	30	10	10	10	10	20	20	--	50	20	10	30	30
		N	8	9	21	9	9	17	9	0	11	9	2	17	16
01025	Dissolved cadmium (µg/L)	Minimum	<1	<1	<1	<1	<1	<1	<1	--	<1	<1	<3	<1	<1
		Median	<1	<1	<1	<1	<1	<1	<1	--	<1	<1	--	<1	<1
		Maximum	3	2	<1	2	<1	<1	2	--	2	1	<10	1	0
		N	6	7	9	5	7	7	7	0	7	7	2	8	7
01030	Dissolved chromium (µg/L)	Minimum	<1	<1	<1	<1	<1	<1	<1	--	<1	<1	1	<1	<1
		Median	<1	<1	1	<1	<1	<1	<1	--	<1	<1	--	<1	<1
		Maximum	2	1	2	2	1	2	2	--	2	2	2	2	2
		N	8	9	16	7	9	17	9	0	11	9	2	16	16
01040	Dissolved copper (µg/L)	Minimum	<1	<1	<1	<1	<1	<1	<1	--	<1	<1	1	<1	1
		Median	<1	1	<1	1	1	1	1	--	<1	1	--	<1	4.5
		Maximum	1	1	4	4	5	3	2	--	1	3	2	1	28
		N	8	9	16	7	9	17	9	0	11	9	2	16	16
01046	Dissolved iron (µg/L)	Minimum	9	5	<3	<3	<3	<3	<3	--	<3	8	63	4	5
		Median	23.5	7	5	7	5	5	7	--	7	18	--	13	16
		Maximum	99	21	76	15	9	56	12	--	69	210	68	140	100
		N	8	9	19	7	9	17	9	0	11	9	2	17	16

Table 2. Summary statistics for selected physical properties and constituents at sampling sites in Lawrence County–Continued

[N, number of observations; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mm, millimeters; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; --, no data available]

WATSTORE[1] parameter code	Physical property/ constituent	Statistic	Station number												
			06422500	06430770	06430800	06430850	06430865	06430898	06430900	06430950	06432020	06432172	06432180	06436156	06437020
01049	Dissolved lead (µg/L)	Minimum	<1	<1	<1	<1	<1	<1	<1	--	<1	<1	<1	<1	<1
		Median	<1	<1	<1	1	<1	<1	<1	--	<1	1	--	<1	<1
		Maximum	1	<1	1	1	1	1	1	--	<1	12	<1	<1	16
		N	5	5	13	5	5	13	5	0	7	6	2	12	13
01056	Dissolved manganese (µg/L)	Minimum	4	<1	<1	<1	<1	<1	<1	--	2	2	<3	7	1
		Median	11	1	<1	<1	<1	<1	<1	--	3	3	--	12	7
		Maximum	24	2	11	2	<1	2	3	--	8	18	1	39	330
		N	8	9	19	7	9	17	9	0	11	9	2	17	16
71890	Dissolved mercury (µg/L)	Minimum	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	--	<0.1	<0.1	<0.1	<0.1	<0.1
		Median	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	--	<0.1	<0.1	--	<0.1	<0.1
		Maximum	<0.1	<0.1	0.3	<0.1	<0.1	0.1	<0.1	--	<0.1	<0.1	<0.1	0.1	0.2
		N	8	9	20	9	9	15	9	0	11	9	2	17	16
01145	Dissolved selenium (µg/L)	Minimum	<1	<1	<1	<1	<1	<1	<1	--	<1	<1	<1	<1	<1
		Median	<1	<1	<1	<1	<1	<1	<1	--	<1	<1	--	<1	<1
		Maximum	<1	<1	1	<1	<1	<1	3	--	2	<1	<1	2	<1
		N	8	9	19	7	9	17	9	0	11	9	2	17	16
01090	Dissolved zinc (µg/L)	Minimum	<3	<3	<3	3	<3	<3	<3	--	<3	<3	<3	<3	4
		Median	4	6	4	6	4	4	5	--	7	6	--	4	9.5
		Maximum	11	45	13	24	20	16	21	--	19	31	<9	22	30
		N	8	9	19	7	9	17	9	0	11	9	2	17	16

[1]WATSTORE - U.S. Geological Survey Water Data Storage and Retrieval System.

[2]Sodium-adsorption ratio is the relative activity of sodium ions in exchange reactions with soil. The higher the sodium-adsorption ratio, the less suitable the water for irrigation.

Table 3. Beneficial-use categories for selected streams in Lawrence County (from South Dakota Department of Environment and Natural Resources, 1998)

[--, not applicable]

Station Name	Domestic water supply	Coldwater permanent fisheries	Coldwater marginal fisheries	Immersion waters	Limited contact waters	Wildlife propagation and stock-watering waters
Boxelder Creek near Nemo	--	X	--	--	X	X
Spearfish Creek near Lead	X	X	--	X	X	X
Annie Creek near Lead	--	--	X	--	X	X
Little Spearfish Creek near Lead	--	X	--	--	X	X
Iron Creek near Lead	--	X	--	--	X	X
Squaw Creek near Spearfish	--	X	--	X	X	X
Spearfish Creek above Spearfish	X	X		X	X	X
Spearfish Creek below Robison Gulch near Spearfish	--	--	X	--	X	X
Spearfish Creek below Spearfish	X	X	--	X	X	X
False Bottom Creek near Central City	--	--	X	--	X	X
False Bottom Creek near Spearfish	--	--	X	--	X	X
Whitetail Creek at Lead	--	X	--	X	X	X
Bear Butte Creek near Deadwood	--	X	--	--	X	X

Table 4. Water-quality standards for selected physical properties and constituents

[All constituents in milligrams per liter unless otherwise noted. MCL, maximum contaminant level; SMCL, secondary maximum contaminant level; µS/cm, microsiemens per centimeter at 25°C; µg/L, micrograms per liter; mL, milliliters; °F, degrees Fahrenheit; °C, degrees Celsius; ≥, greater than or equal to; --, no data available]

Property or constituent	U.S. Environmental Protection Agency drinking-water standards		Beneficial-use criteria						Aquatic-life criteria for fisheries (acute/chronic) (µg/L)[2]
	Drinking water MCL[1]	Drinking water SMCL[1]	Domestic water supply (mean/daily maximum)[2]	Coldwater permanent fisheries[2]	Coldwater marginal fisheries[2]	Immersion waters[2]	Limited contact waters[2]	Wildlife propagation and stock-watering waters[2]	
Specific conductance (µS/cm)	--	--	--	--	--	--	--	4,000/[3]7,000	--
pH (standard units)	--	6.5-8.5	6.5-9.0	6.6-8.6	6.5-8.8	--	--	6.0-9.5	--
Temperature (°F) (maximum)	--	--	--	65 (18.3°C)	75 (24°C)	--	--	--	--
Dissolved oxygen (minimum)	--	--	--	≥6.0 ≥7 during spawning	≥5.0	≥5.0	≥5.0	--	--
Total alkalinity as ($CaCO_3$)	--	--	--	--	--	--	--	750/[3]1,313	--
Total dissolved solids	--	500	1,000/[3]1,750	--	--	--	--	2,500/[3]4,375	--
Total suspended solids	--	--	--	30/[3]53	90/[3]158	--	--	--	--
Chloride	--	250	250/[3]438	100/[3]175	--	--	--	--	--
Fluoride	4.0	2.0	4.0	--	--	--	--	--	--
Sulfate	500	250	500/[3]875	--	--	--	--	--	--
Nitrate (as N)	10	--	10	--	--	--	--	50/[3]88	--
Nitrite	1	--	1	--	--	--	--	--	--
Nitrate + nitrite	10	--	10	--	--	--	--	--	--
Un-ionized ammonia (as N)	--	--	--	0.02	0.02	--	--	--	--
Cyanide (free)	0.2	--	0.2	220	220	--	--	--	22/5.2
Dissolved antimony	0.006	--	0.006	--	--	--	--	--	--
Dissolved arsenic	0.05	--	0.05	0.00014	0.00014	--	--	--	360/190 (340/[4]150)
Dissolved barium	2.0	--	2.0	--	--	--	--	--	--

Table 4. Water-quality standards for selected physical properties and constituents–Continued

[All constituents in milligrams per liter unless otherwise noted. MCL, maximum contaminant level; SMCL, secondary maximum contaminant level; µS/cm, microsiemens per centimeter at 25°C; µg/L, micrograms per liter; mL, milliliters; °F, degrees Fahrenheit; °C, degrees Celsius; ≥, greater than or equal to; --, no data available]

Property or constituent	U.S. Environmental Protection Agency drinking-water standards		Beneficial-use criteria						Aquatic-life criteria for fisheries (acute/chronic) (µg/L)[2]
	Drinking water MCL[1]	Drinking water SMCL[1]	Domestic water supply (mean/daily maximum)[2]	Coldwater permanent fisheries[2]	Coldwater marginal fisheries[2]	Immersion waters[2]	Limited contact waters[2]	Wildlife propagation and stock-watering waters[2]	
Dissolved cadmium	0.005	--	0.005	--	--	--	--	--	[5]3.7/[5]1.0 (4.3/[4]2.2)
Dissolved chromium	0.1	--	0.1	--	--	--	--	--	--
Dissolved copper	--	1.0	1.3	--	--	--	--	--	[5]17/[5]11 (13 / [4]9)
Dissolved iron	--	0.3	--	--	--	--	--	--	--
Dissolved lead	--	--	--	--	--	--	--	--	[5]65/[5]2.5
Dissolved manganese	--	0.05	--	--	--	--	--	--	--
Dissolved mercury	0.002	--	0.002	0.00015	0.00015	--	--	--	2.1/[6]0.012 (1.4/[4]0.77)
Dissolved selenium	0.05	--	0.05	--	--	--	--	--	20/5 (--/[4]5)
Dissolved zinc	--	5	--	--	--	---	--	--	[5]110/[5]100 (120/[4]120)

[1]U.S. Environmental Protection Agency, 1996, 1998b, 1998c, 1998d.
[2]South Dakota Department of Environment and Natural Resources, 1998, unless indicated otherwise.
[3]30-day average/daily maximum.
[4]U.S. Environmental Protection Agency, 1998a.
[5]Hardness-dependent criteria; value given is an example based on hardness of 100 mg/L as $CaCO_3$.
[6]Chronic criteria based on total recoverable concentration.

Federal drinking-water standards and State or Federal aquatic-life criteria also are listed in table 4. Maximum contaminant levels (MCL) are the maximum permissible level of a constituent in waters that are used for public water-supply systems. MCL's are legally enforceable standards. Secondary maximum contaminant levels (SMCL's) are guidelines that generally are related to taste, odor, color, and other aesthetic drinking-water characteristics. Aquatic-life criteria are established to provide protection from either acute or chronic toxicity. The acute criterion is an estimate of the maximum concentration in surface water that aquatic life can be exposed to for very short periods without a resulting unacceptable or harmful effect. The chronic criterion is based on a maximum concentration that the aquatic life can be exposed to for an indefinite period without an unacceptable or harmful effect.

Consideration of Streamflow Conditions

Water-quality constituent concentrations often fluctuate with streamflow conditions (Hem, 1985). Instream concentrations of many dissolved constituents commonly are inversely related to streamflow. During high-flow conditions, concentrations of dissolved constituents generally decrease due to dilution; however, total concentrations (dissolved plus solid-phase) may increase due to increasing concentrations of suspended sediment that usually increase with flow.

Streamflow in the Black Hills area, including Lawrence County, is affected by both geologic conditions and precipitation patterns (Miller and Driscoll, 1998). Streamflow hydrographs for the study period (1988-92) are shown in figure 5 for the continuous-record stations at which water-quality samples were collected (table 1). Summary statistics for measured discharge at times of sampling are presented in table 2. Streamflow generally varied seasonally, with increases resulting from snowmelt and precipitation during spring and early summer and decreases occurring during the dryer late-summer and winter months. The drainage areas for stations Spearfish Creek near Lead (06430770) and Little Spearfish Creek near Lead (06430850) include large outcrop areas of the Madison Limestone and Minnelusa Formation (fig. 3). Streamflow at these stations is relatively stable (figs. 5B and 5D) because flow generally is dominated by discharge from large headwater springs. Drainage areas for the other stations shown in figure 5 include a variety of outcrops (fig. 3), with streamflow demonstrating more response to precipitation and snowmelt patterns.

Eight of the 13 sampling sites listed in table 1 are on, or along tributaries to, Spearfish Creek (fig. 4), which is affected by various diversions. Diversions to Whitewood Creek of about 10 ft^3/s occur upstream from Spearfish Creek near Lead (station 06430770). The entire flow of Spearfish Creek up to an estimated threshold of about 115 to 135 ft^3/s (Hortness and Driscoll, 1998) is diverted just downstream from Spearfish Creek above Spearfish (06430900) to a hydroelectric plant located just upstream from Spearfish Creek at Spearfish (06431500). Spearfish Creek below Robison Gulch (06430950) is located downstream from the diversion, just upstream from a loss zone in the Madison Limestone and Minnelusa Formation. Flow at this site results from possible seepage through the diversion dam, tributary inflow, and springflow within the reach. Flow at Spearfish Creek below Spearfish (06432020) is affected by irrigation diversions and subsequent return flows. False Bottom Creek near Spearfish (06432180) is located downstream from a loss zone in the Madison Limestone and Minnelusa Formation. Flow at this site occurs only during high-flow conditions; thus, only two samples were collected at this site. All other sampling sites listed in table 1 are on perennial streams that are not substantially affected by diversions or other forms of regulation.

During the period of data collection (1988-92), the Black Hills area was experiencing a drought with 4 of the 5 years receiving below-normal precipitation (fig. 6). Because of this, most samples in this study were collected during low-flow conditions. For example, streamflow at Boxelder Creek near Nemo (06422500) and at Spearfish Creek at Spearfish (06431500) during most of 1988-92 was at or below the long-term median streamflow (fig. 7). Although some high-flow events did occur (fig. 5), the number and frequency were below normal; therefore, few opportunities were available to sample and characterize high-flow conditions.

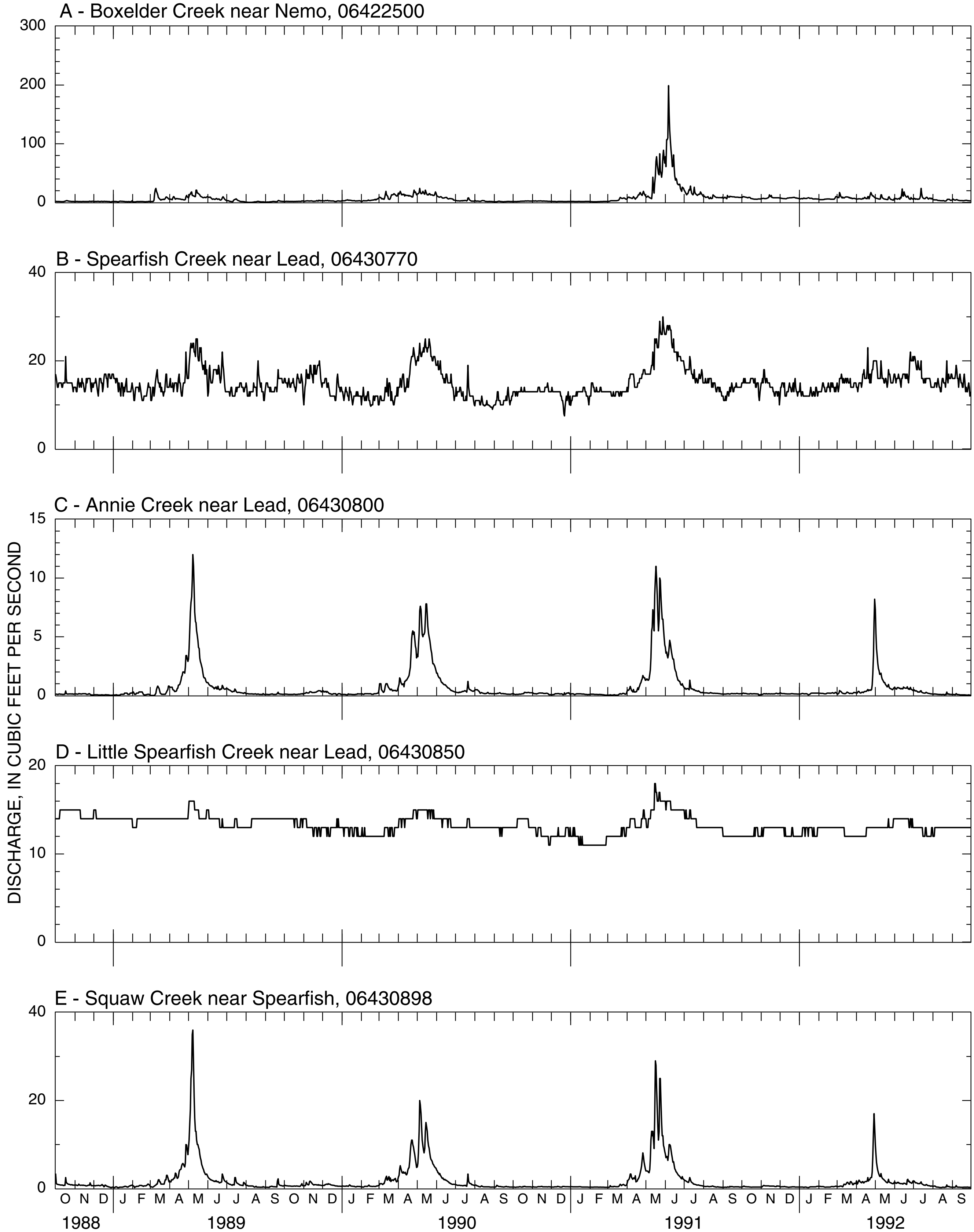


Figure 5. Hydrographs of daily streamflow for selected sites, water years 1989-92.

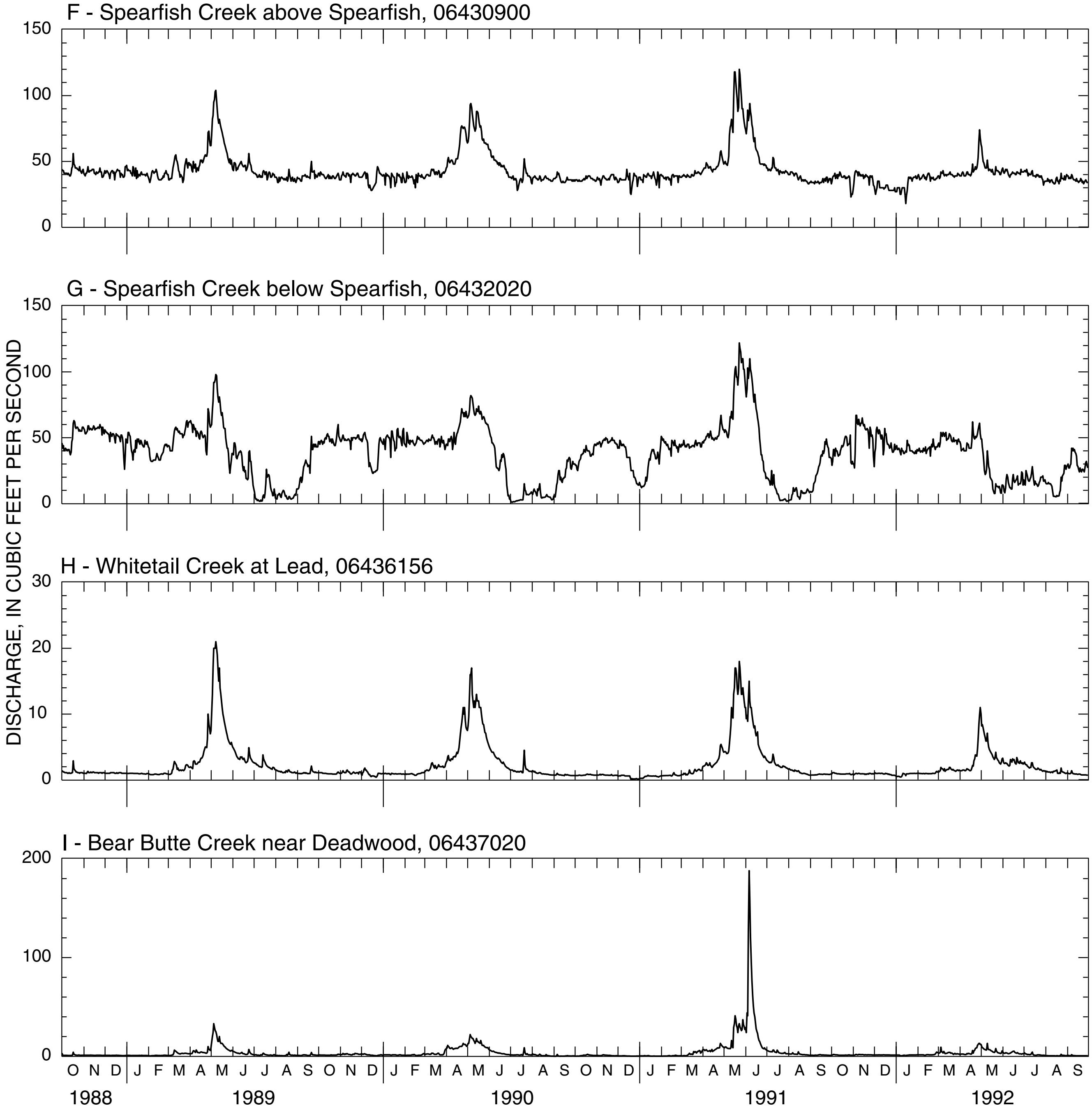


Figure 5. Hydrographs of daily streamflow for selected sites, water years 1989-92.--Continued

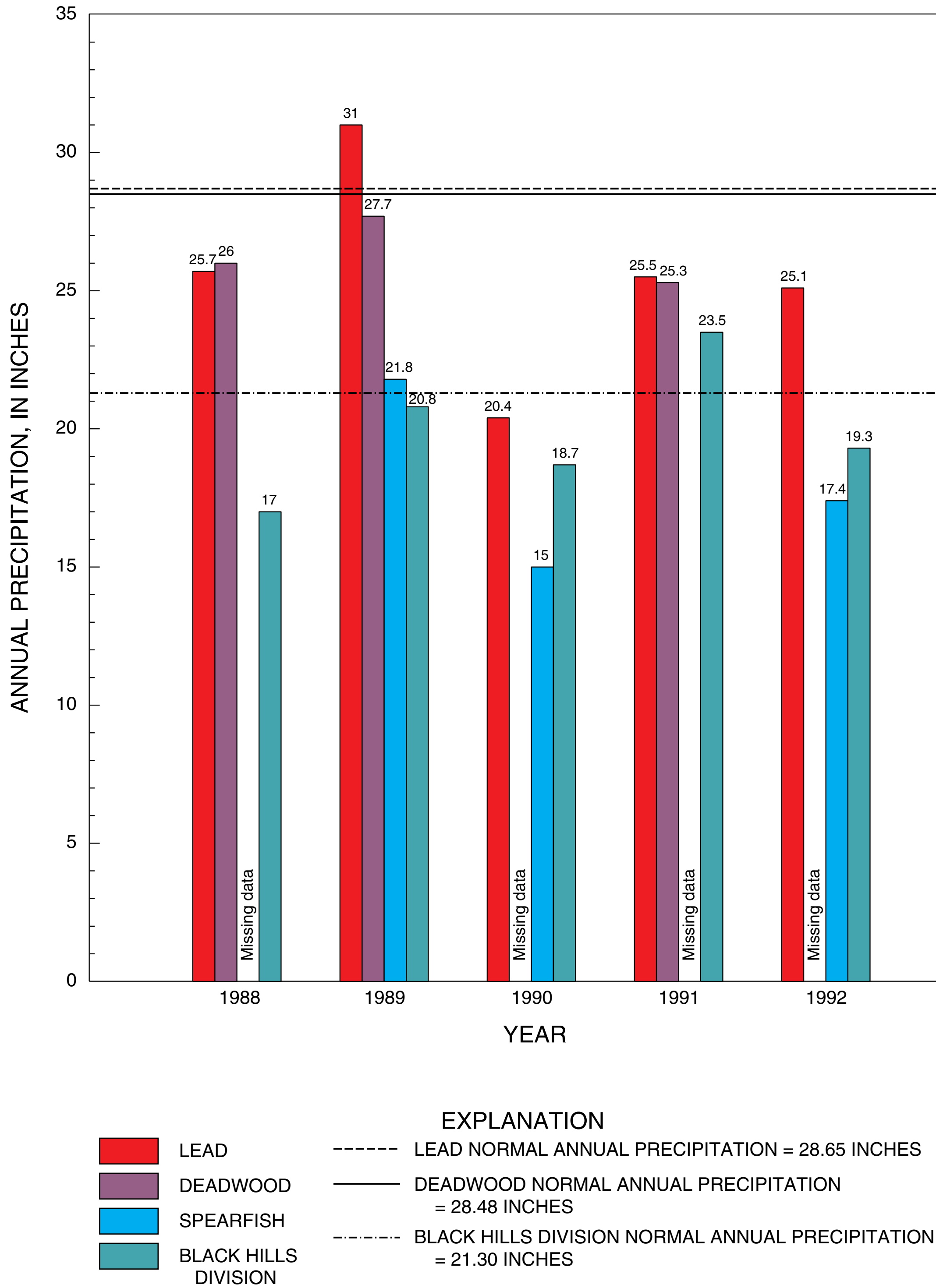


Figure 6. Comparison of annual precipitation for three long-term National Oceanic and Atmospheric Administration weather stations in Lawrence County and for Black Hills division for 1988-92.

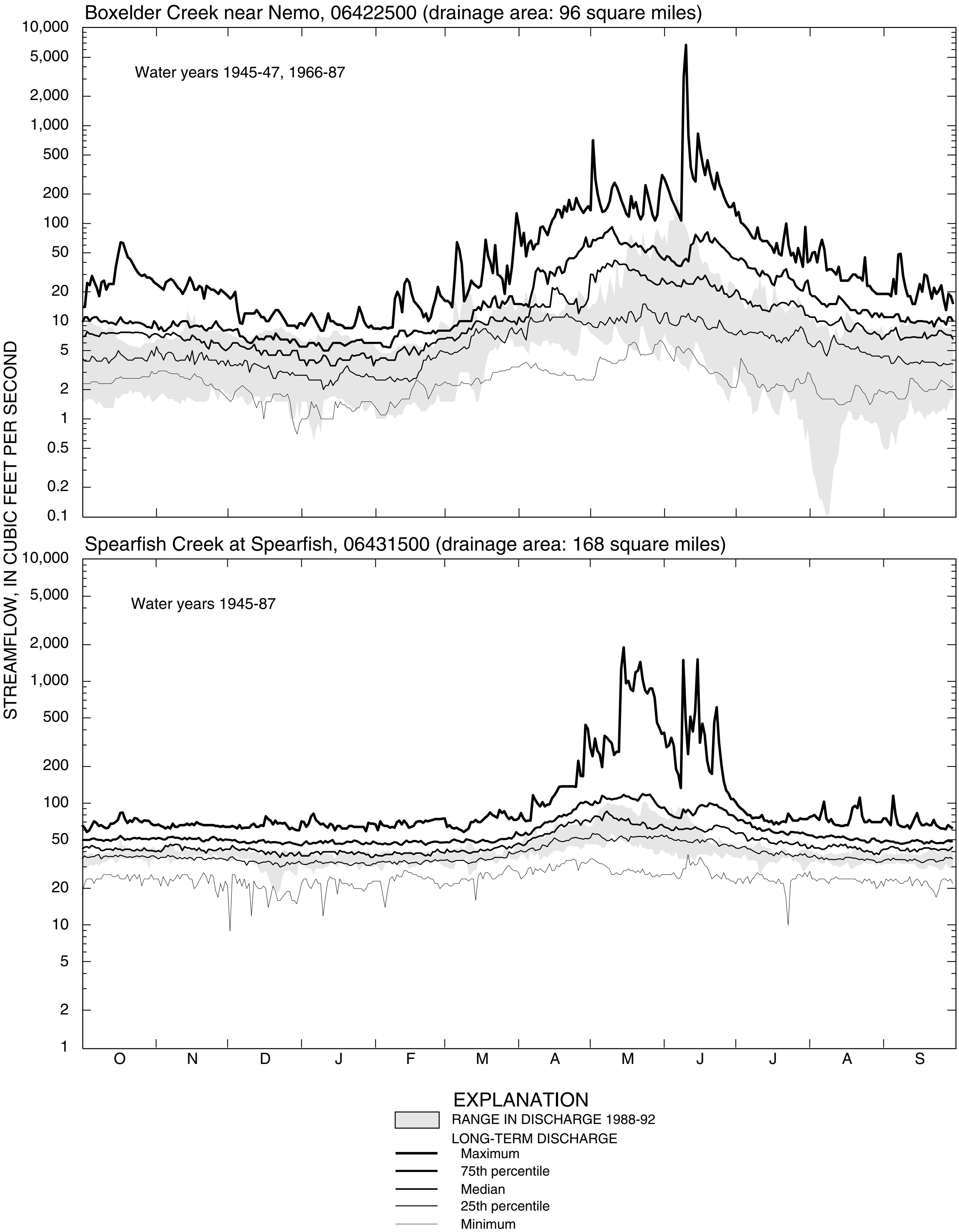


Figure 7. Comparison of the range of daily flows during water years 1988-92 to hydrographs of long-term statistical range of flows.

Water-Quality Characteristics

Analytical results of water-quality samples collected at 13 sampling locations are provided in table 8 of the Supplemental Data section, and summary statistics for this data set are provided in table 2. An analysis of this data set is used to describe water-quality characteristics for selected streams in Lawrence County. A brief explanation of the significance of selected constituents is provided. Graphical comparisons of water quality, by site, and comparisons with applicable water-quality standards and criteria also are presented.

For both temporal and spatial comparisons, boxplots, trilinear diagrams, and summary statistics (table 2) are presented for the physical properties, common ions, nutrients, and trace elements. For some constituents (cadmium, copper, and lead), multiple laboratory reporting limits were used, either due to changes in methods or necessity of sample dilution for analysis. When this was the case, the samples with larger reporting limits were deleted from the data used to generate the boxplots and the summary table because no additional information is gained from these values. For example, if a site has four results at less than 1 µg/L (micrograms per liter), three results with concentrations more than 1 µg/L but less than 5 µg/L, and two results at less than 10 µg/L, the two results at less than 10 µg/L do not provide any additional information and were deleted from the analysis.

Physical Properties

Field measurements of various physical properties generally are made at the time of sample collection. Results of these measurements are presented in table 8 and summarized in table 2.

Specific conductance is a measure of the ability of a solution to conduct an electrical current (Hem, 1985). As minerals dissolve in water, forming ions, specific conductance increases. In many cases, concentrations of dissolved constituents tend to be inversely proportional to streamflow. This can be illustrated through the use of specific conductance, which generally is measured in conjunction with streamflow measurements at USGS gaging stations and can be used as a general indicator of ionic strength of water (Hem, 1985). Figure 8 shows relations between streamflow and specific conductance at selected sites for all available measurements during water years 1988-92.

Drainage areas for Spearfish Creek near Lead and Little Spearfish Creek near Lead are dominated by outcrops of the Madison Limestone and Minnelusa Formation (fig. 3). These sites are predominantly spring fed, with minimal variability in streamflow and minimal change in specific conductance (fig. 8B and 8D). Inverse relations between specific conductance and streamflow are better defined for all of the other sites in figure 8; however, individual characteristics are apparent for each site. Drainage basins dominated by Precambrian rocks or Tertiary intrusive rocks generally have the largest variability in specific conductance and streamflow and generally have the smallest specific conductance values. Examples are Boxelder Creek near Nemo (06422500), Annie Creek near Lead (06430800), Squaw Creek near Spearfish (06430898), False Bottom Creek near Central City (06432172), Whitetail Creek near Lead (06436156), and Bear Butte Creek near Deadwood (06437102) (fig. 8A, C, F, J, K, and L).

The influence of geologic variability is apparent for several of the drainage basins in figure 8. During low-flow conditions, most of the flow at Spearfish Creek above Spearfish (fig. 8G) originates from the large, spring-fed tributaries. Thus, for flow less than about 50 ft^3/s, specific conductance is very similar to Spearfish Creek near Lead and Little Spearfish Creek near Lead (figs. 8B and 8D). At higher streamflow, specific conductance decreases because of increased contributions from tributaries such as Annie Creek and Squaw Creek. A similar pattern exists for Spearfish Creek below Robison Gulch (fig. 8H), which is located several miles farther downstream (fig. 4), where flow is substantially reduced by diversions to a hydroelectric plant in Spearfish. Flow consists of possible seepage through the diversion dam and inflows from small tributaries and springs. A similar pattern also exists for Iron Creek near Lead (fig. 8E), which is a small tributary to Spearfish Creek originating from a mix of intrusive and sedimentary rocks.

Median specific conductance values ranged from 291.5 to 635 µS/cm (microsiemens per centimeter), with most sites being around 300 to 400 µS/cm (table 2, fig. 9). The smallest specific conductance values were slightly more than 100 µS/cm from Annie Creek near Lead, Squaw Creek near Spearfish, and both False Bottom Creek sites. The highest specific conductance values were from Spearfish Creek below Spearfish. This site has the largest drainage area of the sampled sites, representing approximately one-fourth of the study area, as well as exposure to the largest variety of geologic and land use practices.

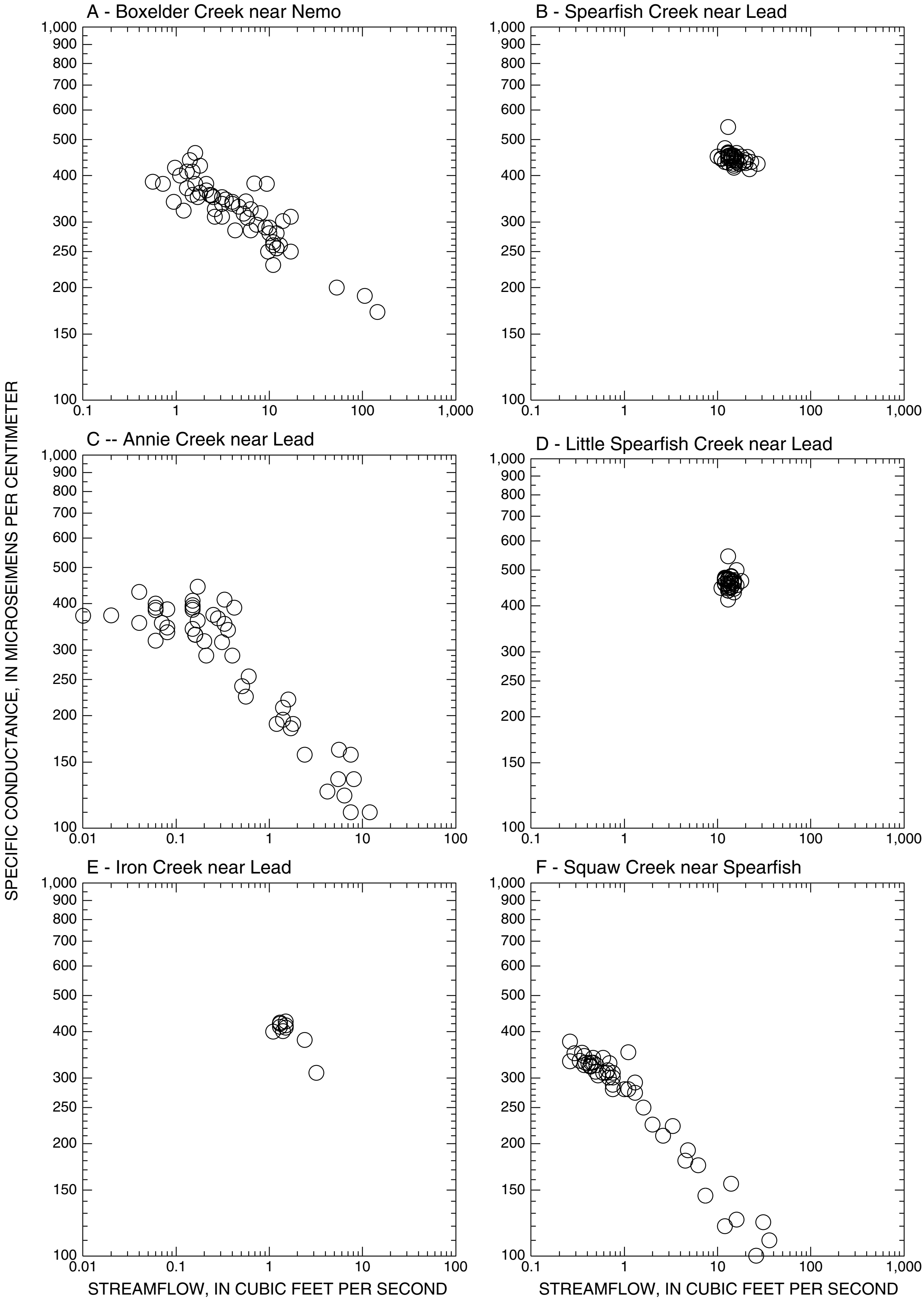


Figure 8. Relations between streamflow and specific conductance for selected sampling sites during 1988-92.

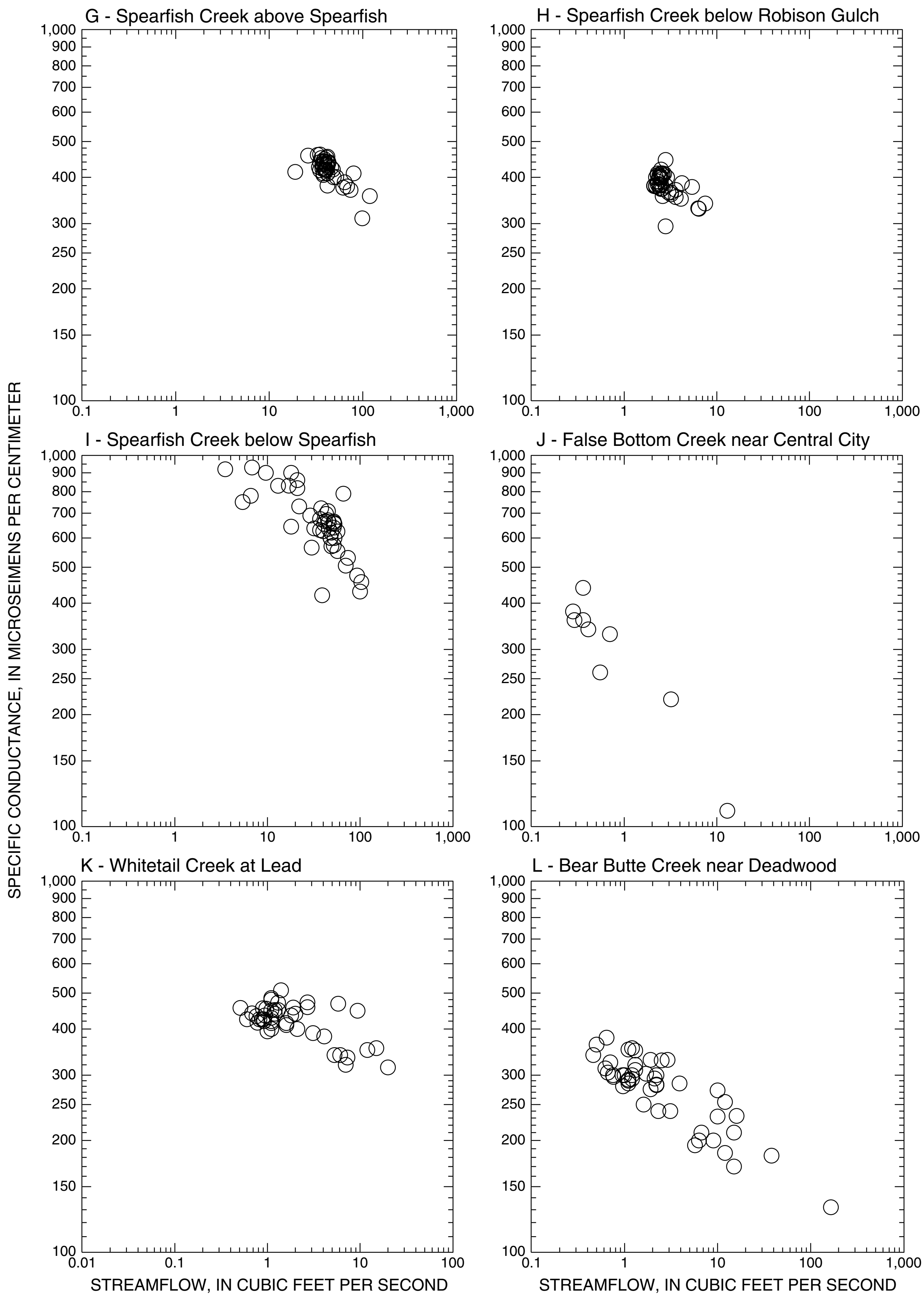


Figure 8. Relations between streamflow and specific conductance for selected sampling sites during 1988-92.--Continued

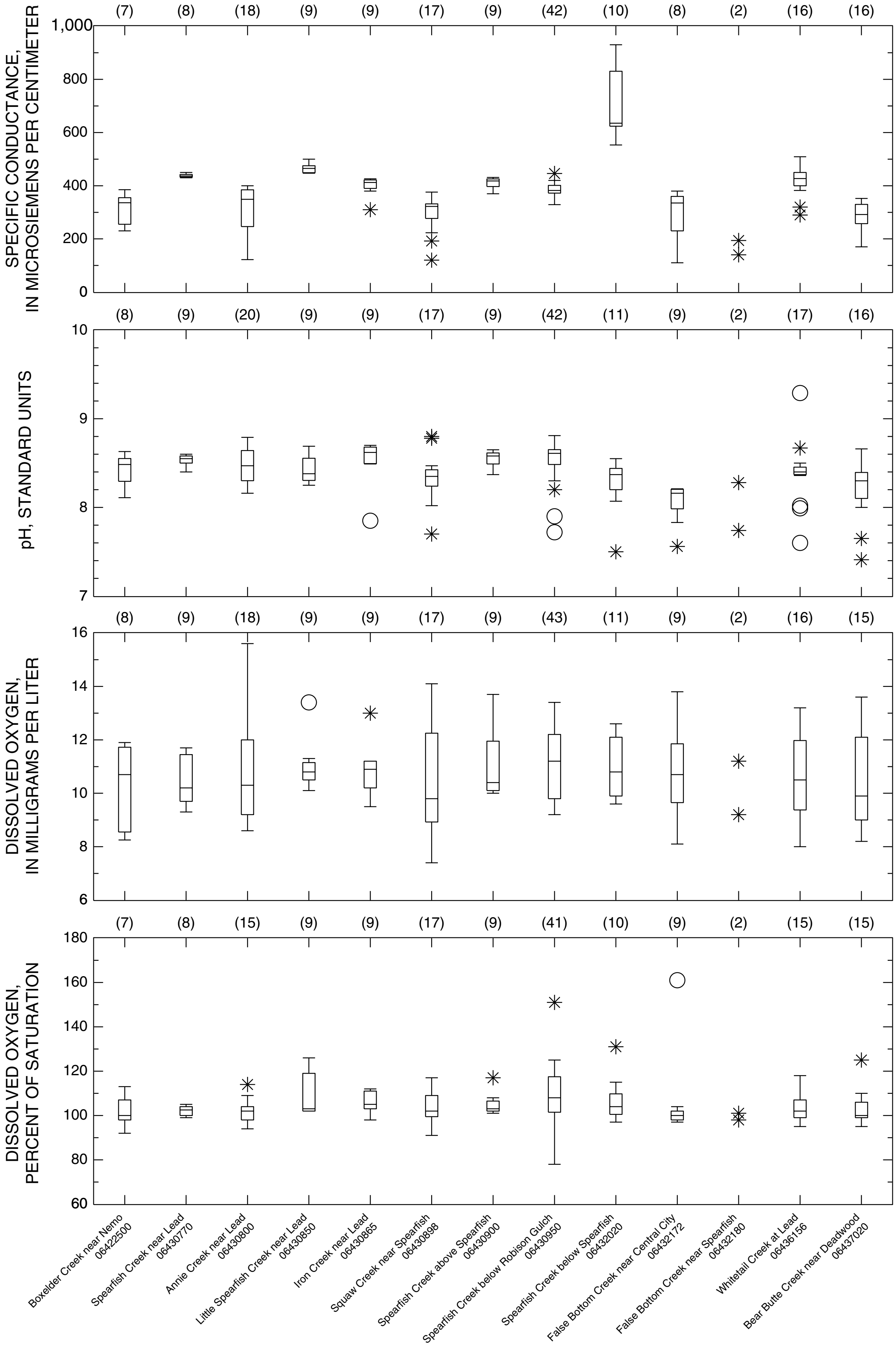
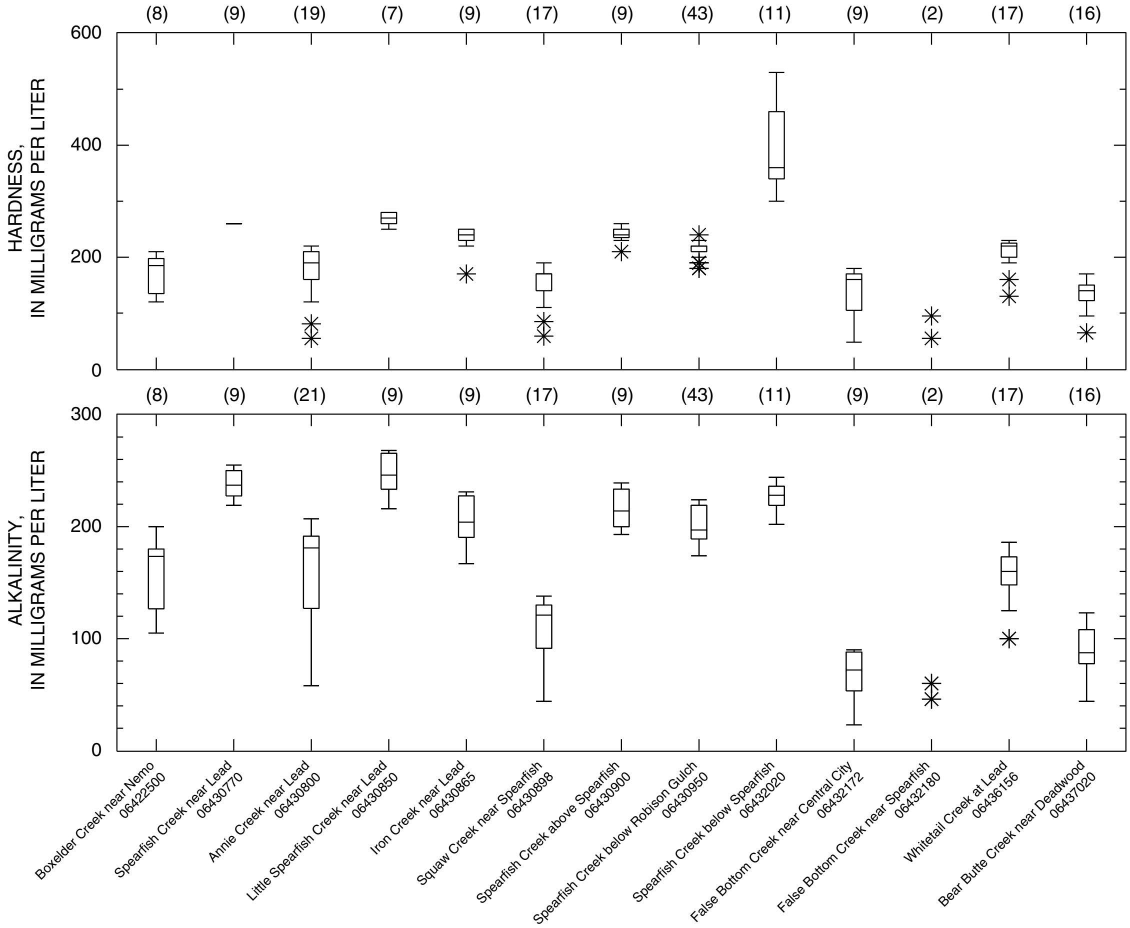


Figure 9. Boxplots of selected physical properties measured during 1988-92.



EXPLANATION

(8) Number of observations

○ Outlier data value more than 3 times the interquartile range outside the quartile

✳ Outlier data value less than or equal to 3 and more than 1.5 times the interquartile range outside the quartile

Data value less than or equal to 1.5 times the interquartile range outside the quartile

75th percentile
Median — Interquartile range
25th percentile

Figure 9. Boxplots of selected physical properties measured during 1988-92.--Continued

The pH of water is a measure of the hydrogen ion activity and is defined as the negative logarithm of the hydrogen ion activity. In surface water, pH generally ranges from 6.5 to 8.5 (Hem, 1985). In Lawrence County, pH values ranged from 7.4 to 9.3 (table 2, fig. 9). All of the sites with the exception of the False Bottom Creek sites occasionally had pH values that exceeded the SMCL of 8.5, and a few samples exceeded the domestic water supply and the coldwater permanent fisheries, or the coldwater marginal fisheries maximum criteria of 9, 8.6, and 8.8, respectively (table 2). One effect of pH in this range is that metals that may be in solution in low-pH spring water or mining-impacted waters that flow into the stream may precipitate out of solution or adsorb onto the sediments. These processes have been associated with minimizing the environmental impacts of the historical mining activities along Whitewood Creek (Goddard, 1989a) by removing a portion of the bioavailable metals from solution. However, metals in the sediments are available for transport and possible re-solution during high flows.

Water temperature affects most water-quality constituents to a certain extent by influencing rates of chemical reactions. Rates of mineral dissolution and precipitation as well as biological activity are affected by temperature. Median water temperatures ranged from 2°C to 9.5°C (35.6°F to 49.1°F). The warmest temperature, 20°C (68°F), was recorded at Bear Butte Creek near Deadwood (table 2).

Dissolved oxygen in water primarily varies with temperature, barometric pressure, turbulence of the water surface, and biological activity. The dissolved oxygen concentrations ranged from 7.4 to 15.6 mg/L (milligrams per liter) with median concentrations near 10 mg/L (table 2, fig. 9); therefore, none of the measured values fell below limits protective of aquatic life. Percent saturation provides a means of comparison for dissolved oxygen that incorporates temperature and pressure. Median percent saturation values ranged from 100 to 108 percent. Extremes were a minimum of 78 percent at Spearfish Creek below Robison Gulch and a maximum of 161 percent at False Bottom Creek near Central City.

Hardness is due to the presence of calcium and magnesium, as well as other dissolved ions (Hem, 1985). The level of hardness is an important factor affecting the toxicity of several trace elements, and many aquatic-life criteria for metals are calculated on the basis of ambient hardness. Median hardness concentrations in Lawrence County streams ranged from 140 to 360 mg/L (table 2, fig. 9) and were more than 180 mg/L (considered level of very hard water) with the exception of Squaw Creek, False Bottom Creek near Central City, and Bear Butte Creek (table 2). Sites with lower hardness concentrations have limited contact with the sedimentary units which typically are abundant in calcium and magnesium, particularly the Madison Limestone.

Alkalinity is defined as the ability of a solution to react with and neutralize acid (Hem, 1985) and primarily includes the summation of the activities of dissolved carbon species, hydrogen, and hydroxide. For the pH ranges found in Lawrence County streams, bicarbonate is the largest contributor to alkalinity. Median alkalinity concentrations ranged from 72 to 246 mg/L as $CaCO_3$ (table 2, fig. 9), and the lowest concentration of 23 mg/L was at False Bottom Creek near Central City. The highest concentration of 268 mg/L was at Little Spearfish Creek near Lead, which has a drainage area with significant exposure to the Madison Limestone as well as the Deadwood Formation. As the limestone dissolves, the calcium concentration in the stream increases as well as the bicarbonate (HCO_3^-) concentration.

Dissolved Solids and Major Ions

The source of dissolved solids in water ultimately is the rocks near land surface (Hem, 1985), or for springs, the rocks from the source formation in combination with near-land-surface rocks. Many factors affect the dissolution of minerals in water, including temperature, pH and oxidation-reduction potential of the water, rock texture, porosity, and duration of exposure.

Specific conductance frequently is used to estimate dissolved solids concentrations (Hem, 1985) because of the generally linear relation between the two constituents (fig. 10). Results of the linear regression between dissolved solids and specific conductance are presented for each site in figure 10, including the R^2 value (fraction of the variance explained by regression) as well as the equation of line: $DS = A * SC + I$, where DS is the dissolved solids concentration in milligrams per liter, A is the slope of the line, SC is specific conductance in microsiemens per centimeter, and I is the x-axis intercept. Spearfish Creek near Lead and Little Spearfish Creek near Lead (figs. 10B and 10D) show little variation in dissolved solids concentrations. Both sites are spring fed and have a relatively constant source of water in both volume and water-quality characteristics. Other sites have a wider range in dissolved solids concentrations and generally have stronger relations with specific conductance.

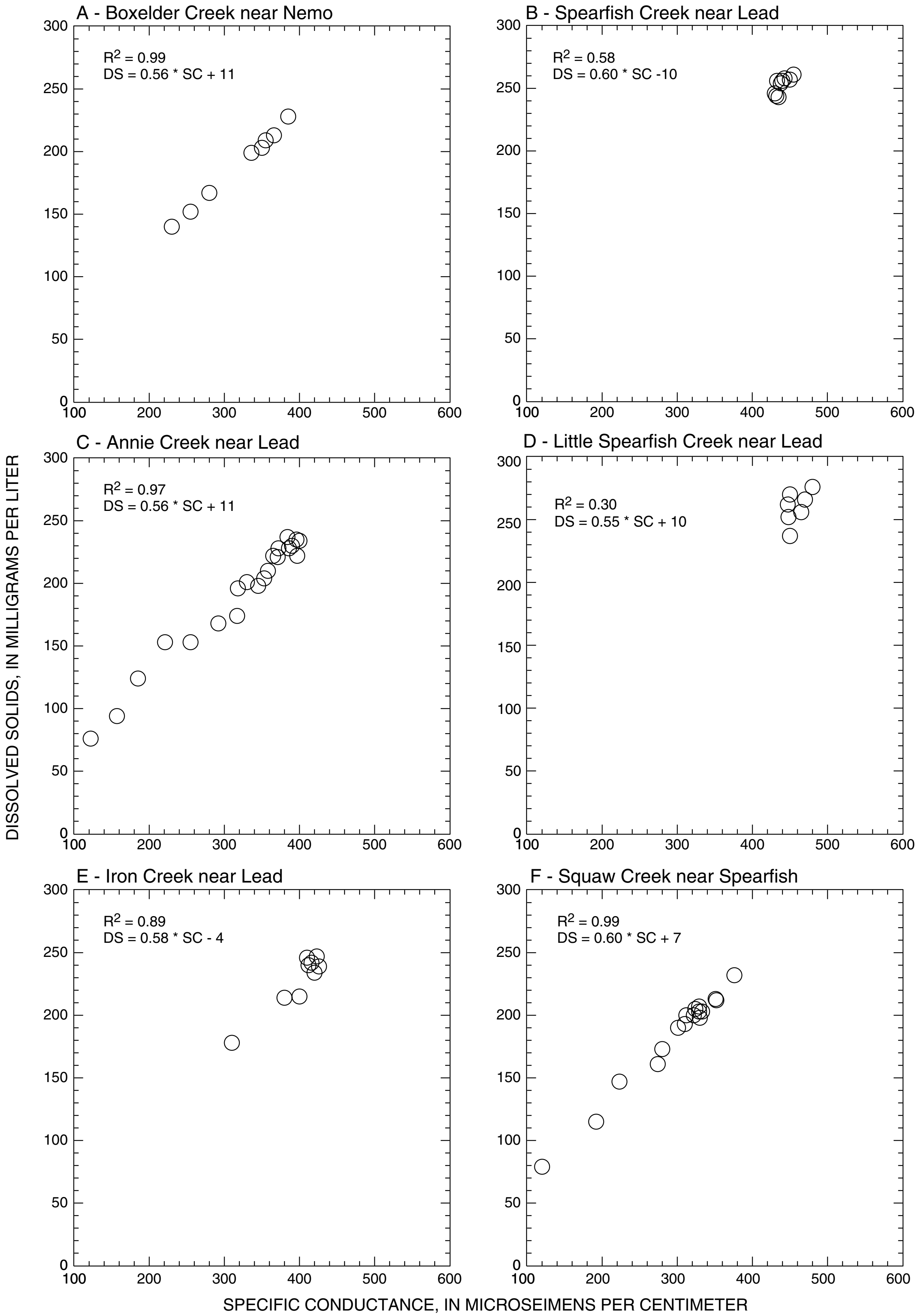


Figure 10. Relations between dissoved solids and specific conductance for selected sampling sites during 1988-92.

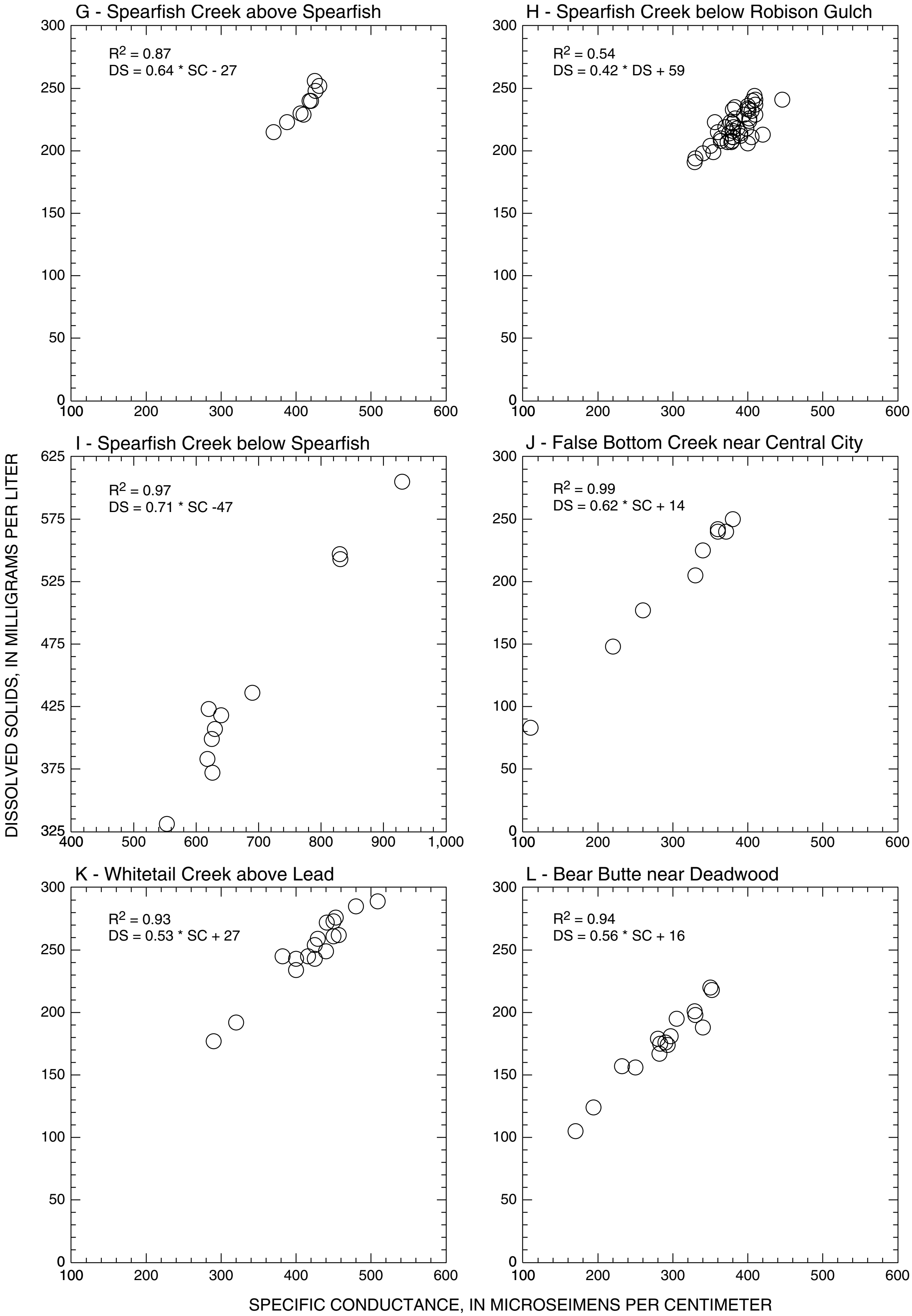


Figure 10. Relations between dissolved solids and specific conductance for selected sampling sites during 1988-92.--Contin ed

Measured dissolved solids concentrations ranged from 81 to 660 mg/L, with median concentrations near 200 mg/L for most sites (table 2, fig. 11). Calculated dissolved solids concentrations (the sum of the dissolved major constituents) ranged from 76 to 605 mg/L. The highest dissolved solids concentrations were at Spearfish Creek below Spearfish, which ranged from 331 to 605 mg/L and exceeded the SMCL of 500 mg/L in two samples. The high concentrations at this site reflect increases in concentrations of sulfate and other major ions that result from contact with the Spearfish Formation (fig. 3).

Ionization is the formation of either cations (ions that have lost or given up an electron and are positively charged) or anions (ions that have gained an electron and are negatively charged) as solids dissolve in water. Chemical processes also can take place that result in the exchange of ions between the solutes in water, which can result in the dissolution of one solid and the formation of another. All solutions must be electrically neutral, so a water-quality sample should have a neutral charge balance between the cations and anions.

Proportions of major ions in water samples from Lawrence County streams are shown in trilinear diagrams in figure 12. Sites with predominantly calcium magnesium bicarbonate type water and showing relatively little variation in percentages of major ions are categorized as group A with respect to water type. Calcium and magnesium generally are the dominant cations with ranges from 50 to 65 percent and 35 to 50 percent of cations, respectively. Bicarbonate is the dominant anion with ranges from 90 to 99 percent of anions. Group A sites include all but one of the Spearfish Creek sites. Water chemistry at these sites is influenced primarily by outcrops of the Madison Limestone and other carbonate rocks. The exception to this pattern of Spearfish Creek sites is Spearfish Creek below Spearfish, which has larger percentages of sulfate than group A sites and is categorized as group B with respect to water type (fig. 12). This site is the most downstream site on Spearfish Creek and is influenced by contact with the Spearfish Formation.

Group C includes sites from the mineralized area of mostly central Lawrence County, including Boxelder Creek, Annie Creek, Squaw Creek, two sites on False Bottom Creek, Whitetail Creek, and Bear Butte Creek. Water samples from these sites generally had larger variability in proportions of most major ions than group A and B sites, larger percentages of sodium, and lower percentages of magnesium (fig. 12). Anion proportions in water from the mineralized area are typified by lower percentages of bicarbonate (40 to 95 percent), higher percentages of sulfate (5 to 60 percent), and higher percentages of chloride (1 to 25 percent). The sites with 20 to 60 percent sulfate also have exposure to Tertiary intrusive units (fig. 2). These sites include Squaw Creek, False Bottom Creek, Whitetail Creek, and Bear Butte Creek. Water types for Group C range from calcium magnesium bicarbonate to calcium magnesium sulfate. False Bottom Creek near Central City is quite different, with higher percentages of sulfate (49 to 57 percent) than bicarbonate (40 to 47 percent) (fig. 12, group C). Available data do not provide enough information to determine the source of the sulfate, but the weathering of the minerals pyrite (iron sulfide) or melanteride (iron sulfate) is one possibility.

Calcium concentrations ranged from 14 to 140 mg/L, with median concentrations ranging from 42 to 94 mg/L (table 2, fig. 11). The maximum concentration was at Spearfish Creek below Spearfish and the low concentrations were from sites originating in the mineralized area of central Lawrence County. Magnesium concentrations ranged from 3 to 44 mg/L, with median concentrations ranging from 11 to 32 mg/L, and spatially followed the same general pattern as calcium. Sodium concentrations ranged from about 1 to 14 mg/L, with the maximum concentration at Whitetail Creek at Lead. Potassium concentrations ranged from 0.4 to 4.6 mg/L. Lower concentrations of potassium were found along Spearfish Creek with some increases through the stream reach and higher variability in the tributaries. False Bottom Creek near Central City and Bear Butte Creek near Deadwood had the highest concentration ranges for potassium.

Bicarbonate concentrations (calculated from laboratory alkalinity) ranged from 28 to 327 mg/L, with ranges in medians from 88 to 300 mg/L (table 2, fig. 11). The majority of sites had median bicarbonate concentrations ranging from 212 to 300 mg/L. Lower concentrations (28 to 168 mg/L) were found at sites with exposure to Tertiary intrusive rocks. Sulfate concentrations ranged from 1.8 to 260 mg/L, with a wide range in median concentrations (table 2, fig. 11). One sample from Spearfish Creek below Spearfish exceeded the SMCL of 250 mg/L with a concentration of 260 mg/L. The median concentration of sulfate increased from 9 mg/L at Spearfish Creek below Robison Gulch to 120 mg/L at Spearfish Creek below Spearfish. This may be attributed to contact with the

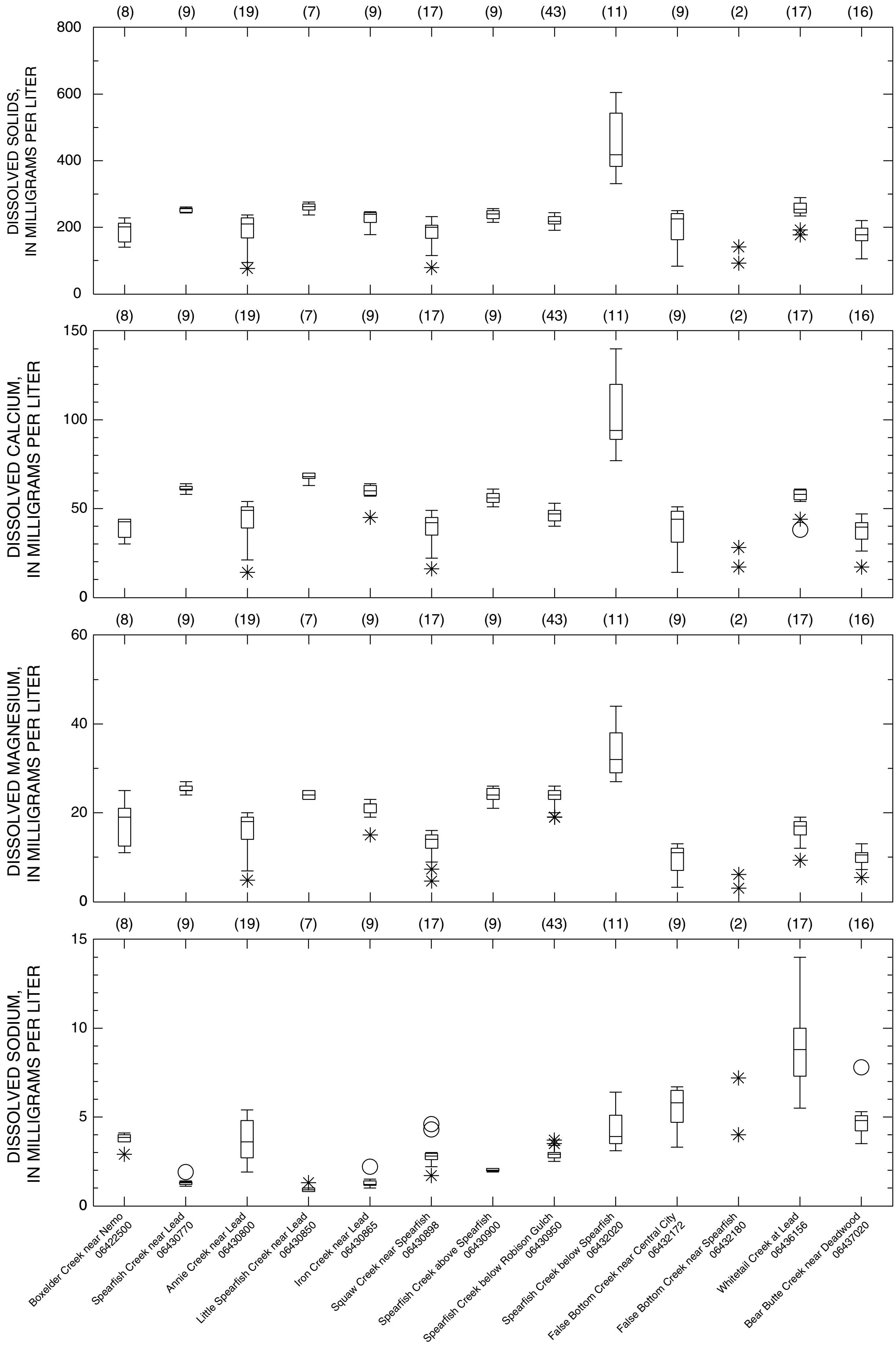


Figure 11. Boxplots of selected ion concentrations measured during 1988-92.

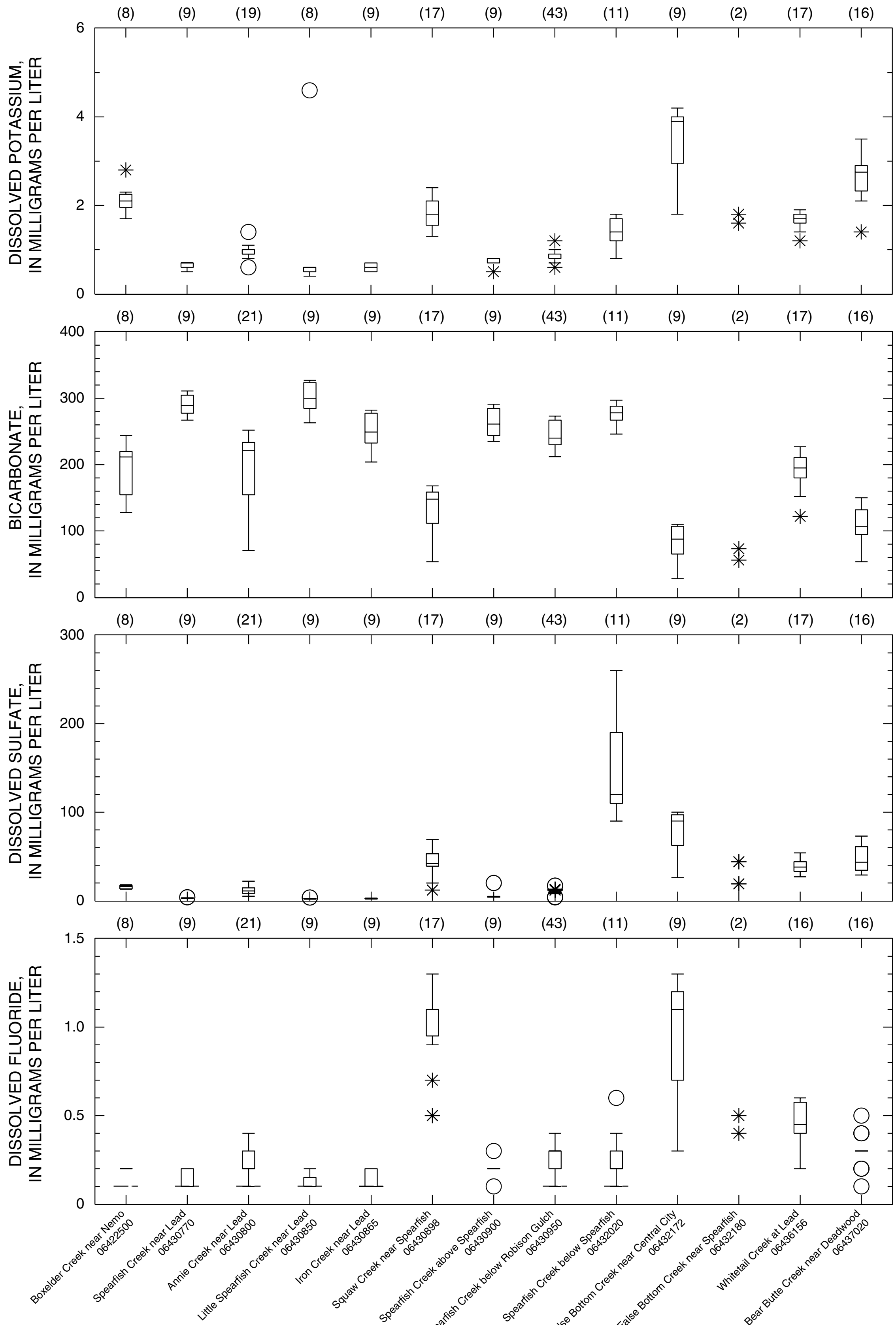


Figure 11. Boxplots of selected ion concentrations measured during 1988-92.--Continued

EXPLANATION

(8) Number of observations

○ Outlier data value more than 3 times the interquartile range outside the quartile

✳ Outlier data value less than or equal to 3 and more than 1.5 times the interquartile range outside the quartile

Data value less than or equal to 1.5 times the interquartile range outside the quartile

75th percentile, Median, 25th percentile — Interquartile range

— - Laboratory reporting limit

Figure 11. Boxplots of selected ion concentrations measured during 1988-92.--Continued

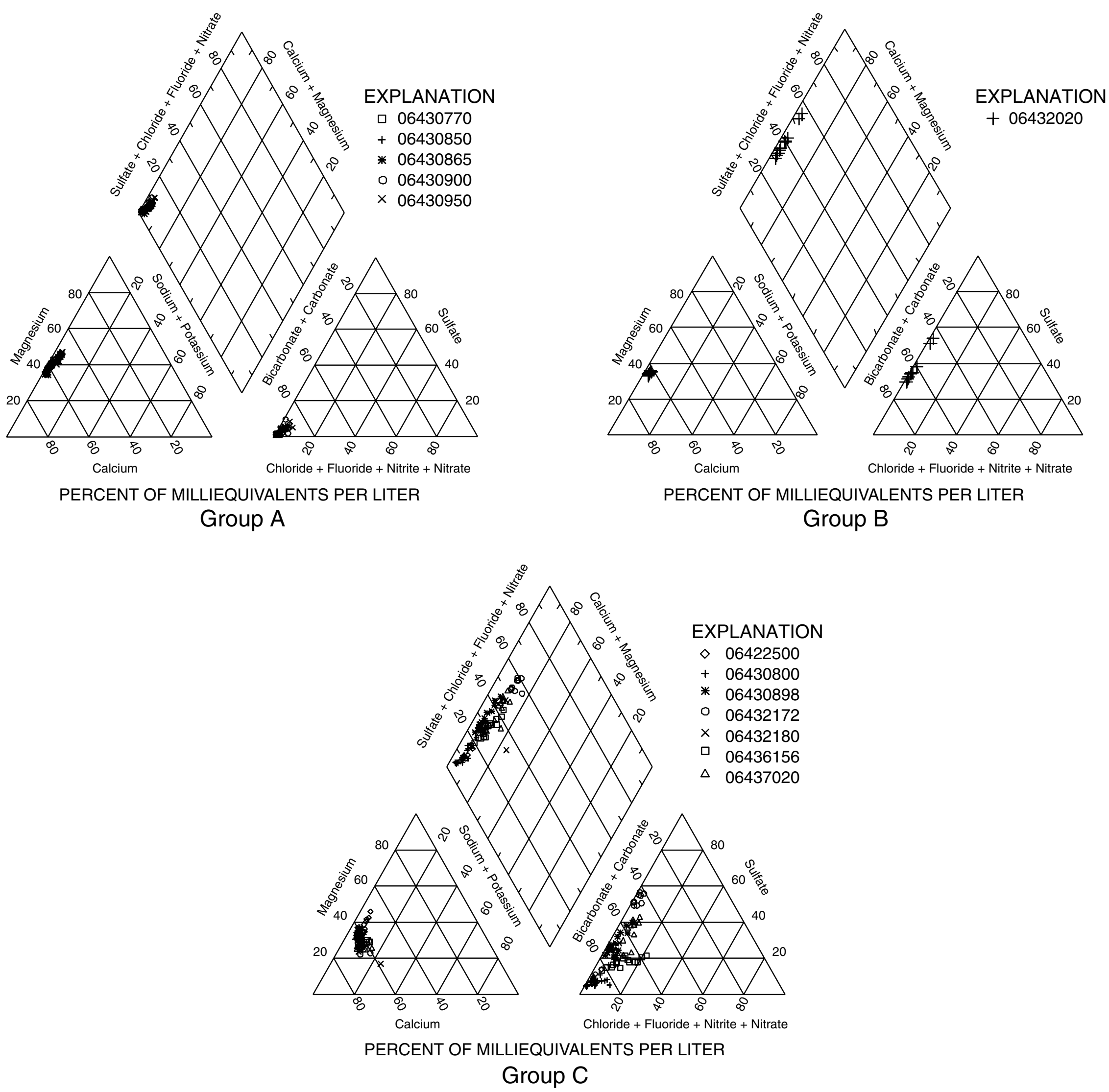


Figure 12. Trilinear diagrams (Piper, 1944) showing proportional concentrations of major ions for selected sites.

Spearfish Formation along this lower reach. Higher concentrations and more variability also were found at sites in the mineralized area. Chloride concentrations ranged from 0.2 to 40 mg/L, with the maximum at Whitetail Creek at Lead. Fluoride concentrations ranged from less than 0.1 to 1.3 mg/L. Silica concentrations ranged from 8.4 to 22 mg/L, with median concentrations about 9 to 20 mg/L. Common ranges for silica in natural waters are 1 to 30 mg/L (Hem, 1985).

Nitrogen, Phosphorus, and Cyanide

Nitrogen occurs in water as nitrite (NO_2^-), nitrate (NO_3^-), and ammonium (NH_4^+), as well as other oxidation states as part of organic solutes (Hem, 1985). Nitrate is the form most commonly found in oxygenated surface waters. Nitrate concentrations in drinking water above 10 mg/L as N (the EPA drinking-water MCL, table 4) can cause methemoglobinemia in small children (blue-baby syndrome). Nitrogen is present in air, water, and soil. Some sources of nitrate in water include septic systems, barnyards where animals are confined to a small area, fertilizers, impacts from mining, including explosives and the breakdown of cyanide, as well as nitrification associated with the in-stream riparian system. The ammonium cation is common in spring waters that have not oxidized. Ammonia, nitrite, and organic nitrogen are unstable in aerated water and, therefore, are considered indicators of recent pollution when found in surface waters (Hem, 1985).

The nitrite concentrations for this study all were at or below the laboratory reporting limit of 0.01 mg/L, with the exception of 0.09 mg/L at Spearfish Creek below Robison Gulch and 0.02 mg/L at Spearfish Creek below Spearfish, Whitetail Creek at Lead, and Bear Butte Creek near Deadwood (fig. 13 and tables 2 and 8). Monthly samples were collected at Spearfish Creek below Robison Gulch, and the sample with a concentration of 0.09 mg/L was the only result exceeding the laboratory reporting limit for nitrite. Median concentrations for nitrate plus nitrite generally were at or close to the laboratory reporting limit (typically 0.1 mg/L), with the exception of Annie Creek near Lead (1.2 mg/L), Spearfish Creek below Spearfish (0.3 mg/L), and Whitetail Creek at Lead (0.36 mg/L) (table 2, fig. 13). The maximum nitrate plus nitrite concentrations were 4.3 mg/L at Annie Creek near Lead, 1.4 mg/L at Whitetail Creek at Lead, 0.84 mg/L at Squaw Creek near Spearfish, and 0.56 mg/L at Spearfish Creek below Spearfish. Mining activity, agricultural activity, and domestic development are possible sources of nitrogen for these streams. Nitrate plus nitrite concentrations increased an order of magnitude at the Annie Creek site between May and August of 1990 and remained higher for the balance of the sampling. Increased mining activities were identified as the probable cause of increased nitrogen concentrations in Annie Creek (Johnson, 1992).

Minimum and median ammonia concentrations were at or near the laboratory reporting limit of 0.01 mg/L. The maximum concentration measured was 0.16 mg/L at Annie Creek near Lead. Several other sites had maximum concentrations in the range of 0.05 to 0.09 mg/L (table 2, fig. 13). Ammonia could be the result of a ground-water source of nitrogen that has not oxidized to nitrate, or could indicate recent inputs of fecal wastes or fertilizers. The un-ionized ammonium criteria for coldwater fisheries is a 30-day average of 0.02 mg/L and is based upon the total ammonia in the stream (South Dakota Department of Environment and Natural Resources, 1996). Two sites, Annie Creek near Lead and Little Spearfish Creek near Lead, had median ammonia concentrations of 0.02 mg/L, but the un-ionized portion would be considerably smaller, in the 0.0002 mg/L range.

Phosphorus is common in igneous rocks as well as some sedimentary units. Phosphate (P^{5+}) is the most common form of phosphorus in natural waters (Hem, 1985), with the orthophosphate ion (PO_4^{3-}) being the most stable of the P^{5+} forms. Phosphorus is also a component of both sewage and fertilizers. Dissolved phosphorus concentrations generally were low, with the maximum for most sites at or below 0.04 mg/L (table 2, fig. 13). Exceptions include maximum values of 0.10 mg/L at Little Spearfish Creek near Lead and 0.11 mg/L at False Bottom Creek near Central City. The highest ortho-phosphate concentrations also were in the False Bottom drainage, with 0.106 mg/L at False Bottom Creek near Central City and 0.035 mg/L at False Bottom Creek near Spearfish. The higher phosphorus could be due to differences in the Tertiary-age units in this drainage compared to the others in the study area.

Cyanide (CN) is used in the leaching processes for gold recovery. Cyanide, like other forms of nitrogen, breaks down readily in surface water, but is toxic to aquatic life at low levels (EPA aquatic-life chronic criterion, 0.0052 mg/L). All of the dissolved and total cyanide concentrations were at or less than the laboratory reporting limit of 0.01 mg/L (table 2).

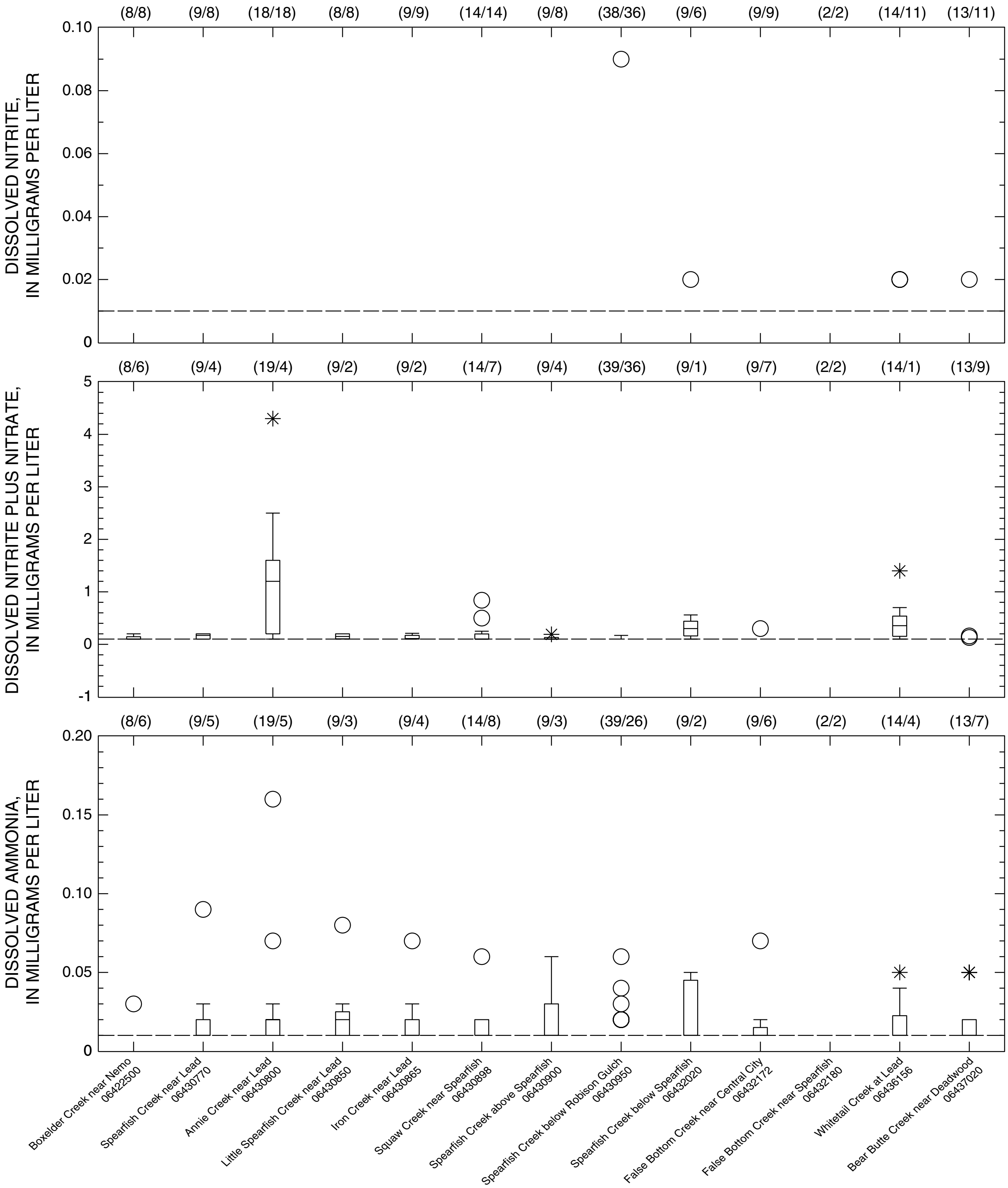


Figure 13. Boxplots of selected nutrient concentrations measured during 1988-92.

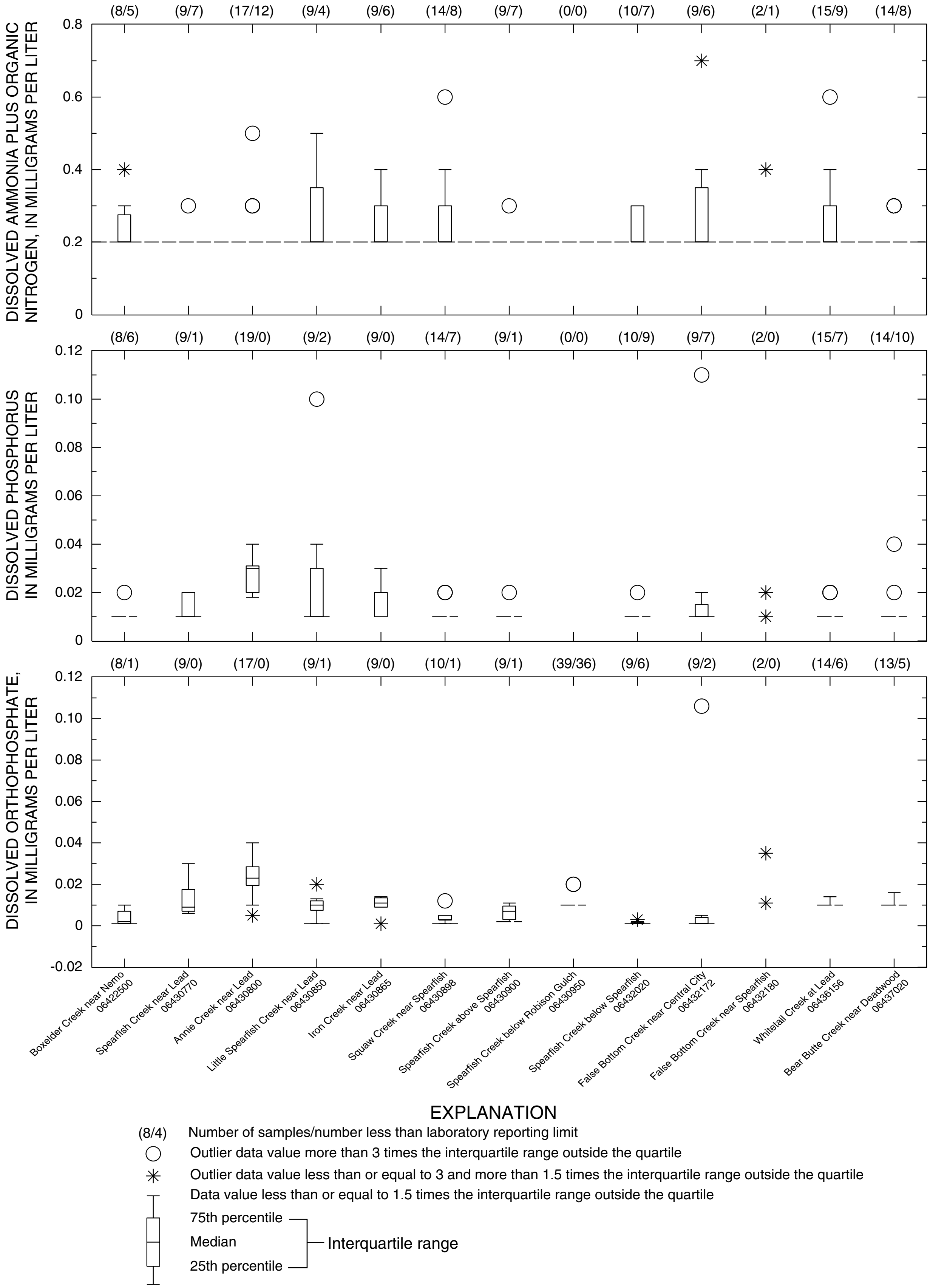


Figure 13. Boxplots of selected nutrient concentrations measured during 1988-92.--Continued

Minor and Trace Elements

Minor or trace elements generally are defined as elements with concentrations in natural water below 1 mg/L (Hem, 1985). Although they are present only in small concentrations, they still can have an impact on human and aquatic life. Because of the geology in Lawrence County and the Black Hills, certain trace elements are common in stream water, especially within the mineralized area. Mining activities (abandoned or presently active) also can release additional metals to streams by exposing buried rock to the atmosphere, initiating chemical oxidation reactions. A discussion of the effects of mining activities in the mineralized area is provided in the following section.

Antimony and arsenic are nonmetallic elements. Antimony is only one-tenth as abundant as arsenic in rocks, and concentrations usually are very low (Hem, 1985). Most samples collected were at or near the laboratory reporting limit of 1 µg/L, except for several samples collected at Annie Creek near Lead and Whitetail Creek at Lead (table 2, fig. 14). The maximum antimony concentration of 7 µg/L, which exceeded the drinking-water MCL of 6 µg/L, occurred at Annie Creek near Lead (table 8). Whitetail Creek at Lead had a maximum concentration of 4 µg/L.

Arsenic is of particular concern in the northern Black Hills because of its natural abundance in the mineralized area and increased potential for release to the environment due to mining activities. Arsenic is highly toxic to humans and aquatic life and has a drinking-water standard of 50 µg/L (under review with a proposed lower limit of 5 µg/L). The stable forms of arsenic in water are arsenate (As^{5+}) and arsenite (As^{3+}). The mineral arsenopyrite is present in the rocks associated with gold ores. Concentrations of total recoverable arsenic were more than the laboratory reporting limit of 1 µg/L for all samples at Annie Creek near Lead, Squaw Creek near Lead, Spearfish Creek above Spearfish, Spearfish Creek below Spearfish, both False Bottom Creek sites, and Whitetail Creek at Lead (table 2, fig. 14). The highest total recoverable arsenic concentrations occurred at Annie Creek near Lead and ranged from 15 to 50 µg/L, with a median concentration of 28.5 µg/L (table 8). Total recoverable arsenic concentrations at Whitetail Creek at Lead ranged from 7 to 20 µg/L, with a median concentration of 14.5 µg/L. Dissolved arsenic concentrations were similar and ranged from 6 to 48 µg/L at Annie Creek near Lead and from 7 to 20 µg/L at Whitetail Creek at Lead. Comparison of total recoverable arsenic with dissolved arsenic concentrations for Annie Creek near Lead and Whitetail Creek at Lead indicate that most arsenic at these two sites was in the dissolved phase; however, because 0.45-µm filters were used, colloidal arsenic would be included in the dissolved concentrations. Arsenic concentrations generally increase slightly in a downstream direction along Spearfish Creek, but only samples from Annie Creek near Lead approached the MCL of 50 µg/L. Further discussions of arsenic are provided by Driscoll and Hayes (1995) and Goddard (1989a).

Barium occurs in many igneous rocks common to the northern Black Hills and has an MCL of 2 mg/L (2,000 µg/L). The lowest concentrations were from sites in the southeastern part of Lawrence County; the concentration range was 26 to 43 µg/L for Boxelder Creek near Nemo and 27 to 46 µg/L for Bear Butte Creek near Deadwood (table 2, fig. 14). Barium concentrations generally were highest in the Spearfish Creek basin (33 to 110 µg/L) as well as Whitetail Creek (82 to 100 µg/L). Barium concentrations in False Bottom Creek (40 to 75 µg/L) were less than most concentrations in the Spearfish Creek basin but higher than Boxelder or Bear Butte Creeks.

Boron is important to the growth of various types of plants in small concentrations, but can be toxic at low concentrations for some plants (Hem, 1985). Boron is common in igneous rocks and is incorporated in the mineral tourmaline that often is found in granitic rocks and pegmatites that are common in the Black Hills. Concentrations of boron ranged from less than the laboratory reporting limit of 10 to 50 µg/L (table 2, fig. 14). The maximum concentration of 50 µg/L occurred at Spearfish Creek below Spearfish.

Cadmium is a relatively rare element that is concentrated in zinc-bearing sulfide ores (Callahan and others, 1979). Multiple reporting limits for cadmium analyses makes characterization of cadmium concentrations in Lawrence County streams difficult. Nearly all of the samples had cadmium concentrations below the various reporting limits, many of which were less than 1 µg/L. Only two sites had more than one detectable concentration. Because of the uncertainties in actual concentration, cadmium was omitted from figure 14. The maximum detected concentration (3 µg/L at Boxelder Creek near Nemo) was less than the MCL of 5 µg/L.

Chromium is present in many rock types and concentrations in natural waters generally are less than 10 µg/L (Hem, 1985). The drinking-water standard is 100 µg/L. For the data collected as part of this study, most concentrations were less than the minimum reporting limit of 1 µg/L (table 2, fig. 14). Concentration ranges were similar for most sites and maximums generally were 1 to 2 µg/L.

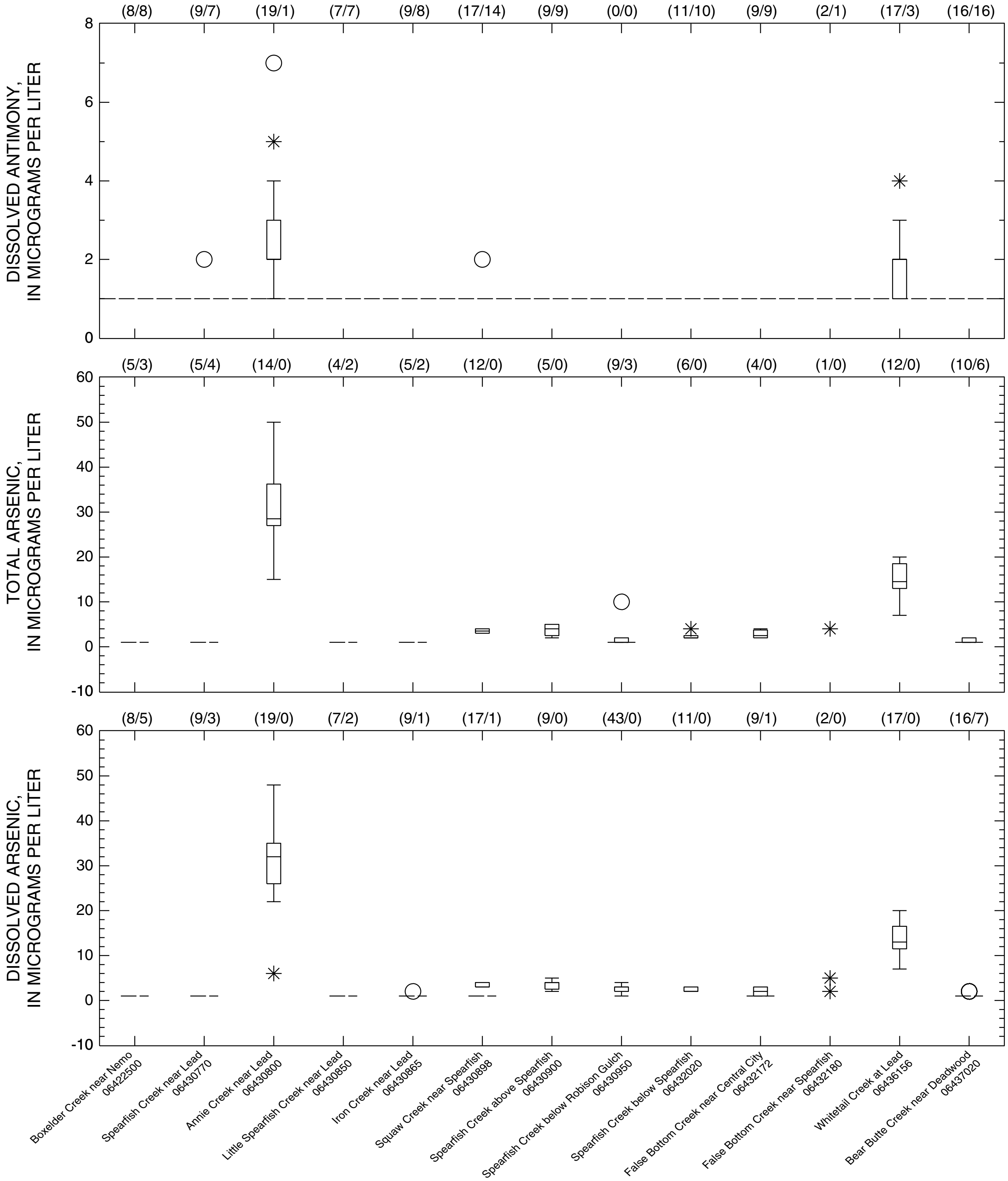


Figure 14. Boxplots of selected trace element concentrations measured during 1988-92.

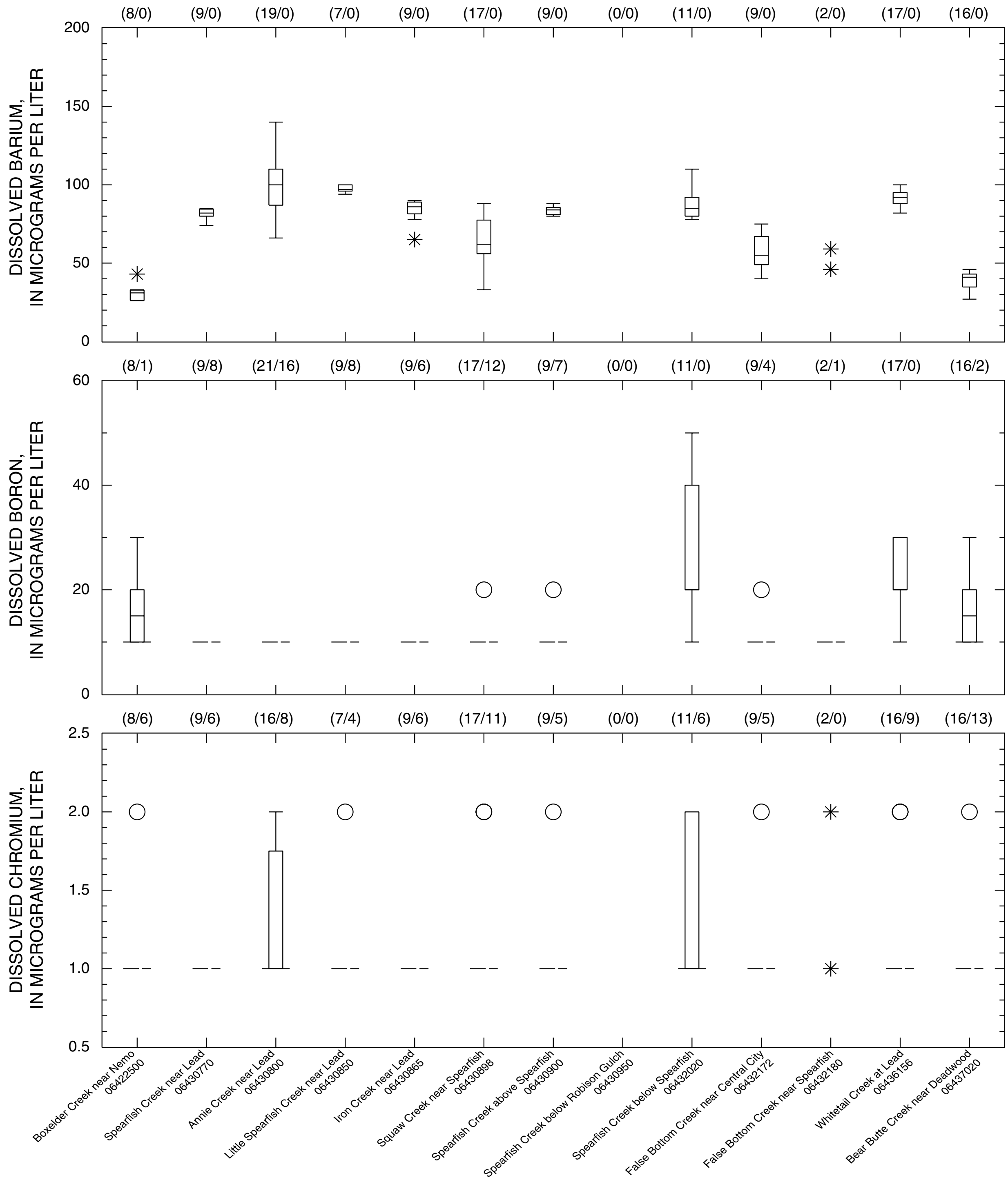


Figure 14. Boxplots of selected trace element concentrations measured during 1988-92.--Continued

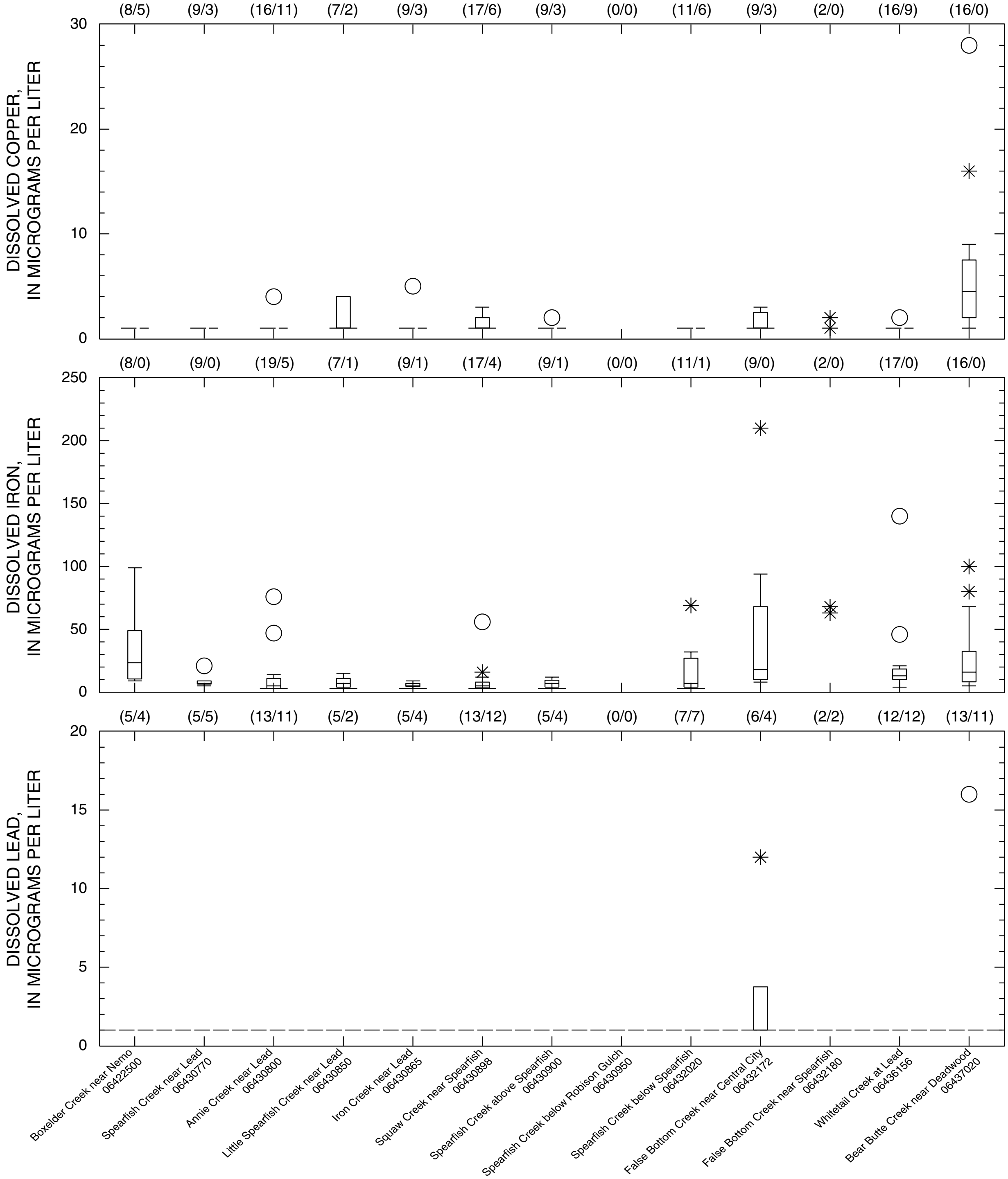


Figure 14. Boxplots of selected trace element concentrations measured during 1988-92.--Continued

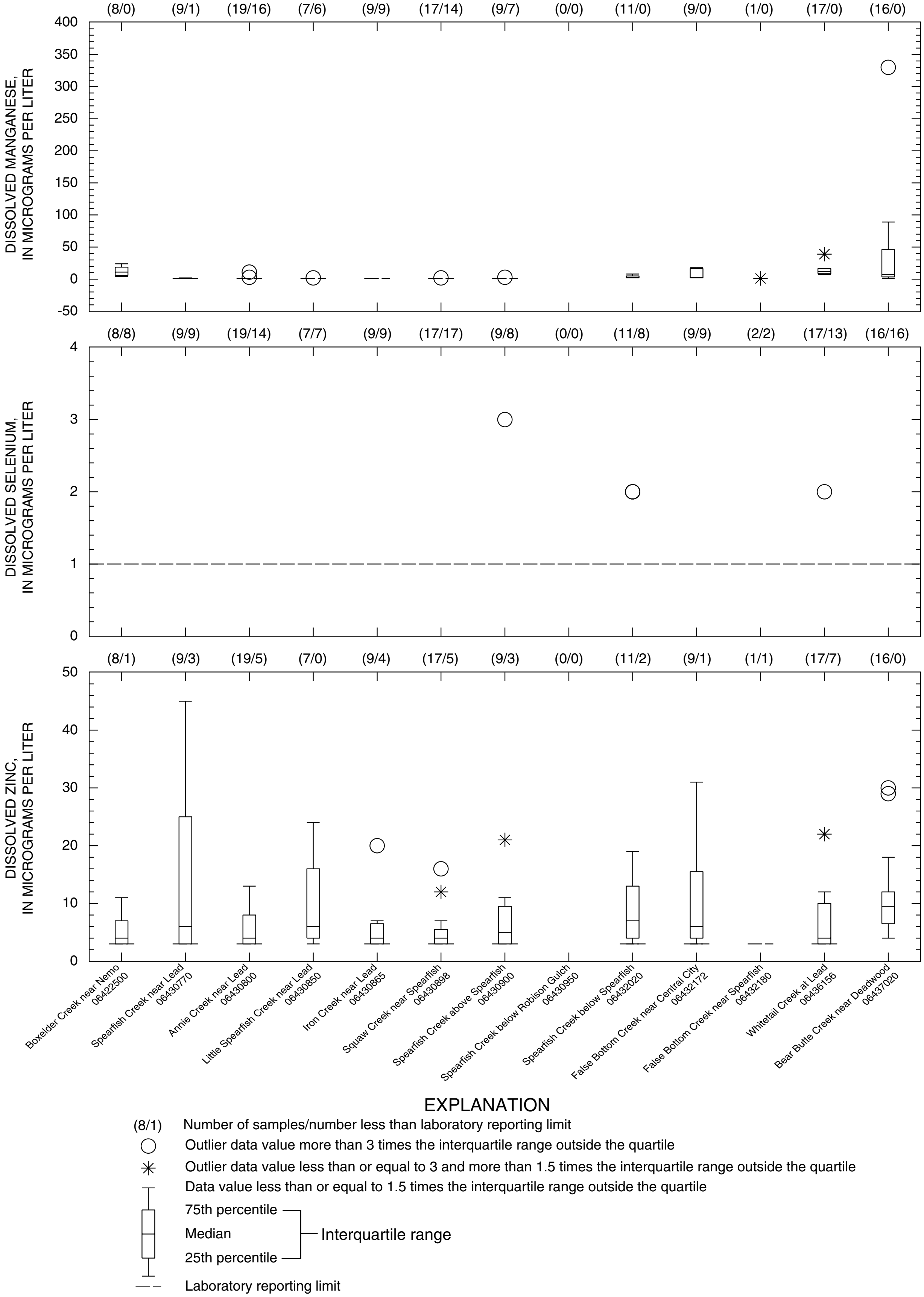


Figure 14. Boxplots of selected trace element concentrations measured during 1988-92.--Continued

Copper is common in ore deposits and is essential to plant and animal metabolisms but can also be toxic to aquatic life at higher levels (Hem, 1985). The specific aquatic-life criteria for copper are dependent on hardness. Dissolved copper was most prevalent in Bear Butte Creek near Deadwood, where detectable concentrations were measured in all 16 samples collected during 1988-92. The maximum concentration of 28 µg/L was on June 24, 1991 (table 8), when measured hardness at Bear Butte Creek near Deadwood was 110 mg/L as $CaCO_3$. This copper value exceeded both the aquatic-life acute criterion of 18.6 µg/L and the chronic criterion of 12.3 µg/L. On July 14, 1992, the copper concentration for Bear Butte Creek near Deadwood was 16 µg/L, which closely approached the chronic aquatic-life criteria of 16.1 µg/L (based on the measured hardness of 150 mg/L as $CaCO_3$). Copper concentrations at other sites during 1988-92 generally were less than or near the reporting limit of 1 µg/L (table 2, fig. 14). None of the samples at other sites approached the aquatic-life criteria.

Iron is the second most abundant metallic element in the earth's outer crust but concentrations in water typically are low (Hem, 1985). Arsenopyrite and pyrite are sources of iron common to the Black Hills as well as iron-rich schists, goethite, and hematite. Oxidation potential and pH control the solubility of iron in water (Hem, 1985). Iron has an SMCL of 300 µg/L, which was not exceeded for any of the samples. For this study, concentrations of dissolved iron ranged from less than the laboratory reporting limit of 3 to 210 µg/L, with the maximum occurring at False Bottom Creek near Central City (table 2, fig. 14). Sites from the mineralized area, including False Bottom Creek near Central City, Boxelder Creek near Nemo, Whitetail Creek at Lead, and Bear Butte Creek near Deadwood, had generally similar distributions of iron concentration. Median concentrations at these sites ranged from 13 to 23.5 µg/L, with maximum concentrations near or exceeding 100 µg/L. Sites within the Spearfish Creek basin had generally lower iron concentrations that were similar to each other, with median concentrations ranging from 5 to 7 µg/L and maximum concentrations less than or equal to 76 µg/L.

Lead is widely dispersed in the environment, in part due to its historic use in leaded gasoline, in pipes, and in the smelting of ores (Hem, 1985). The mineral galena is a natural source of lead and is present in the northern Black Hills. All lead concentrations in this study were at or less than the most commonly used reporting limit of 1 µg/L, except for two samples with concentrations of 12 µg/L (False Bottom Creek near Central City) and 16 µg/L (Bear Butte Creek near Deadwood). Both sites are in the mineralized area of Lawrence County, and the Bear Butte Creek drainage historically had silver/lead mining activities. Both of the maximum concentrations exceeded the aquatic-life chronic criterion of 4.7 µg/L for the False Bottom Creek sample (based on the hardness of 180 mg/L as $CaCO_3$) and 3.6 µg/L for the Bear Butte Creek sample (based on the hardness of 140 mg/L as $CaCO_3$). Ultraclean sampling procedures currently (2000) used by the USGS were not used during the period when samples were collected for this study. Lead is a constituent in water that is particularly susceptible to contamination effects because it typically occurs in low concentrations in water. In the past it was present in the sampling equipment and vehicles used by the USGS. It is possible that the two elevated lead concentrations were the result of random contamination introduced during collection and processing.

Manganese is one of the more abundant metallic elements and is similar to iron in that it precipitates in redox (reduction-oxidation) processes in a weathering environment (Hem, 1985). In-stream concentrations of manganese also are dependent on the natural redox cycling of manganese in the stream-riparian zone. Manganese is undesirable in drinking-water supplies because it tends to deposit black oxide stains. Spearfish Creek and its tributaries typically had minimum and median dissolved manganese concentrations less than the laboratory reporting limit of 1 µg/L (table 2, fig. 14). The maximum concentrations were from the east-southeast part of the county. The highest concentrations occurred at Bear Butte Creek near Deadwood with concentrations of 330 µg/L, 89 µg/L, 60 µg/L, and 52 µg/L that exceeded the SMCL of 50 µg/L. Other relatively high concentrations included Whitetail Creek at Lead with 39 µg/L, and Boxelder Creek near Nemo with 24 µg/L. Possible geologic sources of manganese in the Black Hills include the minerals pyrolusite, columbite-tantalite, triphylite, and lithiophilite.

Mercury is present in the Cretaceous marine shales common to South Dakota, but also is present at low levels throughout the environment in air, water, and sediment. Mercury is a liquid at normal temperatures, but is also somewhat volatile and can vaporize into the atmosphere. The most stable form in water is as a free metal Hg(aq) (Hem, 1985) so solubility in water is extremely low, and dissolved concentrations in stream water seldom exceed the 0.1-µg/L laboratory reporting limit. All dissolved mercury concentrations measured during this study were at or less than the laboratory reporting limit of 0.1 µg/L, with the exception of the maximum of 0.3 µg/L at Annie Creek near Lead and 0.2 µg/L at Bear Butte Creek near Deadwood (table 2, fig. 14). These latter concentrations exceeded both the coldwater permanent fisheries and coldwater marginal fisheries criteria of 0.15 µg/L as well as the aquatic-life chronic criterion of 0.012 µg/L. Again, ultra-clean sampling and processing procedures were not used in this study. Sampling for mercury in environmental water is especially vulnerable to contamination effects because mercury generally occurs in extremely low concentrations in water. However, it is present in solid materials present at the earth's surface and air borne in the atmosphere. Therefore, the detected concentrations of dissolved mercury in this study may have been due to random contamination during sampling, processing, or analysis.

Selenium is an essential element in the diet of grazing animals, but excessive intake can cause problems, including the loss of horns and hoofs (Hem, 1985). Some plant species accumulate selenium in their tissue and can lead to selenium poisoning if ingested in large quantities. Irrigation of soils that are naturally high in selenium can cause high concentrations in irrigation drainage return flows. Cretaceous marine shales common to South Dakota can be high in selenium, with concentrations in soils ranging from <0.5 to 160 µg/g (microgram per gram) (Greene and others, 1990). Concentrations in water in the study area were generally at or less than the laboratory reporting limit of 1 µg/L, with the exception of Spearfish Creek above Spearfish (3 µg/L), Spearfish Creek below Spearfish (2 µg/L), and Whitetail Creek at Lead (2 µg/L) (table 2, fig. 14). None of the results exceeded water-quality standards for selenium.

Zinc is a common element in ore deposits and is similar to copper in abundance but is more soluble in water. Typical concentrations for surface waters range from about 5 to 45 µg/L, and the average is closer to 100 µg/L for acid-mine drainage streams (Hem, 1985). Minimum concentrations measured during this study generally were at or less than the laboratory reporting limit of 3 µg/L (table 2, fig. 14). Medians ranged from 4 to 9.5 µg/L, and maximums ranged from less than 9 to 45 µg/L. None of the samples exceeded any of the water-quality standards for zinc (table 4).

SELECTED WATER-QUALITY CHARACTERISTICS RELATED TO MINING

In the mineralized area of the northern Black Hills, separating the impacts of mining on metal concentrations in streams from natural background levels is difficult. Mining activities began in the Black Hills prior to any water-quality sampling; therefore, no pre-mining data are available. Because the climate and geology of the Lawrence County study area are slightly different from other parts of the Black Hills, comparisons with other basins within the Black Hills are problematic.

Early mining activities included placer mining and mining of weathered ore veins, where large percentages of the ore could be recovered by grinding the ore and amalgamating the free gold with mercury (Gries, 1996). By the late 1890's, many small mining operations had folded, leaving several larger mills that processed the ore from remaining consolidated mines. The unoxidized ores below the zone of weathering were too expensive to mine until the development of cyanide leaching in the early 1900's, a process where finely crushed ores were treated with a sodium cyanide solution that dissolved the gold (Gries, 1996). The cyanide mills could process larger amounts of ore, resulting in further consolidation of mines and mills as well as an increase in underground mining. In the last 20 years, the development of cyanide heap-leach recovery methods has led to large-scale, open-pit mining of lower grade ores.

Historically, little concern was given to the environment in mining areas. The impacts of abandoned and historic mining activities still can be found in the Black Hills (Rahn and others, 1996). The greatest impact from abandoned mines generally is from mine tailing piles that typically have high concentrations of metals such as arsenic, copper, iron, and zinc. The weathering reaction of sulfides in the tailings, as well as precipitation runoff over and through these oxidized tailings, produces very low-pH waters, which results in the dissolution of metals. This metal-laden runoff eventually reaches a stream with generally much higher pH, usually above 7. At the higher pH, most of the dissolved metals tend to adsorb onto suspended or bed-sediment particles.

In contrast to transition metals, arsenic forms oxyanions that decrease sorption at higher pH levels resulting in higher dissolved concentrations. However, arsenic also has a high affinity for adsorbing onto iron oxides; consequently much of the dissolved iron precipitates in oxygenated surface water to form iron oxides, such as ferrihydrite. If sufficient ferrihydrite is present in the stream sediments, sorption of arsenic by ferrihydrite can control dissolved arsenic concentrations (Fuller and others, 1989). If ferrihydrite is not available or if pH is sufficiently high, higher concentrations of arsenic will result due to decreased adsorption.

Whitewood Creek Studies

Numerous studies have been conducted to examine potential effects of mining activities on water quality in Whitewood Creek and downstream to the Belle Fourche and Cheyenne Rivers (northeast of the study area). From 1875-1977, about 100 million tons of finely ground gold-mill mine tailings were discharged into Whitewood Creek (Goddard, 1989a). Much of the discharged tailings were deposited in the flood plain along Whitewood Creek and downstream along the Belle Fourche and Cheyenne Rivers, providing a continuous source of contamination to the streams. Besides potential contaminants in the ore, mercury and cyanide from milling and recovery processes were added to the waste. In addition, Whitewood Creek was used for industrial, septic, and municipal waste discharges. A study by the South Dakota Department of Game, Fish and Parks determined that Whitewood Creek and about 60 mi of the Belle Fourche River were unable to support aquatic life (Thilenius, 1965).

In 1972, the Federal Water Pollution Control Act was passed, resulting in several activities to clean up the discharges to Whitewood Creek. During 1977, Homestake Mining Company completed the Grizzly Gulch tailings impoundment, discontinuing the discharge of tailings to the stream. In 1978, Homestake Mining Company built a wastewater plant for cyanide treatment and, in 1979, the City of Deadwood sewage treatment plant went on line. In 1985, Homestake completed a biological treatment system with improved efficiency for cyanide removal. In 1986, a Whitewood Creek rehabilitation project was completed, which removed trash and stabilized the bank of Whitewood Creek at the City of Deadwood dump.

In 1983, an 18-mi reach of Whitewood Creek and its flood plain from just above the City of Whitewood to the confluence with the Belle Fourche River was included on the EPA listing as a Interim Priority Site under the Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA). As a result, extensive work was completed along Whitewood Creek as part of a superfund investigation. Research activities were conducted by EPA, DENR, Homestake Mining Company, USGS, and various universities. Much of this research was summarized by Cherry and others (1986a, 1986b, 1986c), Goddard (1988, 1989a, 1989b, 1990), Cain and others (1989), Ficklin and Callender (1989), Fuller and Davis (1989), Horowitz and others (1989), Kuwabara and others (1989), McKallip and others (1989), and Marron (1989).

From these investigations, arsenic, cadmium, copper, silver, manganese, iron, cyanide, and mercury were found to be the constituents of concern because of their association with the mine tailings. Arsenic was found to be the element of most concern within the mine-tailings-contaminated flood plain along Whitewood Creek and downstream because arsenic at elevated concentrations is toxic to aquatic and human life and high arsenic concentrations were extensive. The concentrations of arsenic and several other trace metals were found to be higher in the contaminated sediments along Whitewood Creek than in the uncontaminated sediments along Whitewood Creek and the Belle Fourche River. In-stream concentrations of these constituents are primarily controlled by biological and geochemical processes acting on the contaminated sediments along the flood plain and in the stream. Results of continued monitoring at several sites along Whitewood Creek have been published routinely by USGS (1989-2000).

Part of the research along Whitewood Creek found that arsenic mobility is primarily controlled by adsorption and coprecipitation with ferrihydrite and that the adsorption/desorption of arsenic was controlled by the pH of Whitewood Creek (Fuller and others, 1989). Whitewood Creek, between where the stream crosses the outcrop of the Madison Limestone and the confluence with the Belle Fourche River, was shown to be buffered to pH values within a narrow range near and above 8 by the presence of abundant calcite in its bed materials and alluvium (Fuller and Davis, 1989; Fuller and others, 1989). Photosynthesis and respiration in Whitewood Creek resulted in a diurnal variation in pH by as much as 0.5 units. The change in pH through the day resulted in a fluctuation in dissolved arsenic concentration as the pH-dependent adsorption/desorption equilibrium changes. For example, desorption of arsenic occurred as pH increased from 8 to 8.5, and adsorption of arsenic onto the sediments occurred as pH decreased from 8.5 to 8. The principal adsorbent in the sediment was the newly precipitated ferrihydrite. However, arsenic concentration does not necessarily vary directly with fluctuations in pH because both the abundance of arsenic and the availability of iron are controlling factors. Also, the arsenic adsorption/desorption process was rate limited by diffusion to surface sites within the ferrihydrite (Fuller and others, 1993).

Water and Sediment Chemistry near Selected Mining Areas

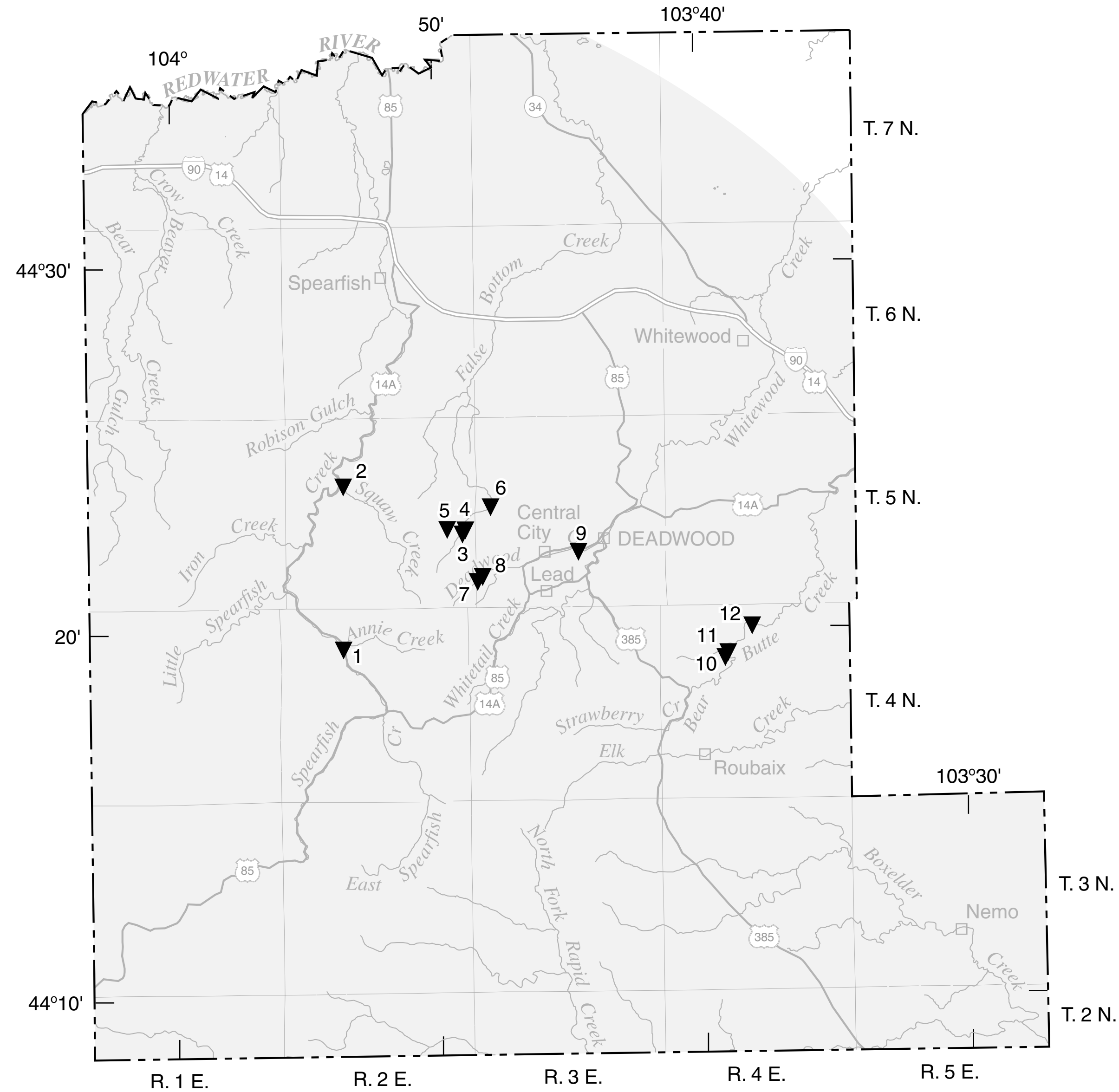
Much water-quality data collected during this study were for relatively large drainages (greater than 20 mi^2), with a purpose of characterizing water quality of major streams. Some site-specific studies were performed to examine potential effects of mining activities, by collecting water and bed-sediment samples in the immediate vicinity of several active and abandoned mines. Preliminary results were presented by Torve (1991), with additional results presented in this section. Again, results cannot provide definitive conclusions regarding effects of mining activities because mines typically are preferentially located in highly mineralized settings where natural water quality may be substantially different than at other nearby locations.

Site information for water-quality and bed-sediment sites used by Torve (1991) are presented in table 5, and locations are shown in figure 15. Four of Torve's sites were included in the data set previously presented—Annie Creek near Lead, Squaw Creek near Spearfish, False Bottom Creek near Central City, and Bear Butte Creek near Deadwood. Analytical results of in-stream water-quality samples are presented in table 9 in the Supplemental Data section, and corresponding bed-sediment data are presented in table 10 in the Supplemental Data section.

Detailed methods for sampling and analyses of water and bed sediment were discussed by Torve (1991). Bed-sediment samples were split into two grain-size fractions: equal to or greater than 62 µm (sand and coarser sizes) and finer than 62 µm (silt/clay). Each silt/clay fraction was analyzed for 45 trace elements by inductively coupled plasma emission spectroscopy and for total carbon, inorganic carbon, and organic carbon by the former USGS Branch of Geochemistry in Denver, Colorado (table 10). The sand and coarser fractions were not analyzed because most trace elements are typically concentrated in the silt/clay fraction (Horowitz, 1985).

Table 5. Site information for selected water-quality and bed-sediment sites (sampled by Torve, 1991) in mineralized area of Lawrence County

Map identification number (fig. 15)	Station number	Station name	Latitude	Longitude
			(degrees, minutes, seconds)	
1	06430800	Annie Creek near Lead	441937	1035338
2	06430898	Squaw Creek near Spearfish	442404	1035335
3	442250103485700	Southeast False Bottom Creek near Lead	442250	1034857
4	442246103490300	False Bottom Creek below Bald Mountain Mine, near Lead	442246	1034903
5	442252103493800	False Bottom Creek above Columbia Mine, near Lead	442252	1034938
6	06432172	False Bottom Creek near Central City	442328	1034758
7	442125103483000	South Deadwood Creek above Hidden Treasure Mine, near Lead	442125	1034830
8	442131103482000	Deadwood Creek below Hidden Treasure Mine, near Lead	442131	1034820
9	442213103443900	Deadwood Creek below Broken Boot Mine, at Deadwood	442213	1034439
10	441919103390800	Bear Butte Creek above Strawberry Creek, near Deadwood	441919	1033908
11	441925103390400	Strawberry Creek near Deadwood	441925	1033904
12	06437020	Bear Butte Creek near Deadwood	442008	1033806



Base from U.S. Geological Survey digital line graph, 1:100,000:
Belle Fourche, 1983; Rapid City, 1977
Universal Transverse Mercator projection, zone 13
North American Horizontal Datum 1927

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

EXPLANATION

▼ 3 WATER-QUALITY AND BED-SEDIMENT SAMPLING SITE--Number is map identification number

Map Identification Number	Station Number	Station Name
1	06430800	Annie Creek near Lead
2	06430898	Squaw Creek near Spearfish
3	442250103485700	Southeast False Bottom Creek near Lead
4	442246103490300	False Bottom Creek below Bald Mountain Mine, near Lead
5	442252103493800	False Bottom Creek above Columbia, near Lead
6	06432172	False Bottom Creek near Central City
7	442125103483000	South Deadwood Creek above Hidden Treasure, near Lead
8	442131103482000	Deadwood Creek below Hidden Treasure, near Lead
9	442213103443900	Deadwood Creek below Broken Boot, at Deadwood
10	441919103390800	Bear Butte Creek above Strawberry Creek, near Deadwood
11	441925103390400	Strawberry Creek near Deadwood
12	06437020	Bear Butte Creek near Deadwood

Figure 15. Locations of water-quality and bed-sediment sampling sites of Torve (1991).

For the sites investigated, Torve (1991) found that water-quality degradation generally was limited to localized areas. Two sites, Deadwood Creek below Hidden Treasure Mine and False Bottom Creek above Columbia Mine, had acidic pH values (5.5 and 3.8, respectively) and higher dissolved concentrations of transition metals (iron, copper, and zinc). Concentrations decreased below the drinking-water and beneficial-use standards for most constituents after the waters were diluted with additional higher pH water downstream. Torve (1991) concluded that the buffering capacity of the receiving streams generally limits high metal concentrations.

Arsenic Mobility for Selected Sites near Mining Areas

Although elevated arsenic concentrations in Whitewood Creek have been shown to be associated with mining activities (Cherry and others, 1986a, 1986b, 1986c; Goddard, 1989a), arsenic also is found naturally within the mineralized area of the Black Hills. Arsenic concentrations near the EPA MCL of 50 µg/L have occurred in some northern Black Hills streams. Examination of the water-quality results from Torve (1991) confirms that arsenic can be found at high concentrations in mining-area streams (48 µg/L at Annie Creek near Lead, table 9). Annie Creek has the highest arsenic concentrations, but values from 10 to 20 µg/L also were found in Whitetail Creek at Lead (table 8). Additional sampling in the Black Hills in non-mining-area streams after 1992 (Driscoll and Bradford, 1994; Driscoll and others, 1996) reported similar ranges with 17 to 43 µg/L at Battle Creek near Keystone (approximately 20 mi south of Boxelder Creek) and 19 to 68 µg/L at Elk Creek near Roubaix. Arsenic is readily soluble in water at higher pH levels; however, adsorption/desorption processes can affect mobility of arsenic (Hem, 1985; Fuller and Davis, 1989; Fuller and others, 1993). Factors influencing mobility of arsenic are examined in this section.

Data from selected sites from Torve (1991) were used to further examine arsenic mobility in basins other than Whitewood Creek in Lawrence County. All of the surface-water sites sampled by Torve (1991), with the exception of the two sites on short stream reaches with visible acid mine drainage impacts and measured acidic pH values (sites 5 and 8) and a site where sample results are suspected of contamination from road salt (site 9), were selected to be used for analysis of arsenic mobility. The selected sites had pH ranges generally found in the northern Black Hills, and also have natural sources of arsenic, as well as potential inputs of arsenic from small abandoned mines. The streams investigated by Torve (1991) are different from Whitewood Creek in that they have not been impacted by large amounts of arsenic-laden sediments.

Dissolved arsenic concentrations are first compared to the arsenic concentrations in bed sediments (fig. 16A). This plot indicates that concentrations of dissolved arsenic are not controlled by arsenic concentrations in bed sediments. Both high and low arsenic concentrations in the water occur at sites with a high concentration of arsenic in the bed sediment. False Bottom Creek below Bald Mountain Mine had the highest concentration of arsenic in its bed sediment but had dissolved arsenic that was below laboratory reporting limits. Annie Creek near Lead had the second highest concentration of arsenic in its bed sediment and the highest dissolved arsenic concentrations.

Dissolved arsenic concentrations are next compared to concentrations of iron in the bed sediments (fig. 16B), whereby an inverse relation is apparent. This supports a hypothesis that dissolved arsenic concentrations may be controlled by adsorption/coprecipitation on ferrihydrite. A comparison of dissolved arsenic concentration to pH is presented in figure 16C, which indicates that increasing pH generally results in higher concentrations of arsenic in water over the range of pH from 8.1 to 8.6. The covariation of pH and dissolved arsenic concentration between pH 8.1 and 8.6 was recognized as comparable with pH-dependent adsorption edges for arsenic from experimental studies such as DeVitre and others (1991) and Pierce and Moore (1982). Despite the fact that the pH position of an element's adsorption edge is also dependent on total arsenic concentration and on the abundance of adsorption sites (Davis, 1978), the adsorption edge for these small northern Black Hills streams occurs at pH values nearly identical with much simpler laboratory systems. There is a well known pH-dependence of arsenic adsorption resulting in higher dissolved arsenic concentrations at higher pH (C. Fuller, USGS, written commun., 1999). This supports a hypothesis that arsenic concentrations in small mining-area streams are controlled by adsorption much as arsenic concentrations in Whitewood Creek are controlled by adsorption/coprecipitation on ferrihydrite (Fuller and Davis, 1989).

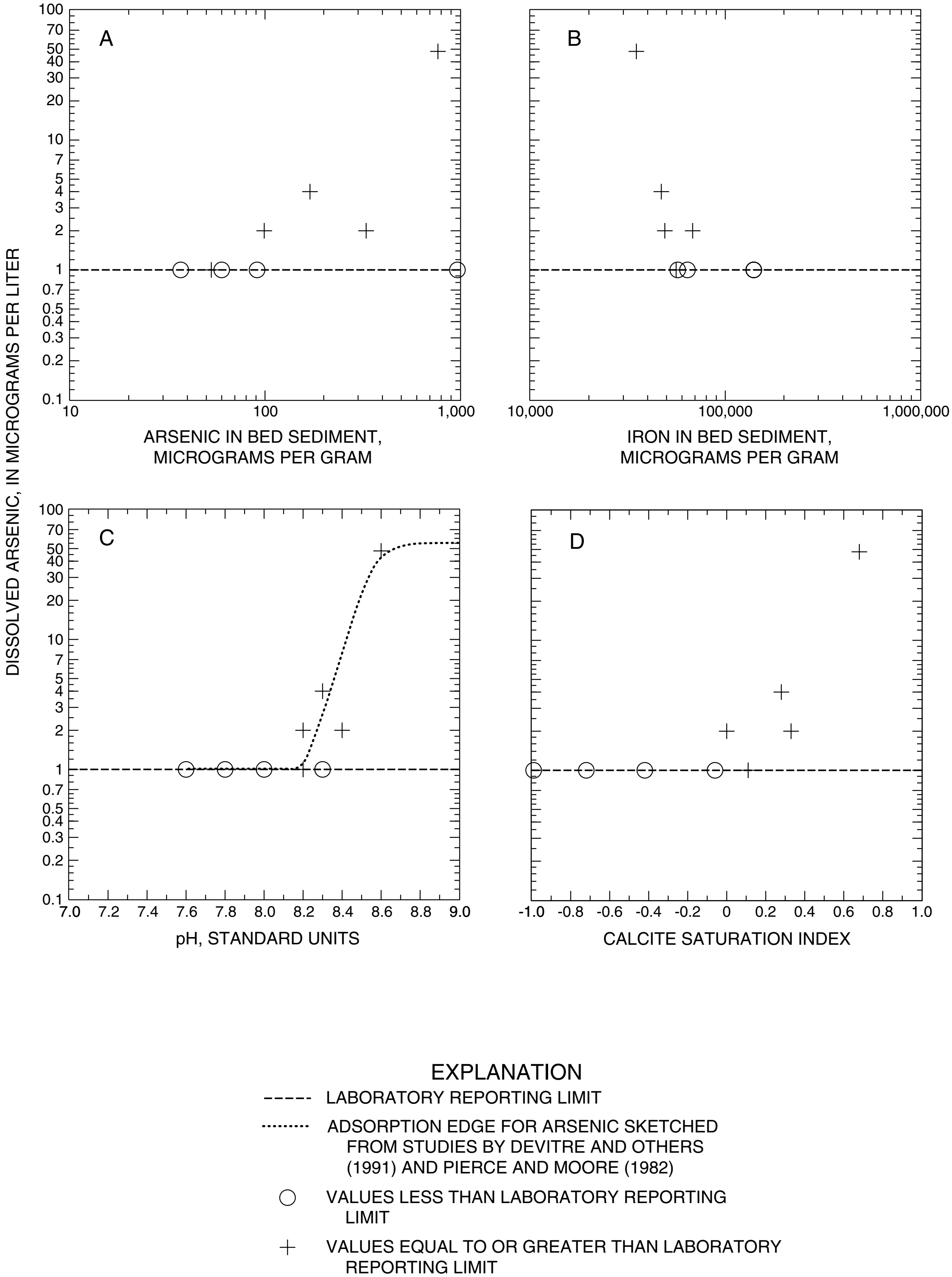


Figure 16. Relation of dissolved arsenic concentrations to bed-sediment arsenic, bed-sediment iron, pH, and the calcite saturation index for selected sites of Torve (1991).

The studies along Whitewood Creek found that the water reacting with abundant calcite in the streambed and alluvial flood-plain deposits brought the stream pH up to values of 8 or greater; that is, the reaction increasing pH occurs in the seepage from the contaminated flood plain as well as after entering the stream. It has long been known that water equilibrating with atmospheric CO_2 and with calcite at standard pressure and temperature comes to an equilibrium pH of 8.4 (Stumm and Morgan, 1970, p. 176-180). To examine the relation between bed-sediment calcite and arsenic concentration, the calcite saturation index (SI) for each sample was generated from the computer code PHREEQC (Parkhurst and others, 1980; Parkhurst, 1995) and plotted versus arsenic concentrations (fig. 16D). The calcite SI is a measure of the amount of calcite dissolved in the water. If the SI is positive, the stream is oversaturated with respect to calcite and should theoretically precipitate some of the mineral. If the calcite SI is zero, the stream is at equilibrium with calcite. If it is negative, the stream is undersaturated with respect to calcite and should dissolve calcite from its bed sediments if the mineral is available there. Dissolved arsenic concentrations were detectable only at the sites that were oversaturated with calcite (fig. 16D); arsenic concentration generally increases as the calcite SI increases, indicating that calcite in bed sediments is dissolving to produce the higher values of pH at which more arsenic is desorbed to produce higher arsenic concentrations in the water.

Multiple regression analyses were performed testing relations between the base-10 logarithm of dissolved arsenic concentration and the base-10 logarithm of arsenic concentrations in bed sediments, the base-10 logarithm of the iron concentrations in bed sediments, pH, and the calculated calcite SI. Because a number of dissolved arsenic concentrations are less than the laboratory reporting limit, these concentrations could be anywhere from 0 to 1.0 µg/L. To account for this, regressions were run substituting a value of 0.5 for the less-than values. No regressions were run that included both pH or calcite SI because these two are interdependent geochemically. Results from all regressions are presented in table 6. The R^2 value is the fraction of the variability in the dependent variable (dissolved arsenic) that is explained by the regression equation. The attained level of significance or p-value is based upon the ratio of the explained variance to the unexplained variance.

Table 6. Results of multiple regression analyses of dissolved arsenic concentration in water with bed-sediment arsenic concentration, bed-sediment iron concentration, pH, and calcite saturation index

[Equations are considered significant for p-value of 0.10 or less; number of observations=9; µg/g, micrograms per gram; R^2, fraction of the variability in the dependent variable that is explained by the regression equation]

Variable(s)	R^2	P-value	Coefficient for the logarithm of µg/g of bed-sediment arsenic (v1)	Coefficient for the logarithm of µg/g of bed-sediment iron (v2)	Coefficient for pH (v3)	Coefficient for calcite saturation index (v4)	Intercept
v1	0.2693	0.1523	0.6632				-3.25
v2	.4933	.0349		-2.2369			10.96
v3	.5515	.0219			1.5727		-12.64
v4	.6337	.0103				0.9767	.27
v1, v2	.8438	.0038	.7604	-2.4262			10.21
v1, v3	.6561	.0407	.4307		1.3723		-11.95
v1, v4	.7467	.0163	.4429			.8738	-.70
v2, v3	.7200	.0220		-1.4666	1.1310		-1.97
v2, v4	.6656	.0374		-.8309		.7435	4.25
v1, v2, v3	.9211	.0035	.6193	-1.9074	.7101		2.23
v1, v2, v4	.8693	.0120	.6536	-1.7899		.3224	7.41

Results of regression analyses (table 6) indicate that there are relatively strong, statistically significant correlations between arsenic in water and the bed-sediment concentrations of iron and arsenic as well as pH. The coefficients for the variables used in the regression support the observations from the scatter plots of dissolved arsenic versus bed-sediment arsenic, bed-sediment iron, and pH. The positive bed-sediment arsenic and pH coefficients indicate that these two variables increase the dissolved arsenic concentration. Bed-sediment arsenic is the source of arsenic for the stream, and increases in pH result in increased arsenic desorbtion. The negative coefficient for bed-sediment iron indicates that when more bed-sediment iron is available for the arsenic to sorb onto, less arsenic is available for dissolution and transport in the stream as dissolved arsenic. The variations in dissolved arsenic concentration relative to bed-sediment arsenic concentration, bed-sediment iron concentration, and pH together indicate that controls on arsenic solubility in these mining-area streams are similar to those at Whitewood Creek. The regression results are useful for the intended purpose of testing relations between variables; however, they should not be used for predictive purposes.

To examine mineralogic controls, selected bed-sediment samples were mineralogically analyzed using X-ray diffraction (XRD) patterns. Mineralogic XRD peak areas are directly proportional to the concentration of the minerals in the corresponding samples; however, these are not linear relationships and, at best, semi-quantitative (C. Gene Whitney, USGS, oral commun., 1993). These semi-quantitative measures of mineral concentrations in bed sediments were then expressed as a ratio of calcite, the mineral assumed to be buffering the pH to high values where arsenic presumably is desorbed, to ferrihydrite, the suspected adsorbent. The mineral ratios are plotted against partitioning coefficients for each site (fig. 17). The partitioning coefficient is the ratio of dissolved arsenic concentration in the stream water to the arsenic concentration in the silt/clay fraction of bed sediment from the same site. Dividing the stream-water concentration by the bed-sediment concentration serves to minimize or normalize the effect of an arsenic-rich source in the analysis. Plotting the partitioning coefficients rather than just the stream-water concentrations has the effect of showing arsenic's chemical reaction behavior rather than having that behavior masked by high source abundances at particular places.

Figure 17 shows that arsenic solubility generally decreases (lower ratio of dissolved:bed arsenic concentration) as the abundance of ferrihydrite increases in the bed sediments (lower ratio of calcite:ferrihydrite XRD peak). Arsenic solubility generally increases as the abundance of calcite in the bed sediments increases, possibly the result of the stream dissolving calcite to reach higher pH values, whereby arsenic begins to desorb from ferrihydrite or other adsorbent minerals. This indicates that controls on arsenic solubility for these streams are similar to Whitewood Creek. Arsenic solubility is largely controlled by adsorption, mainly on ferrihydrite. In addition, arsenic adsorption/desorption is controlled by the stream pH, with high dissolved arsenic concentrations occurring only at higher pH conditions (above 8.1). Stream pH is influenced by the major rock types of the drainage. In drainages where the Madison Limestone is prevalent, calcite (limestone) is likely the mineral that dissolves in stream water to produce the higher pH levels where arsenic, if present, would be highly mobile. Even though other streams besides Annie Creek and Whitetail Creek have substantial arsenic sources, they are not similarly buffered to a higher pH by calcite, so the available arsenic is largely adsorbed on solids and is relatively immobile.

The previous analyses of factors affecting arsenic solubility were based on dissolved arsenic concentrations at the time when other constituents were sampled. Dissolved arsenic concentrations at any site may be subject to considerable temporal variability as shown in figure 18, which includes data for Annie Creek near Lead and Whitetail Creek at Lead. Although increasing pH has been shown to generally increase arsenic solubility, no clear relation between dissolved arsenic and pH is apparent in figure 18. A weak, inverse relation between dissolved arsenic and streamflow is discernible, which is common for many constituents. It is apparent that other factors besides pH and streamflow affect in-stream arsenic concentrations.

As reflected by Annie Creek and Whitetail Creek data, arsenic solubility is very complex and may be influenced by numerous factors in addition to stream water pH—biological activity, other solutes competing for the iron oxides, and additional solutes that could complex with arsenic. The available data provide a preliminary indication of several factors influencing arsenic solubility, but additional data may be necessary to enhance the knowledge of geochemical controls that could aid in understanding arsenic concentrations.

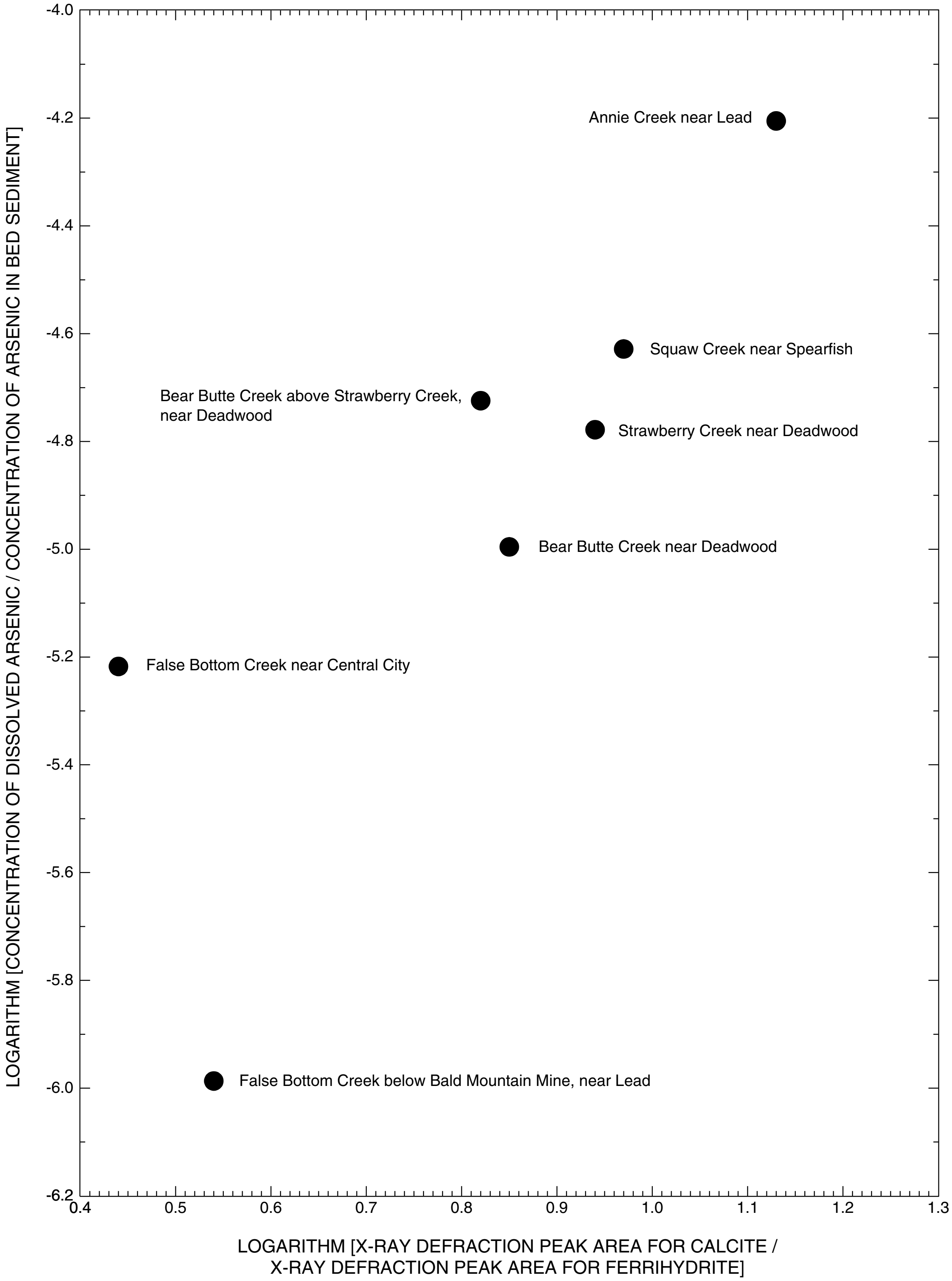


Figure 17. Relation of arsenic partitioning coefficients to ratio expressing the relative abundances of bed-sediment calcite and ferrihydrite in selected streams.

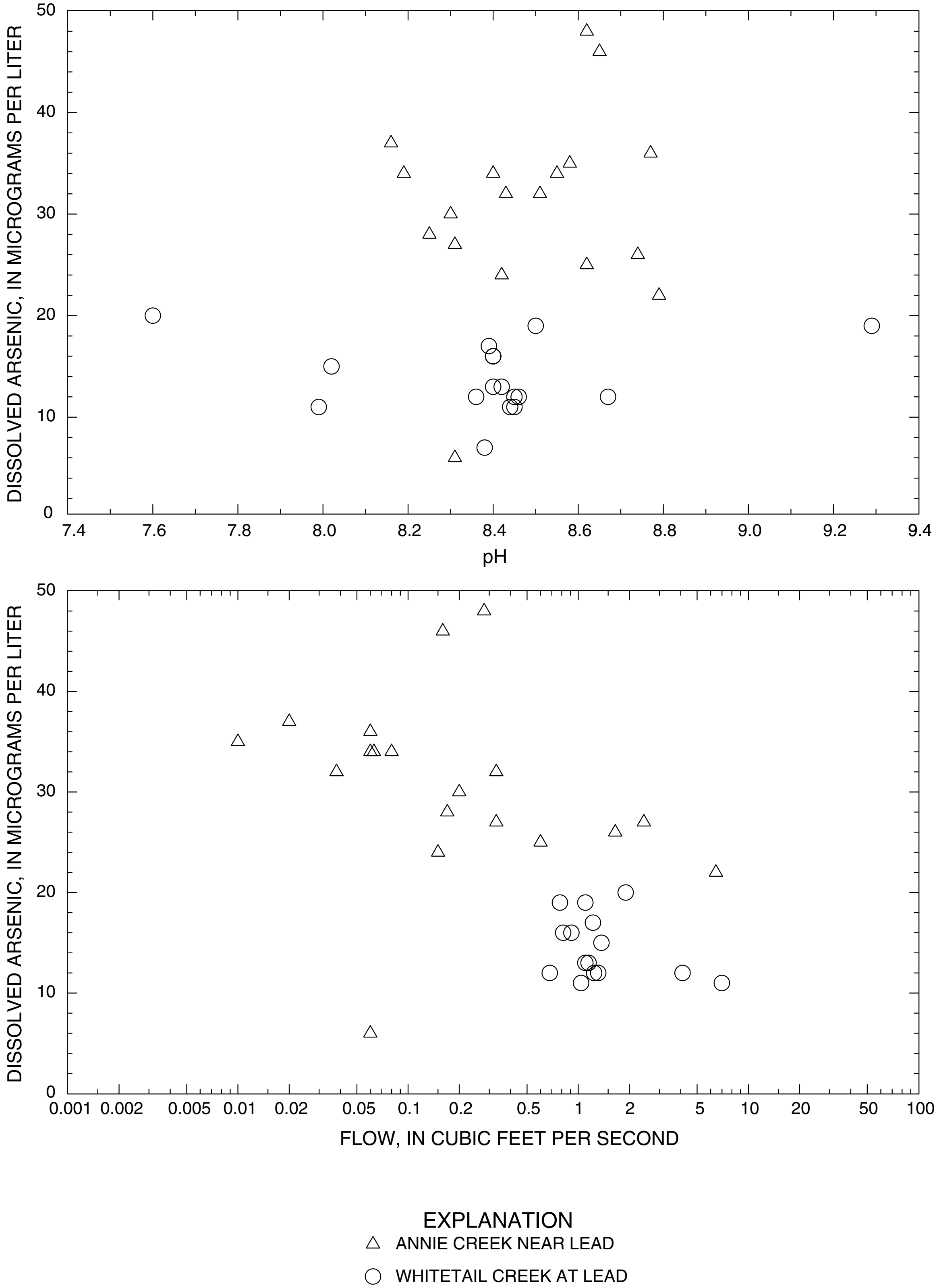


Figure 18. Relation of dissolved arsenic concentrations to pH and streamflow for Annie Creek near Lead and Whitetail Creek at Lead.

ADDITIONAL WATER-QUALITY DATA

Additional water-quality data have been collected as part of other studies or monitoring programs by DENR, EPA, USFS, and USGS. DENR collects water-quality data in the study area primarily for a general assessment of stream quality within South Dakota that is completed every 2 years for a state report, 305b Water-Quality Assessment, and to monitor permitted wastewater discharges. The USFS collects water-quality data in their role in management of the Black Hills National Forest. As discussed previously, the USGS has collected data in the Whitewood Creek Basin. The EPA also has conducted some limited sampling within the study area.

In an effort to provide additional background information, a retrieval from the EPA database STORET for all sites within Lawrence County for the entire period of record until the end of the study period September 30, 1992, was completed. The STORET database generally does not include data from mining companies or educational institutions. From the STORET data, a table of summary statistics is included for all sites with at least two analyses that included more than field measurements of streamflow, specific conductance, temperature, and pH. Summary statistics are based on values as retrieved from STORET; no attempt was made to review for consistency or accuracy. Site information for the summarized sampling sites is presented in table 7. Locations of sampling sites, by agency, are presented in figures 19 (DENR), 20 (USFS), and 21 (USGS and EPA). Summary statistics are presented in the Supplemental Data section, with separate tables for physical properties and field measurements (table 11), selected ions (table 12), nutrients (table 13), and trace constituents (table 14).

Most of the results from these additional sites are similar to the results presented previously in this report. Some sites had longer periods of record and a larger number of samples, with slightly larger ranges, but median concentrations were very similar. Exceptions include data from a few sites from the USGS database that show lower concentrations than data from DENR, USFS, and EPA. One notable difference was total arsenic at Boxelder Creek near Nemo (fig 20; map identification number 33), which had less than the laboratory reporting limit for all five of the USGS sample concentrations and a range of 5 to 20 µg/L for the 28 USFS samples. For some constituents, differences in sampling methods, analytical methods, flow conditions, and the possibility for temporal changes in water quality may be some of the reasons for these differences.

Table 7. Site information for water-quality sites with selected data retrieved from U.S. Environmental Protection Agency STORET database

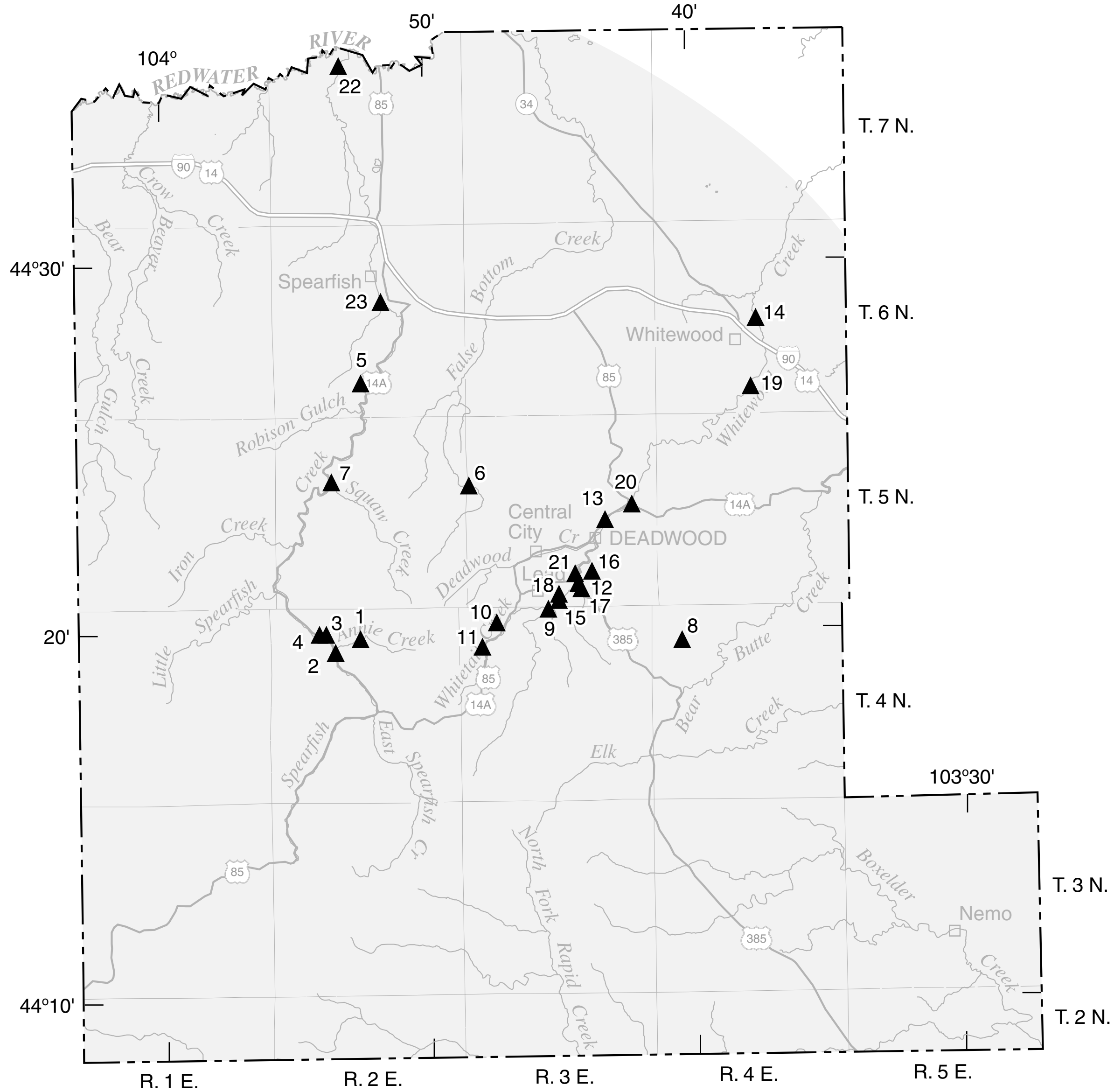
[DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA; U.S. Environmental Protection Agency]

Map identification number (figs. 19-21)	Collecting agency	Station number	Latitude	Longitude	Sampling period (up to Sept. 30, 1992)
1	DENR	46MN31	441949	1035236	1990-92
2	DENR	46MN32	441927	1035334	1987-92
3	DENR	46MN33	441955	1035357	1987-92
4	DENR	46MN34	441956	1035410	1987-92
5	DENR	46MN35	442644	1035230	1990-92
6	DENR	46MN38	442356	1034827	1990-92
7	DENR	46MN39	442404	1035338	1990-92
8	DENR	460116	441943	1034027	1989-92
9	DENR	460118	442034	1034529	1990-92
10	DENR	460119	442012	1034728	1990-92
11	DENR	460120	441933	1034800	1990-92
12	DENR	460122	442115	1034420	1991-92
13	DENR	460123	442259	1034318	1991-92

Table 7. Site information for water-quality sites with selected data retrieved from U.S. Environmental Protection Agency STORET database–Continued

[DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA; U.S. Environmental Protection Agency]

Map identification number (figs. 19-21)	Collecting agency	Station number	Latitude	Longitude	Sampling period (up to Sept. 30, 1992)
14	DENR	460652	442824	1033729	1974-92
15	DENR	460658	442057	1034507	1974-91
16	DENR	460659	442135	1034349	1974-92
17	DENR	460660	442050	1034506	1974-90
18	DENR	460675	442108	1034416	1975-92
19	DENR	460684	442632	1033742	1977-92
20	DENR	460685	442324	1034217	1977-92
21	DENR	460686	442132	1034429	1977-92
22	DENR	460689	443521	1035310	1978-92
23	DENR	460900	442857	1035141	1967-92
24	USFS	460550	440821	1035042	1968-82
25	USFS	460561	441241	1033300	1969-81
26	USFS	460562	441232	1033234	1969-82
27	USFS	460563	441348	1032838	1969-76
28	USFS	460564	442300	1033555	1969-73
29	USFS	460568	441156	1033935	1969-75
30	USFS	460600	441225	1034837	1974-78
31	USFS	460601	441040	1034521	1975-82
32	USFS	460606	441149	1033158	1976-82
33	USFS	460607	441143	1033003	1976-82
34	USFS	460608	440850	1033006	1975-80
35	USFS	460609	441622	1034242	1975-82
36	USFS	460611	441629	1035109	1975-82
37	USFS	460612	441618	1035424	1976-82
38	USFS	460613	441909	1035952	1975-79
39	USFS	460614	441909	1035952	1975-82
40	USFS	460615	442225	1035512	1975-82
41	USFS	460616	441939	1035340	1976-82
42	USGS	06436170	442248	1034325	1981-92
43	USGS	06436180	442632	1033744	1983-92
44	USGS	06436190	443230	1033416	1982-92
45	USGS	442134103441901	442134	1034419	1983-86
46	USGS	442135103442001	442135	1034420	1983-87
47	USGS	442320103422301	442320	1034223	1986-89
48	USGS	442322103423701	442322	1034237	1987-89
49	USGS	442330103421501	442330	1034215	1983-84
50	USGS	442825103373001	442825	1033730	1983-84
51	USGS	442940103371501	4429400	1033715	1983-84
52	EPA	SD-0000159-1	442200	1035000	1978-87



Base from U.S. Geological Survey digital line graph, 1:100,000:
Belle Fourche, 1983; Rapid City, 1977
Universal Transverse Mercator projection, zone 13
North American Horizontal Datum 1927

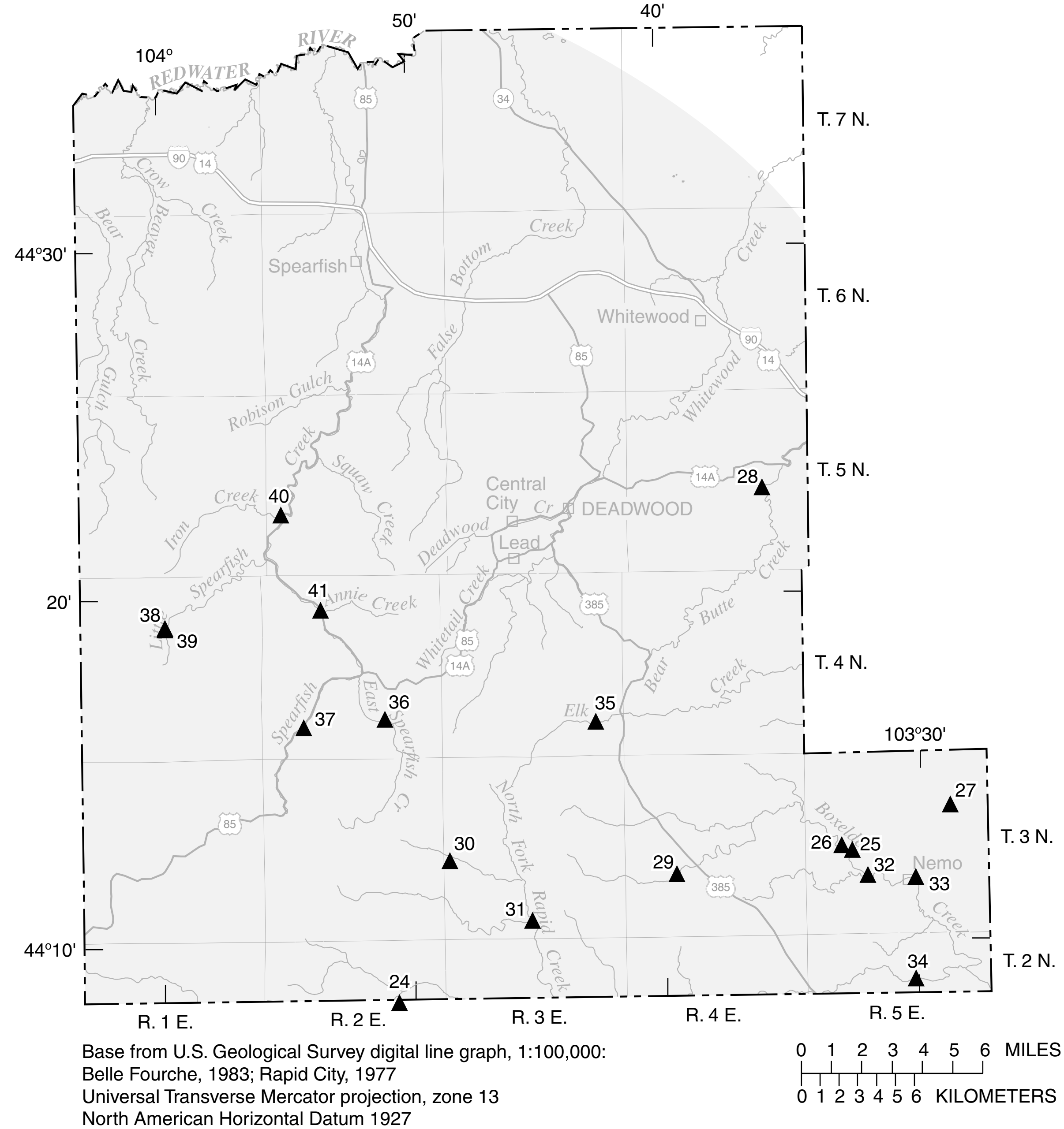
0 1 2 3 4 5 6 MILES
0 1 2 3 4 5 6 KILOMETERS

EXPLANATION

▲8 DENR SAMPLING SITE--Number is map identification number

Map Identificaiton Number	Station Identifier	Map Identificaiton Number	Station Identifier
1	44MN31	13	460123
2	46MN32	14	460652
3	46MN33	15	460658
4	46MN34	16	460659
5	46MN35	17	460660
6	46MN38	18	460675
7	46MN39	19	460684
8	460116	20	460685
9	460118	21	460686
10	460119	22	460689
11	460120	23	460900
12	460122		

Figure 19. Location of selected South Dakota Department of Environment and Natural Resources sampling sites.

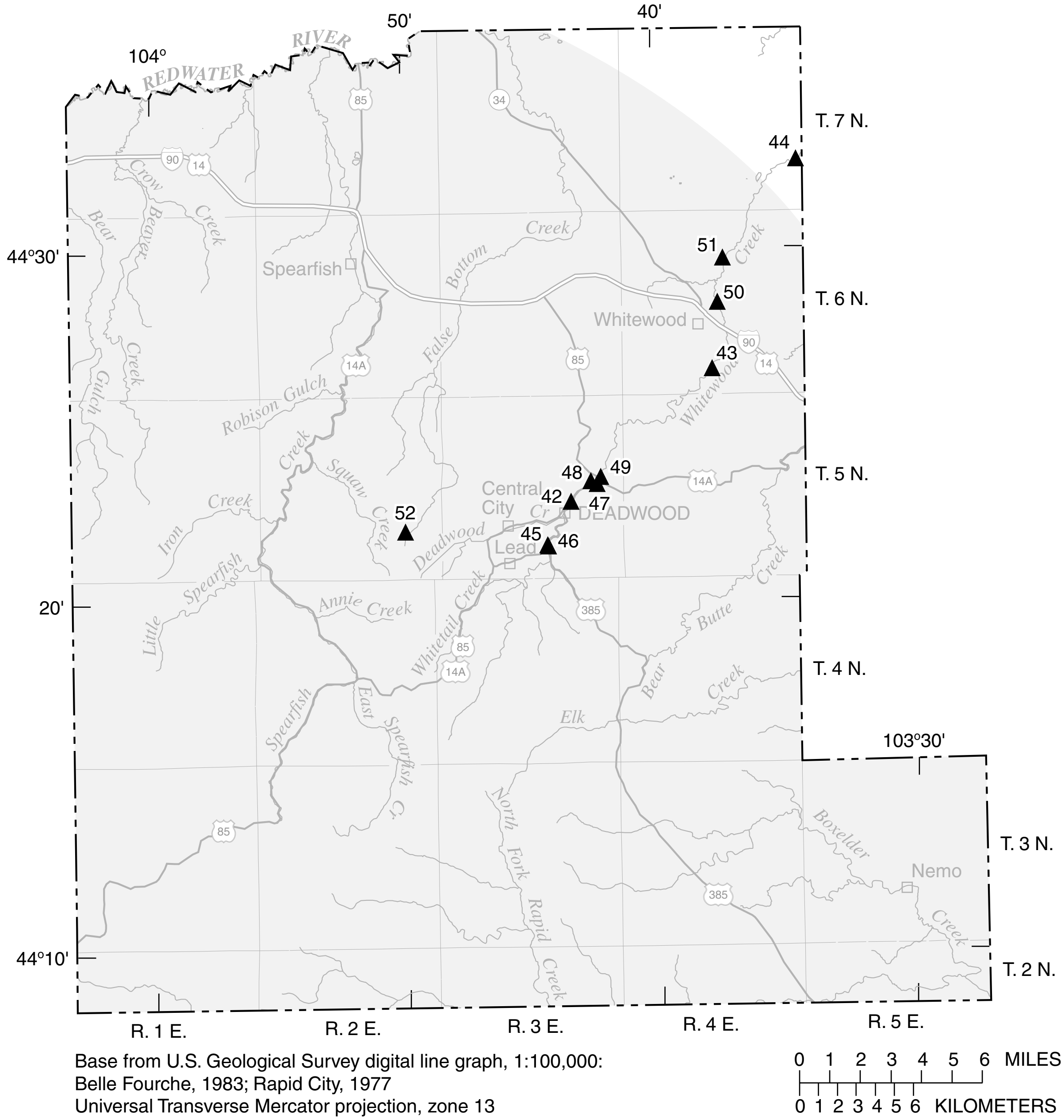


EXPLANATION

▲24 USFS SAMPLING SITE--Number is map identification number

Map Identificaiton Number	Station Identifier	Map Identificaiton Number	Station Identifier
24	460550	33	460607
25	460561	34	460608
26	460562	35	460609
27	460563	36	460611
28	460564	37	460612
29	460568	38	460613
30	460600	39	460614
31	460601	40	460615
32	460606	41	460616

Figure 20. Location of selected U.S. Forest Service sampling sites.



Base from U.S. Geological Survey digital line graph, 1:100,000:
Belle Fourche, 1983; Rapid City, 1977
Universal Transverse Mercator projection, zone 13
North American Horizontal Datum 1927

EXPLANATION

▲50 USGS AND USEPA SAMPLING SITE--Number is map identification number

Map Identificaiton Number	Station Identifier	Agency
42	06436170	USGS
43	06436180	USGS
44	06436190	USGS
45	442134103441901	USGS
46	442136103442001	USGS
47	442320103422301	USGS
48	442322103423701	USGS
49	442330103421501	USGS
50	442825103373001	USGS
51	442940103371501	USGS
52	SD-0000159-1	USEPA

Figure 21. Location of selected U.S. Geological Survey and U.S. Environmental Protection Agency sampling sites.

SUMMARY

During the 1980's, significant economic development and population growth began to occur in Lawrence County. Rising gold prices and heap-leach extraction methods allowed the economic recovery of marginal gold-ore deposits, resulting in development of several large-scale, open-pit gold mines in Lawrence County. There was increasing local concern regarding potential impacts on the hydrologic system, especially relating to the quantity and quality of water in the numerous streams and springs of Lawrence County.

Water-quality samples were collected from 1988 through 1992 at different times of the year and under variable hydrologic conditions in order to characterize the general water quality of selected streams within Lawrence County in the northern part of the Black Hills. During the time of this study, the Black Hills area was experiencing a drought; thus, most samples were collected during low-flow conditions. These data provide a baseline against which future changes can be compared. Relations between variability of constituent concentrations and streamflow are examined, and spatial variability of water quality is described. Water-quality characteristics related to mining, including relations between water and sediment chemistry, are examined for the mineralized area to investigate patterns that may help to discern geochemical processes.

Streamflow and water-quality characteristics in Lawrence County are affected by both geologic conditions and precipitation patterns. Most streams that cross outcrops of the Madison Limestone and Minnelusa Formation lose all or a part of their streamflow to aquifer recharge. Streams that are dominated by outcrops of the Madison Limestone and Minnelusa Formation are predominantly spring fed and have relatively stable streamflow and minimal variability in specific conductance and dissolved solids. Streams that are dominated by Precambrian rocks or Tertiary intrusive rocks generally have more variability in streamflow, specific conductance, and dissolved solids with inverse relations between flow and specific conductance. These sites also have a generally linear relation between specific conductance and dissolved solids.

Most streams in Lawrence County generally have calcium magnesium bicarbonate type water. Streams dominated by outcrops of the Madison Limestone and Minnelusa Formation have very similar ion chemistry and show little temporal variability in ion proportions. Streams in the mineralized area of central Lawrence County generally have larger variability in proportions of major ions with additional sodium, less magnesium, and slightly more calcium. Anions from the mineralized area have less bicarbonate, more sulfate, and more chloride. False Bottom Creek near Central City is quite different, with more sulfate than bicarbonate.

Nitrogen, phosphorous, and cyanide concentrations were at or near the laboratory reporting limits for most sites and did not exceed any of the water-quality standards. Nitrite plus nitrate concentrations at Annie Creek near Lead, Whitetail Creek at Lead, Squaw Creek near Spearfish, and Spearfish Creek below Robison Gulch were somewhat higher than at other sites. Mining activity, agricultural activity, and domestic development are possible sources of nitrogen to the streams. Increased mining activities were identified as the probable cause of increased nitrogen concentrations in Annie Creek.

In the mineralized area of the northern Black Hills, trace elements are common in water. Comparisons were made to drinking water, beneficial use, and aquatic-life criteria but few exceedances were found. The maximum antimony concentration of 7 μg/L exceeded the MCL of 6 μg/L and occurred at Annie Creek near Lead. Arsenic is highly toxic to humans and aquatic life and has an MCL of 50 μg/L (under review with proposed limit of 5 μg/L). The maximum dissolved arsenic concentration at Annie Creek near Lead (48 μg/L) approached the drinking-water standard. Concentrations at or greater than 5 μg/L were found in samples from Annie Creek near Lead, Spearfish Creek above Spearfish, Whitetail Creek at Lead, and False Bottom Creek near Spearfish. Dissolved copper concentrations were most prevalent at Bear Butte Creek near Deadwood where detectable concentrations were measured in all 16 samples, and one sample exceeded both the aquatic-life acute and chronic criterion. Bear Butte Creek near Deadwood had several manganese concentrations that exceeded the SMCL of 50 μg/L.

In the mineralized area of the northern Black Hills, separating the impacts of mining and the natural impacts is difficult. Mining activities began in the Black Hills before any water-quality sampling, so no historical data are available. A large amount of work has been published on contamination of Whitewood Creek and its flood plain from the discharge of mine tailings from the Homestake mine for nearly 100 years, with arsenic being the principal element of concern.

Earlier work demonstrated that arsenic mobility is controlled by adsorption on newly precipitated ferrihydrite and that the adsorption/desorption of arsenic is dependent on the pH of the water.

Bed-sediment and water-quality data from selected sites in small drainage basins were examined to determine if factors such as pH, arsenic availability, and calcite saturation control dissolved arsenic concentrations. Arsenic concentrations in water were compared to the previous factors with no single parameter showing a strong relation, although an apparent inverse relation existed between dissolved arsenic and bed-sediment iron, increasing pH generally results in higher dissolved arsenic, and detectable levels of dissolved arsenic were only found when the calcite saturation index was greater than zero. Multiple regression analysis indicated that there are relatively strong correlations between arsenic in water and bed-sediment concentrations of iron and arsenic as well as pH.

An examination of mineralogic controls for selected sites indicates that arsenic solubility is controlled by adsorption, mainly on ferrihydrite. The pH within each reach of stream is influenced by the major rock types of the reach, with calcite, principally from the Madison Limestone, dissolving to near equilibrium in certain streams to produce pH levels greater than 8, where adsorption of arsenic is less favored, resulting in increased mobility of arsenic. There are significant arsenic sources available to almost all the small streams of the northern Black Hills mining area, but arsenic is less mobile in streams that are not influenced to the higher pH values by calcite. Streams where arsenic is more mobile have lower iron concentrations in their bed sediments (less abundant ferrihydrite), and they have relatively high concentrations of calcite in the bed sediment.

Additional water-quality data have been collected as part of other studies or monitoring programs by the South Dakota Department of Environment and Natural Resources, U.S. Environmental Protection Agency, U.S. Forest Service, and the U.S. Geological Survey. Summaries for selected data from these other sources are also included for additional information.

REFERENCES

Addison, E.L., 1991, Rainfall/runoff relationships and modeling of changes in water yield from timber harvest in the Black Hills of South Dakota: Rapid City, South Dakota School of Mines and Technology, unpublished M.S. thesis, 103 p.

Cain, D.J., Fend, S.V., and Carter, J.L., 1989, Temporal and spatial variability of arsenic in benthic insects from Whitewood Creek, South Dakota, *in* Mallard, G.E., and Ragone, S.E., eds., U.S. Geological Survey Toxic Substances Hydrology Program—Proceedings of the technical meeting, Phoenix, Arizona, Sept. 26-30, 1988: U.S. Geological Survey Water-Resources Investigations Report 88-4220, p. 257-269.

Callahan, M.A., Slimak, M.W., Gabel, N.W., May, I.P., Fowler, C.F., Freed, J.R., Jennings, Patricia, Durfee, R.L., Whitmore, F.C., Maestri, Bruno, Mabey, W.R., Holt, B.R., and Gold, Constance, 1979, Water-related environmental fate of 129 priority pollutants, Vol. 1—Introduction and technical background, metals, and inorganics, pesticides, and PCBs: U.S. Environmental Protection Agency, Washington, D.C., EPA-440/4-79-029a, variously paged.

Carter, J.M., and Redden, J.A., 1999a, Altitude of the top of the Minnelusa Formation in the Black Hills area, South Dakota: U.S. Geological Survey Hydrologic Investigations Atlas HA-744-C, 2 sheets, scale 1:100,000.

———1999b, Altitude of the top of the Madison Limestone in the Black Hills area, South Dakota: U.S. Geological Survey Hydrologic Investigations Atlas HA-744-D, 2 sheets, scale 1:100,000.

———1999c, Altitude of the top of the Deadwood Formation in the Black Hills area, South Dakota: U.S. Geological Survey Hydrologic Investigations Atlas HA-744-E, 2 sheets, scale 1:100,000.

Cherry, J.A., Morel, F.M.M., Rouse, J.V., Schnoor, J.L, and Wolman, M.G., 1986a, Hydrogeochemistry of sulfide and arsenic-rich tailings and alluvium along Whitewood Creek, South Dakota (part 1 of 3 parts): Mineral and Energy Resources, v. 29, no. 4, p. 1-12.

———1986b, Hydrogeochemistry of sulfide and arsenic-rich tailings and alluvium along Whitewood Creek, South Dakota (part 2 of 3 parts): Mineral and Energy Resources, v. 29, no. 5, p. 1-62.

———1986c, Hydrogeochemistry of sulfide and arsenic-rich tailings and alluvium along Whitewood Creek, South Dakota (part 3 of 3 parts): Mineral and Energy Resources, v. 29, no. 6, p. 1-17.

Davis, J.A., 1978, Adsorption of trace metals and complexing ligands at the oxide/water interface: Stanford, Calif., Stanford University, unpublished Ph.D. dissertation, 286 p.

DeVitre, R., Belzile, N., and Tessier, A., 1991, Speciation and adsorption of arsenic on diagenetic iron oxyhydroxides: Limnology and Oceanography, v. 36, p. 148-1485.

DeWitt, Ed, Redden, J.A., Wilson, A.B., and Buscher, David, 1986, Mineral resource potential and geology of the Black Hills National Forest, South Dakota and Wyoming: U.S. Geological Survey Bulletin 1580, 135 p.

Driscoll, D.G., and Bradford, W.L., 1994, Compilation of selected hydrologic data, through water year 1992, Black Hills Hydrology Study, western South Dakota: U.S. Geological Survey Open-File Report 94-319, 158 p.

Driscoll, D.G., Bradford, W.L., and Moran, M.J., 2000, Selected hydrologic data, through water year 1998, Black Hills Hydrology Study, South Dakota: U.S. Geological Survey Open-File Report 00-70, 284 p.

Driscoll, D.G., Bradford, W.L., and Neitzert, K.M., 1996, Selected hydrologic data, through water year 1994, Black Hills Hydrology Study, South Dakota: U.S. Geological Survey Open-File Report 96-399, 162 p.

Driscoll, D.G., and Hayes, T.S., 1995, Arsenic loads in Spearfish Creek, western South Dakota, water years 1989-91: U.S. Geological Survey Water-Resources Investigations Report 95-4080, 28 p.

Ficklin, W.H., and Callender, Edward, 1989, Arsenic geochemistry of rapidly accumulating sediments, Lake Oahe, South Dakota, *in* Mallard, G.E., and Ragone, S.E., eds., U.S. Geological Survey Toxic Substances Hydrology Program—Proceedings of the technical meeting, Phoenix, Arizona, Sept. 26-30, 1988: U.S. Geological Survey Water-Resources Investigations Report 88-4220, p. 217-222.

Fishman, M.J., and Friedman, L.C., eds., 1989, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 545 p.

Fuller, C.C., and Davis, J.A., 1989, Influence of coupling of sorption and photosynthetic processes on trace element cycles in natural waters: Nature, v. 340, p. 52-54.

Fuller, C.C., Davis, J.A., and Claypool-Frey, R.G., 1988, Partitioning of arsenic by iron oxides in Whitewood Creek, South Dakota, *in* Mallard, G.E., U.S. Geological Survey Toxic Substances Hydrology Program—Proceedings of the technical meeting, Denver, Colo., Feb. 2-4, 1987: U.S. Geological Survey Open-File Report 87-764, p. 19-21.

Fuller, C.C., Davis, J.A., and Waychunas, G.A., 1993, Surface chemistry of ferrihydrite; Part 2, Kinetics of arsenate adsorption and coprecipitation: Geochimica et Cosmochimica Acta, v. 57, no. 10, p. 2271-282.

Fuller, C.C., Davis, J.A., Zellwegger, G.W., and Goddard, K.E., 1989, Coupled chemical, biological, and physical processes in Whitewood Creek, South Dakota: Evaluation of the controls of dissolved arsenic, *in* Mallard, G.E. and Ragone, S.E., eds., U.S. Geological Survey Toxic Substances Hydrology Program—Proceedings of the technical meeting, Phoenix, Arizona, Sept. 26-30, 1988: U.S. Geological Survey Water-Resources Investigations Report 88-4220, p. 235-246.

Goddard, K.E., ed., 1988, U.S. Geological Survey applied research studies of the Cheyenne River system, South Dakota—Description and collation of data, water years 1985-86: U.S. Geological Survey Open-File Report 88-484, 158 p.

———1990, U.S. Geological Survey applied research studies of the Cheyenne River system, South Dakota—Description and collation of data, water years 1987-88: U.S. Geological Survey Open-File Report 89‘-580, 145 p.

Goddard, K.E., 1989a, Composition, distribution, and hydrologic effects of contaminated sediments resulting from the discharge of gold milling wastes to Whitewood Creek at Lead and Deadwood, South Dakota: U.S. Geological Survey Water-Resources Investigations Report 87-4051, 76 p.

———1989b, Overview of research activities on the Cheyenne River system, western South Dakota, *in* Mallard, G.E., and Ragone, S.E., eds., U.S. Geological Survey Toxic Substances Hydrology Program—Proceedings of the technical meeting, Phoenix, Arizona, Sept. 26-30, 1988: U.S. Geological Survey Water-Resources Investigations Report 88-4220, p. 199-202.

Greene, E.A., Sowards, C.L., and Hansmann, E.W., 1990, Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Angostura Reclamation Unit, southwestern South Dakota, 1988-89: U.S. Geological Survey Water-Resources Investigations Report 90-4152, 75 p.

Gries, J.P., 1996, Roadside geology of South Dakota: Missoula, Mont., Mountain Press Publishing Company, 358 p.

Hem, J.D., 1985, Study and interpretation of the chemical characteristics of natural water (3d ed.): U.S. Geological Survey Water-Supply Paper 2254, 263 p.

Horowitz, A.J., 1985, A primer on trace-metal sediment chemistry: U.S. Geological Survey Water-Supply Paper 2277, 58 p.

Horowitz, A.J., Elrick, K.A., and Cook, R.B., 1989, Source and transport of arsenic in the Whitewood Creek-Belle Fourche-Cheyenne River-Lake Oahe system, South Dakota, 1989, *in* Mallard, G.E., and Ragone, S.E., eds., U.S. Geological Survey Toxic Substances Hydrology Program—Proceedings of the technical meeting, Phoenix, Arizona, Sept. 26-30, 1988: U.S. Geological Survey Water-Resources Investigations Report 88-4220, p. 223-234.

Hortness, J.E., and Driscoll, D.G., 1998, Streamflow losses in the Black Hills of western South Dakota: U.S. Geological Survey Water-Resources Investigations Report 98-4116, 99 p.

Johnson, S.L., 1992, Nutrient, chloride, and indicator bacteria in water of the Spearfish Creek Basin in Lawrence County, South Dakota—Baseline conditions and comparative analyses for the period 1988-1990: Rapid City, South Dakota School of Mines and Technology, unpublished M.S. thesis, 130 p.

Klemp, J.A., 1995, Source aquifers for large springs in northwestern Lawrence County, South Dakota: Rapid City, South Dakota School of Mines and Technology, unpublished M.S. thesis, 175 p.

Kuwabara, J.S., Chang, C.C.Y., and Pasilis, S.P., 1989, Periphyton effects on arsenic transport in Whitewood Creek, South Dakota, *in* Mallard, G.E., and Ragone, S.E., eds., U.S. Geological Survey Toxic Substances Hydrology Program—Proceedings of the technical meeting, Phoenix, Arizona, Sept. 26-30, 1988: U.S. Geological Survey Water-Resources Investigations Report 88-4220, p. 247-256.

Kyllonen, D.P., and Peter, K.D., 1987, Geohydrology and water quality of the Inyan Kara, Minnelusa, and Madison aquifers of the northern Black Hills, South Dakota and Wyoming, and Bear Lodge Mountains, Wyoming: U.S. Geological Survey Water-Resources Investigations Report 86-4158, 61 p.

Marron, D.C., 1989, Trends in arsenic concentration and grain-size distribution of metal-contaminated overbank sediments along the Belle Fourche River downstream from Whitewood Creek, South Dakota, *in* Mallard, G.E., and Ragone, S.E., eds., U.S. Geological Survey Toxic Substances Hydrology Program—Proceedings of the technical meeting, Phoenix, Arizona, Sept. 26-30, 1988: U.S. Geological Survey Water-Resources Investigations Report 88-4220, p. 211-216.

McKallip, T.E., Goddard, K.E., and Horowitz, A.J., 1989, Arsenic in the alluvial sediments of Whitewood Creek and the Belle Fourche and Cheyenne rivers in western South Dakota, *in* Mallard, G.E., and Ragone, S.E., eds., U.S. Geological Survey Toxic Substances Hydrology Program—Proceedings of the technical meeting, Phoenix, Arizona, Sept. 26-30, 1988: U.S. Geological Survey Water-Resources Investigations Report 88-4220, p. 203-210.

Miller, L.D., and Driscoll, D.G., 1998, Streamflow characteristics for the Black Hills of South Dakota, through water year 1993: U.S. Geological Survey Water-Resources Investigations Report 97-4288, 382 p.

Orr, H.K., 1959, Precipitation and streamflow in the Black Hills: U.S. Department of Agriculture, Rocky Mountain Forest and Range Experiment Station, Station Paper no. 44, 25 p.

Parkhurst, D.L., 1995, User's guide to PHREEQC—A computer program for speciation, reaction-path, advective-transport, and inverse geochemical calculations: U.S. Geological Survey Water-Resources Investigations Report 95-4227, 143 p.

Parkhurst, D.L., Thorstenson, D.C., and Plummer, L.N., 1980, PHREEQE—A computer program for geochemical calculations: U.S. Geological Survey Water-Resources Investigations Report 80-96, 195 p.

Peter, K.D., 1985, Availability and quality of water from bedrock aquifers in the Rapid City area, South Dakota: U.S. Geological Survey Water-Resources Investigations Report 85-4022, 34 p.

Pierce, M.L., and Moore, C.B., 1982, Adsorption of arsenite and arsenate on amorphous iron hydroxide: Water Research, v. 16, p. 1247-1253.

Piper, A.M., 1944, A graphical procedure in the geochemical interpretation of water analyses: American Geophysical Union Transactions, v. 25, p. 914-923.

Rahn, P.H., Davis, A.D., Webb, C.J., and Nichols, A.D., 1996, Water quality impacts from mining in the Black Hills, South Dakota, USA: Environmental Geology, v. 27, p. 38-53.

Robinson, C.S., Mapel, W.J., and Bergendahl, M.H., 1964, Stratigraphy and structure of the northern and western flanks of the Black Hills uplift, Wyoming, Montana, and South Dakota: U.S. Geological Survey Professional Paper 404, 124 p.

South Dakota Department of Environment and Natural Resources, 1996, Drinking water standards: Administrative rules of South Dakota, 74:04:05.

———1998, Surface water quality: Administrative Rules of South Dakota, 74:51, retrieved Aug. 14, 1998, from URL http://www.state.sd.us/state/legis/lrc/rules/7451.htm

South Dakota Department of Water and Natural Resources, 1987, Surface water quality standards: Administrative Rules of South Dakota, 74:03:02.

Strobel, M.L., Sawyer, J.F., Jarrell, G.J., Schleicher, J.R., and Fahrenbach, M.D., 1999, Distribution of hydrogeologic units in the Black Hills area, South Dakota: U.S. Geological Survey Hydrologic Investigations Atlas HA-743, 3 sheets, scale 1:100,000.

Stumm, W., and Morgan, J.J., 1970, Aquatic chemistry—an introduction emphasizing chemical equilibria in natural waters: New York, Wiley-Interscience, 583 p.

Thilenius, C.A., 1965, An evaluation of pollution in the Belle Fourche and Cheyenne Rivers due to wastes carried by Whitewood Creek: Pierre, South Dakota Department of Game, Fish and Parks, 47 p.

Torve, K.C., 1991, Reconnaissance water-quality investigation of bed material, surface water, and ground water of select tributaries draining the mineralized region of Lawrence County near Lead, South Dakota: Rapid City, South Dakota School of Mines and Technology, unpublished M.S. thesis, 109 p.

U.S. Department of Commerce, 1988-94, Climatological data for South Dakota, annual summary: Asheville, North Carolina (issued annually.)

U.S. Departments of Interior and Agriculture, 1967, Black Hills area resources study: U.S. Departments of Interior and Agriculture, 225 p.

U.S. Environmental Protection Agency, 1996, Drinking water regulations and health advisories: Washington, D.C., Office of Water, February 1996, EPA 822-R-96-001.

———1998a, National recommended water quality criteria: Federal Register, December 10, 1998, v. 63, no. 237, p. 68353-68364.

———1998b, Drinking water standards and health advisories—Inorganics—Aluminum to nitrate: revised June 10, 1998, retrieved August 14, 1998, from URL http://www.epa.gov/OST/Tools/dwstds8.html

———1998c, Drinking water standards and health advisories—Inorganics—Nitrate to zinc chloride—and radionuclides: revised March 9, 1998, retrieved August 14, 1998, from URL http://www.epa.gov/OST/Tools/ dwstds9.html

———1998d, Secondary maximum contaminant levels: revised March 9, 1998, retrieved August 14, 1998, from URL http://www.epa.gov/OST/Tools/dwstds10.html

U.S. Forest Service, 1994, Appendix B, Historic and contemporary use and occupation of the Black Hills, *in* Proposed revised land and resource management plan, draft environmental impact statement: 34 p.

U.S. Geological Survey, 1989-2000, Water resources data, South Dakota, water years 1988-99: U.S. Geological Survey Water Data Reports SD-88-1 to SD-99-1 (published annually).

Ward, J.R., and Harr, C.A., eds., 1990, Methods for collection and processing of surface-water and bed-material samples for physical and chemical analyses: U.S. Geological Survey Open-File Report 90-140, 71 p.

Wenker, G.A., 1997, Geological setting and water quality of headwater springs in the Black Hills of South Dakota: Rapid City, South Dakota School of Mines and Technology, unpublished M.S. thesis, 101 p.

SUPPLEMENTAL INFORMATION

Table 8. Water-quality data for selected streams in Lawrence County

[US/CM, microsiemens per centimeter; DEG C, degrees Celsius; NTU, nephelometric turbidity units; MM, millimeters; MG/L, milligrams per liter; AC-FT, acre-feet; UG/L, micrograms per liter; ANC, acid-neutralizing capacity; PCI/L, picocuries per liter; UM-MF, micrometer-membrane filter; COLS, colonies; ML, milliliters; INST, instantaneous; UNFLTRD, unfiltered; DISS, dissolved; NAT U, natural uranium; TIT, titration; LAB, laboratory; K, non-ideal colony count; <, less than; --, no data available]

DATE	TIME	DIS- CHARGE, INST CUBIC FEET PER SECOND (00061)	SPE- CIFIC CON- DUCT- ANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STAND- ARD UNITS) (00400)	TEMPER- ATURE WATER (DEG C) (00010)	TEMPER- ATURE AIR (DEG C) (00020)	TUR- BID- ITY (NTU) (00076)	BARO- METRIC PRES- SURE (MM OF HG) (00025)	OXYGEN, DIS- SOLVED (MG/L) (00300)	OXYGEN, DIS- SOLVED (PER- CENT SATUR- ATION) (00301)	HARD- NESS TOTAL (MG/L AS CACO3) (00900)
06422500 BOXELDER CREEK NEAR NEMO, SD (LAT 44 08 38N LONG 103 27 16W)											
SEP 1988 07...	0730	.56	385	8.1	12.0	15.0	1.9	643	8.3	92	210
NOV 16...	1300	1.6	--	8.4	1.0	.0	1.6	650	11.8	98	200
MAR 1989 13...	1300	10	230	8.3	2.5	11.0	3.3	642	11.5	100	120
JUN 01...	1200	10	280	8.6	15.0	27.0	6.5	656	9.3	107	150
SEP 12...	1330	1.7	350	8.6	14.0	17.0	.30	657	10.0	113	190
DEC 05...	1230	3.1	336	8.5	1.5	4.0	.40	--	11.9	--	180
JUN 1990 01...	1030	12	255	8.5	15.4	18.0	1.7	643	8.2	98	130
NOV 21...	1400	2.3	355	8.5	3.0	4.0	.40	645	11.4	100	190
06430770 SPEARFISH CREEK NEAR LEAD, SD (LAT 44 17 56N LONG 103 52 02W)											
AUG 1988 02...	1100	14	440	8.5	10.0	26.0	.30	631	9.6	103	260
SEP 07...	1030	11	443	8.4	7.5	18.0	.30	624	10.2	104	260
NOV 29...	1300	13	--	8.6	1.5	-1.0	.80	631	11.2	--	260
MAR 1989 06...	1040	15	450	8.5	2.0	4.0	.60	626	11.3	100	260
MAY 23...	1245	19	435	8.6	11.5	22.0	.10	624	9.3	105	260
SEP 07...	0900	14	430	8.6	8.6	15.0	.30	628	9.8	102	260
NOV 29...	1130	16	438	8.6	1.5	1.0	.40	636	11.7	100	260
MAY 1990 31...	0800	20	432	8.6	7.5	13.5	1.0	622	10.1	104	260
NOV 28...	1045	13	433	8.5	1.0	-3.0	.80	630	11.6	99	260
06430800 ANNIE CREEK NEAR LEAD, SD (LAT 44 19 37N LONG 103 53 38W)											
JUL 1988 27...	1115	.16	330	8.6	16.0	30.0	.20	635	8.6	105	190
SEP 12...	1130	.08	345	8.7	8.5	9.0	.70	642	9.4	96	--
NOV 29...	0930	.04	--	8.4	.0	-1.0	.30	634	11.9	--	200
MAR 1989 10...	1145	.33	--	8.3	.0	14.0	1.6	636	15.6	--	160
MAY 22...	1330	2.4	157	--	10.8	25.0	2.1	631	9.5	104	81
SEP 07...	1215	.06	318	8.8	11.5	18.0	.50	632	8.9	99	180
NOV 29...	1315	.33	353	8.5	.0	-2.0	.30	638	12.0	98	190
APR 1990 11...	1200	1.7	185	8.3	.0	-1.0	6.7	636	12.0	98	--
MAY 17...	1030	6.4	122	8.8	4.5	10.0	10	634	10.6	99	55
AUG 22...	1230	.28	365	8.6	14.5	22.5	1.0	632	9.2	109	190
NOV 28...	1400	.06	384	8.6	.0	-3.0	.40	635	12.4	102	220
DEC 18...	1000	.06	400	8.3	.0	-3.0	--	--	--	--	210
JAN 1991 15...	0915	.06	390	8.2	.0	-3.5	--	--	--	--	210
FEB 25...	0930	.02	372	8.2	.1	-4.0	--	--	--	--	210
MAR 13...	1130	.01	371	8.6	.5	4.0	.40	632	11.2	94	200
JUN 20...	0845	1.6	221	8.7	11.0	17.0	2.2	628	9.2	102	120
SEP 05...	1145	.15	396	8.4	13.2	24.0	.40	631	9.9	114	210
DEC 03...	1500	.17	--	8.2	.5	-4.5	.60	625	12.6	--	210
MAR 1992 31...	1330	.20	317	8.3	2.0	4.0	.50	633	11.0	96	160
JUN 03...	1230	.60	255	8.6	12.5	25.0	12	625	9.1	104	130
SEP 09...	1100	.08	386	8.4	8.0	14.0	.80	630	10.0	102	200

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	ANC UNFLTRD TIT 4.5 LAB (MG/L AS CACO3) (90410)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L) (70301)	SOLIDS, DIS-SOLVED (TONS PER DAY) (70302)	SOLIDS, RESIDUE AT 180 DEG C DIS-SOLVED (MG/L) (70300)	SOLIDS, DIS-SOLVED (TONS PER AC-FT) (70303)	RESIDUE TOTAL AT 105 DEG C, SUS-PENDED (MG/L) (00530)	CALCIUM DIS-SOLVED (MG/L AS CA) (00915)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG) (00925)	SODIUM, DIS-SOLVED (MG/L AS NA) (00930)	SODIUM PERCENT (00932)	SODIUM AD-SORP-TION RATIO (00931)
06422500 BOXELDER CREEK NEAR NEMO, SD (LAT 44 08 38N LONG 103 27 16W)											
SEP 1988 07...	200	228	.32	212	.29	3	44	25	3.9	4	.1
NOV 16...	177	213	.93	209	.28	<1	44	21	3.8	4	.1
MAR 1989 13...	105	140	3.88	137	.19	4	30	11	2.9	5	.1
JUN 01...	135	167	4.31	160	.22	5	36	14	4.0	5	.1
SEP 12...	175	203	.85	190	.26	<1	42	21	4.1	4	.1
DEC 05...	172	199	1.52	182	.25	2	43	18	3.6	4	.1
JUN 1990 01...	124	152	4.78	145	.20	2	33	12	3.6	6	.1
NOV 21...	181	209	1.18	194	.26	5	44	20	4.0	4	.1
06430770 SPEARFISH CREEK NEAR LEAD, SD (LAT 44 17 56N LONG 103 52 02W)											
AUG 1988 02...	222	256	8.59	229	.31	2	58	27	1.3	1	.0
SEP 07...	219	258	5.64	190	.26	1	61	26	1.4	1	.0
NOV 29...	252	261	8.09	234	.32	3	61	26	1.2	1	.0
MAR 1989 06...	255	257	9.85	250	.34	2	62	25	1.2	1	.0
MAY 23...	233	243	12.8	254	.35	<1	60	26	1.9	2	.1
SEP 07...	237	246	8.30	212	.29	<1	62	25	1.3	1	.0
NOV 29...	248	254	11.2	256	.35	16	63	24	1.1	1	.0
MAY 1990 31...	236	244	12.7	238	.32	<1	61	25	1.3	1	.0
NOV 28...	246	256	9.05	252	.34	<1	64	25	1.2	1	.0
06430800 ANNIE CREEK NEAR LEAD, SD (LAT 44 19 37N LONG 103 53 38W)											
JUL 1988 27...	178	201	.08	193	.26	5	47	18	2.9	3	.1
SEP 12...	181	--	--	198	--	5	--	--	--	--	--
NOV 29...	186	210	.02	186	.25	1	49	19	2.7	3	.1
MAR 1989 10...	150	168	.14	153	.21	1	39	15	2.4	3	.1
MAY 22...	75	94	.77	117	.16	<1	21	6.9	2.1	5	.1
SEP 07...	173	196	.03	188	.26	<1	46	16	3.2	4	.1
NOV 29...	189	204	.18	206	.28	8	48	18	2.3	3	.1
APR 1990 11...	66	--	--	124	--	10	--	--	--	--	--
MAY 17...	58	76	1.45	83	.11	22	14	4.8	1.9	7	.1
AUG 22...	166	222	.16	215	.29	10	49	16	5.4	6	.2
NOV 28...	207	237	.04	219	.30	<1	54	20	4.8	5	.1
DEC 18...	202	234	.04	257	.35	--	51	19	4.5	5	.1
JAN 1991 15...	201	230	.03	216	.29	--	51	20	4.9	5	.1
FEB 25...	194	228	.01	207	.28	--	52	19	4.5	4	.1
MAR 13...	186	221	.01	208	.28	16	50	18	4.5	5	.1
JUN 20...	107	153	.57	127	.17	23	31	9.7	3.3	6	.1
SEP 05...	189	235	.09	224	.30	<1	53	18	4.9	5	.1
DEC 03...	194	222	.09	197	.27	17	51	19	4.8	5	.1
MAR 1992 31...	139	174	.09	171	.23	11	39	14	3.7	5	.1
JUN 03...	115	153	.19	116	.16	14	34	9.9	2.7	4	.1
SEP 09...	181	228	.05	210	.29	<1	51	18	3.6	4	.1

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	POTAS-SIUM, DIS-SOLVED (MG/L AS K) (00935)	SULFATE DIS-SOLVED (MG/L AS SO4) (00945)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL) (00940)	FLUO-RIDE, DIS-SOLVED (MG/L AS F) (00950)	SILICA, DIS-SOLVED (MG/L AS SIO2) (00955)	NITRO-GEN, NITRITE DIS-SOLVED (MG/L AS N) (00613)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N) (00631)	NITRO-GEN, AMMONIA DIS-SOLVED (MG/L AS N) (00608)	NITRO-GEN,AM-MONIA + ORGANIC DISS (MG/L AS N) (00623)	PHOS-PHORUS DIS-SOLVED (MG/L AS P) (00666)
			06422500 BOXELDER CREEK NEAR NEMO, SD (LAT 44 08 38N LONG 103 27 16W)							
SEP 1988 07...	2.1	13	2.8	.20	12	<.010	<.100	<.010	<.20	<.010
NOV 16...	2.1	18	3.0	.20	10	<.010	<.100	<.010	<.20	.010
MAR 1989 13...	2.8	17	2.6	.20	9.4	<.010	.160	.010	.40	.020
JUN 01...	1.9	17	2.0	.20	11	<.010	<.100	<.010	.30	<.010
SEP 12...	2.3	15	3.1	.20	10	<.010	<.100	<.010	<.20	<.010
DEC 05...	2.1	16	2.8	.20	10	<.010	<.100	<.010	<.20	<.010
JUN 1990 01...	1.7	13	1.5	<.10	12	<.010	.200	<.010	.20	<.010
NOV 21...	2.1	16	4.4	.20	9.5	<.010	<.100	.030	<.20	<.010
			06430770 SPEARFISH CREEK NEAR LEAD, SD (LAT 44 17 56N LONG 103 52 02W)							
AUG 1988 02...	.70	3.9	1.0	.20	10	<.010	<.100	.030	<.20	.020
SEP 07...	.60	3.1	1.0	.10	10	<.010	<.100	<.010	.30	.010
NOV 29...	.70	3.2	1.0	.10	10	.010	.190	<.010	.20	.020
MAR 1989 06...	.70	3.1	.60	.20	10	<.010	.170	<.010	<.20	.020
MAY 23...	.50	3.0	1.8	.20	10	<.010	<.100	.010	<.20	.010
SEP 07...	.70	3.0	1.1	.10	11	<.010	<.100	<.010	<.20	.010
NOV 29...	.70	3.0	.90	.10	11	<.010	.200	.010	<.20	.020
MAY 1990 31...	.60	2.8	1.4	<.10	9.8	<.010	.200	<.010	<.20	<.010
NOV 28...	.70	3.0	2.7	.20	11	<.010	.200	.090	<.20	.010
			06430800 ANNIE CREEK NEAR LEAD, SD (LAT 44 19 37N LONG 103 53 38W)							
JUL 1988 27...	1.1	8.7	.50	.30	15	<.010	<.100	.010	--	.040
SEP 12...	--	9.9	.70	.20	--	<.010	<.100	<.010	.20	.030
NOV 29...	.90	8.8	1.3	.20	12	<.010	.200	.160	<.20	.020
MAR 1989 10...	1.0	7.9	.70	.20	11	<.010	.240	<.010	<.20	.020
MAY 22...	.80	5.0	1.3	.10	12	<.010	<.100	.020	.30	.040
SEP 07...	1.0	10	.90	.20	15	<.010	<.100	.020	.30	.030
NOV 29...	.80	8.0	.80	.20	11	<.010	.240	.020	<.20	.020
APR 1990 11...	--	5.9	2.9	.10	12	<.010	.300	<.010	<.20	.040
MAY 17...	.60	5.0	1.6	<.10	12	<.010	.300	<.010	<.20	.030
AUG 22...	1.4	10	5.6	.40	15	<.010	4.30	<.010	.50	.020
NOV 28...	1.0	11	3.9	.30	11	<.010	1.50	.070	<.20	.020
DEC 18...	.90	14	3.6	.20	12	<.010	1.60	.020	<.20	.018
JAN 1991 15...	.90	12	.90	.30	12	<.010	1.50	.010	<.20	.027
FEB 25...	.90	13	4.2	.20	12	--	1.30	.020	<.20	.031
MAR 13...	1.0	13	4.3	.20	12	<.010	1.40	.030	<.20	.030
JUN 20...	.90	22	2.5	.20	14	<.010	1.20	.020	<.20	.030
SEP 05...	1.1	16	4.3	.20	13	<.010	2.50	.020	.20	.020
DEC 03...	.90	15	2.6	.30	12	--	--	--	--	--
MAR 1992 31...	.80	17	5.2	.20	11	--	--	--	--	--
JUN 03...	.90	11	4.8	.20	13	<.010	1.60	.030	--	.040
SEP 09...	1.1	16	7.5	.30	13	<.010	1.90	.020	<.20	.020

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	PHOS-PHORUS ORTHO, DIS-SOLVED (MG/L AS P) (00671)	CYANIDE TOTAL (MG/L AS CN) (00720)	CYANIDE DIS-SOLVED (MG/L AS CN) (00723)	ANTI-MONY, DIS-SOLVED (UG/L AS SB) (01095)	ARSENIC TOTAL (UG/L AS AS) (01002)	ARSENIC DIS-SOLVED (UG/L AS AS) (01000)	BARIUM, DIS-SOLVED (UG/L AS BA) (01005)	BORON, DIS-SOLVED (UG/L AS B) (01020)	CADMIUM DIS-SOLVED (UG/L AS CD) (01025)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR) (01030)
06422500 BOXELDER CREEK NEAR NEMO, SD (LAT 44 08 38N LONG 103 27 16W)										
SEP 1988 07...	.004	--	<.01	<1.0	--	1	43	20	<1.0	<1.0
NOV 16...	<.001	--	<.01	<1.0	--	<1	32	10	3.0	<1.0
MAR 1989 13...	.010	<.010	<.01	<1.0	--	1	26	10	<1.0	<1.0
JUN 01...	.002	--	<.01	<1.0	<1	<1	27	30	1.0	2.0
SEP 12...	.002	.010	<.01	<1.0	1	<1	33	<10	<1.0	<1.0
DEC 05...	.002	<.010	<.01	<1.0	<1	<1	30	20	<1.0	1.0
JUN 1990 01...	.008	<.010	<.01	<1.0	1	1	26	20	<10	<1.0
NOV 21...	.001	<.010	<.01	<1.0	<1	<1	32	10	<10	<1.0
06430770 SPEARFISH CREEK NEAR LEAD, SD (LAT 44 17 56N LONG 103 52 02W)										
AUG 1988 02...	.007	--	<.01	1.0	--	1	84	<10	<1.0	1.0
SEP 07...	.009	--	<.01	<1.0	--	1	83	<10	<1.0	<1.0
NOV 29...	.009	--	<.01	<1.0	--	1	80	<10	2.0	<1.0
MAR 1989 06...	.021	<.010	<.01	<1.0	--	1	82	<10	<1.0	<1.0
MAY 23...	.006	--	<.01	2.0	1	1	80	<10	<1.0	<1.0
SEP 07...	.007	<.010	<.01	<1.0	<1	<1	85	<10	<1.0	1.0
NOV 29...	.014	<.010	<.01	<1.0	<1	<1	81	10	<1.0	1.0
MAY 1990 31...	.009	<.010	<.01	<1.0	<1	<1	74	<10	<10	<1.0
NOV 28...	.030	<.010	<.01	<1.0	<1	1	85	<10	<10	<1.0
06430800 ANNIE CREEK NEAR LEAD, SD (LAT 44 19 37N LONG 103 53 38W)										
JUL 1988 27...	.028	--	<.01	2.0	--	46	120	<10	<1.0	1.0
SEP 12...	.029	--	<.01	--	--	--	--	<10	--	--
NOV 29...	.019	--	<.01	2.0	--	32	94	<10	<1.0	1.0
MAR 1989 10...	.035	<.010	<.01	1.0	--	27	76	<10	<1.0	<1.0
MAY 22...	.026	--	<.01	2.0	26	27	67	<10	<1.0	1.0
SEP 07...	.028	<.010	<.01	4.0	36	36	110	<10	<1.0	2.0
NOV 29...	.023	<.010	<.01	4.0	28	32	91	<10	<1.0	1.0
APR 1990 11...	.024	<.010	<.01	--	15	--	--	<10	--	--
MAY 17...	.005	<.010	<.01	2.0	27	22	66	<10	<10	2.0
AUG 22...	.010	<.010	<.01	3.0	50	48	140	<10	<10	2.0
NOV 28...	.016	<.010	<.01	2.0	37	34	110	<10	<10	<1.0
DEC 18...	.020	--	--	3.0	--	6	100	<10	<1.0	<5.0
JAN 1991 15...	.040	--	--	3.0	--	34	100	<10	<1.0	<5.0
FEB 25...	--	--	--	3.0	--	37	100	10	<1.0	<5.0
MAR 13...	.030	<.010	<.01	1.0	37	35	100	<10	<10	<1.0
JUN 20...	.020	<.010	<.01	3.0	28	26	98	10	<10	<1.0
SEP 05...	<.010	<.010	<.01	2.0	34	24	130	10	<10	2.0
DEC 03...	--	<.010	<.01	2.0	27	28	110	10	<10	<1.0
MAR 1992 31...	--	<.010	<.01	5.0	29	30	79	<10	<10	<1.0
JUN 03...	.020	<.010	<.01	<1.0	27	25	87	10	<10	<1.0
SEP 09...	.020	<.010	<.01	7.0	32	34	120	<10	<10	<1.0

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	COPPER, DIS- SOLVED (UG/L AS CU) (01040)	IRON, DIS- SOLVED (UG/L AS FE) (01046)	LEAD, DIS- SOLVED (UG/L AS PB) (01049)	MANGA- NESE, DIS- SOLVED (UG/L AS MN) (01056)	MERCURY DIS- SOLVED (UG/L AS HG) (71890)	SELE- NIUM, DIS- SOLVED (UG/L AS SE) (01145)	SILVER, DIS- SOLVED (UG/L AS AG) (01075)	ZINC, DIS- SOLVED (UG/L AS ZN) (01090)
06422500 BOXELDER CREEK NEAR NEMO, SD (LAT 44 08 38N LONG 103 27 16W)								
SEP 1988								
07...	1.0	19	<5.0	19	<.1	<1	--	11
NOV								
16...	<1.0	34	<5.0	12	<.1	<1	--	4.0
MAR 1989								
13...	<1.0	99	<5.0	24	<.1	<1	--	7.0
JUN								
01...	1.0	28	<1.0	10	<.1	<1	--	<3.0
SEP								
12...	<1.0	12	<1.0	9.0	<.1	<1	--	7.0
DEC								
05...	<1.0	9.0	<1.0	4.0	<.1	<1	--	3.0
JUN 1990								
01...	1.0	54	1.0	18	<.1	<1	--	3.0
NOV								
21...	<1.0	10	<1.0	5.0	<.1	<1	--	4.0
06430770 SPEARFISH CREEK NEAR LEAD, SD (LAT 44 17 56N LONG 103 52 02W)								
AUG 1988								
02...	1.0	9.0	<5.0	1.0	<.1	<1	--	6.0
SEP								
07...	1.0	9.0	<5.0	<1.0	<.1	<1	--	24
NOV								
29...	1.0	7.0	<5.0	2.0	<.1	<1	--	5.0
MAR 1989								
06...	1.0	9.0	<5.0	1.0	<.1	<1	--	18
MAY								
23...	<1.0	21	<1.0	2.0	<.1	<1	--	45
SEP								
07...	1.0	7.0	<1.0	2.0	<.1	<1	--	26
NOV								
29...	<1.0	5.0	<1.0	1.0	<.1	<1	--	<3.0
MAY 1990								
31...	1.0	6.0	<1.0	2.0	<.1	<1	--	<3.0
NOV								
28...	<1.0	7.0	<1.0	1.0	<.1	<1	--	<3.0
06430800 ANNIE CREEK NEAR LEAD, SD (LAT 44 19 37N LONG 103 53 38W)								
JUL 1988								
27...	<1.0	5.0	<5.0	<1.0	<.1	<1	--	8.0
SEP								
12...	--	--	--	--	<.1	--	--	--
NOV								
29...	<1.0	8.0	<5.0	3.0	<.1	<1	--	12
MAR 1989								
10...	<1.0	12	<5.0	<1.0	<.1	<1	--	13
MAY								
22...	1.0	76	1.0	<1.0	<.1	<1	--	4.0
SEP								
07...	4.0	6.0	<1.0	<1.0	<.1	<1	--	3.0
NOV								
29...	<1.0	<3.0	<1.0	<1.0	<.1	<1	--	<3.0
APR 1990								
11...	--	--	--	--	<.1	--	--	--
MAY								
17...	<1.0	47	<1.0	1.0	<.1	<1	--	<3.0
AUG								
22...	1.0	5.0	1.0	<1.0	--	<1	--	4.0
NOV								
28...	<1.0	<3.0	<1.0	<1.0	<.1	<1	--	5.0
DEC								
18...	<10	6.0	<10	<1.0	<.1	<1	<1.0	<3.0
JAN 1991								
15...	<10	11	<10	<1.0	.2	<1	<1.0	3.0
FEB								
25...	<10	<3.0	<10	11	.3	<1	<1.0	3.0
MAR								
13...	1.0	5.0	<1.0	<1.0	<.1	1	--	6.0
JUN								
20...	1.0	14	<1.0	<1.0	<.1	1	--	8.0
SEP								
05...	<1.0	4.0	<1.0	<1.0	<.1	<1	--	<3.0
DEC								
03...	<1.0	<3.0	<1.0	<1.0	<.1	<1	--	<3.0
MAR 1992								
31...	<1.0	5.0	<1.0	<1.0	<.1	1	--	5.0
JUN								
03...	<1.0	7.0	<1.0	<1.0	<.1	1	--	12
SEP								
09...	<1.0	<3.0	<1.0	<1.0	<.1	1	--	9.0

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	TIME	DIS-CHARGE, INST CUBIC FEET PER SECOND (00061)	SPE-CIFIC CON-DUCT-ANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STAND-ARD UNITS) (00400)	TEMPER-ATURE WATER (DEG C) (00010)	TEMPER-ATURE AIR (DEG C) (00020)	TUR-BID-ITY (NTU) (00076)	BARO-METRIC PRES-SURE (MM OF HG) (00025)	OXYGEN, DIS-SOLVED (MG/L) (00300)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION) (00301)	HARD-NESS TOTAL (MG/L AS CACO3) (00900)
06430850 LITTLE SPEARFISH CREEK NEAR LEAD, SD (LAT 44 20 58N LONG 103 56 08W)											
JUL 1988											
26...	1130	16	500	8.4	12.0	30.0	.20	641	10.8	120	--
SEP											
12...	0900	15	470	8.3	7.0	7.0	.40	642	10.4	102	--
NOV											
28...	1300	14	480	8.4	6.0	.0	.40	629	10.6	103	280
MAR 1989											
06...	0915	14	470	8.4	5.0	5.0	.70	632	10.8	102	270
MAY											
22...	1045	14	465	8.2	9.5	24.0	.10	634	10.6	112	270
SEP											
07...	1400	14	450	8.7	10.0	21.0	.20	633	11.0	118	250
NOV											
30...	0830	13	450	8.3	4.2	-10.0	.20	640	11.3	103	280
MAY 1990											
30...	0830	14	448	8.4	7.5	13.0	.40	630	10.1	102	260
NOV											
29...	1030	11	447	8.7	5.0	6.0	.60	636	13.4	126	270
06430865 IRON CREEK NEAR LEAD, SD (LAT 44 22 25N LONG 103 55 07W)											
AUG 1988											
03...	1030	1.5	410	7.8	10.0	14.0	.40	645	10.6	112	250
SEP											
08...	1145	1.5	416	8.5	9.0	17.0	.30	645	10.9	111	240
NOV											
15...	1140	1.3	423	8.6	4.0	-2.0	1.3	638	11.2	102	240
MAR 1989											
07...	1215	1.3	420	8.7	5.0	10.0	.10	636	11.2	105	240
MAY											
11...	1130	3.2	310	8.5	11.0	23.0	.30	636	9.5	104	170
SEP											
11...	1315	1.1	400	8.7	8.0	17.0	.20	645	10.4	104	240
NOV											
29...	0900	1.5	426	8.6	2.1	-3.0	.10	646	13.0	111	250
MAY 1990											
30...	0945	2.4	380	8.7	10.0	13.0	2.4	636	10.0	106	220
NOV											
29...	1430	1.3	412	8.5	3.5	1.0	.40	638	10.9	98	250
06430898 SQUAW CREEK NEAR SPEARFISH, SD (LAT 44 24 04N LONG 103 53 35W)											
JUL 1988											
21...	1115	.64	310	8.4	18.0	22.0	.40	654	7.4	91	160
SEP											
08...	0800	.26	333	8.3	10.0	8.0	.50	653	9.5	98	180
NOV											
09...	0815	.75	301	8.4	.5	1.0	.40	648	14.1	115	160
MAR 1989											
07...	0815	.46	330	8.4	.0	2.0	.10	646	13.6	110	170
MAY											
12...	1245	12	120	8.0	9.0	20.0	3.7	643	9.8	101	59
SEP											
08...	0845	.43	322	8.4	11.5	10.0	.20	650	8.6	92	170
NOV											
30...	1030	.75	280	8.4	1.5	-10.0	.10	653	12.2	102	150
MAY 1990											
29...	0900	4.8	192	8.5	9.5	13.0	2.5	643	9.8	102	85
AUG											
23...	0930	.41	329	8.3	15.0	16.0	.20	648	10.0	117	170
NOV											
30...	0945	.69	329	8.3	.0	6.5	.40	644	12.8	104	170
MAR 1991											
13...	1500	.49	312	8.8	.0	3.5	.30	648	12.3	99	160
JUN											
20...	1100	3.3	223	8.8	14.5	20.0	.70	648	9.3	108	110
SEP											
05...	1445	.35	351	8.3	16.0	25.0	.40	638	8.4	102	180
DEC											
04...	1300	.43	324	8.4	.5	6.0	.50	640	12.1	100	170
MAR 1992											
31...	1530	1.3	274	8.1	2.5	3.5	.40	650	12.0	103	130
JUL											
15...	1115	1.1	352	7.7	15.0	22.5	.40	646	8.6	102	170
AUG											
13...	1145	.26	376	8.2	17.5	28.0	.50	650	9.2	113	190

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	ANC UNFLTRD TIT 4.5 LAB (MG/L AS CACO3) (90410)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L) (70301)	SOLIDS, DIS-SOLVED (TONS PER DAY) (70302)	SOLIDS, RESIDUE AT 180 DEG C DIS-SOLVED (MG/L) (70300)	SOLIDS, DIS-SOLVED (TONS PER AC-FT) (70303)	RESIDUE TOTAL AT 105 DEG C, SUS-PENDED (MG/L) (00530)	CALCIUM DIS-SOLVED (MG/L AS CA) (00915)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG) (00925)	SODIUM, DIS-SOLVED (MG/L AS NA) (00930)	SODIUM PERCENT (00932)
06430850 LITTLE SPEARFISH CREEK NEAR LEAD, SD (LAT 44 20 58N LONG 103 56 08W)										
JUL 1988										
26...	216	--	--	234	--	5	--	--	--	--
SEP										
12...	238	--	--	212	--	6	--	--	--	--
NOV										
28...	268	276	9.03	246	.33	<1	69	25	.80	1
MAR 1989										
06...	265	266	9.82	258	.35	3	68	24	.90	1
MAY										
22...	246	256	9.54	247	.34	8	68	25	1.3	1
SEP										
07...	229	237	5.52	147	.20	<1	63	23	1.0	1
NOV										
30...	266	270	8.71	250	.34	10	70	25	.90	1
MAY 1990										
30...	242	252	9.21	237	.32	<1	67	23	.80	1
NOV										
29...	253	262	7.60	249	.34	<1	70	24	.90	1
06430865 IRON CREEK NEAR LEAD, SD (LAT 44 22 25N LONG 103 55 07W)										
AUG 1988										
03...	187	246	.90	219	.30	<1	62	22	1.3	1
SEP										
08...	194	242	.62	154	.21	1	58	23	1.3	1
NOV										
15...	227	247	.80	234	.32	<1	60	22	1.0	1
MAR 1989										
07...	228	234	.83	237	.32	<1	60	22	1.2	1
MAY										
11...	167	178	1.44	167	.23	3	45	15	2.2	3
SEP										
11...	198	215	.84	285	.39	3	60	22	1.2	1
NOV										
29...	231	239	1.00	249	.34	7	64	21	1.1	1
MAY 1990										
30...	204	214	1.44	219	.30	<1	57	19	1.5	1
NOV										
29...	227	240	.85	239	.33	<1	64	22	1.2	1
06430898 SQUAW CREEK NEAR SPEARFISH, SD (LAT 44 24 04N LONG 103 53 35W)										
JUL 1988										
21...	124	193	.32	187	.25	3	41	14	2.7	3
SEP										
08...	135	203	.15	212	.29	<1	45	16	2.7	3
NOV										
09...	117	190	.39	192	.26	<1	40	15	2.5	3
MAR 1989										
07...	126	198	.24	197	.27	<1	43	15	2.8	3
MAY										
12...	44	79	2.65	81	.11	6	16	4.6	1.7	6
SEP										
08...	129	200	.24	208	.28	<1	44	15	2.9	3
NOV										
30...	103	173	.33	163	.22	10	37	13	2.6	4
MAY 1990										
29...	73	115	1.49	115	.16	1	22	7.3	2.2	5
AUG										
23...	134	203	.22	200	.27	3	45	14	3.0	4
NOV										
30...	131	207	.37	199	.27	<1	45	15	3.0	4
MAR 1991										
13...	101	200	.25	186	.25	7	40	14	2.9	4
JUN										
20...	85	147	1.25	139	.19	2	31	8.9	2.6	5
SEP										
05...	138	213	.22	230	.31	<1	47	15	2.9	3
DEC										
04...	121	205	.20	176	.24	1	42	15	2.9	4
MAR 1992										
31...	82	161	.54	155	.21	6	33	11	2.8	4
JUL										
15...	98	212	.61	212	.29	<1	44	14	4.3	5
AUG										
13...	127	232	.16	222	.30	<1	49	16	4.6	5

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	SODIUM AD-SORP-TION RATIO (00931)	POTAS-SIUM, DIS-SOLVED (MG/L AS K) (00935)	SULFATE DIS-SOLVED (MG/L AS SO4) (00945)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL) (00940)	FLUO-RIDE, DIS-SOLVED (MG/L AS F) (00950)	SILICA, DIS-SOLVED (MG/L AS SIO2) (00955)	NITRO-GEN, NITRITE DIS-SOLVED (MG/L AS N) (00613)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N) (00631)	NITRO-GEN, AMMONIA DIS-SOLVED (MG/L AS N) (00608)	NITRO-GEN,AM-MONIA + ORGANIC DISS (MG/L AS N) (00623)
			06430850 LITTLE SPEARFISH CREEK NEAR LEAD, SD (LAT 44 20 58N LONG 103 56 08W)							
JUL 1988										
26...	--	4.6	3.6	2.7	.10	--	<.010	.110	.010	<.20
SEP										
12...	--	--	2.2	.80	.10	--	<.050	.140	<.010	.20
NOV										
28...	.0	.60	2.3	2.9	.10	9.1	<.010	.200	<.010	.20
MAR 1989										
06...	.0	.60	2.5	.90	.20	9.1	<.010	.160	.020	<.20
MAY										
22...	.0	.60	2.0	1.4	.10	8.9	<.010	.150	.030	.40
SEP										
07...	.0	.50	2.0	.80	.10	9.2	<.010	<.100	.020	.30
NOV										
30...	.0	.60	2.0	3.1	.10	9.1	<.010	<.100	.020	<.20
MAY 1990										
30...	.0	.40	1.8	3.9	<.10	8.8	<.010	.200	<.010	.50
NOV										
29...	.0	.50	2.1	3.3	.20	8.6	<.010	.200	.080	<.20
			06430865 IRON CREEK NEAR LEAD, SD (LAT 44 22 25N LONG 103 55 07W)							
AUG 1988										
03...	.0	.60	3.0	.50	.20	9.7	<.010	.120	.030	.30
SEP										
08...	.0	.50	2.8	.50	.10	10	<.010	.100	.010	<.20
NOV										
15...	.0	.60	2.4	.40	.10	11	<.010	.140	.010	<.20
MAR 1989										
07...	.0	.70	2.5	.30	.20	9.8	<.010	.110	<.010	<.20
MAY										
11...	.1	.70	2.0	1.3	.10	11	<.010	<.100	<.010	.30
SEP										
11...	.0	.60	2.0	.50	.10	10	<.010	<.100	<.010	<.20
NOV										
29...	.0	.50	2.0	.50	.10	10	<.010	.210	.010	<.20
MAY 1990										
30...	.0	.50	2.0	1.1	<.10	10	<.010	.100	<.010	.40
NOV										
29...	.0	.70	1.9	2.7	.20	10	<.010	.200	.070	<.20
			06430898 SQUAW CREEK NEAR SPEARFISH, SD (LAT 44 24 04N LONG 103 53 35W)							
JUL 1988										
21...	.1	2.0	41	.60	1.0	16	<.010	<.100	<.010	.60
SEP										
08...	.1	1.7	38	.30	1.0	15	<.010	<.100	<.010	<.20
NOV										
09...	.1	1.5	42	.50	1.1	13	<.010	<.100	<.010	<.20
MAR 1989										
07...	.1	1.9	44	.20	1.3	14	<.010	.100	<.010	<.20
MAY										
12...	.1	1.3	12	1.5	.50	14	<.010	.180	.020	.30
SEP										
08...	.1	2.0	42	.50	1.1	15	<.010	<.100	.010	.40
NOV										
30...	.1	1.6	41	1.3	1.1	13	<.010	.160	<.010	<.20
MAY 1990										
29...	.1	1.5	20	3.2	.50	12	<.010	.500	<.010	.30
AUG										
23...	.1	2.2	40	.80	1.0	17	<.010	<.100	<.010	<.20
NOV										
30...	.1	1.8	49	.20	1.1	13	<.010	<.100	.060	<.20
MAR 1991										
13...	.1	1.8	64	1.5	1.3	13	<.010	.250	.020	.30
JUN										
20...	.1	1.8	29	2.5	.70	16	<.010	.840	.020	.30
SEP										
05...	.1	2.2	49	.60	.90	13	<.010	<.050	.010	<.20
DEC										
04...	.1	1.4	57	1.3	1.1	12	--	--	--	--
MAR 1992										
31...	.1	1.9	45	4.3	1.1	13	--	--	--	--
JUL										
15...	.1	2.4	69	5.7	1.0	13	--	--	--	<.20
AUG										
13...	.1	2.4	67	1.9	1.1	14	<.010	.055	<.010	--

Table 8. Water-quality data for selected streams in Lawrence County—Continued

06430850 LITTLE SPEARFISH CREEK NEAR LEAD, SD (LAT 44 20 58N LONG 103 56 08W)

DATE	PHOS-PHORUS DIS-SOLVED (MG/L AS P) (00666)	PHOS-PHORUS ORTHO, DIS-SOLVED (MG/L AS P) (00671)	CYANIDE TOTAL (MG/L AS CN) (00720)	CYANIDE DIS-SOLVED (MG/L AS CN) (00723)	ANTI-MONY, DIS-SOLVED (UG/L AS SB) (01095)	ARSENIC TOTAL (UG/L AS AS) (01002)	ARSENIC DIS-SOLVED (UG/L AS AS) (01000)	BARIUM, DIS-SOLVED (UG/L AS BA) (01005)	BORON, DIS-SOLVED (UG/L AS B) (01020)	CADMIUM DIS-SOLVED (UG/L AS CD) (01025)
JUL 1988 26...	.100	<.001	--	<.01	--	--	--	--	<10	--
SEP 12...	.020	.008	--	<.01	--	--	--	--	<10	--
NOV 28...	.010	.011	--	<.01	<1.0	--	1	96	<10	2.0
MAR 1989 06...	<.010	.013	<.010	<.01	<1.0	--	1	100	<10	<1.0
MAY 22...	.010	.020	--	<.01	<1.0	1	1	100	<10	<1.0
SEP 07...	.010	.007	<.010	<.01	<1.0	<1	<1	99	<10	<1.0
NOV 30...	<.010	.010	<.010	<.01	<1.0	--	1	97	<10	<1.0
MAY 1990 30...	.010	.010	<.010	<.01	<1.0	1	1	94	10	<10
NOV 29...	.040	.011	<.010	<.01	<1.0	<1	<1	97	<10	<10

06430865 IRON CREEK NEAR LEAD, SD (LAT 44 22 25N LONG 103 55 07W)

DATE	PHOS-PHORUS DIS-SOLVED (MG/L AS P) (00666)	PHOS-PHORUS ORTHO, DIS-SOLVED (MG/L AS P) (00671)	CYANIDE TOTAL (MG/L AS CN) (00720)	CYANIDE DIS-SOLVED (MG/L AS CN) (00723)	ANTI-MONY, DIS-SOLVED (UG/L AS SB) (01095)	ARSENIC TOTAL (UG/L AS AS) (01002)	ARSENIC DIS-SOLVED (UG/L AS AS) (01000)	BARIUM, DIS-SOLVED (UG/L AS BA) (01005)	BORON, DIS-SOLVED (UG/L AS B) (01020)	CADMIUM DIS-SOLVED (UG/L AS CD) (01025)
AUG 1988 03...	.030	.001	--	<.01	<1.0	--	1	89	10	<1.0
SEP 08...	.010	.010	--	<.01	1.0	--	1	89	<10	<1.0
NOV 15...	.020	.009	--	<.01	<1.0	--	1	86	<10	<1.0
MAR 1989 07...	.010	.013	<.010	<.01	<1.0	--	1	86	<10	<1.0
MAY 11...	.020	.011	--	<.01	<1.0	1	2	65	10	<1.0
SEP 11...	.020	.009	<.010	<.01	<1.0	1	1	85	<10	<1.0
NOV 29...	.010	.014	<.010	<.01	<1.0	<1	<1	86	10	<1.0
MAY 1990 30...	.010	.012	<.010	<.01	<1.0	1	1	78	<10	<10
NOV 29...	.020	.014	<.010	<.01	<1.0	<1	1	90	<10	<10

06430898 SQUAW CREEK NEAR SPEARFISH, SD (LAT 44 24 04N LONG 103 53 35W)

DATE	PHOS-PHORUS DIS-SOLVED (MG/L AS P) (00666)	PHOS-PHORUS ORTHO, DIS-SOLVED (MG/L AS P) (00671)	CYANIDE TOTAL (MG/L AS CN) (00720)	CYANIDE DIS-SOLVED (MG/L AS CN) (00723)	ANTI-MONY, DIS-SOLVED (UG/L AS SB) (01095)	ARSENIC TOTAL (UG/L AS AS) (01002)	ARSENIC DIS-SOLVED (UG/L AS AS) (01000)	BARIUM, DIS-SOLVED (UG/L AS BA) (01005)	BORON, DIS-SOLVED (UG/L AS B) (01020)	CADMIUM DIS-SOLVED (UG/L AS CD) (01025)
JUL 1988 21...	.020	<.001	--	<.01	<1.0	--	4	75	10	<1.0
SEP 08...	.010	.005	--	<.01	<1.0	--	<1	73	<10	<1.0
NOV 09...	.010	.003	--	<.01	<1.0	--	4	57	<10	<1.0
MAR 1989 07...	.010	.012	<.010	<.01	<1.0	--	4	62	<10	<1.0
MAY 12...	.010	.005	<.010	<.01	1.0	4	4	33	20	<1.0
SEP 08...	<.010	.003	<.010	<.01	<1.0	4	3	77	<10	<1.0
NOV 30...	.010	.003	<.010	<.01	<1.0	4	3	55	<10	<1.0
MAY 1990 29...	.020	.003	<.010	<.01	<1.0	3	3	51	<10	<10
AUG 23...	<.010	.002	<.010	<.01	<1.0	4	4	84	<10	<10
NOV 30...	<.010	.003	<.010	<.01	<1.0	4	4	66	<10	<10
MAR 1991 13...	<.010	<.010	<.010	<.01	<1.0	3	3	62	10	<10
JUN 20...	<.010	<.010	<.010	<.01	<1.0	3	3	62	<10	<10
SEP 05...	<.010	<.010	<.010	<.01	<1.0	4	3	85	10	<10
DEC 04...	--	--	<.010	<.01	<1.0	3	3	62	<10	<10
MAR 1992 31...	--	--	<.010	<.01	1.0	3	3	50	<10	<10
JUL 15...	<.010	--	<.010	<.01	<1.0	--	4	78	10	<10
AUG 13...	--	<.010	<.010	<.01	2.0	3	3	88	<10	<10

06430850 LITTLE SPEARFISH CREEK NEAR LEAD, SD (LAT 44 20 58N LONG 103 56 08W)

DATE	CHROMIUM, DISSOLVED (UG/L AS CR) (01030)	COPPER, DISSOLVED (UG/L AS CU) (01040)	IRON, DISSOLVED (UG/L AS FE) (01046)	LEAD, DISSOLVED (UG/L AS PB) (01049)	MANGANESE, DISSOLVED (UG/L AS MN) (01056)	MERCURY DISSOLVED (UG/L AS HG) (71890)	SELENIUM, DISSOLVED (UG/L AS SE) (01145)	ZINC, DISSOLVED (UG/L AS ZN) (01090)
JUL 1988 26...	--	--	--	--	--	<.1	--	--
SEP 12...	--	--	--	--	--	<.1	--	--
NOV 28...	1.0	1.0	15	<5.0	2.0	<.1	<1	8.0
MAR 1989 06...	<1.0	1.0	4.0	<5.0	<1.0	<.1	<1	5.0
MAY 22...	<1.0	4.0	7.0	1.0	<1.0	<.1	<1	6.0
SEP 07...	2.0	4.0	7.0	<1.0	<1.0	<.1	<1	24
NOV 30...	<1.0	<1.0	5.0	<1.0	<1.0	<.1	<1	16
MAY 1990 30...	1.0	1.0	<3.0	1.0	<1.0	<.1	<1	4.0
NOV 29...	<1.0	<1.0	11	1.0	<1.0	<.1	<1	3.0

06430865 IRON CREEK NEAR LEAD, SD (LAT 44 22 25N LONG 103 55 07W)

DATE	CHROMIUM, DISSOLVED (UG/L AS CR) (01030)	COPPER, DISSOLVED (UG/L AS CU) (01040)	IRON, DISSOLVED (UG/L AS FE) (01046)	LEAD, DISSOLVED (UG/L AS PB) (01049)	MANGANESE, DISSOLVED (UG/L AS MN) (01056)	MERCURY DISSOLVED (UG/L AS HG) (71890)	SELENIUM, DISSOLVED (UG/L AS SE) (01145)	ZINC, DISSOLVED (UG/L AS ZN) (01090)
AUG 1988 03...	1.0	5.0	8.0	<5.0	<1.0	<.1	<1	5.0
SEP 08...	<1.0	1.0	9.0	<5.0	<1.0	<.1	<1	20
NOV 15...	<1.0	<1.0	5.0	<5.0	<1.0	<.1	<1	6.0
MAR 1989 07...	<1.0	1.0	6.0	<5.0	<1.0	<.1	<1	7.0
MAY 11...	<1.0	1.0	5.0	<1.0	<1.0	<.1	<1	<3.0
SEP 11...	1.0	1.0	4.0	<1.0	<1.0	<.1	<1	4.0
NOV 29...	1.0	1.0	5.0	<1.0	<1.0	<.1	<1	<3.0
MAY 1990 30...	<1.0	<1.0	5.0	<1.0	<1.0	<.1	<1	<3.0
NOV 29...	<1.0	<1.0	<3.0	1.0	<1.0	<.1	<1	<3.0

06430898 SQUAW CREEK NEAR SPEARFISH, SD (LAT 44 24 04N LONG 103 53 35W)

DATE	CHROMIUM, DISSOLVED (UG/L AS CR) (01030)	COPPER, DISSOLVED (UG/L AS CU) (01040)	IRON, DISSOLVED (UG/L AS FE) (01046)	LEAD, DISSOLVED (UG/L AS PB) (01049)	MANGANESE, DISSOLVED (UG/L AS MN) (01056)	MERCURY DISSOLVED (UG/L AS HG) (71890)	SELENIUM, DISSOLVED (UG/L AS SE) (01145)	ZINC, DISSOLVED (UG/L AS ZN) (01090)
JUL 1988 21...	2.0	<1.0	4.0	<5.0	1.0	<.1	<1	12
SEP 08...	<1.0	1.0	5.0	<5.0	<1.0	<.1	<1	7.0
NOV 09...	<1.0	<1.0	7.0	<5.0	<1.0	<.1	<1	<3.0
MAR 1989 07...	<1.0	1.0	4.0	<5.0	<1.0	<.1	<1	5.0
MAY 12...	1.0	3.0	56	<1.0	1.0	<.1	<1	<3.0
SEP 08...	1.0	2.0	4.0	<1.0	<1.0	<.1	<1	5.0
NOV 30...	1.0	1.0	6.0	<1.0	<1.0	--	<1	4.0
MAY 1990 29...	<1.0	<1.0	6.0	<1.0	<1.0	<.1	<1	<3.0
AUG 23...	1.0	1.0	<3.0	<1.0	<1.0	--	<1	3.0
NOV 30...	<1.0	2.0	<3.0	1.0	<1.0	<.1	<1	4.0
MAR 1991 13...	2.0	1.0	5.0	<1.0	<1.0	.1	<1	5.0
JUN 20...	<1.0	2.0	6.0	<1.0	<1.0	<.1	<1	6.0
SEP 05...	<1.0	<1.0	9.0	<1.0	<1.0	<.1	<1	16
DEC 04...	<1.0	<1.0	<3.0	<1.0	<1.0	<.1	<1	4.0
MAR 1992 31...	<1.0	<1.0	12	<1.0	<1.0	<.1	<1	<3.0
JUL 15...	<1.0	2.0	16	<1.0	2.0	<.1	<1	3.0
AUG 13...	<1.0	1.0	<3.0	<1.0	<1.0	<.1	<1	<3.0

DATE	TIME	DIS-CHARGE, INST CUBIC FEET PER SECOND (00061)	SPE-CIFIC CON-DUCT-ANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STAND-ARD UNITS) (00400)	TEMPER-ATURE WATER (DEG C) (00010)	TEMPER-ATURE AIR (DEG C) (00020)	TUR-BID-ITY (NTU) (00076)	BARO-METRIC PRES-SURE (MM OF HG) (00025)	OXYGEN, DIS-SOLVED (MG/L) (00300)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION) (00301)	HARD-NESS TOTAL (MG/L AS CACO3) (00900)
06430900 SPEARFISH CREEK ABOVE SPEARFISH, SD (LAT 44 24 06N LONG 103 53 40W)											
JUL 1988											
25...	1100	42	410	8.5	12.0	28.0	.70	656	10.0	108	240
SEP											
08...	0915	38	425	8.6	9.0	14.0	.40	653	10.4	105	240
NOV											
09...	1015	41	431	8.6	3.0	1.0	.30	648	11.5	101	250
MAR 1989											
07...	1030	39	420	8.6	2.0	2.0	.40	646	13.7	117	250
MAY											
12...	0830	74	370	8.4	8.0	17.0	1.3	643	10.3	103	210
SEP											
08...	1045	40	418	8.5	8.7	10.0	.20	650	10.1	102	240
NOV											
30...	1300	34	426	8.6	1.5	-5.0	.20	654	12.3	103	260
MAY 1990											
29...	1015	64	388	8.6	9.5	13.5	.50	643	10.1	105	230
NOV											
30...	1230	38	406	8.6	3.0	1.0	.30	645	11.6	102	240
06430950 SPEARFISH CREEK BELOW ROBISON GULCH, NEAR SPEARFISH, SD (LAT 44 26 14N LONG 103 52 32W)											
JUL 1988											
22...	1030	2.5	395	8.4	18.0	22.0	--	661	9.8	120	220
AUG											
17...	0945	2.5	420	8.6	12.5	21.0	--	664	10.0	108	220
SEP											
13...	1130	E2.4	400	8.7	11.0	15.0	--	669	10.9	112	220
OCT											
19...	1030	2.9	400	8.6	8.0	10.0	--	659	11.2	110	230
NOV											
15...	0840	2.5	410	8.5	3.0	-4.0	--	657	11.4	98	230
DEC											
14...	0930	2.5	401	8.6	3.0	-1.0	--	661	11.6	100	220
JAN 1989											
17...	1030	2.2	380	8.5	2.5	5.0	--	655	12.0	103	220
FEB											
15...	1145	2.6	410	8.6	1.0	-3.0	--	667	12.8	103	230
MAR											
10...	0900	2.8	--	8.5	4.0	8.0	--	685	12.2	--	220
APR											
18...	0930	3.6	370	8.4	2.5	3.0	--	665	11.7	98	210
MAY											
11...	0830	6.4	329	8.3	7.5	17.5	--	654	10.3	100	180
JUN											
14...	1030	3.2	364	8.7	9.0	20.0	--	666	10.8	107	210
JUL											
19...	1325	3.0	364	8.7	18.5	27.0	--	667	9.6	117	200
AUG											
17...	1230	2.6	405	8.6	16.0	34.0	--	657	10.3	122	210
SEP											
11...	1200	2.3	390	8.7	9.5	13.5	--	665	11.3	114	230
OCT											
18...	1030	2.3	410	8.3	4.2	4.5	--	670	12.0	105	230
NOV											
20...	1200	2.5	380	8.7	5.5	8.0	--	664	11.8	108	220
DEC											
14...	1245	2.6	356	8.8	.0	-18.0	--	656	12.7	101	220
JAN 1990											
24...	1045	2.3	390	8.6	1.5	-.5	--	657	12.7	105	210
MAR											
27...	1045	2.8	380	8.6	4.0	15.5	--	659	12.3	109	210
APR											
11...	0900	3.2	360	8.6	1.0	-1.0	--	665	13.0	105	210
MAY											
17...	0815	6.3	330	8.6	4.5	5.5	--	660	11.1	99	180
JUN											
12...	1400	3.6	354	8.8	15.5	25.0	--	650	10.0	118	190

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	TIME	DIS-CHARGE, INST CUBIC FEET PER SECOND (00061)	SPE-CIFIC CON-DUCT-ANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STAND-ARD UNITS) (00400)	TEMPER-ATURE WATER (DEG C) (00010)	TEMPER-ATURE AIR (DEG C) (00020)	TUR-BID-ITY (NTU) (00076)	BARO-METRIC PRES-SURE (MM OF HG) (00025)	OXYGEN, DIS-SOLVED (MG/L) (00300)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION) (00301)	HARD-NESS TOTAL (MG/L AS CACO3) (00900)
06430950 SPEARFISH CREEK BELOW ROBISON GULCH, NEAR SPEARFISH, SD (LAT 44 26 14N LONG 103 52 32W)--Continued											
AUG											
15...	1315	2.4	375	8.6	19.0	30.0	--	660	9.5	119	200
SEP											
12...	1330	2.1	380	8.6	17.0	35.5	--	660	12.6	151	210
OCT											
11...	1200	2.3	383	8.6	8.5	5.0	--	662	11.0	108	220
NOV											
30...	1500	2.5	383	8.6	4.0	.0	--	658	11.4	101	220
DEC											
27...	1200	2.8	446	8.8	1.5	.5	--	649	12.5	105	230
FEB 1991											
05...	1045	2.4	405	8.7	3.0	5.0	--	663	13.4	115	220
MAR											
14...	0900	2.7	409	8.7	1.0	-2.0	--	657	12.9	105	240
APR											
24...	1145	4.1	350	8.6	9.5	21.5	--	653	10.8	111	190
MAY											
22...	1200	7.5	340	8.4	10.5	15.0	--	--	9.6	--	190
JUN											
17...	0830	5.4	377	8.6	10.0	15.0	--	658	9.4	97	220
27...	0845	4.2	386	8.5	10.0	13.0	--	658	11.7	120	220
SEP											
06...	1430	2.2	378	8.6	17.0	33.5	--	656	9.2	111	210
OCT											
23...	1415	2.4	402	--	7.5	3.5	--	648	12.3	121	220
DEC											
04...	1515	2.4	398	7.7	1.0	3.5	--	649	12.0	99	220
JAN 1992											
22...	1100	2.3	406	8.5	1.5	3.5	--	654	9.4	78	230
APR											
02...	1615	2.4	381	7.9	10.0	15.5	--	653	9.8	102	200
MAY											
19...	1215	2.8	380	8.6	16.5	28.5	--	655	9.4	112	210
JUN											
03...	1500	2.6	373	8.6	17.5	24.5	--	652	9.6	118	210
AUG											
13...	1345	2.1	379	8.4	18.0	25.5	--	661	9.8	120	200
SEP											
09...	1330	2.2	400	8.2	13.5	18.5	--	658	11.2	125	210

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	ANC UNFLTRD TIT 4.5 LAB (MG/L AS CACO3) (90410)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L) (70301)	SOLIDS, DIS- SOLVED (TONS PER DAY) (70302)	SOLIDS, RESIDUE AT 180 DEG C DIS- SOLVED (MG/L) (70300)	SOLIDS, DIS- SOLVED (TONS PER AC-FT) (70303)	RESIDUE TOTAL AT 105 DEG C, SUS- PENDED (MG/L) (00530)	CALCIUM DIS- SOLVED (MG/L AS CA) (00915)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG) (00925)	SODIUM, DIS- SOLVED (MG/L AS NA) (00930)	SODIUM PERCENT (00932)	SODIUM AD- SORP- TION RATIO (00931)
06430900 SPEARFISH CREEK ABOVE SPEARFISH, SD (LAT 44 24 06N LONG 103 53 40W)											
JUL 1988											
25...	195	229	26.2	230	.31	14	53	25	2.0	2	.1
SEP											
08...	193	256	18.5	182	.25	<1	55	26	2.0	2	.1
NOV											
09...	234	252	24.9	227	.31	<1	58	26	1.9	2	.1
MAR 1989											
07...	230	240	25.4	242	.33	2	59	24	2.1	2	.1
MAY											
12...	205	215	41.5	207	.28	2	51	21	2.1	2	.1
SEP											
08...	233	240	21.3	195	.27	<1	58	24	2.0	2	.1
NOV											
30...	239	248	21.3	229	.31	21	61	25	1.9	2	.1
MAY 1990											
29...	208	223	37.7	220	.30	2	54	22	2.1	2	.1
NOV											
30...	214	230	22.9	223	.30	<1	56	24	2.1	2	.1
06430950 SPEARFISH CREEK BELOW ROBISON GULCH, NEAR SPEARFISH, SD (LAT 44 26 14N LONG 103 52 32W)											
JUL 1988											
22...	194	229	1.53	--	.31	--	49	24	2.9	3	.1
AUG											
17...	194	213	1.42	--	.29	--	47	24	2.8	3	.1
SEP											
13...	194	234	--	--	.32	--	47	26	2.6	2	.1
OCT											
19...	220	236	1.87	--	.32	--	48	26	2.9	3	.1
NOV											
15...	223	241	1.63	--	.33	--	51	26	2.5	2	.1
DEC											
14...	223	233	1.59	--	.32	--	48	24	2.6	3	.1
JAN 1989											
17...	224	233	1.36	--	.32	--	47	25	2.7	3	.1
FEB											
15...	220	237	1.68	--	.32	--	50	25	2.8	3	.1
MAR											
10...	216	226	1.70	--	.31	--	49	24	2.8	3	.1
APR											
18...	209	219	2.13	--	.30	--	47	23	2.6	3	.1
MAY											
11...	174	191	3.30	--	.26	--	41	19	2.9	3	.1
JUN											
14...	188	208	1.79	--	.28	--	46	23	2.9	3	.1
JUL											
19...	197	210	1.71	--	.29	--	42	23	3.2	3	.1
AUG											
17...	195	211	1.47	--	.29	--	45	24	2.8	3	.1
SEP											
11...	193	214	1.32	--	.29	--	49	25	2.8	3	.1
OCT											
18...	214	229	1.45	--	.31	--	52	24	2.9	3	.1
NOV											
20...	205	222	1.51	--	.30	--	49	24	2.6	2	.1
DEC											
14...	209	223	1.57	--	.30	--	48	24	2.7	3	.1
JAN 1990											
24...	195	212	1.31	--	.29	--	48	23	2.6	3	.1
MAR											
27...	199	216	1.62	--	.29	--	47	23	2.9	3	.1
APR											
11...	199	215	1.87	--	.29	--	46	22	2.8	3	.1
MAY											
17...	178	194	3.29	--	.26	--	40	19	3.2	4	.1

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	ANC UNFLTRD TIT 4.5 LAB (MG/L AS CACO3) (90410)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L) (70301)	SOLIDS, DIS- SOLVED (TONS PER DAY) (70302)	SOLIDS, RESIDUE AT 180 DEG C DIS- SOLVED (MG/L) (70300)	SOLIDS, DIS- SOLVED (TONS PER AC-FT) (70303)	RESIDUE TOTAL AT 105 DEG C, SUS- PENDED (MG/L) (00530)	CALCIUM DIS- SOLVED (MG/L AS CA) (00915)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG) (00925)	SODIUM, DIS- SOLVED (MG/L AS NA) (00930)	SODIUM PERCENT (00932)	SODIUM AD- SORP- TION RATIO (00931)
06430950 SPEARFISH CREEK BELOW ROBISON GULCH, NEAR SPEARFISH, SD (LAT 44 26 14N LONG 103 52 32W)--Continued											
JUN											
12...	183	199	1.96	--	.27	--	40	21	3.0	3	.1
AUG											
15...	185	214	1.39	--	.29	--	42	24	2.9	3	.1
SEP											
12...	193	211	1.22	--	.29	--	43	24	2.8	3	.1
OCT											
11...	219	235	1.44	--	.32	--	49	24	2.8	3	.1
NOV											
30...	221	226	1.54	--	.31	--	49	24	2.8	3	.1
DEC											
27...	223	241	1.83	--	.33	--	51	25	2.7	2	.1
FEB 1991											
05...	221	232	1.51	--	.31	--	50	24	2.5	2	.1
MAR											
14...	224	244	1.77	--	.33	--	53	26	3.1	3	.1
APR											
24...	186	204	2.23	--	.28	--	43	21	2.8	3	.1
MAY											
22...	180	198	4.02	--	.27	--	42	20	3.4	4	.1
JUN											
17...	203	223	3.27	--	.30	--	50	22	3.7	4	.1
27...	189	218	2.49	--	.30	--	49	23	3.5	3	.1
SEP											
06...	184	207	1.24	--	.28	--	43	25	3.0	3	.1
OCT											
23...	207	224	1.44	--	.30	--	48	24	2.9	3	.1
DEC											
04...	197	218	1.40	--	.30	--	48	25	3.1	3	.1
JAN 1992											
22...	224	240	1.52	--	.33	--	52	24	2.6	2	.1
APR											
02...	196	219	1.40	--	.30	--	44	23	2.9	3	.1
MAY											
19...	187	211	1.60	--	.29	--	45	23	2.9	3	.1
JUN											
03...	181	207	1.43	--	.28	--	43	24	3.1	3	.1
AUG											
13...	192	208	1.17	--	.28	--	42	24	3.1	3	.1
SEP											
09...	192	206	1.22	--	.28	--	44	25	3.0	3	.1

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	POTASSIUM, DISSOLVED (MG/L AS K) (00935)	SULFATE DISSOLVED (MG/L AS SO4) (00945)	CHLORIDE, DISSOLVED (MG/L AS CL) (00940)	FLUORIDE, DISSOLVED (MG/L AS F) (00950)	SILICA, DISSOLVED (MG/L AS SIO2) (00955)	NITROGEN, NITRITE DISSOLVED (MG/L AS N) (00613)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N) (00631)	NITROGEN, AMMONIA DISSOLVED (MG/L AS N) (00608)	NITROGEN,AMMONIA + ORGANIC DISS (MG/L AS N) (00623)	PHOSPHORUS DISSOLVED (MG/L AS P) (00666)	PHOSPHORUS ORTHO, DISSOLVED (MG/L AS P) (00671)
06430900 SPEARFISH CREEK ABOVE SPEARFISH, SD (LAT 44 24 06N LONG 103 53 40W)											
JUL 1988											
25...	.70	20	1.3	.10	10	<.010	<.100	.030	.20	.020	<.002
SEP											
08...	.70	4.3	11	.20	11	<.010	<.100	.010	<.20	.010	.004
NOV											
09...	.80	4.2	.90	.20	9.8	.010	<.100	.010	<.20	.010	.001
MAR 1989											
07...	.50	4.4	.90	.20	9.8	<.010	.130	<.010	<.20	.010	.010
MAY											
12...	.80	4.0	2.2	.20	10	<.010	.130	.030	.30	.010	.009
SEP											
08...	.80	4.0	1.2	.20	9.9	<.010	<.100	<.010	<.20	.010	.011
NOV											
30...	.80	4.0	1.2	.20	10	<.010	.190	.010	<.20	<.010	.007
MAY 1990											
29...	.70	4.9	4.3	.20	9.8	<.010	.100	<.010	<.20	.010	.007
NOV											
30...	.80	4.0	3.8	.30	9.6	<.010	.100	.060	<.20	.010	.005
06430950 SPEARFISH CREEK BELOW ROBISON GULCH, NEAR SPEARFISH, SD (LAT 44 26 14N LONG 103 52 32W)											
JUL 1988											
22...	.80	8.8	1.7	.30	12	--	--	--	--	--	--
AUG											
17...	.80	8.8	1.5	.20	12	<.010	<.100	<.010	--	--	<.010
SEP											
13...	.80	9.2	1.4	.20	12	<.020	<.100	<.010	--	--	<.010
OCT											
19...	.90	9.9	1.4	.20	11	<.010	<.100	<.010	--	--	<.010
NOV											
15...	.90	9.5	1.3	.30	11	--	--	--	--	--	--
DEC											
14...	.70	8.3	1.4	.30	10	<.010	.170	<.010	--	--	<.010
JAN 1989											
17...	.90	9.0	1.2	.30	9.9	<.010	<.100	<.010	--	--	<.010
FEB											
15...	.90	9.9	1.2	.20	10	<.010	<.100	<.010	--	--	<.010
MAR											
10...	.80	8.4	2.0	.30	9.3	<.010	<.100	<.010	--	--	<.010
APR											
18...	.80	8.4	2.4	.20	9.7	<.010	<.100	<.010	--	--	<.010
MAY											
11...	.90	10	2.7	.30	9.9	<.010	<.100	<.010	--	--	<.010
JUN											
14...	.70	9.0	2.2	.30	11	<.010	<.100	<.010	--	--	.010
JUL											
19...	.90	9.0	2.3	.20	11	<.010	<.100	<.010	--	--	<.010
AUG											
17...	.80	8.0	1.9	.20	11	<.010	<.100	<.010	--	--	<.010
SEP											
11...	.80	8.0	1.7	.30	11	<.010	<.100	<.010	--	--	<.010
OCT											
18...	.90	8.0	2.0	.30	11	<.010	<.100	.010	--	--	.020
NOV											
20...	.70	9.0	2.1	.30	11	<.010	<.100	<.010	--	--	<.010
DEC											
14...	.70	9.0	1.7	.30	11	<.010	<.100	.020	--	--	<.010
JAN 1990											
24...	.80	9.0	1.7	.40	9.7	<.010	<.100	<.010	--	--	<.010
MAR											
27...	.80	8.8	4.5	.30	9.5	<.010	<.100	<.010	--	--	<.010
APR											
11...	.60	10	4.6	.20	9.9	<.010	<.100	<.010	--	--	<.010
MAY											
17...	.70	9.3	5.2	.30	10	<.010	<.100	<.010	--	--	<.010
JUN											
12...	.70	9.1	4.6	.30	11	<.010	<.100	<.010	--	--	<.010

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	POTAS-SIUM, DIS-SOLVED (MG/L AS K) (00935)	SULFATE DIS-SOLVED (MG/L AS SO4) (00945)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL) (00940)	FLUO-RIDE, DIS-SOLVED (MG/L AS F) (00950)	SILICA, DIS-SOLVED (MG/L AS SIO2) (00955)	NITRO-GEN, NITRITE DIS-SOLVED (MG/L AS N) (00613)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N) (00631)	NITRO-GEN, AMMONIA DIS-SOLVED (MG/L AS N) (00608)	NITRO-GEN,AM-MONIA + ORGANIC DISS (MG/L AS N) (00623)	PHOS-PHORUS DIS-SOLVED (MG/L AS P) (00666)	PHOS-PHORUS ORTHO, DIS-SOLVED (MG/L AS P) (00671)
06430950 SPEARFISH CREEK BELOW ROBISON GULCH, NEAR SPEARFISH, SD (LAT 44 26 14N LONG 103 52 32W)--Continued											
AUG											
15...	.80	17	5.0	.20	11	<.010	<.100	.030	--	--	<.010
SEP											
12...	.80	8.9	4.7	.20	11	--	--	--	--	--	--
OCT											
11...	.90	11	4.6	<.10	11	<.010	<.100	<.010	--	--	<.010
NOV											
30...	.80	3.9	3.0	.30	10	<.010	<.100	.060	--	--	<.010
DEC											
27...	.80	13	3.8	.40	10	<.010	.100	.040	--	--	<.010
FEB 1991											
05...	.80	8.0	3.8	.30	9.6	<.010	<.100	<.010	--	--	<.010
MAR											
14...	.80	12	5.1	.30	9.4	<.010	<.050	.010	--	--	<.010
APR											
24...	.70	9.3	5.3	.20	9.8	.090	.130	.020	--	--	<.010
MAY											
22...	.80	10	3.3	.20	9.9	<.010	<.050	.020	--	--	<.010
JUN											
17...	.80	8.8	4.3	.30	11	<.010	<.050	.010	--	--	<.010
27...	.80	12	4.9	.30	11	<.010	<.050	<.010	--	--	<.010
SEP											
06...	1.0	9.2	4.4	.30	11	<.010	<.050	<.010	--	--	<.010
OCT											
23...	.90	8.1	3.2	.30	12	<.010	<.050	.010	--	--	.020
DEC											
04...	.90	9.0	3.7	.30	10	<.010	<.050	<.010	--	--	<.010
JAN 1992											
22...	.70	11	5.2	.30	10	<.010	<.050	<.010	--	--	<.010
APR											
02...	1.2	11	10	.30	9.2	--	--	--	--	--	--
MAY											
19...	.70	12	4.8	.30	10	.010	<.050	.010	--	--	<.010
JUN											
03...	.80	11	6.4	.30	9.7	<.010	<.050	.020	--	--	<.010
AUG											
13...	.80	10	3.1	.30	10	<.010	<.050	<.010	--	--	<.010
SEP											
09...	.90	4.0	2.4	.20	11	<.010	<.050	.010	--	--	<.010

Table 8. Water-quality data for selected streams in Lawrence County—Continued

06430900 SPEARFISH CREEK ABOVE SPEARFISH, SD (LAT 44 24 06N LONG 103 53 40W)

DATE	CYANIDE TOTAL (MG/L AS CN) (00720)	CYANIDE DIS-SOLVED (MG/L AS CN) (00723)	ANTI-MONY, DIS-SOLVED (UG/L AS SB) (01095)	ARSENIC TOTAL (UG/L AS AS) (01002)	ARSENIC DIS-SOLVED (UG/L AS AS) (01000)	BARIUM, DIS-SOLVED (UG/L AS BA) (01005)	BORON, DIS-SOLVED (UG/L AS B) (01020)	CADMIUM DIS-SOLVED (UG/L AS CD) (01025)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR) (01030)	COPPER, DIS-SOLVED (UG/L AS CU) (01040)
JUL 1988										
25...	--	<.01	<1.0	--	4	85	10	<1.0	<1.0	<1.0
SEP										
08...	--	--	<1.0	--	4	83	<10	<1.0	1.0	1.0
NOV										
09...	--	<.01	<1.0	--	3	84	<10	2.0	<1.0	2.0
MAR 1989										
07...	<.010	<.01	<1.0	--	3	84	<10	<1.0	1.0	<1.0
MAY										
12...	<.010	<.01	<1.0	5	5	80	<10	<1.0	1.0	1.0
SEP										
08...	<.010	<.01	<1.0	2	2	88	<10	<1.0	2.0	1.0
NOV										
30...	<.010	<.01	<1.0	3	2	86	20	<1.0	<1.0	1.0
MAY 1990										
29...	<.010	<.01	<1.0	5	4	82	<10	<10	<1.0	<1.0
NOV										
30...	<.010	<.01	<1.0	4	4	80	<10	<10	<1.0	1.0

06430950 SPEARFISH CREEK BELOW ROBISON GULCH, NEAR SPEARFISH, SD (LAT 44 26 14N LONG 103 52 32W)

DATE	CYANIDE TOTAL (MG/L AS CN) (00720)	CYANIDE DIS-SOLVED (MG/L AS CN) (00723)	ANTI-MONY, DIS-SOLVED (UG/L AS SB) (01095)	ARSENIC TOTAL (UG/L AS AS) (01002)	ARSENIC DIS-SOLVED (UG/L AS AS) (01000)	BARIUM, DIS-SOLVED (UG/L AS BA) (01005)	BORON, DIS-SOLVED (UG/L AS B) (01020)	CADMIUM DIS-SOLVED (UG/L AS CD) (01025)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR) (01030)	COPPER, DIS-SOLVED (UG/L AS CU) (01040)
JUL 1988										
22...	<.010	<.01	--	--	3	--	--	--	--	--
AUG										
17...	<.010	--	--	2	3	--	--	--	--	--
SEP										
13...	<.010	<.01	--	--	4	--	--	--	--	--
OCT										
19...	--	--	--	1	1	--	--	--	--	--
NOV										
15...	<.010	<.01	--	--	3	--	--	--	--	--
DEC										
14...	<.010	<.01	--	--	3	--	--	--	--	--
JAN 1989										
17...	<.010	<.01	--	1	3	--	--	--	--	--
FEB										
15...	--	<.01	--	2	3	--	--	--	--	--
MAR										
10...	<.010	<.01	--	--	3	--	--	--	--	--
APR										
18...	<.010	<.01	--	--	4	--	--	--	--	--
MAY										
11...	<.010	<.01	--	--	4	--	--	--	--	--
JUN										
14...	<.010	<.01	--	--	3	--	--	--	--	--
JUL										
19...	<.010	<.01	--	--	3	--	--	--	--	--
AUG										
17...	<.010	<.01	--	--	3	--	--	--	--	--
SEP										
11...	<.010	<.01	--	<1	3	--	--	--	--	--
OCT										
18...	<.010	<.01	--	<1	3	--	--	--	--	--
NOV										
20...	<.010	<.01	--	<1	2	--	--	--	--	--
DEC										
14...	<.010	<.01	--	--	2	--	--	--	--	--
JAN 1990										
24...	<.010	<.01	--	--	2	--	--	--	--	--
MAR										
27...	<.010	<.01	--	1	3	--	--	--	--	--
APR										
11...	<.010	<.01	--	10	3	--	--	--	--	--
MAY										
17...	<.010	<.01	--	--	2	--	--	--	--	--
JUN										
12...	<.010	<.01	--	--	3	--	--	--	--	--

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	CYANIDE TOTAL (MG/L AS CN) (00720)	CYANIDE DIS-SOLVED (MG/L AS CN) (00723)	ANTI-MONY, DIS-SOLVED (UG/L AS SB) (01095)	ARSENIC TOTAL (UG/L AS AS) (01002)	ARSENIC DIS-SOLVED (UG/L AS AS) (01000)	BARIUM, DIS-SOLVED (UG/L AS BA) (01005)	BORON, DIS-SOLVED (UG/L AS B) (01020)	CADMIUM DIS-SOLVED (UG/L AS CD) (01025)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR) (01030)	COPPER, DIS-SOLVED (UG/L AS CU) (01040)
06430950 SPEARFISH CREEK BELOW ROBISON GULCH, NEAR SPEARFISH, SD (LAT 44 26 14N LONG 103 52 32W)--Continued										
AUG										
15...	<.010	<.01	--	--	3	--	--	--	--	--
SEP										
12...	<.010	<.01	--	--	3	--	--	--	--	--
OCT										
11...	<.010	<.01	--	--	2	--	--	--	--	--
NOV										
30...	<.010	<.01	--	--	3	--	--	--	--	--
DEC										
27...	<.010	<.01	--	--	2	--	--	--	--	--
FEB 1991										
05...	<.010	<.01	--	--	3	--	--	--	--	--
MAR										
14...	<.010	<.01	--	--	2	--	--	--	--	--
APR										
24...	<.010	<.01	--	--	3	--	--	--	--	--
MAY										
22...	<.010	<.01	--	--	3	--	--	--	--	--
JUN										
17...	<.010	<.01	--	--	3	--	--	--	--	--
27...	<.010	<.01	--	--	3	--	--	--	--	--
SEP										
06...	<.010	<.01	--	--	3	--	--	--	--	--
OCT										
23...	<.010	<.01	--	--	2	--	--	--	--	--
DEC										
04...	<.010	<.01	--	--	3	--	--	--	--	--
JAN 1992										
22...	<.010	<.01	--	--	2	--	--	--	--	--
APR										
02...	<.010	<.01	--	--	2	--	--	--	--	--
MAY										
19...	<.010	<.01	--	--	3	--	--	--	--	--
JUN										
03...	<.010	<.01	--	--	2	--	--	--	--	--
AUG										
13...	<.010	<.01	--	--	2	--	--	--	--	--
SEP										
09...	<.010	<.01	--	--	3	--	--	--	--	--

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	IRON, TOTAL RECOV-ERABLE (UG/L AS FE) (01045)	IRON, DIS-SOLVED (UG/L AS FE) (01046)	LEAD, DIS-SOLVED (UG/L AS PB) (01049)	MANGA-NESE, TOTAL RECOV-ERABLE (UG/L AS MN) (01055)	MANGA-NESE, DIS-SOLVED (UG/L AS MN) (01056)	MERCURY DIS-SOLVED (UG/L AS HG) (71890)	SELE-NIUM, DIS-SOLVED (UG/L AS SE) (01145)	ZINC, DIS-SOLVED (UG/L AS ZN) (01090)
06430900 SPEARFISH CREEK ABOVE SPEARFISH, SD (LAT 44 24 06N LONG 103 53 40W)								
JUL 1988								
25...	--	6.0	<5.0	--	<1.0	<.1	3	<3.0
SEP								
08...	--	10	<5.0	--	<1.0	<.1	<1	8.0
NOV								
09...	--	7.0	<5.0	--	3.0	<.1	<1	<3.0
MAR 1989								
07...	--	4.0	<5.0	--	<1.0	<.1	<1	5.0
MAY								
12...	--	9.0	1.0	--	1.0	<.1	<1	<3.0
SEP								
08...	--	12	<1.0	--	<1.0	<.1	<1	21
NOV								
30...	--	4.0	<1.0	--	<1.0	<.1	<1	11
MAY 1990								
29...	--	8.0	<1.0	--	<1.0	<.1	<1	8.0
NOV								
30...	--	<3.0	<1.0	--	<1.0	<.1	<1	4.0
06430950 SPEARFISH CREEK BELOW ROBISON GULCH, NEAR SPEARFISH, SD (LAT 44 26 14N LONG 103 52 32W)								
JUL 1988								
22...	20	--	--	<10	--	--	--	--
AUG								
17...	30	--	--	<10	--	--	--	--
SEP								
13...	50	--	--	<10	--	--	--	--
OCT								
19...	40	--	--	<10	--	--	--	--
NOV								
15...	30	--	--	20	--	--	--	--
DEC								
14...	40	--	--	<10	--	--	--	--
JAN 1989								
17...	<10	--	--	<10	--	--	--	--
FEB								
15...	20	--	--	<10	--	--	--	--
MAR								
10...	40	--	--	<10	--	--	--	--
APR								
18...	40	--	--	<10	--	--	--	--
MAY								
11...	60	--	--	<10	--	--	--	--
JUN								
14...	30	--	--	<10	--	--	--	--
JUL								
19...	70	--	--	<10	--	--	--	--
AUG								
17...	<10	--	--	<10	--	--	--	--
SEP								
11...	40	--	--	<10	--	--	--	--
OCT								
18...	30	--	--	<10	--	--	--	--
NOV								
20...	<10	--	--	40	--	--	--	--
DEC								
14...	20	--	--	40	--	--	--	--
JAN 1990								
24...	30	--	--	10	--	--	--	--
MAR								
27...	40	--	--	<10	--	--	--	--
APR								
11...	30	--	--	<10	--	--	--	--
MAY								
17...	60	--	--	<10	--	--	--	--
JUN								
12...	90	--	--	10	--	--	--	--
AUG								
15...	10	--	--	<10	--	--	--	--
SEP								
12...	<10	--	--	<10	--	--	--	--
OCT								
11...	<10	--	--	<10	--	--	--	--
NOV								
30...	<10	--	--	70	--	--	--	--
DEC								
27...	<10	--	--	<10	--	--	--	--
FEB 1991								
05...	<10	--	--	<10	--	--	--	--
MAR								
14...	<10	--	--	<10	--	--	--	--
APR								
24...	<10	--	--	<10	--	--	--	--
MAY								
22...	20	--	--	<10	--	--	--	--

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	IRON, TOTAL RECOV-ERABLE (UG/L AS FE) (01045)	IRON, DIS-SOLVED (UG/L AS FE) (01046)	LEAD, DIS-SOLVED (UG/L AS PB) (01049)	MANGA-NESE, TOTAL RECOV-ERABLE (UG/L AS MN) (01055)	MANGA-NESE, DIS-SOLVED (UG/L AS MN) (01056)	MERCURY DIS-SOLVED (UG/L AS HG) (71890)	SELE-NIUM, DIS-SOLVED (UG/L AS SE) (01145)	ZINC, DIS-SOLVED (UG/L AS ZN) (01090)
06430950 SPEARFISH CREEK BELOW ROBISON GULCH, NEAR SPEARFISH, SD (LAT 44 26 14N LONG 103 52 32W)--Continued								
JUN								
17...	40	--	--	<10	--	--	--	--
27...	70	--	--	<10	--	--	--	--
SEP								
06...	120	--	--	<10	--	--	--	--
OCT								
23...	30	--	--	10	--	--	--	--
DEC								
04...	<10	--	--	<10	--	--	--	--
JAN 1992								
22...	<10	--	--	<10	--	--	--	--
APR								
02...	<10	--	--	<10	--	--	--	--
MAY								
19...	<10	--	--	<10	--	--	--	--
JUN								
03...	50	--	--	<10	--	--	--	--
AUG								
13...	<10	--	--	<10	--	--	--	--
SEP								
09...	40	--	--	10	--	--	--	--

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	ALPHA COUNT, 2 SIGMA WATER DISS AS TH-230 (PCI/L) (75987)	GROSS BETA, DIS-SOLVED (PCI/L AS CS-137) (03515)	BETA, 2 SIGMA WATER, DISS, AS CS-137 (PCI/L) (75989)	GROSS BETA, DIS-SOLVED (PCI/L AS SR/ Y-90) (80050)	BETA, 2 SIGMA WATER, DISS, AS SR90 /Y90 (PCI/L (75988)	RA-226 2 SIGMA WATER, DISS, (PCI/L) (76001)	RA-226, DIS-SOLVED, PLAN-CHET COUNT (PCI/L) (09510)	PHENOLS TOTAL (UG/L) (32730)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML) (31625)	STREP-TOCOCCI FECAL, KF AGAR (COLS. PER 100 ML) (31673)
06430950 SPEARFISH CREEK BELOW ROBISON GULCH, NEAR SPEARFISH, SD (LAT 44 26 14N LONG 103 52 32W)--Continued										
AUG										
15...	--	--	--	--	--	--	--	2	K7	K16
SEP										
12...	--	--	--	--	--	--	--	<1	K6	K18
OCT										
11...	--	--	--	--	--	--	--	4	K10	20
NOV										
30...	--	--	--	--	--	--	--	3	<1	K2
DEC										
27...	--	--	--	--	--	--	--	<1	K1	K1
FEB 1991										
05...	--	--	--	--	--	--	--	3	<1	<1
MAR										
14...	--	--	--	--	--	--	--	<1	<1	<1
APR										
24...	--	--	--	--	--	--	--	2	--	--
MAY										
22...	--	--	--	--	--	--	--	<1	K4	--
JUN										
17...	--	--	--	--	--	--	--	1	--	--
27...	--	--	--	--	--	--	--	<1	K1	K13
SEP										
06...	--	--	--	--	--	--	--	2	<1	21
OCT										
23...	--	--	--	--	--	--	--	1	<1	<1
DEC										
04...	--	--	--	--	--	--	--	<1	10	4
JAN 1992										
22...	--	--	--	--	--	--	--	18	<1	<1
APR										
02...	--	--	--	--	--	--	--	2	<1	<1
MAY										
19...	--	--	--	--	--	--	--	1	--	--
JUN										
03...	--	--	--	--	--	--	--	2	K2	K6
AUG										
13...	--	--	--	--	--	--	--	1	31	K13
SEP										
09...	--	--	--	--	--	--	--	<1	K1	K14

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	TIME	DIS-CHARGE, INST CUBIC FEET PER SECOND (00061)	SPE-CIFIC CON-DUCT-ANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STAND-ARD UNITS) (00400)	TEMPER-ATURE WATER (DEG C) (00010)	TEMPER-ATURE AIR (DEG C) (00020)	TUR-BID-ITY (NTU) (00076)	BARO-METRIC PRES-SURE (MM OF HG) (00025)	OXYGEN, DIS-SOLVED (MG/L) (00300)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION) (00301)	HARD-NESS TOTAL (MG/L AS CACO3) (00900)
06432020 SPEARFISH CREEK BELOW SPEARFISH, SD (LAT 44 34 48N LONG 103 53 37W)											
AUG 1988 04...	1000	6.8	930	8.1	14.0	22.5	1.1	683	9.6	103	530
SEP 15...	1015	13	830	8.2	12.0	15.0	.40	681	9.9	103	470
NOV 28...	0900	52	640	8.4	3.5	4.0	.40	671	12.1	104	360
MAR 1989 09...	1200	49	--	8.2	6.5	14.0	.50	680	11.6	--	340
MAY 31...	0950	37	630	8.4	8.3	10.5	.30	681	10.2	97	370
SEP 11...	0900	29	690	8.3	7.0	5.0	.30	685	10.8	99	390
DEC 01...	1300	56	625	8.4	3.5	10.0	.30	686	12.1	101	360
MAY 1990 31...	1245	57	553	8.6	17.0	25.0	1.0	670	9.7	115	300
NOV 26...	1145	49	620	8.4	2.0	-5.0	.60	669	12.6	104	360
APR 1992 02...	1315	40	626	8.4	10.0	18.0	.40	673	10.7	108	340
JUL 15...	1500	17	831	7.5	17.5	22.5	.30	675	11.0	131	460
06432172 FALSE BOTTOM CREEK NEAR CENTRAL CITY, SD (LAT 44 23 28N LONG 103 47 58W)											
AUG 1988 03...	0815	.36	--	7.8	16.0	17.0	2.8	642	8.1	98	170
SEP 13...	0845	.28	380	8.1	8.0	10.0	.40	646	9.8	98	180
NOV 14...	1045	.41	340	8.2	2.0	12.0	10	628	11.4	100	160
MAR 1989 08...	1350	.55	260	8.1	2.0	10.0	46	638	11.6	100	120
MAY 10...	1000	13	110	7.6	6.7	13.0	14	635	10.2	100	48
SEP 12...	0800	.36	360	8.2	4.0	7.5	.30	642	10.7	97	170
NOV 28...	0830	.70	330	8.2	.0	-12.0	8.0	640	12.1	99	140
MAY 1990 30...	1300	3.2	220	8.2	11.0	15.0	6.5	633	9.5	104	90
AUG 24...	0915	.29	360	8.2	14.0	22.5	.60	637	13.8	161	170
06432180 FALSE BOTTOM CREEK NEAR SPEARFISH, SD (LAT 44 27 09N LONG 103 48 22W)											
MAY 1989 09...	0845	20	140	7.7	5.2	5.0	15	663	11.2	101	55
MAY 1990 17...	1315	2.7	194	8.3	11.2	20.0	8.5	655	9.2	98	95
06436156 WHITETAIL CREEK AT LEAD, SD (LAT 44 20 36N LONG 103 45 57W)											
AUG 1988 02...	0845	1.2	440	8.4	12.0	25.0	1.6	638	9.6	107	220
SEP 06...	1300	.82	425	8.4	13.0	29.0	1.5	632	9.3	107	210
NOV 08...	1230	1.1	429	8.4	3.5	4.5	.70	628	11.0	101	230
MAR 1989 08...	1200	1.3	450	8.4	3.0	10.0	10	637	13.2	118	230
MAY 23...	0930	7.0	320	8.4	8.8	21.0	2.5	629	9.7	101	160
SEP 12...	1030	.91	425	8.4	5.5	9.0	.80	640	10.8	102	210
NOV 28...	1115	1.2	450	8.4	.0	-4.0	.60	645	12.0	97	220
APR 1990 10...	1045	--	400	8.4	1.0	6.0	.50	642	12.8	107	200
MAY 16...	0830	--	290	8.4	5.0	11.0	5.0	630	10.2	97	130
AUG 24...	1230	1.1	400	8.5	16.5	26.0	.60	633	8.0	99	200
NOV 27...	1245	.68	441	8.5	.5	-5.0	.90	625	11.2	95	230
MAR 1991 12...	1415	1.1	480	8.4	1.5	.0	2.7	632	11.9	103	220
JUN 24...	1115	4.1	382	8.7	14.0	21.0	2.0	633	9.0	106	190
SEP 04...	1430	.78	416	9.3	15.0	25.0	.50	--	--	--	210
DEC 03...	1115	1.0	--	8.0	.5	-4.0	.80	626	12.0	--	220
MAR 1992 30...	1600	1.4	509	8.0	8.0	16.0	.90	630	10.2	105	230
JUL 14...	1430	1.9	457	7.6	16.5	29.0	1.3	628	8.0	100	220

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	ANC UNFLTRD TIT 4.5 LAB (MG/L AS CACO3) (90410)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L) (70301)	SOLIDS, DIS-SOLVED (TONS PER DAY) (70302)	SOLIDS, RESIDUE AT 180 DEG C DIS-SOLVED (MG/L) (70300)	SOLIDS, DIS-SOLVED (TONS PER AC-FT) (70303)	RESIDUE TOTAL AT 105 DEG C, SUS-PENDED (MG/L) (00530)	CALCIUM DIS-SOLVED (MG/L AS CA) (00915)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG) (00925)	SODIUM, DIS-SOLVED (MG/L AS NA) (00930)	SODIUM PERCENT (00932)
06432020 SPEARFISH CREEK BELOW SPEARFISH, SD (LAT 44 34 48N LONG 103 53 37W)										
AUG 1988 04...	221	605	12.1	660	.90	9	140	44	6.4	3
SEP 15...	235	547	17.7	498	.68	9	120	42	5.8	3
NOV 28...	238	418	58.1	414	.56	<1	91	32	3.9	2
MAR 1989 09...	244	383	54.1	407	.55	<1	89	29	3.6	2
MAY 31...	236	407	42.0	417	.57	1	96	32	3.9	2
SEP 11...	227	436	30.4	388	.53	<1	100	35	5.0	3
DEC 01...	229	399	62.4	409	.56	8	93	30	3.5	2
MAY 1990 31...	202	331	51.7	334	.45	<1	77	27	3.1	2
NOV 26...	228	423	52.7	398	.54	<1	94	31	3.7	2
APR 1992 02...	211	372	42.3	394	.54	3	89	29	3.3	2
JUL 15...	219	543	25.3	552	.75	<1	120	38	5.1	2
06432172 FALSE BOTTOM CREEK NEAR CENTRAL CITY, SD (LAT 44 23 28N LONG 103 47 58W)										
AUG 1988 03...	88	240	.24	247	.34	11	49	12	6.4	7
SEP 13...	88	250	.19	253	.34	6	51	13	6.7	7
NOV 14...	72	225	.24	220	.30	1	44	11	5.8	7
MAR 1989 08...	64	177	.27	182	.25	180	35	8.5	5.3	8
MAY 10...	23	83	2.82	81	.11	3	14	3.2	3.3	12
SEP 12...	79	242	.23	236	.32	<1	48	12	6.6	8
NOV 28...	65	205	.40	211	.29	8	40	10	5.8	8
MAY 1990 30...	43	148	1.32	153	.21	4	27	5.5	4.1	9
AUG 24...	90	240	.18	229	.31	11	48	12	6.3	7
06432180 FALSE BOTTOM CREEK NEAR SPEARFISH, SD (LAT 44 27 09N LONG 103 48 22W)										
MAY 1989 09...	46	92	5.61	105	.14	5	17	3.0	7.2	22
MAY 1990 17...	60	141	.93	130	.18	7	28	6.1	4.0	8
06436156 WHITETAIL CREEK AT LEAD, SD (LAT 44 20 36N LONG 103 45 57W)										
AUG 1988 02...	175	249	.82	249	.34	5	57	18	6.8	6
SEP 06...	171	243	.48	219	.30	2	56	18	5.5	5
NOV 08...	186	259	.78	252	.34	15	61	18	6.8	6
MAR 1989 08...	180	273	1.02	287	.39	2	61	19	12	10
MAY 23...	125	192	3.79	201	.27	3	44	12	7.1	9
SEP 12...	167	254	.60	244	.33	<1	58	17	7.5	7
NOV 28...	160	261	.87	261	.35	8	59	17	8.8	8
APR 1990 10...	136	243	--	257	.35	7	54	15	10	10
MAY 16...	100	177	--	173	.24	3	38	9.3	8.0	11
AUG 24...	158	234	.71	239	.33	10	55	15	7.8	8
NOV 27...	182	272	.48	260	.35	<1	61	18	8.9	8
MAR 1991 12...	153	285	.84	282	.38	<1	59	18	14	12
JUN 24...	148	245	2.50	226	.31	20	55	13	8.9	9
SEP 04...	160	245	.52	247	.34	<1	58	15	7.5	7
DEC 03...	169	276	.80	285	.39	1	60	17	9.2	8
MAR 1992 30...	148	289	1.05	284	.39	4	61	18	13	11
JUL 14...	158	262	1.40	272	.37	2	60	16	10	9

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	SODIUM AD- SORP- TION RATIO (00931)	POTAS- SIUM, DIS- SOLVED (MG/L AS K) (00935)	SULFATE DIS- SOLVED (MG/L AS SO4) (00945)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL) (00940)	FLUO- RIDE, DIS- SOLVED (MG/L AS F) (00950)	SILICA, DIS- SOLVED (MG/L AS SIO2) (00955)	NITRO- GEN, NITRITE DIS- SOLVED (MG/L AS N) (00613)	NITRO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N) (00631)	NITRO- GEN, AMMONIA DIS- SOLVED (MG/L AS N) (00608)	NITRO- GEN,AM- MONIA + ORGANIC DISS (MG/L AS N) (00623)
06432020 SPEARFISH CREEK BELOW SPEARFISH, SD (LAT 44 34 48N LONG 103 53 37W)										
AUG 1988 04...	.1	1.8	260	4.1	.30	13	<.010	.560	.050	.30
SEP 15...	.1	1.7	190	3.9	.60	13	.010	.490	<.010	<.20
NOV 28...	.1	1.3	120	2.3	.20	11	.010	.350	<.010	.30
MAR 1989 09...	.1	1.4	100	2.4	.20	9.6	<.010	.220	.040	<.20
MAY 31...	.1	1.2	120	2.5	.20	10	<.010	<.100	.010	<.20
SEP 11...	.1	1.7	140	3.8	.20	12	<.010	.390	.010	<.20
DEC 01...	.1	1.1	120	2.5	.20	10	<.010	.280	.020	.30
MAY 1990 31...	.1	.80	90	2.1	<.10	9.1	<.010	.100	.010	<.20
NOV 26...	.1	1.3	140	4.6	.40	9.7	.020	.300	.050	<.20
APR 1992 02...	.1	1.5	110	4.1	.20	8.4	--	--	--	--
JUL 15...	.1	1.6	230	6.6	.20	9.7	--	--	--	<.20
06432172 FALSE BOTTOM CREEK NEAR CENTRAL CITY, SD (LAT 44 23 28N LONG 103 47 58W)										
AUG 1988 03...	.2	4.0	92	1.1	1.0	22	<.010	<.100	.020	.40
SEP 13...	.2	4.0	98	1.3	1.2	20	<.010	<.100	<.010	.30
NOV 14...	.2	3.4	96	1.2	1.1	19	<.010	<.100	.010	<.20
MAR 1989 08...	.2	4.2	66	3.0	1.0	15	<.010	<.100	.070	.70
MAY 10...	.2	1.8	26	1.7	.40	19	<.010	<.100	<.010	<.20
SEP 12...	.2	4.0	100	1.8	1.2	21	<.010	<.100	<.010	<.20
NOV 28...	.2	3.7	83	2.2	1.2	20	<.010	<.100	<.010	<.20
MAY 1990 30...	.2	2.5	59	3.1	.30	20	<.010	.100	<.010	<.20
AUG 24...	.2	3.9	90	1.5	1.3	22	<.010	.300	<.010	<.20
06432180 FALSE BOTTOM CREEK NEAR SPEARFISH, SD (LAT 44 27 09N LONG 103 48 22W)										
MAY 1989 09...	.4	1.6	19	1.8	.40	14	<.010	<.100	<.010	.40
MAY 1990 17...	.2	1.8	44	4.8	.50	16	<.010	<.100	<.010	<.20
06436156 WHITETAIL CREEK AT LEAD, SD (LAT 44 20 36N LONG 103 45 57W)										
AUG 1988 02...	.2	1.7	33	12	.50	14	<.010	.160	.030	<.20
SEP 06...	.2	1.2	29	5.5	.60	14	<.010	.130	.010	<.20
NOV 08...	.2	1.4	34	8.8	--	14	<.010	.110	.010	<.20
MAR 1989 08...	.3	1.6	35	20	.60	14	<.010	.300	<.010	<.20
MAY 23...	.2	1.5	28	10	.40	13	<.010	.290	.010	.60
SEP 12...	.2	1.8	39	14	.50	15	<.010	.170	<.010	<.20
NOV 28...	.3	1.9	45	17	.40	14	<.010	.440	.010	<.20
APR 1990 10...	.3	1.7	37	28	.20	12	<.010	.700	.020	.40
MAY 16...	.3	1.7	27	18	.50	12	.010	.500	.010	.20
AUG 24...	.2	1.6	33	11	.60	15	<.010	<.100	<.010	.20
NOV 27...	.3	1.8	42	14	.60	14	.020	.500	.050	<.20
MAR 1991 12...	.4	1.8	51	35	.40	12	<.010	.410	<.010	.30
JUN 24...	.3	1.6	38	20	.40	13	.020	1.40	.040	<.20
SEP 04...	.2	1.6	38	12	.40	13	<.010	.650	.020	.30
DEC 03...	.3	1.6	52	20	.50	14	--	--	--	--
MAR 1992 30...	.4	1.8	54	40	.40	12	--	--	--	--
JUL 14...	.3	1.8	43	23	.40	13	--	--	--	<.20

DATE	PHOS-PHORUS DIS-SOLVED (MG/L AS P) (00666)	PHOS-PHORUS ORTHO, DIS-SOLVED (MG/L AS P) (00671)	CYANIDE TOTAL (MG/L AS CN) (00720)	CYANIDE DIS-SOLVED (MG/L AS CN) (00723)	ANTI-MONY, DIS-SOLVED (UG/L AS SB) (01095)	ARSENIC TOTAL (UG/L AS AS) (01002)	ARSENIC DIS-SOLVED (UG/L AS AS) (01000)	BARIUM, DIS-SOLVED (UG/L AS BA) (01005)	BORON, DIS-SOLVED (UG/L AS B) (01020)	CADMIUM DIS-SOLVED (UG/L AS CD) (01025)
06432020 SPEARFISH CREEK BELOW SPEARFISH, SD (LAT 44 34 48N LONG 103 53 37W)										
AUG 1988 04...	.020	<.001	--	<.01	<1.0	--	2	92	40	<1.0
SEP 15...	<.010	<.001	--	<.01	<1.0	--	2	110	40	<1.0
NOV 28...	<.010	<.001	--	<.01	<1.0	--	2	91	20	2.0
MAR 1989 09...	<.010	.002	<.010	<.01	<1.0	--	2	85	20	<1.0
MAY 31...	<.010	<.001	--	<.01	<1.0	2	3	81	20	<1.0
SEP 11...	<.010	<.001	<.010	<.01	<1.0	2	2	93	20	<1.0
DEC 01...	<.010	<.001	<.010	<.01	<1.0	2	2	84	10	<1.0
MAY 1990 31...	<.010	.001	<.010	<.01	<1.0	4	3	80	10	<10
NOV 26...	<.010	.003	<.010	<.01	<1.0	2	3	86	20	<10
APR 1992 02...	--	--	<.010	<.01	1.0	2	2	78	20	<10
JUL 15...	<.010	--	<.010	<.01	<1.0	--	3	78	50	<10
06432172 FALSE BOTTOM CREEK NEAR CENTRAL CITY, SD (LAT 44 23 28N LONG 103 47 58W)										
AUG 1988 03...	.020	.002	--	<.01	<1.0	--	3	75	20	1.0
SEP 13...	<.010	<.001	--	<.01	<1.0	--	3	65	10	<1.0
NOV 14...	<.010	<.001	--	<.01	<1.0	--	2	54	<10	<1.0
MAR 1989 08...	.110	.106	<.010	<.01	<1.0	--	3	47	10	<1.0
MAY 10...	<.010	.001	<.010	<.01	<1.0	4	1	40	<10	1.0
SEP 12...	<.010	.001	<.010	<.01	<1.0	2	2	62	<10	<1.0
NOV 28...	<.010	.001	<.010	<.01	<1.0	--	<1	55	10	<1.0
MAY 1990 30...	<.010	.005	<.010	<.01	<1.0	2	1	51	10	<10
AUG 24...	<.010	.003	<.010	<.01	<1.0	3	2	69	<10	<10
06432180 FALSE BOTTOM CREEK NEAR SPEARFISH, SD (LAT 44 27 09N LONG 103 48 22W)										
MAY 1989 09...	.020	.011	--	<.01	1.0	--	2	46	<10	<3.0
MAY 1990 17...	.010	.035	<.010	<.01	<1.0	4	5	59	10	<10
06436156 WHITETAIL CREEK AT LEAD, SD (LAT 44 20 36N LONG 103 45 57W)										
AUG 1988 02...	.020	.007	--	<.01	2.0	--	17	99	30	1.0
SEP 06...	.010	.009	--	<.01	<1.0	--	16	87	20	<1.0
NOV 08...	.010	<.001	--	<.01	1.0	--	13	88	10	<1.0
MAR 1989 08...	.010	.014	<.010	<.01	<1.0	--	12	90	20	<1.0
MAY 23...	.020	.009	--	<.01	2.0	12	11	82	30	<1.0
SEP 12...	<.010	.006	<.010	<.01	2.0	19	16	92	20	<1.0
NOV 28...	.010	.005	<.010	<.01	3.0	15	12	90	30	<1.0
APR 1990 10...	.010	<.001	<.010	<.01	2.0	14	11	88	30	<1.0
MAY 16...	<.010	.006	<.010	<.01	1.0	7	7	85	20	<10
AUG 24...	<.010	.002	<.010	<.01	1.0	20	19	95	20	<10
NOV 27...	<.010	<.010	<.010	<.01	2.0	13	12	94	20	<10
MAR 1991 12...	<.010	<.010	<.010	<.01	<1.0	14	13	92	30	<10
JUN 24...	.010	<.010	<.010	<.01	2.0	17	12	99	30	<10
SEP 04...	<.010	<.010	<.010	<.01	2.0	19	19	95	20	<10
DEC 03...	--	--	<.010	<.01	1.0	13	11	90	30	<10
MAR 1992 30...	--	--	<.010	<.01	3.0	16	15	95	20	<10
JUL 14...	<.010	--	<.010	<.01	4.0	--	20	100	30	<10

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	CHRO-MIUM, DIS-SOLVED (UG/L AS CR) (01030)	COPPER, DIS-SOLVED (UG/L AS CU) (01040)	IRON, DIS-SOLVED (UG/L AS FE) (01046)	LEAD, DIS-SOLVED (UG/L AS PB) (01049)	MANGA-NESE, DIS-SOLVED (UG/L AS MN) (01056)	MERCURY DIS-SOLVED (UG/L AS HG) (71890)	SELE-NIUM, DIS-SOLVED (UG/L AS SE) (01145)	ZINC, DIS-SOLVED (UG/L AS ZN) (01090)
06432020 SPEARFISH CREEK BELOW SPEARFISH, SD (LAT 44 34 48N LONG 103 53 37W)								
AUG 1988 04...	2.0	1.0	32	<5.0	8.0	<.1	2	8.0
SEP 15...	<1.0	<1.0	69	<5.0	3.0	<.1	2	19
NOV 28...	1.0	<1.0	6.0	<5.0	2.0	<.1	<1	13
MAR 1989 09...	2.0	<1.0	7.0	<5.0	5.0	<.1	<1	5.0
MAY 31...	2.0	<1.0	10	<1.0	5.0	<.1	<1	11
SEP 11...	<1.0	1.0	8.0	<1.0	3.0	<.1	<1	16
DEC 01...	1.0	1.0	4.0	<1.0	2.0	<.1	<1	7.0
MAY 1990 31...	<1.0	1.0	4.0	<1.0	4.0	<.1	<1	<3.0
NOV 26...	<1.0	1.0	5.0	<1.0	3.0	<.1	<1	6.0
APR 1992 02...	<1.0	<1.0	<3.0	<1.0	2.0	<.1	<1	<3.0
JUL 15...	<1.0	<1.0	27	<1.0	5.0	<.1	1	4.0
06432172 FALSE BOTTOM CREEK NEAR CENTRAL CITY, SD (LAT 44 23 28N LONG 103 47 58W)								
AUG 1988 03...	<1.0	1.0	18	<5.0	7.0	<.1	<1	6.0
SEP 13...	1.0	3.0	18	12	3.0	<.1	<1	9.0
NOV 14...	<1.0	<1.0	11	<5.0	2.0	<.1	<1	4.0
MAR 1989 08...	2.0	1.0	42	<5.0	18	<.1	<1	16
MAY 10...	1.0	3.0	210	1.0	15	<.1	<1	31
SEP 12...	<1.0	<1.0	11	<1.0	2.0	<.1	<1	4.0
NOV 28...	<1.0	1.0	9.0	<1.0	2.0	<.1	<1	4.0
MAY 1990 30...	1.0	2.0	94	<1.0	18	<.1	<1	15
AUG 24...	<1.0	<1.0	8.0	<1.0	3.0	<.1	<1	<3.0
06432180 FALSE BOTTOM CREEK NEAR SPEARFISH, SD (LAT 44 27 09N LONG 103 48 22W)								
MAY 1989 09...	1.0	2.0	63	<1.0	<3.0	<.1	<1	<9.0
MAY 1990 17...	2.0	1.0	68	<1.0	1.0	<.1	<1	<3.0
06436156 WHITETAIL CREEK AT LEAD, SD (LAT 44 20 36N LONG 103 45 57W)								
AUG 1988 02...	1.0	1.0	17	<5.0	16	<.1	<1	12
SEP 06...	<1.0	<1.0	17	<5.0	15	<.1	<1	<3.0
NOV 08...	1.0	<1.0	17	<5.0	15	<.1	1	9.0
MAR 1989 08...	1.0	<1.0	21	<5.0	7.0	<.1	<1	11
MAY 23...	2.0	2.0	12	<1.0	10	<.1	2	<3.0
SEP 12...	2.0	<1.0	12	<1.0	16	<.1	<1	9.0
NOV 28...	1.0	1.0	6.0	<1.0	8.0	<.1	<1	<3.0
APR 1990 10...	<5.0	<10	13	<10	7.0	<.1	<1	<3.0
MAY 16...	<1.0	1.0	46	<1.0	12	<.1	<1	5.0
AUG 24...	1.0	<1.0	9.0	<1.0	7.0	<.1	<1	<3.0
NOV 27...	<1.0	1.0	20	<1.0	12	<.1	<1	11
MAR 1991 12...	<1.0	1.0	4.0	<1.0	9.0	.1	1	4.0
JUN 24...	<1.0	1.0	5.0	<1.0	17	<.1	<1	<3.0
SEP 04...	<1.0	<1.0	13	<1.0	17	<.1	<1	3.0
DEC 03...	<1.0	<1.0	12	<1.0	17	<.1	<1	<3.0
MAR 1992 30...	<1.0	<1.0	11	<1.0	11	<.1	<1	4.0
JUL 14...	<1.0	<1.0	140	<1.0	39	.1	1	22

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	TIME	DIS- CHARGE, INST CUBIC FEET PER SECOND (00061)	SPE- CIFIC CON- DUCT- ANCE (US/CM) (00095)	PH WATER WHOLE FIELD (STAND- ARD UNITS) (00400)	TEMPER- ATURE WATER (DEG C) (00010)	TEMPER- ATURE AIR (DEG C) (00020)	TUR- BID- ITY (NTU) (00076)	BARO- METRIC PRES- SURE (MM OF HG) (00025)	OXYGEN, DIS- SOLVED (MG/L) (00300)	OXYGEN, DIS- SOLVED (PER- CENT SATUR- ATION) (00301)	HARD- NESS TOTAL (MG/L AS CACO3) (00900)
06437020 BEAR BUTTE CREEK NEAR DEADWOOD, SD (LAT 44 20 08N LONG 103 38 06W)											
JUL 1988											
18...	1120	.96	280	8.4	18.0	20.0	.20	649	8.2	103	140
SEP											
06...	1000	.46	340	8.3	12.0	28.0	.60	640	9.0	100	150
NOV											
08...	0930	1.1	290	8.3	.0	1.0	.60	637	12.1	99	140
MAR 1989											
08...	0830	1.6	250	8.0	.0	-1.0	5.2	644	13.6	110	120
MAY											
31...	1400	5.7	194	8.3	8.5	7.5	2.4	644	9.9	100	95
SEP											
12...	1200	1.3	350	8.4	7.5	8.0	.20	647	9.9	97	170
NOV											
28...	1400	1.9	330	8.1	.0	-4.0	.50	645	11.8	96	150
MAY 1990											
16...	1140	15	170	8.7	10.0	8.0	7.5	639	10.0	106	65
AUG											
23...	1445	.76	297	8.4	20.0	23.0	.70	640	9.5	125	150
NOV											
27...	0915	.66	305	8.3	.0	-5.0	.40	634	13.1	108	160
MAR 1991											
12...	1000	2.2	283	8.1	.0	2.5	1.6	640	11.7	95	130
JUN											
24...	0845	10	232	8.5	14.5	19.5	5.5	640	8.5	100	110
SEP											
04...	1100	1.1	352	8.2	13.5	21.0	.50	--	--	--	160
DEC											
05...	1245	1.2	293	8.3	.5	4.5	.50	634	12.5	104	140
MAR 1992											
30...	1300	2.2	282	7.7	9.0	13.5	.70	639	9.8	101	130
JUL											
14...	1145	2.4	329	7.4	15.0	19.0	.60	635	8.2	98	150

DATE	ANC UNFLTRD TIT 4.5 LAB (MG/L AS CACO3) (90410)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L) (70301)	SOLIDS, DIS- SOLVED (TONS PER DAY) (70302)	SOLIDS, RESIDUE AT 180 DEG C DIS- SOLVED (MG/L) (70300)	SOLIDS, DIS- SOLVED (TONS PER AC-FT) (70303)	RESIDUE TOTAL AT 105 DEG C, SUS- PENDED (MG/L) (00530)	CALCIUM DIS- SOLVED (MG/L AS CA) (00915)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG) (00925)	SODIUM, DIS- SOLVED (MG/L AS NA) (00930)	SODIUM PERCENT (00932)
06437020 BEAR BUTTE CREEK NEAR DEADWOOD, SD (LAT 44 20 08N LONG 103 38 06W)										
JUL 1988										
18...	108	179	.50	191	.26	1	38	10	4.6	7
SEP										
06...	113	188	.24	192	.26	5	41	12	4.9	6
NOV										
08...	108	176	.53	178	.24	8	39	11	4.2	6
MAR 1989										
08...	84	156	.65	148	.20	2	32	8.6	7.8	12
MAY										
31...	64	124	2.14	139	.19	1	26	7.2	3.8	8
SEP										
12...	97	220	.70	206	.28	2	47	13	5.0	6
NOV										
28...	90	198	1.04	202	.27	11	42	11	4.8	6
MAY 1990										
16...	44	105	4.89	120	.16	18	17	5.4	3.5	10
AUG										
23...	111	181	.35	170	.23	17	41	11	5.3	7
NOV										
27...	123	195	.33	185	.25	<1	43	12	4.9	6
MAR 1991										
12...	85	175	1.05	176	.24	20	36	10	5.3	8
JUN										
24...	70	157	3.81	141	.19	9	32	7.9	4.0	7
SEP										
04...	105	218	.65	208	.28	3	47	11	5.1	6
DEC										
05...	83	174	.51	157	.21	11	40	10	4.3	6
MAR 1992										
30...	76	167	.93	156	.21	1	35	9.4	4.4	7
JUL										
14...	83	201	1.27	194	.26	8	42	11	4.8	6

Table 8. Water-quality data for selected streams in Lawrence County—Continued

DATE	SODIUM AD-SORP-TION RATIO (00931)	POTAS-SIUM, DIS-SOLVED (MG/L AS K) (00935)	SULFATE DIS-SOLVED (MG/L AS SO4) (00945)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL) (00940)	FLUO-RIDE, DIS-SOLVED (MG/L AS F) (00950)	SILICA, DIS-SOLVED (MG/L AS SIO2) (00955)	NITRO-GEN, NITRITE DIS-SOLVED (MG/L AS N) (00613)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N) (00631)	NITRO-GEN, AMMONIA DIS-SOLVED (MG/L AS N) (00608)	NITRO-GEN,AM-MONIA + ORGANIC DISS (MG/L AS N) (00623)
06437020 BEAR BUTTE CREEK NEAR DEADWOOD, SD (LAT 44 20 08N LONG 103 38 06W)										
JUL 1988										
18...	.2	2.8	34	11	.30	13	<.010	<.100	.020	<.20
SEP										
06...	.2	2.7	39	4.6	.30	13	<.010	.160	.020	.30
NOV										
08...	.2	2.6	37	5.1	.30	11	<.010	<.100	<.010	<.20
MAR 1989										
08...	.3	3.5	30	12	.30	11	<.010	.130	<.010	.20
MAY										
31...	.2	2.1	29	4.1	.20	13	<.010	<.100	.010	<.20
SEP										
12...	.2	2.9	73	6.3	.30	14	<.010	<.100	<.010	<.20
NOV										
28...	.2	2.9	64	6.3	.30	13	<.010	<.100	<.010	.20
MAY 1990										
16...	.2	1.4	33	5.3	.10	13	<.010	<.100	<.010	.20
AUG										
23...	.2	2.9	36	5.5	.40	12	<.010	<.100	<.010	<.20
NOV										
27...	.2	2.3	39	7.7	.50	12	.020	<.100	.050	<.20
MAR 1991										
12...	.2	2.9	48	9.8	.30	11	<.010	.062	<.010	.30
JUN										
24...	.2	2.4	48	6.1	.30	13	.010	.100	.050	.20
SEP										
04...	.2	3.2	69	7.3	.30	12	<.010	<.050	.010	<.20
DEC										
05...	.2	2.4	51	4.7	.30	11	--	--	--	--
MAR 1992										
30...	.2	2.3	52	6.9	.20	11	--	--	--	--
JUL										
14...	.2	2.8	70	8.7	.40	11	--	--	--	<.20

DATE	PHOS-PHORUS DIS-SOLVED (MG/L AS P) (00666)	PHOS-PHORUS ORTHO, DIS-SOLVED (MG/L AS P) (00671)	CYANIDE TOTAL (MG/L AS CN) (00720)	CYANIDE DIS-SOLVED (MG/L AS CN) (00723)	ANTI-MONY, DIS-SOLVED (UG/L AS SB) (01095)	ARSENIC TOTAL (UG/L AS AS) (01002)	ARSENIC DIS-SOLVED (UG/L AS AS) (01000)	BARIUM, DIS-SOLVED (UG/L AS BA) (01005)	BORON, DIS-SOLVED (UG/L AS B) (01020)	CADMIUM DIS-SOLVED (UG/L AS CD) (01025)
06437020 BEAR BUTTE CREEK NEAR DEADWOOD, SD (LAT 44 20 08N LONG 103 38 06W)										
JUL 1988										
18...	.040	.002	--	<.01	<1.0	--	2	42	20	<1.0
SEP										
06...	.010	.003	--	<.01	<1.0	--	1	41	20	<1.0
NOV										
08...	.010	<.001	--	<.01	<1.0	--	1	37	<10	2.0
MAR 1989										
08...	.020	.016	--	--	<1.0	--	1	40	10	<1.0
MAY										
31...	<.010	.001	--	<.01	<1.0	<1	<1	31	20	<1.0
SEP										
12...	<.010	<.001	<.010	<.01	<1.0	1	<1	42	<10	<1.0
NOV										
28...	<.010	.001	<.010	<.01	<1.0	--	<1	41	30	<1.0
MAY 1990										
16...	<.010	.002	<.010	<.01	<1.0	<1	<1	27	10	<10
AUG										
23...	<.010	.002	<.010	<.01	<1.0	2	2	46	20	<10
NOV										
27...	<.010	.001	<.010	<.01	<1.0	<1	1	44	10	<10
MAR 1991										
12...	<.010	<.010	<.010	<.01	<1.0	<1	<1	41	10	<10
JUN										
24...	<.010	<.010	<.010	<.01	<1.0	2	<1	44	20	<10
SEP										
04...	<.010	<.010	<.010	<.01	<1.0	2	2	43	20	<10
DEC										
05...	--	--	<.010	<.01	<1.0	<1	1	34	10	<10
MAR 1992										
30...	--	--	<.010	<.01	<1.0	<1	<1	33	10	<10
JUL										
14...	<.010	--	<.010	<.01	<1.0	--	1	43	20	<10

DATE	CHRO-MIUM, DIS-SOLVED (UG/L AS CR) (01030)	COPPER, DIS-SOLVED (UG/L AS CU) (01040)	IRON, DIS-SOLVED (UG/L AS FE) (01046)	LEAD, DIS-SOLVED (UG/L AS PB) (01049)	MANGA-NESE, DIS-SOLVED (UG/L AS MN) (01056)	MERCURY DIS-SOLVED (UG/L AS HG) (71890)	SELE-NIUM, DIS-SOLVED (UG/L AS SE) (01145)	ZINC, DIS-SOLVED (UG/L AS ZN) (01090)
06437020 BEAR BUTTE CREEK NEAR DEADWOOD, SD (LAT 44 20 08N LONG 103 38 06W)								
JUL 1988 18...	1.0	5.0	13	<5.0	6.0	<.1	<1	12
SEP 06...	<1.0	2.0	11	<5.0	5.0	<.1	<1	8.0
NOV 08...	<1.0	1.0	20	16	3.0	<.1	<1	4.0
MAR 1989 08...	2.0	2.0	68	<5.0	3.0	<.1	<1	18
MAY 31...	1.0	5.0	36	<1.0	14	<.1	<1	10
SEP 12...	<1.0	6.0	6.0	<1.0	2.0	<.1	<1	6.0
NOV 28...	<1.0	4.0	9.0	<1.0	7.0	<.1	<1	29
MAY 1990 16...	<1.0	9.0	80	1.0	52	<.1	<1	12
AUG 23...	<1.0	4.0	6.0	<1.0	6.0	<.1	<1	5.0
NOV 27...	<1.0	1.0	8.0	<1.0	1.0	<.1	<1	6.0
MAR 1991 12...	<1.0	2.0	22	<1.0	7.0	<.1	<1	8.0
JUN 24...	<1.0	28	19	<1.0	330	<.1	<1	12
SEP 04...	<1.0	6.0	21	<1.0	60	<.1	<1	11
DEC 05...	<1.0	4.0	5.0	<1.0	14	<.1	<1	9.0
MAR 1992 30...	<1.0	8.0	10	<1.0	28	<.1	<1	8.0
JUL 14...	<1.0	16	100	<1.0	89	.2	<1	30

Table 9. Water-quality data in the mineralized area of Lawrence County from Torve (1991)

[US/CM, microsiemens per centimeter; DEG C, degrees Celsius; NTU, nephelometric turbidity units; MM, millimeters; MG/L, milligrams per liter; UG/L, micrograms per liter; ANC, acid-neutralizing capacity; UM-MF, micrometer-membrane filter; COLS, colonies; ML, milliliters; INST, instantaneous; UNFLTRD, unfiltered; DISS, dissolved; TIT, titration; LAB, laboratory; <, less than; --, no data available]

DATE	TIME	DIS-CHARGE, INST CUBIC FEET PER SECOND (00061)	SPE-CIFIC CON-DUCT-ANCE (US/CM) (00095)	SPE-CIFIC CON-DUCT-ANCE LAB (US/CM) (90095)	PH WATER WHOLE FIELD (STAND-ARD UNITS) (00400)	TEMPER-ATURE WATER (DEG C) (00010)	TEMPER-ATURE AIR (DEG C) (00020)	TUR-BID-ITY (NTU) (00076)	BARO-METRIC PRES-SURE (MM OF HG) (00025)	OXYGEN, DIS-SOLVED (MG/L) (00300)	OXYGEN, DIS-SOLVED (PER-CENT SATUR-ATION) (00301)
06430800 ANNIE CREEK NEAR LEAD, SD (LAT 44 19 37N LONG 103 53 38W)											
AUG 1990											
22...	1230	.28	365	373	8.6	14.5	22.5	1.0	632	9.2	109
06430898 SQUAW CREEK NEAR SPEARFISH, SD (LAT 44 24 04N LONG 103 53 35W)											
AUG 1990											
23...	0930	.41	329	337	8.3	15.0	16.0	.20	648	10.0	117
442250103485700 S.E. FALSE BOTTOM CREEK NEAR LEAD, SD (LAT 44 22 50N LONG 103 48 57W)											
AUG 1990											
28...	1115	.03	226	238	7.6	18.0	26.0	1.5	635	5.7	73
442246103490300 FALSE BOTTOM CREEK BELOW BALD MOUNTAIN MINE, NEAR LEAD, SD (LAT 44 22 46N LONG 103 49 03W)											
AUG 1990											
28...	0930	.11	363	379	7.8	14.0	25.0	4.1	635	7.7	90
442252103493800 FALSE BOTTOM CREEK ABOVE COLUMBIA, NEAR LEAD, SD (LAT 44 22 52N LONG 103 49 38W)											
AUG 1990											
28...	1400	.02	182	194	3.8	17.5	25.0	4.5	630	7.4	94
06432172 FALSE BOTTOM CREEK NEAR CENTRAL CITY, SD (LAT 44 23 28N LONG 103 47 58W)											
AUG 1990											
24...	0915	.29	360	367	8.2	14.0	22.5	.60	637	13.8	161
442125103483000 S. DEADWOOD CREEK ABOVE HIDDEN TREASURE, NEAR LEAD, SD (LAT 44 21 25N LONG 103 48 30W											
AUG 1990											
29...	1000	.04	245	265	8.3	12.0	17.5	2.0	631	8.3	93
442131103482000 DEADWOOD CREEK BELOW HIDDEN TREASURE, NEAR LEAD, SD (LAT 44 21 31N LONG 103 48 20W)											
AUG 1990											
29...	1115	.08	294	317	5.5	14.5	22.0	14	631	6.7	79
442213103443900 DEADWOOD CREEK BELOW BROKEN BOOT, AT DEADWOOD, SD (LAT 44 22 13N LONG 103 44 39W)											
AUG 1990											
29...	1330	.82	715	779	7.4	19.0	29.5	25	646	7.3	94
441919103390800 BEAR BUTTE CREEK ABOVE STRAWBERRY CREEK, NEAR DEADWOOD, SD (LAT 44 19 19N LONG 103 39 08W)											
AUG 1990											
30...	1230	.44	263	288	8.2	20.0	30.5	2.1	635	7.8	104
441925103390400 STRAWBERRY CREEK NEAR DEADWOOD, SD (LAT 44 19 25N LONG 103 39 04W											
AUG 1990											
30...	1010	.21	302	328	8.0	12.5	21.0	1.0	635	8.5	96
06437020 BEAR BUTTE CREEK NEAR DEADWOOD, SD (LAT 44 20 08N LONG 103 38 06W)											
AUG 1990											
23...	1445	.76	297	309	8.4	20.0	23.0	.70	640	9.5	125

Table 9. Water-quality data in the mineralized area of Lawrence County from Torve (1991)—Continued

DATE	HARD-NESS TOTAL (MG/L AS CACO3) (00900)	ANC UNFLTRD TIT 4.5 LAB (MG/L AS CACO3) (90410)	SOLIDS, RESIDUE AT 180 DEG C DIS-SOLVED (MG/L) (70300)	RESIDUE TOTAL AT 105 DEG C, SUS-PENDED (MG/L) (00530)	CALCIUM DIS-SOLVED (MG/L AS CA) (00915)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG) (00925)	SODIUM, DIS-SOLVED (MG/L AS NA) (00930)	SODIUM AD-SORP-TION RATIO (00931)	SODIUM PERCENT (00932)	POTAS-SIUM, DIS-SOLVED (MG/L AS K) (00935)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL) (00940)
06430800 ANNIE CREEK NEAR LEAD, SD (LAT 44 19 37N LONG 103 53 38W)											
AUG 1990											
22...	190	166	215	10	49	16	5.4	.2	6	1.4	5.6
06430898 SQUAW CREEK NEAR SPEARFISH, SD (LAT 44 24 04N LONG 103 53 35W)											
AUG 1990											
23...	170	134	200	3	45	14	3.0	.1	4	2.2	.80
442250103485700 S.E. FALSE BOTTOM CREEK NEAR LEAD, SD (LAT 44 22 50N LONG 103 48 57W)											
AUG 1990											
28...	92	49	158	14	28	5.4	6.7	.3	13	2.4	<.10
442246103490300 FALSE BOTTOM CREEK BELOW BALD MOUNTAIN MINE, NEAR LEAD, SD (LAT 44 22 46N LONG 103 49 03W)											
AUG 1990											
28...	160	45	257	12	47	9.6	8.1	.3	10	4.9	3.3
442252103493800 FALSE BOTTOM CREEK ABOVE COLUMBIA, NEAR LEAD, SD (LAT 44 22 52N LONG 103 49 38W)											
AUG 1990											
28...	32	<1.0	114	26	6.8	3.6	2.8	.2	14	5.2	1.0
06432172 FALSE BOTTOM CREEK NEAR CENTRAL CITY, SD (LAT 44 23 28N LONG 103 47 58W)											
AUG 1990											
24...	170	90	229	11	48	12	6.3	.2	7	3.9	1.5
442125103483000 S. DEADWOOD CREEK ABOVE HIDDEN TREASURE, NEAR LEAD, SD (LAT 44 21 25N LONG 103 48 30W)											
AUG 1990											
29...	110	39	175	<1	34	7.2	2.3	.1	4	4.2	.60
442131103482000 DEADWOOD CREEK BELOW HIDDEN TREASURE, NEAR LEAD, SD (LAT 44 21 31N LONG 103 48 20W)											
AUG 1990											
29...	98	<1.0	216	5	26	8.0	3.4	.1	7	5.3	1.2
442213103443900 DEADWOOD CREEK BELOW BROKEN BOOT, AT DEADWOOD, SD (LAT 44 22 13N LONG 103 44 39W)											
AUG 1990											
29...	370	172	534	28	89	37	17	.4	9	4.5	22
441919103390800 BEAR BUTTE CREEK ABOVE STRAWBERRY CREEK, NEAR DEADWOOD, SD (LAT 44 19 19N LONG 103 39 08W)											
AUG 1990											
30...	130	114	156	13	36	9.9	4.9	.2	7	2.8	7.4
441925103390400 STRAWBERRY CREEK NEAR DEADWOOD, SD (LAT 44 19 25N LONG 103 39 04W)											
AUG 1990											
30...	160	120	205	<1	49	9.1	4.0	.1	5	2.0	2.3
06437020 BEAR BUTTE CREEK NEAR DEADWOOD, SD (LAT 44 20 08N LONG 103 38 06W)											
AUG 1990											
23...	150	111	170	17	41	11	5.3	.2	7	2.9	5.5

Table 9. Water-quality data in the mineralized area of Lawrence County from Torve (1991)—Continued

DATE	SULFATE DIS-SOLVED (MG/L AS SO4) (00945)	NITRO-GEN, NITRITE DIS-SOLVED (MG/L AS N) (00613)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N) (00631)	NITRO-GEN, AMMONIA DIS-SOLVED (MG/L AS N) (00608)	NITRO-GEN,AM-MONIA + ORGANIC DISS (MG/L AS N) (00623)	PHOS-PHORUS DIS-SOLVED (MG/L AS P) (00666)	PHOS-PHORUS ORTHO, DIS-SOLVED (MG/L AS P) (00671)	CYANIDE DIS-SOLVED (MG/L AS CN) (00723)	ARSENIC DIS-SOLVED (UG/L AS AS) (01000)	BORON, DIS-SOLVED (UG/L AS B) (01020)	CADMIUM DIS-SOLVED (UG/L AS CD) (01025)
06430800 ANNIE CREEK NEAR LEAD, SD (LAT 44 19 37N LONG 103 53 38W)											
AUG 1990											
22...	10	<.010	4.30	<.010	.50	.020	.010	<.01	48	<10	<10
06430898 SQUAW CREEK NEAR SPEARFISH, SD (LAT 44 24 04N LONG 103 53 35W)											
AUG 1990											
23...	40	<.010	<.100	<.010	<.20	<.010	.002	<.01	4	<10	<10
442250103485700 S.E. FALSE BOTTOM CREEK NEAR LEAD, SD (LAT 44 22 50N LONG 103 48 57W)											
AUG 1990											
28...	67	<.010	<.100	.030	<.20	<.010	<.001	<.01	<1	<10	<10
442246103490300 FALSE BOTTOM CREEL BELOW BALD MOUNTAIN MINE, NEAR LEAD, SD (LAT 44 22 46N LONG 103 49 03W)											
AUG 1990											
28...	130	<.010	.100	.030	<.20	<.010	.002	<.01	<1	20	<10
442252103493800 FALSE BOTTOM CREEK ABOVE COLUMBIA, NEAR LEAD, SD (LAT 44 22 52N LONG 103 49 38W)											
AUG 1990											
28...	49	<.010	<.100	.040	<.20	<.010	.002	<.01	<1	<10	<10
06432172 FALSE BOTTOM CREEK NEAR CENTRAL CITY, SD (LAT 44 23 28N LONG 103 47 58W)											
AUG 1990											
24...	90	<.010	.300	<.010	<.20	<.010	.003	<.01	2	<10	<10
442125103483000 S. DEADWOOD CREEK ABOVE HIDDEN TREASURE, NEAR LEAD, SD (LAT 44 21 25N LONG 103 48 30W)											
AUG 1990											
29...	87	<.010	<.100	<.010	<.20	<.010	<.001	<.01	<1	<10	<10
442131103482000 DEADWOOD CREEK BELOW HIDDEN TREASURE, NEAR LEAD, SD (LAT 44 21 31N LONG 103 48 20W)											
AUG 1990											
29...	120	<.010	.200	.030	<.20	<.010	<.001	<.01	2	10	<10
442213103443900 DEADWOOD CREEK BELOW BROKEN BOOT, AT DEADWOOD, SD (LAT 44 22 13N LONG 103 44 39W)											
AUG 1990											
29...	210	<.010	.800	.010	<.20	<.010	<.001	<.01	<1	50	<10
441919103390800 BEAR BUTTE CREEL ABOVE STRAWBERRY CREEK, NEAR DEADWOOD, SD (LAT 44 19 19N LONG 103 39 08W)											
AUG 1990											
30...	24	<.010	<.100	.020	.30	<.010	.011	<.01	1	20	<10
441925103390400 STRAWBERRY CREEK NEAR DEADWOOD, SD (LAT 44 19 25N LONG 103 39 04W)											
AUG 1990											
30...	47	<.010	<.100	.030	<.20	.020	.029	<.01	<1	20	<10
06437020 BEAR BUTTE CREEK NEAR DEADWOOD, SD (LAT 44 20 08N LONG 103 38 06W)											
AUG 1990											
23...	36	<.010	<.100	<.010	<.20	<.010	.002	<.01	2	20	<10

Table 9. Water-quality data in the mineralized area of Lawrence County from Torve (1991)—Continued

DATE	COPPER, DIS- SOLVED (UG/L AS CU) (01040)	IRON, DIS- SOLVED (UG/L AS FE) (01046)	LEAD, DIS- SOLVED (UG/L AS PB) (01049)	MANGA- NESE, DIS- SOLVED (UG/L AS MN) (01056)	SELE- NIUM, DIS- SOLVED (UG/L AS SE) (01145)	ZINC, DIS- SOLVED (UG/L AS ZN) (01090)	MERCURY DIS- SOLVED (UG/L AS HG) (71890)	COLI- FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML) (31625)	STREP- TOCOCCI FECAL, KF AGAR (COLS. PER 100 ML) (31673)	PHENOLS TOTAL (UG/L) (32730)
06430800 ANNIE CREEK NEAR LEAD, SD (LAT 44 19 37N LONG 103 53 38W)										
AUG 1990 22...	1.0	5.0	1.0	<1.0	<1	4.0	--	150	30	1
06430898 SQUAW CREEK NEAR SPEARFISH, SD (LAT 44 24 04N LONG 103 53 35W)										
AUG 1990 23...	1.0	<3.0	<1.0	<1.0	<1	3.0	--	K5	40	2
442250103485700 S.E. FALSE BOTTOM CREEK NEAR LEAD, SD (LAT 44 22 50N LONG 103 48 57W)										
AUG 1990 28...	1.0	9.0	<1.0	1.0	<1	<3.0	<.1	--	--	--
442246103490300 FALSE BOTTOM CREEK BELOW BALD MOUNTAIN MINE, NEAR LEAD, SD (LAT 44 22 46N LONG 103 49 03W)										
AUG 1990 28...	2.0	20	<1.0	32	<1	15	<.1	--	--	--
442252103493800 FALSE BOTTOM CREEK ABOVE COLUMBIA, NEAR LEAD, SD (LAT 44 22 52N LONG 103 49 38W)										
AUG 1990 28...	2.0	560	<1.0	460	<1	95	<.1	--	--	--
06432172 FALSE BOTTOM CREEK NEAR CENTRAL CITY, SD (LAT 44 23 28N LONG 103 47 58W)										
AUG 1990 24...	<1.0	8.0	<1.0	3.0	<1	<3.0	<.1	27	31	1
442125103483000 S. DEADWOOD CREEK ABOVE HIDDEN TREASURE, NEAR LEAD, SD (LAT 44 21 25N LONG 103 48 30W)										
AUG 1990 29...	<1.0	11	<1.0	2.0	<3	7.0	<.1	--	--	--
442131103482000 DEADWOOD CREEK BELOW HIDDEN TREASURE, NEAR LEAD, SD (LAT 44 21 31N LONG 103 48 20W)										
AUG 1990 29...	4.0	8200	<1.0	690	<1	170	<.1	--	--	--
442213103443900 DEADWOOD CREEL BELOW BROKEN BOOT, AT DEADWOOD, SD (LAT 44 22 13N LONG 103 44 39W)										
AUG 1990 29...	2.0	26	<1.0	44	<3	11	.3	--	--	--
441919103390800 BEAR BUTTE CREEK ABOVE STRAWBERRY CREEK, NEAR DEADWOOD, SD (LAT 44 19 19N LONG 103 39 08W)										
AUG 1990 30...	1.0	14	<1.0	6.0	<1	<3.0	.1	--	--	--
441925103390400 STRAWBERRY CREEK NEAR DEADWOOD, SD (LAT 44 19 25N LONG 103 39 04W)										
AUG 1990 30...	6.0	10	<1.0	8.0	<1	21	.4	--	--	--
06437020 BEAR BUTTE CREEK NEAR DEADWOOD, SD (LAT 44 20 08N LONG 103 38 06W)										
AUG 1990 23...	4.0	6.0	<1.0	6.0	<1	5.0	<.1	23	57	2

Table 10. Bed-sediment data in the mineralized area of Lawrence County from Torve (1991)

[G/KG, grams per kilogram; UG/G, micrograms per gram; TOT, total; BOT MAT, bottom material; INORG, inorganic; LAB, laboratory; U, micron; DS, diameter screen; <, less than]

DATE	CARBON, INOR-GANIC, TOT IN BOT MAT (G/KG AS C) (00686)	CARBON, INORG + ORGANIC TOT. IN BOT MAT (G/KG AS C) (00693)	ALUM-INUM BOT MAT <63U DS LAB PERCENT (34792)	ARSENIC BOT MAT <63U DS LAB (UG/G) (34802)	BARIUM BOT MAT <63U DS LAB (UG/G) (34807)	BERYL-LIUM BOT MAT <63U DS LAB (UG/G) (34812)	BISMUTH BOT MAT <63U DS LAB (UG/G) (34817)	CADMIUM BOT MAT <63U DS LAB (UG/G) (34827)	CALCIUM BOT MAT <63U DS LAB PERCENT (34832)	CERIUM BOT MAT <63U DS LAB (UG/G) (34837)	CHRO-MIUM BOT MAT <63U DS LAB (UG/G) (34842)
06430800 ANNIE CREEK NEAR LEAD, SD (LAT 44 19 37N LONG 103 53 38W)											
AUG 1990											
22...	.5	4.5	6.7	770	590	4	<10	<2.0	2.1	110	70
06430898 SQUAW CREEK NEAR SPEARFISH, SD (LAT 44 24 04N LONG 103 53 35W)											
AUG 1990											
23...	.9	8.1	6.2	170	640	5	<10	<2.0	3.1	130	95
442250103485700 S.E. FALSE BOTTOM CREEK NEAR LEAD, SD (LAT 44 22 50N LONG 103 48 57W)											
AUG 1990											
28...	<.0	3.9	6.6	37	980	5	<10	2.0	1.0	160	120
442246103490300 FALSE BOTTOM CREEK BELOW BALD MOUNTAIN MINE, NEAR LEAD, SD (LAT 44 22 46N LONG 103 49 03W)											
AUG 1990											
28...	.2	4.7	5.3	970	690	12	<10	6.0	1.4	200	130
442252103493800 FALSE BOTTOM CREEK ABOVE COLUMBIA NEAR LEAD, SD (LAT 44 22 52N LONG 103 49 38W)											
AUG 1990											
28...	.0	2.3	7.5	240	750	5	<10	<2.0	.23	110	170
06432172 FALSE BOTTOM CREEK NEAR CENTRAL CITY, SD (LAT 44 23 28N LONG 103 47 58W)											
AUG 1990											
24...	.1	4.0	6.4	330	770	4	<10	3.0	1.0	110	100
442125103483000 S. DEADWOOD CREEK ABOVE HIDDEN TREASURE, NEAR LEAD, SD (LAT 44 21 25N LONG 103 48 30W)											
AUG 1990											
29...	.1	6.7	5.5	91	670	4	<10	4.0	1.0	84	140
442131103482000 DEADWOOD CREEK BELOW HIDDEN TREASURE, NEAR LEAD, SD (LAT 44 21 31N LONG 103 48 20W)											
AUG 1990											
29...	.1	3.4	3.1	200	190	2	<10	<2.0	.15	110	51
442213103443900 DEADWOOD CREEK BELOW BROKEN BOOT, AT DEADWOOD, SD (LAT 44 22 13N LONG 103 44 39W)											
AUG 1990											
29...	.4	2.1	5.2	400	590	2	<10	<2.0	1.6	63	110
441919103390800 BEAR BUTTE CREEK ABOVE STRAWBERRY, NEAR DEADWOOD, SD (LAT 44 19 19N LONG 103 39 08W)											
AUG 1990											
30...	.1	4.8	6.5	53	710	2	<10	<2.0	1.1	73	68
441925103390400 STRAWBERRY CREEK NEAR DEADWOOD, SD (LAT 44 19 25N LONG 103 39 04W)											
AUG 1990											
30...	.1	1.5	9.4	60	560	8	10	12	1.0	440	82
06437020 BEAR BUTTE CREEK NEAR DEADWOOD, SD (LAT 44 20 08N LONG 103 38 06W)											
AUG 1990											
23...	.1	4.1	7.0	99	650	3	<10	16	1.1	120	72

Table 10. Bed-sediment data in the mineralized area of Lawrence County from Torve (1991)—Continued

DATE	COBALT BOT MAT <63U DS LAB (UG/G) (34847)	COPPER BOT MAT <63U DS LAB (UG/G) (34852)	EURO-PIUM BOT MAT <63U DS LAB (UG/G) (34857)	GALLIUM BOT MAT <63U DS LAB (UG/G) (34862)	GOLD BOT MAT <63U DS LAB (UG/G) (34872)	HOLMIUM BOT MAT <63U DS LAB (UG/G) (34877)	IRON BOT MAT <63U DS LAB PERCENT (34882)	LANTHA-NUM BOT MAT <63U DS LAB (UG/G) (34887)	LEAD BOT MAT <63U DS LAB (UG/G) (34892)	LITHIUM BOT MAT <63U DS LAB (UG/G) (34897)	MAGNE-SIUM BOT MAT <63U DS LAB PERCENT (34902)
06430800 ANNIE CREEK NEAR LEAD, SD (LAT 44 19 37N LONG 103 53 38W)											
AUG 1990											
22...	13	23	<2	18	<8	<4	3.5	60	33	29	.85
06430898 SQUAW CREEK NEAR SPEARFISH, SD (LAT 44 24 04N LONG 103 53 35W)											
AUG 1990											
23...	24	78	<2	16	<8	<4	4.7	92	61	36	1.5
442250103485700 S.E. FALSE BOTTOM CREEK NEAR LEAD, SD (LAT 44 22 50N LONG 103 48 57W)											
AUG 1990											
28...	31	75	3	18	<8	<4	4.4	110	58	50	1.0
442246103490300 FALSE BOTTOM CREEK BELOW BALD MOUNTAIN MINE, NEAR LEAD, SD (LAT 44 22 46N LONG 103 49 03W)											
AUG 1990											
28...	55	330	3	13	<8	<4	14	160	270	29	.89
442252103493800 FALSE BOTTOM CREEK ABOVE COLUMBIA NEAR LEAD, SD (LAT 44 22 52N LONG 103 49 38W)											
AUG 1990											
28...	36	92	<2	18	<8	<4	17	100	29	33	.86
06432172 FALSE BOTTOM CREEK NEAR CENTRAL CITY, SD (LAT 44 23 28N LONG 103 47 58W)											
AUG 1990											
24...	40	98	<2	17	<8	<4	6.8	71	110	37	.92
442125103483000 S. DEADWOOD CREEK ABOVE HIDDEN TREASURE, NEAR LEAD, SD (LAT 44 21 25N LONG 103 48 30W)											
AUG 1990											
29...	88	69	<2	15	<8	<4	14	53	32	27	.84
442131103482000 DEADWOOD CREEK BELOW HIDDEN TREASURE, NEAR LEAD, SD (LAT 44 21 31N LONG 103 48 20W)											
AUG 1990											
29...	19	120	3	12	<8	<4	30	68	24	11	.31
442213103443900 DEADWOOD CREEK BELOW BROKEN BOOT, AT DEADWOOD, SD (LAT 44 22 13N LONG 103 44 39W)											
AUG 1990											
29...	15	150	<2	15	<8	<4	16	37	34	26	.81
441919103390800 BEAR BUTTE CREEK ABOVE STRAWBERRY, NEAR DEADWOOD, SD (LAT 44 19 19N LONG 103 39 08W)											
AUG 1990											
30...	36	62	<2	21	<8	<4	5.6	39	39	48	.87
441925103390400 STRAWBERRY CREEK NEAR DEADWOOD, SD (LAT 44 19 25N LONG 103 39 04W)											
AUG 1990											
30...	78	1800	9	20	<8	<4	5.7	260	99	32	1.1
06437020 BEAR BUTTE CREEK NEAR DEADWOOD, SD (LAT 44 20 08N LONG 103 38 06W)											
AUG 1990											
23...	63	510	2	20	<8	<4	4.9	62	200	45	.89

DATE	MANGA-NESE BOT MAT <63U DS LAB (UG/G) (34907)	MOLYB-DENUM BOT MAT <63U DS LAB (UG/G) (34917)	NEODYM-IUM BOT MAT <63U DS LAB (UG/G) (34922)	NICKEL BOT MAT <63U DS LAB (UG/G) (34927)	NIOBIUM BOT MAT <63U DS LAB (UG/G) (34932)	PHOS-PHORUS BOT MAT <63U DS LAB PERCENT (34937)	POTAS-SIUM BOT MAT <63U DS LAB PERCENT (34942)	SCAN-DIUM BOT MAT <63U DS LAB (UG/G) (34947)	SILVER BOT MAT <63U DS LAB (UG/G) (34957)	SODIUM BOT MAT <63U DS LAB PERCENT (34962)
06430800 ANNIE CREEK NEAR LEAD, SD (LAT 44 19 37N LONG 103 53 38W)										
AUG 1990										
22...	520	<2	42	28	7	.14	3.7	10	<4.0	.35
06430898 SQUAW CREEK NEAR SPEARFISH, SD (LAT 44 24 04N LONG 103 53 35W)										
AUG 1990										
23...	2000	5	45	53	5	.16	2.3	17	<4.0	.25
442250103485700 S.E. FALSE BOTTOM CREEK NEAR LEAD, SD (LAT 44 22 50N LONG 103 48 57W)										
AUG 1990										
28...	1700	15	70	83	9	.11	2.1	12	4.0	1.4
442246103490300 FALSE BOTTOM CREEK BELOW BALD MOUNTAIN MINE, NEAR LEAD, SD (LAT 44 22 46N LONG 103 49 03W)										
AUG 1990										
28...	2600	14	78	150	<4	.15	1.5	13	5.0	.31
442252103493800 FALSE BOTTOM CREEK ABOVE COLUMBIA NEAR LEAD, SD (LAT 44 22 52N LONG 103 49 38W)										
AUG 1990										
28...	1200	10	48	83	5	.080	2.6	23	<4.0	.26
06432172 FALSE BOTTOM CREEK NEAR CENTRAL CITY, SD (LAT 44 23 28N LONG 103 47 58W)										
AUG 1990										
24...	2400	6	47	130	8	.14	2.1	12	<4.0	.75
442125103483000 S. DEADWOOD CREEK ABOVE HIDDEN TREASURE, NEAR LEAD, SD (LAT 44 21 25N LONG 103 48 30W)										
AUG 1990										
29...	4200	4	41	290	<4	.12	1.3	10	<4.0	.40
442131103482000 DEADWOOD CREEK BELOW HIDDEN TREASURE, NEAR LEAD, SD (LAT 44 21 31N LONG 103 48 20W)										
AUG 1990										
29...	730	55	60	33	<4	.090	.67	6	100	.22
442213103443900 DEADWOOD CREEK BELOW BROKEN BOOT, AT DEADWOOD, SD (LAT 44 22 13N LONG 103 44 39W)										
AUG 1990										
29...	540	4	31	46	<4	.090	1.8	11	<4.0	.31
41919103390800 BEAR BUTTE CREEK ABOVE STRAWBERRY, NEAR DEADWOOD, SD (LAT 44 19 19N LONG 103 39 08W)										
AUG 1990										
30...	4800	<2	33	66	5	.15	2.3	11	<4.0	.55
441925103390400 STRAWBERRY CREEK NEAR DEADWOOD, SD (LAT 44 19 25N LONG 103 39 04W)										
AUG 1990										
30...	4300	2	260	110	5	.16	3.1	15	<4.0	.50
06437020 BEAR BUTTE CREEK NEAR DEADWOOD, SD (LAT 44 20 08N LONG 103 38 06W)										
AUG 1990										
23...	4100	<2	59	91	6	.14	2.6	11	<4.0	.63

Table 10. Bed-sediment data in the mineralized area of Lawrence County from Torve (1991)—Continued

DATE	STRONTIUM BOT MAT <63U DS LAB (UG/G) (34967)	TANTALUM BOT MAT <63U DS LAB (UG/G) (34977)	THORIUM BOT MAT <63U DS LAB (UG/G) (34982)	TIN BOT MAT <63U DS LAB (UG/G) (34987)	TITANIUM BOT MAT <63U DS LAB PERCENT (34992)	URANIUM BOT MAT <63U DS LAB (UG/G) (35002)	VANADIUM BOT MAT <63U DS LAB (UG/G) (35007)	YTTRIUM BOT MAT <63U DS LAB (UG/G) (35012)	YTTERBIUM BOT MAT <63U DS LAB (UG/G) (35017)	ZINC BOT MAT <63U DS LAB (UG/G) (35022)
06430800 ANNIE CREEK NEAR LEAD, SD (LAT 44 19 37N LONG 103 53 38W)										
AUG 1990										
22...	200	<40	24	<5	.22	<100	88	24	2	220
06430898 SQUAW CREEK NEAR SPEARFISH, SD (LAT 44 24 04N LONG 103 53 35W)										
AUG 1990										
23...	300	<40	16	<5	.19	<100	120	27	2	270
442250103485700 S.E. FALSE BOTTOM CREEK NEAR LEAD, SD (LAT 44 22 50N LONG 103 48 57W)										
AUG 1990										
28...	620	<40	25	<5	.41	<100	120	39	3	210
442246103490300 FALSE BOTTOM CREEK BELOW BALD MOUNTAIN MINE, NEAR LEAD, SD (LAT 44 22 46N LONG 103 49 03W)										
AUG 1990										
28...	670	<40	17	5	.20	<100	120	52	4	760
442252103493800 FALSE BOTTOM CREEK ABOVE COLUMBIA NEAR LEAD, SD (LAT 44 22 52N LONG 103 49 38W)										
AUG 1990										
28...	260	<40	17	<5	.19	<100	160	26	2	320
06432172 FALSE BOTTOM CREEK NEAR CENTRAL CITY, SD (LAT 44 23 28N LONG 103 47 58W)										
AUG 1990										
24...	450	<40	17	<5	.31	<100	120	28	2	500
442125103483000 S. DEADWOOD CREEK ABOVE HIDDEN TREASURE, NEAR LEAD, SD (LAT 44 21 25N LONG 103 48 30W)										
AUG 1990										
29...	140	<40	16	<5	.20	<100	120	27	2	1000
442131103482000 DEADWOOD CREEK BELOW HIDDEN TREASURE, NEAR LEAD, SD (LAT 44 21 31N LONG 103 48 20W)										
AUG 1990										
29...	70	<40	9	16	.11	<100	110	35	3	200
442213103443900 DEADWOOD CREEK BELOW BROKEN BOOT, AT DEADWOOD, SD (LAT 44 22 13N LONG 103 44 39W)										
AUG 1990										
29...	260	<40	17	6	.16	<100	M160	17	2	390
441919103390800 BEAR BUTTE CREEK ABOVE STRAWBERRY, NEAR DEADWOOD, SD (LAT 44 19 19N LONG 103 39 08W)										
AUG 1990										
30...	150	<40	15	<5	.22	<100	92	19	2	260
441925103390400 STRAWBERRY CREEK NEAR DEADWOOD, SD (LAT 44 19 25N LONG 103 39 04W)										
AUG 1990										
30...	160	<40	47	<5	.29	<100	99	160	8	E1600
06437020 BEAR BUTTE CREEK NEAR DEADWOOD, SD (LAT 44 20 08N LONG 103 38 06W)										
AUG 1990										
23...	180	<40	17	<5	.23	<100	89	39	3	1200

Table 11. Summary statistics for selected physical properties and field measurements from the U.S. Environmental Protection Agency STORET water-quality database

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency. ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter; NTU, nephelometric turbidity units; mm, millimeters; mg/L, milligrams per liter; mL, milliliter; deg C, degrees Celsius, <, less than; --, no data available; E, estimated; N, number of observations]

Station	Agency	Statistic	Discharge instantaneous (ft^3/s)	Specific conductance (µS/cm)	pH water, whole field (standard units)	Temperature air (deg C)	Temperature water (deg C)	Turbidity (NTU)	Barometric pressure (mm of Hg)	Oxygen dissolved (mg/L)	Oxygen dissolved (percent saturation)	Hardness, total (mg/l as $CaCO_3$)	Solids, residue at 180 deg C dissolved (mg/L)	Residue total at 104 deg C, suspended (mg/L)	Streptococci fecal, KF agar (colonies per 100 mL)
46MN31	DENR	Minimum	--	83	8.12	1.11	0.56	--	--	8.1	--	65	90	2	--
		Median	--	397.5	8.52	15.3	2.22	--	--	10.75	--	210	209.5	5	--
		Maximum	--	400	8.6	28.9	14.4	--	--	12.8	--	260	302	12	--
		N	--	8	7	8	7	--	--	8	--	8	8	8	--
46MN32	DENR	Minimum	15.87	340	8.15	-1.1	0.56	--	--	9.9	--	248	160	2	--
		Median	18.15	435	8.525	16.7	8.33	--	--	11.2	--	257.5	231.5	5	--
		Maximum	24.91	445	8.82	29.4	14.4	--	--	13.4	--	650	305	12	--
		N	5	8	10	16	15	--	--	8	--	8	8	8	--
46MN33	DENR	Minimum	14.66	360	8.41	-4.4	1.11	--	--	10.2	--	218	120	2	--
		Median	16.5	440	8.525	16.4	8.33	--	--	11.35	--	246.5	220.5	6.5	--
		Maximum	25.38	440	8.85	30	17.2	--	--	13	--	320	279	13	--
		N	5	8	10	16	15	--	--	8	--	8	8	8	--
46MN34	DENR	Minimum	15.39	360	8.26	-5.0	0.56	--	--	10.1	--	220	202	<1	--
		Median	18.67	430	8.58	15.55	8.33	--	--	11	--	257.5	228	4.5	--
		Maximum	26.03	440	9.64	27.8	15.6	--	--	13.2	--	300	270	6	--
		N	5	8	10	16	15	--	--	8	--	8	8	8	--
46MN35	DENR	Minimum	--	325	8.39	3.33	3.33	--	--	8.9	--	190	164	<1	--
		Median	--	410	8.61	15.6	5.56	--	--	11.45	--	235	204	2.5	--
		Maximum	--	430	8.92	27.8	16.7	--	--	13.6	--	340	266	6	--
		N	--	8	7	8	7	--	--	8	--	8	8	8	--
46MN38	DENR	Minimum	--	180	7.03	2.22	1.11	--	--	8.6	--	110	146	<1	--
		Median	--	452.5	8.245	13.35	7.24	--	--	11.2	--	240	274	7	--
		Maximum	--	500	8.65	30.6	21.7	--	--	12.8	--	280	370	12	--
		N	--	8	8	8	8	--	--	8	--	8	8	8	--

Table 11. Summary statistics for selected physical properties and field measurements from the U.S. Environmental Protection Agency STORET water-quality database–Continued

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency. ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter; NTU, nephelometric turbidity units; mm, millimeters; mg/L, milligrams per liter; mL, milliliter; deg C, degrees Celsius, <, less than; --, no data available; E, estimated; N, number of observations]

Station	Agency	Statistic	Discharge instantaneous (ft^3/s)	Specific conductance (µS/cm)	pH water, whole field (standard units)	Temperature air (deg C)	Temperature water (deg C)	Turbidity (NTU)	Barometric pressure (mm of Hg)	Oxygen dissolved (mg/L)	Oxygen dissolved (percent saturation)	Hardness, total (mg/l as $CaCO_3$)	Solids, residue at 180 deg C dissolved (mg/L)	Residue total at 104 deg C, suspended (mg/L)	Streptococci fecal, KF agar (colonies per 100 mL)
46MN39	DENR	Minimum	--	134	7.67	3.33	1.11	--	--	9.2	--	75	88	<1	--
		Median	--	325	8.46	14.15	2.22	--	--	10.5	--	195	208	4	--
		Maximum	--	370	8.79	27.8	18.9	--	--	13.2	--	260	277	6	--
		N	--	8	7	8	7	--	--	8	--	8	8	8	--
460116	DENR	Minimum	0	380	2.31	2.22	0	--	--	3.8	--	9.0	236	<1	--
		Median	0	1,210	4.3	14.4	11.1	--	--	9.45	--	470	1,016.5	35	--
		Maximum	0	5,900	8.43	27.8	20	--	--	11.8	--	4,400	1,962	43,200	--
		N	3	37	37	34	37	--	--	36	--	37	36	37	--
460118	DENR	Minimum	--	350	6.09	-1.1	1.67	--	--	7.4	--	180	188	<1	--
		Median	--	500	8.45	14.15	9.44	--	--	10.7	--	267.5	299.5	6	--
		Maximum	--	705	8.72	30	24.4	--	--	12.6	--	445	488	25	--
		N	--	24	23	24	24	--	--	23	--	24	24	24	--
460119	DENR	Minimum	--	620	7.13	3.89	3.33	--	--	7.8	--	310	376	3	--
		Median	--	680	7.975	15.55	7.77	--	--	9.15	--	360	410.5	18	--
		Maximum	--	1,000	8.52	26.7	20.6	--	--	10.6	--	500	554	49	--
		N	--	8	8	8	8	--	--	8	--	8	8	8	--
460120	DENR	Minimum	--	130	7.82	5.56	8.33	--	--	8.7	--	120	148	<1	--
		Median	--	352.5	8.065	14.45	9.445	--	--	9.8	--	187.5	196	2.5	--
		Maximum	--	440	8.52	28.9	21.1	--	--	10.4	--	425	265	11	--
		N	--	8	8	8	8	--	--	8	--	8	8	8	--
460122	DENR	Minimum	--	515	7.52	-0.55	8.89	--	--	8.6	--	230	362	1	--
		Median	--	1,350	8.54	18.3	16.1	--	--	10.2	--	605	1009	10.5	--
		Maximum	--	1,650	9.06	27.8	23.3	--	--	12.2	--	785	1358	32	--
		N	--	20	20	20	20	--	--	20	--	20	20	20	--

Table 11. Summary statistics for selected physical properties and field measurements from the U.S. Environmental Protection Agency STORET water-quality database–Continued

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency. ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter; NTU, nephelometric turbidity units; mm, millimeters; mg/L, milligrams per liter; mL, milliliter; deg C, degrees Celsius, <, less than; --, no data available; E, estimated; N, number of observations]

Station	Agency	Statistic	Discharge instantaneous (ft^3/s)	Specific conductance (µS/cm)	pH water, whole field (standard units)	Temperature air (deg C)	Temperature water (deg C)	Turbidity (NTU)	Barometric pressure (mm of Hg)	Oxygen dissolved (mg/L)	Oxygen dissolved (percent saturation)	Hardness, total (mg/l as $CaCO_3$)	Solids, residue at 180 deg C dissolved (mg/L)	Residue total at 104 deg C, suspended (mg/L)	Streptococci fecal, KF agar (colonies per 100 mL)
460123	DENR	Minimum	--	530	7.45	-0.55	5	--	--	8.7	--	245	368	5	--
		Median	--	1,195	8.6	18.9	12.2	--	--	10.4	--	585	872	14.5	--
		Maximum	--	1525	8.9	27.2	23.9	--	--	12.6	--	915	1225	50	--
		N	--	18	18	18	18	--	--	17	--	18	18	18	--
460652	DENR	Minimum	--	249.6	6.9	0	0	--	--	7	--	114	202	0	3,000
		Median	--	840	8	13.9	6.67	--	--	11.1	--	353.5	609.5	12.5	35,500
		Maximum	--	1,360	9.74	36	27.8	--	--	13.3	--	670	1,030	75,011	80,000
		N	--	210	173	167	188	--	--	171	--	86	130	208	8
460658	DENR	Minimum	--	170	7	0	0	--	--	7.5	--	90	51	0	4
		Median	--	450	8.2	14	6.96	--	--	10.7	--	235	254	9	60
		Maximum	--	1,500	8.85	35.6	21.7	--	--	13.6	--	460	1,446	177	4,100
		N	--	200	189	159	172	--	--	197	--	72	112	200	37
460659	DENR	Minimum	--	400	6.95	0	0	--	--	6	--	185	340	<1	24,000
		Median	--	1,440	8.19	15	16.1	--	--	8.3	--	670	1,170	13	52,000
		Maximum	--	2,600	8.8	35	26	--	--	10.6	--	1,070	2,000	139,300	80,000
		N	--	214	172	170	187	--	--	174	--	89	131	212	2
460660	DENR	Minimum	--	240	6.95	0	0	--	--	7.5	--	108	242	<1	--
		Median	--	835	8	15	8.9	--	--	10.3	--	304	586	17	--
		Maximum	--	1,600	8.9	35.6	36	--	--	12.6	--	580	981	190,309	21,000
		N	--	188	150	149	164	--	--	149	--	65	105	187	1
460675	DENR	Minimum	--	180	6.55	0	0	--	--	7	--	60	114	<1	5
		Median	--	395	8	15.6	7.5	--	--	10.3	--	186	232	5	310
		Maximum	--	590	8.98	32.8	26	--	--	14	--	360	377	285	3,800
		N	--	76	72	64	70	--	--	76	--	41	38	76	23

Table 11. Summary statistics for selected physical properties and field measurements from the U.S. Environmental Protection Agency STORET water-quality database–Continued

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency. ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter; NTU, nephelometric turbidity units; mm, millimeters; mg/L, milligrams per liter; mL, milliliter; deg C, degrees Celsius, <, less than; --, no data available; E, estimated; N, number of observations]

Station	Agency	Statistic	Discharge instantaneous (ft^3/s)	Specific conductance (µS/cm)	pH water, whole field (standard units)	Temperature air (deg C)	Temperature water (deg C)	Turbidity (NTU)	Barometric pressure (mm of Hg)	Oxygen dissolved (mg/L)	Oxygen dissolved (percent saturation)	Hardness, total (mg/l as $CaCO_3$)	Solids, residue at 180 deg C dissolved (mg/L)	Residue total at 104 deg C, suspended (mg/L)	Streptococci fecal, KF agar (colonies per 100 mL)
460684	DENR	Minimum	0	320	6.6	0	0	--	--	7.3	--	58	198	<1	--
		Median	--	922.5	8.1	13.5	6.115	--	--	10.85	--	431	608	12	--
		Maximum	--	1,300	8.79	33	26	--	--	13.4	--	750	944	41,971	--
		N	1	54	59	50	58	--	--	60	--	36	49	63	--
460685	DENR	Minimum	--	420	6.95	0	0	--	--	7.6	--	160	240	2	--
		Median	--	890	8	17.25	10	--	--	10.5	--	415	596	12	--
		Maximum	--	1,330	8.84	31.1	22.8	--	--	12.2	--	680	1,006	50,374	--
		N	--	55	61	54	58	--	--	61	--	39	51	65	--
460686	DENR	Minimum	--	250	7.2	0	0	--	--	7.9	--	80	130	<1	--
		Median	--	475	8.2	16.2	7.78	--	--	10.6	--	248	251	8	--
		Maximum	--	650	8.9	31	22.2	--	--	12.4	--	535	379	208	--
		N	--	57	64	55	60	--	--	65	--	39	52	66	--
460689	DENR	Minimum	--	6.05	7.2	0	0	--	--	2.4	--	50	86	<1	--
		Median	--	630	8.04	14.4	7.9	--	--	11	--	390	396	6	--
		Maximum	--	1,740	8.65	35.6	25	--	--	15	--	870	3,760	1,380	--
		N	--	148	144	127	140	--	--	148	--	49	113	147	--
460900	DENR	Minimum	--	239.2	7.05	0	0	--	--	6.9	--	140	165	0	4
		Median	--	425.7	8.2	15	6.67	--	--	11.4	--	243	220	4	5
		Maximum	--	3,952	10.7	35.6	24.4	--	--	14.1	--	768	1,242	2,319	610
		N	--	206	196	162	179	--	--	204	--	95	113	205	47
460550	USFS	Minimum	E0.5	255	6.8	0	0	1.2	--	8.4	--	176	--	0	0
		Median	4.25	459	8.3	16.4	7.2	3.4	--	9.25	--	248	--	5	8
		Maximum	20	1,050	8.7	33	14.4	41	--	11.3	--	288	--	254	130
		N	58	52	59	60	63	34	--	22	--	39	--	62	34

Table 11. Summary statistics for selected physical properties and field measurements from the U.S. Environmental Protection Agency STORET water-quality database–Continued

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency. ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter; NTU, nephelometric turbidity units; mm, millimeters; mg/L, milligrams per liter; mL, milliliter; deg C, degrees Celsius, <, less than; --, no data available; E, estimated; N, number of observations]

Station	Agency	Statistic	Discharge instantaneous (ft^3/s)	Specific conductance (µS/cm)	pH water, whole field (standard units)	Temperature air (deg C)	Temperature water (deg C)	Turbidity (NTU)	Barometric pressure (mm of Hg)	Oxygen dissolved (mg/L)	Oxygen dissolved (percent saturation)	Hardness, total (mg/l as $CaCO_3$)	Solids, residue at 180 deg C dissolved (mg/L)	Residue total at 104 deg C, suspended (mg/L)	Streptococci fecal, KF agar (colonies per 100 mL)
460561	USFS	Minimum	0.3	138	7.3	4	0	1.1	--	7.4	--	111	--	0	0
		Median	9	260	8.1	18.5	12	2.2	--	8.6	--	136	--	2	47.5
		Maximum	45	470	8.7	35	20	13.5	--	11.4	--	156	--	290	191
		N	28	28	29	28	27	12	--	16	--	11	--	27	12
460562	USFS	Minimum	0.3	138	7.4	2	0	1	--	7.2	--	90.8	--	0	1
		Median	9.4	260	8.05	19	12.5	3.15	--	8.9	--	143	--	4.45	39
		Maximum	45	650	8.6	34	23.5	8.5	--	11.8	--	168	--	299	550
		N	29	28	28	29	30	12	--	16	--	12	--	28	13
460563	USFS	Minimum	E0.5	250	6.9	5	2	1	--	7.4	--	--	--	0	4
		Median	5	415	8.15	22	12	1	--	9.25	--	--	--	1.7	7
		Maximum	12	750	8.6	32	17	4	--	12.2	--	282	--	286	10
		N	19	19	18	17	19	3	--	16	--	1	--	18	2
460564	USFS	Minimum	0.01	106	7.1	6	3	--	--	7.6	--	--	--	0	--
		Median	10	188	7.7	20	12	--	--	8.8	--	--	--	11	--
		Maximum	40	1,690	8.8	31	20	--	--	12	--	--	--	302	32
		N	13	13	13	13	13	--	--	13	--	--	--	13	1
460568	USFS	Minimum	--	201	7.1	12	8	--	--	8.1	--	103	--	1	--
		Median	--	252	8.1	18.5	16.3	--	--	8.65	--	135.5	--	3.5	--
		Maximum	--	590	9.2	35	20	2.1	--	11.5	--	166	--	275	--
		N	--	9	10	10	10	1	--	8	--	8	--	10	--
460600	USFS	Minimum	0.08	360	7.25	2.2	0.5	0.6	--	--	--	131.5	--	0.2	1
		Median	0.42	415	8.2	16.6	10	2	--	--	--	248	--	6	36
		Maximum	3	450	8.7	24	15.5	7.5	--	--	--	267.2	--	228	338
		N	15	16	16	15	17	14	--	--	--	16	--	16	10

Table 11. Summary statistics for selected physical properties and field measurements from the U.S. Environmental Protection Agency STORET water-quality database–Continued

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency. ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter; NTU, nephelometric turbidity units; mm, millimeters; mg/L, milligrams per liter; mL, milliliter; deg C, degrees Celsius, <, less than; --, no data available; E, estimated; N, number of observations]

Station	Agency	Statistic	Discharge instantaneous (ft^3/s)	Specific conductance (µS/cm)	pH water, whole field (standard units)	Temperature air (deg C)	Temperature water (deg C)	Turbidity (NTU)	Barometric pressure (mm of Hg)	Oxygen dissolved (mg/L)	Oxygen dissolved (percent saturation)	Hardness, total (mg/l as $CaCO_3$)	Solids, residue at 180 deg C dissolved (mg/L)	Residue total at 104 deg C, suspended (mg/L)	Streptococci fecal, KF agar (colonies per 100 mL)
460601	USFS	Minimum	0.16	95	7.4	0.5	0	1.7	--	--	--	36.5	--	0	1
		Median	1	225	8	5.1	11	5.95	--	--	--	128.3	--	6	84
		Maximum	10.9	340	8.6	27.8	23.8	24	--	--	--	172	--	40	1920
		N	31	33	31	32	35	34	--	--	--	33	--	33	30
460606	USFS	Minimum	E1	13.8	7.4	0	0	0.32	--	--	--	5.8	--	0	0
		Median	6.545	260	8.3	15	11	2.6	--	--	--	133.55	--	1	28
		Maximum	33.1	382.24	8.7	27	20.5	11	--	--	--	180	--	50	800
		N	40	45	40	47	43	46	--	--	--	42	--	43	43
460607	USFS	Minimum	0.65	174	7.6	1.7	0	0.8	--	--	--	62	--	0	0
		Median	5.15	290	8.3	9	11.34	2.2	--	--	--	148	--	2.2	56
		Maximum	49.2	378	8.9	30	23	7.8	--	--	--	180	--	35.5	740
		N	38	48	40	47	46	47	--	--	--	47	--	47	42
460608	USFS	Minimum	0.1	130	7.7	0	0	<1	--	--	--	58	--	0	0
		Median	0.9	265	8.2	14.5	11.1	1.75	--	--	--	138	--	0.8	48
		Maximum	8.6	316	8.6	27	17.8	5.3	--	--	--	170	--	24.4	810
		N	37	39	35	35	39	40	--	--	--	39	--	41	29
460609	USFS	Minimum	0	<242	709	2.2	0	<1	--	--	--	94.8	--	0	1
		Median	2.4	400	8.35	13.3	6.4	3.95	--	--	--	216	--	6	26
		Maximum	15.2	510	8.6	21.1	16.1	13	--	--	--	265	--	48.8	387
		N	34	37	30	33	38	38	--	--	--	32	--	33	30
460611	USFS	Minimum	2	302.4	7.7	0	0	0.7	--	--	--	158	--	0	0
		Median	9.55	435	8.35	12.95	6.3	2.45	--	--	--	239	--	2	12
		Maximum	21.02	570	E8.8	29	25.6	6.1	--	--	--	272	--	12	246
		N	40	41	40	38	44	42	--	--	--	43	--	43	35

Table 11. Summary statistics for selected physical properties and field measurements from the U.S. Environmental Protection Agency STORET water-quality database–Continued

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency. ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter; NTU, nephelometric turbidity units; mm, millimeters; mg/L, milligrams per liter; mL, milliliter; deg C, degrees Celsius, <, less than; --, no data available; E, estimated; N, number of observations]

Station	Agency	Statistic	Discharge instantaneous (ft^3/s)	Specific conductance (µS/cm)	pH water, whole field (standard units)	Temperature air (deg C)	Temperature water (deg C)	Turbidity (NTU)	Barometric pressure (mm of Hg)	Oxygen dissolved (mg/L)	Oxygen dissolved (percent saturation)	Hardness, total (mg/l as $CaCO_3$)	Solids, residue at 180 deg C dissolved (mg/L)	Residue total at 104 deg C, suspended (mg/L)	Streptococci fecal, KF agar (colonies per 100 mL)
460612	USFS	Minimum	1.3	4.8	7.4	1	0	0.8	--	--	--	169.8	--	0	0
		Median	4.0	459	8.2	11.9	5.65	2.3	--	--	--	256.8	--	0.3	12
		Maximum	24.79	600	8.6	28	13.3	13	--	--	--	283.1	--	10.4	265
		N	43	41	36	40	44	41	--	--	--	40	--	40	36
460613	USFS	Minimum	1.2	402	7.5	3.8	1	<1	--	--	--	22.4	--	<0.2	0
		Median	6.165	455	8.1	15	10.5	2.3	--	--	--	257	--	1.75	72
		Maximum	9.1	510	8.3	27.8	14.4	16	--	--	--	275.2	--	44.8	536
		N	16	17	14	16	17	17	--	--	--	16	--	16	10
460614	USFS	Minimum	0.3	18.5	7	0.5	0	<1	--	--	--	16.6	--	0	0
		Median	4.3	430	8.3	15.5	9.75	2.95	--	--	--	231.45	--	3.8	13
		Maximum	15.9	540	8.7	30.56	17.7	7.1	--	--	--	257	--	39.2	582
		N	37	39	35	39	42	42	--	--	--	40	--	40	35
460615	USFS	Minimum	0.5	230	7	0	0	0.8	--	--	--	22	--	0	0
		Median	1.97	420	8.35	12.65	7.8	1.95	--	--	--	224	--	0.4	11
		Maximum	19.6	523	8.7	27.8	16.1	17	--	--	--	272	--	57.6	390
		N	57	55	52	52	58	54	--	--	--	57	--	56	47
460616	USFS	Minimum	0	115	5.1	2	0	<1	--	--	--	4.7	--	<0.2	0
		Median	0.9	290	8.35	16.7	9.3	3.65	--	--	--	148.7	--	0.9	17
		Maximum	19	360	9.4	29	17.8	18	--	--	--	236	--	24	170
		N	35	35	32	35	38	38	--	--	--	38	--	36	29
06436170	USGS	Minimum	6.91	258	--	0	0	--	--	--	--	--	--	--	--
		Median	15	947.5	--	12	8.5	--	--	--	--	--	--	--	--
		Maximum	704	1,645	7.4	35	25	--	630	--	--	--	539	--	--
		N	119	116	1	102	117	--	1	--	--	--	1	--	--

Table 11. Summary statistics for selected physical properties and field measurements from the U.S. Environmental Protection Agency STORET water-quality database–Continued

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency. ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter; NTU, nephelometric turbidity units; mm, millimeters; mg/L, milligrams per liter; mL, milliliter; deg C, degrees Celsius, <, less than; --, no data available; E, estimated; N, number of observations]

Station	Agency	Statistic	Discharge instantaneous (ft^3/s)	Specific conductance (µS/cm)	pH water, whole field (standard units)	Temperature air (deg C)	Temperature water (deg C)	Turbidity (NTU)	Barometric pressure (mm of Hg)	Oxygen dissolved (mg/L)	Oxygen dissolved (percent saturation)	Hardness, total (mg/l as $CaCO_3$)	Solids, residue at 180 deg C dissolved (mg/L)	Residue total at 104 deg C, suspended (mg/L)	Streptococci fecal, KF agar (colonies per 100 mL)
06436180	USGS	Minimum	4.3	190	7.1	0	0	--	650	6.9	87	99	158	--	--
		Median	23	918.5	8.76	9.75	16	--	668	10.2	107	380	607	--	--
		Maximum	640	1,381	9.7	27	32.5	--	748	15	150	580	1,060	--	--
		N	260	160	133	160	97	--	107	122	103	112	107	--	--
06436190	USGS	Minimum	3.26	388	6.7	0	0	--	--	6.8	--	--	580	--	--
		Median	18.55	1,030	8.2	17	10.5	--	--	9.95	--	--	793	--	--
		Maximum	651	1,460	9	35	28	--	--	13.8	--	--	810	--	--
		N	138	113	17	89	115	--	--	16	--	--	3	--	--
442134103441901	USGS	Minimum	7.1	340	7.2	--	6.5	--	--	11.3	--	--	--	--	--
		Median	9.35	430	8.2	--	8	--	--	11.3	--	--	--	--	--
		Maximum	15	434	8.7	9	15	--	620	11.7	--	--	256	--	--
		N	5	3	3	1	3	--	1	3	--	--	1	--	--
442135103442001	USGS	Minimum	5.2	1,046	8.38	--	13.5	--	--	--	--	--	--	--	--
		Median	7.83	1,193	8.49	--	16.95	--	--	--	--	--	--	--	--
		Maximum	8.1	1,340	8.6	--	20.4	--	636	9.1	--	--	1,110	--	--
		N	4	2	2	--	2	--	1	1	--	--	1	--	--
442320103422301	USGS	Minimum	--	786	7.3	--	7.2	--	624	7.4	--	--	--	--	--
		Median	--	845.5	7.945	--	10.75	--	638	9.65	--	--	--	--	--
		Maximum	20	905	8.59	7	14.3	--	652	11.9	--	--	504	--	--
		N	1	2	2	1	2	--	2	2	--	--	1	--	--
442322103423701	USGS	Minimum	--	647	7.11	--	--	--	--	--	--	--	--	--	--
		Median	--	656	7.305	--	--	--	--	--	--	--	--	--	--
		Maximum	3.9	665	7.5	--	11.4	--	643	6.8	--	--	382	--	--
		N	1	2	2	--	1	--	1	1	--	--	1	--	--

Table 11. Summary statistics for selected physical properties and field measurements from the U.S. Environmental Protection Agency STORET water-quality database–Continued

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency. ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter; NTU, nephelometric turbidity units; mm, millimeters; mg/L, milligrams per liter; mL, milliliter; deg C, degrees Celsius, <, less than; --, no data available; E, estimated; N, number of observations]

Station	Agency	Statistic	Discharge instantaneous (ft^3/s)	Specific conductance (µS/cm)	pH water, whole field (standard units)	Temperature air (deg C)	Temperature water (deg C)	Turbidity (NTU)	Barometric pressure (mm of Hg)	Oxygen dissolved (mg/L)	Oxygen dissolved (percent saturation)	Hardness, total (mg/l as $CaCO_3$)	Solids, residue at 180 deg C dissolved (mg/L)	Residue total at 104 deg C, suspended (mg/L)	Streptococci fecal, KF agar (colonies per 100 mL)
442330103421501	USGS	Minimum	17	--	--	--	--	--	--	--	--	--	--	--	--
		Median	41	--	--	--	--	--	--	--	--	--	--	--	--
		Maximum	41	550	8.4	--	8	--	--	9.6	--	--	--	--	--
		N	3	1	1	--	1	--	--	1	--	--	--	--	--
442825103373001	USGS	Minimum	16	560	--	--	11.5	--	--	7.9	--	--	--	--	--
		Median	17	662.5	--	--	17.75	--	--	9.3	--	--	--	--	--
		Maximum	33	765	8.8	--	24	--	--	10.7	--	--	505	--	--
		N	5	2	1	--	2	--	--	2	--	--	1	--	--
442940103371501	USGS	Minimum	19	--	--	--	--	--	--	--	--	--	--	--	--
		Median	35	--	--	--	--	--	--	--	--	--	--	--	--
		Maximum	35	680	--	--	13	--	--	10	--	--	--	--	--
		N	3	1	--	--	1	--	--	1	--	--	--	--	--
SD-0000159-1	EPA	Minimum	--	--	7.1	--	1.6	--	--	--	--	--	--	4	--
		Median	--	--	8.5	--	12	--	--	--	--	--	--	8.4	--
		Maximum	--	--	8.95	--	24	--	--	--	--	--	--	10	--
		N	--	--	13	--	13	--	--	--	--	--	--	3	--

Table 12. Summary statistics for selected ions from the U.S. Environmental Protection Agency STORET water-quality database

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency. mg/L, milligrams per liter; N, number of observations]

Station	Agency	Statistic	Calcium, dis-solved (mg/L as Ca)	Magne-sium, dis-solved (mg/L as Mg)	Sodium, dis-solved (mg/L as Na)	Potas-sium, dis-solved (mg/L as K)	Sulfate, dis-solved (mg/L as So_4)	Chloride, dis-solved (mg/L as Cl)	Fluoride, dis-solved (mg/L as F)	Silica, dis-solved (mg/L as SiO_2)
460652	DENR	Minimum	28.3	10	6.4	4.5	<0.03	4.7	--	--
		Median	57	28.4	35	15.7	184	19.75	--	--
		Maximum	72.7	39.6	55.7	27.9	234	46.4	--	--
		N	31	31	31	31	11	40	--	--
460658	DENR	Minimum	--	--	--	--	16	2	--	--
		Median	--	--	--	--	65.4	6.4	--	--
		Maximum	--	--	--	--	154	23.1	--	--
		N	--	--	--	--	37	37	--	--
460659	DENR	Minimum	32.9	15	17.5	8	--	10	--	--
		Median	68.15	33	62.25	26.05	--	46.05	--	--
		Maximum	88.7	58.3	245	35	237	333	--	--
		N	36	36	36	36	1	36	--	--
460660	DENR	Minimum	26.3	9.7	6.1	4.3	--	4.3	--	--
		Median	61.65	25.8	38.75	15	--	26.3	--	--
		Maximum	76.7	39.2	69.9	29.7	172	77.6	--	--
		N	36	36	36	36	1	37	--	--
460675	DENR	Minimum	--	--	--	--	19	6.1	--	--
		Median	--	--	--	--	77.6	12.1	--	--
		Maximum	--	--	--	--	112	20.3	--	--
		N	--	--	--	--	23	23	--	--
460900	DENR	Minimum	3.2	4.9	1.84	0.6	<1	0	0.15	--
		Median	48.2	19.9	2.53	0.9	3.9	2.7	0.26	--
		Maximum	77	24.4	5.8	2	20.7	23.2	0.55	--
		N	9	9	9	9	48	51	7	--
460550	USFS	Minimum	46	22	<1	<1	3.5	0.5	--	4.5
		Median	51	26	1	1	6	1	--	9
		Maximum	66	31	10	1	12	1	--	10
		N	7	7	7	7	7	7	--	7
460561	USFS	Minimum	--	--	--	--	--	0	--	--
		Median	--	--	--	--	--	0.5	--	--
		Maximum	32	10	3	2	7	2.3	--	13
		N	1	1	1	1	1	17	--	1

Table 12. Summary statistics for selected ions from the U.S. Environmental Protection Agency STORET water-quality database–Continued

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency. mg/L, milligrams per liter; N, number of observations]

Station	Agency	Statistic	Calcium, dis-solved (mg/L as Ca)	Magne-sium, dis-solved (mg/L as Mg)	Sodium, dis-solved (mg/L as Na)	Potas-sium, dis-solved (mg/L as K)	Sulfate, dis-solved (mg/L as So_4)	Chloride, dis-solved (mg/L as Cl)	Fluoride, dis-solved (mg/L as F)	Silica, dis-solved (mg/L as SiO_2)
460562	USFS	Minimum	--	--	--	--	--	0	--	--
		Median	--	--	--	--	--	0.5	--	--
		Maximum	32	12	3	2	7	2.3	--	12
		N	1	1	1	1	1	17	--	1
460568	USFS	Minimum	27	7	--	1	10	0	--	7
		Median	33	14	2	2	13	1	--	9.5
		Maximum	38	19	8	3	19.5	2	--	11.2
		N	8	8	7	8	8	8	--	8
460600	USFS	Minimum	53	1	1	1	3.5	0.5	--	4
		Median	59.5	24.5	1	1	4	1	--	8.2
		Maximum	97	29	1	1	5	1.5	--	9
		N	4	4	4	4	4	4	--	4
460607	USFS	Minimum	1	9	2	1.9	14	2.5	--	8.3
		Median	28.85	10	2.8	1.9	17	3	--	8.3
		Maximum	35	13	3	2	30	5	--	11
		N	4	3	3	3	3	3	--	3
460608	USFS	Minimum	34	10	3.5	1	18	3	--	12.7
		Median	--	--	--	--	--	--	--	--
		Maximum	38	13	4	1	23.6	4	--	16
		N	2	2	2	2	2	2	--	2
460611	USFS	Minimum	40	23	0.7	0.4	<3.5	1	--	10.7
		Median	--	--	--	--	--	--	--	--
		Maximum	53	33	2	1	7.5	2	--	11
		N	2	2	2	2	2	2	--	2
460613	USFS	Minimum	56	21	0.7	0.4	3.5	1	--	11
		Median	--	--	--	--	--	--	--	--
		Maximum	69	29	1	1	7.5	4.5	--	14
		N	2	2	2	2	2	2	--	2
460614	USFS	Minimum	51	20	0.7	0.4	<3.5	1.5	--	11
		Median	--	--	--	--	--	--	--	--
		Maximum	58	25	1	2	7.5	1.5	--	13
		N	2	2	2	2	2	2	--	2

Table 12. Summary statistics for selected ions from the U.S. Environmental Protection Agency STORET water-quality database–Continued

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency. mg/L, milligrams per liter; N, number of observations]

Station	Agency	Statistic	Calcium, dis-solved (mg/L as Ca)	Magne-sium, dis-solved (mg/L as Mg)	Sodium, dis-solved (mg/L as Na)	Potas-sium, dis-solved (mg/L as K)	Sulfate, dis-solved (mg/L as SO_4)	Chloride, dis-solved (mg/L as Cl)	Fluoride, dis-solved (mg/L as F)	Silica, dis-solved (mg/L as SiO_2)
460615	USFS	Minimum	43.3	16.5	1	0.4	<2	0.5	--	8
		Median	48	20	1	1	6	0.75	--	9.9
		Maximum	57	24	2	1	22	1.8	--	11.3
		N	4	4	4	4	4	4	--	4
460616	USFS	Minimum	14.2	6	2	0.6	2	1.5	--	9.4
		Median	21	7.4	2	1	4.75	1.5	--	10.85
		Maximum	49	20	2.6	1	22	2.5	--	11.3
		N	4	4	4	4	4	4	4	4
06436170	USGS	Minimum	60.6	29.8	30.1	7.9	157	13	--	--
		Median	--	--	--	--	--	--	--	--
		Maximum	71	>39	44	8.6	240	15.9	0.7	11
		N	2	2	2	2	2	2	1	1
06436180	USGS	Minimum	26	5	3.8	1.3	17	<3	0.2	0.33
		Median	81	42	48	9	280	17	0.8	8.85
		Maximum	130	67	89	15	614	68	1.3	13
		N	113	113	113	112	112	113	72	66
06436190	USGS	Minimum	68.2	27.8	17	5.5	180	9.7	0.5	--
		Median	124	44.3	30.65	8.205	340	16	0.5	--
		Maximum	147	57	56	49	510	20.4	0.7	--
		N	10	10	10	10	9	10	3	--
442134103441901	USGS	Minimum	51	>5	5.35	2	60	5.9	--	--
		Median	--	--	--	--	--	--	--	--
		Maximum	58.9	23.1	7.9	2.4	64	12	0.4	10
		N	2	2	2	2	2	2	1	1
442135103442001	USGS	Minimum	104	68	90.9	18	500	8.7	--	--
		Median	107	68.5	100	21.6	526	20	--	--
		Maximum	110	84.2	110	22.6	670	40.8	1.2	11
		N	3	3	3	3	3	3	1	1
442330103421501	USGS	Minimum	59.6	27.1	26.9	6.4	150	15	--	--
		Median	--	--	--	--	--	--	--	--
		Maximum	75.4	38.9	28	7.8	153	19.2	--	--
		N	2	2	2	2	2	2	--	--
442825103373001	USGS	Minimum	79.9	42.4	43.1	9.6	236	17	--	--
		Median	--	--	--	--	--	--	--	--
		Maximum	87	47	75	11	240	17	--	--
		N	2	2	2	2	2	2	--	--

Table 13. Summary statistics for selected nutrients from the U.S. Environmental Protection Agency STORET water-quality database

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USGS, U.S. Geological Survey. mg/L, milligrams per liter; N, number of observations]

Station	Agency	Statistic	Nitrogen, nitrite dis-solved (mg/L as N)	Nitrogen, NO_2+ NO_3 dis-solved (mg/L as N)	Nitrogen, ammo-nia dis-solved (mg/L as N)	Nitrogen, ammo-nia + organic dis-solved (mg/L as N)	Phos-phorus dis-solved (mg/L as P)	Phos-phorus ortho, dis-solved (mg/L as P)	Cyanide, total (mg/L as Cn)	Cyanide, dis-solved (mg/L as Cn)
46MN31	DENR	Minimum	--	--	--	--	--	<0.03	<0.01	--
		Median	--	--	--	--	--	0.035	<0.01	--
		Maximum	--	--	--	--	--	0.07	0.01	--
		N	--	--	--	--	--	8	8	--
46MN32	DENR	Minimum	--	--	--	--	--	<0.01	<0.01	--
		Median	--	--	--	--	--	0.01	<0.01	--
		Maximum	--	--	--	--	--	0.04	<0.01	--
		N	--	--	--	--	--	8	16	--
46MN33	DENR	Minimum	--	--	--	--	--	<0.01	<0.01	--
		Median	--	--	--	--	--	0.01	<0.01	--
		Maximum	--	--	--	--	--	0.03	<0.01	--
		N	--	--	--	--	--	8	16	--
46MN34	DENR	Minimum	--	--	--	--	--	<0.01	<0.01	--
		Median	--	--	--	--	--	<0.01	<0.01	--
		Maximum	--	--	--	--	--	0.02	<0.01	--
		N	--	--	--	--	--	16	16	--
46MN35	DENR	Minimum	--	--	--	--	--	<0.01	<0.01	--
		Median	--	--	--	--	--	<0.01	<0.01	--
		Maximum	--	--	--	--	--	0.01	<0.01	--
		N	--	--	--	--	--	8	8	--
46MN38	DENR	Minimum	--	--	--	--	--	<0.01	<0.01	--
		Median	--	--	--	--	--	0.01	<0.01	--
		Maximum	--	--	--	--	--	0.03	<0.01	--
		N	--	--	--	--	--	8	8	--
46MN39	DENR	Minimum	--	--	--	--	--	<0.01	<0.01	--
		Median	--	--	--	--	--	0.01	<0.01	--
		Maximum	--	--	--	--	--	0.03	<0.01	--
		N	--	--	--	--	--	8	8	--
460116	DENR	Minimum	--	--	--	--	--	<0.01	<0.01	--
		Median	--	--	--	--	--	0.01	<0.01	--
		Maximum	--	--	--	--	--	0.05	<0.01	--
		N	--	--	--	--	--	21	21	--

Table 13. Summary statistics for selected nutrients from the U.S. Environmental Protection Agency STORET water-quality database–Continued

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USGS, U.S. Geological Survey. mg/L, milligrams per liter; N, number of observations]

Station	Agency	Statistic	Nitrogen, nitrite dis-solved (mg/L as N)	Nitrogen, NO_2+ NO_3 dis-solved (mg/L as N)	Nitrogen, ammo-nia dis-solved (mg/L as N)	Nitrogen, ammo-nia + organic dis-solved (mg/L as N)	Phos-phorus dis-solved (mg/L as P)	Phos-phorus ortho, dis-solved (mg/L as P)	Cyanide, total (mg/L as Cn)	Cyanide, dis-solved (mg/L as Cn)
460118	DENR	Minimum	--	--	--	--	--	<0.01	<0.01	--
		Median	--	--	--	--	--	0.02	<0.01	--
		Maximum	--	--	--	--	--	0.04	0.01	--
		N	--	--	--	--	--	24	24	--
460119	DENR	Minimum	--	--	--	--	--	<0.01	<0.01	--
		Median	--	--	--	--	--	0.02	<0.01	--
		Maximum	--	--	--	--	--	0.05	0.04	--
		N	--	--	--	--	--	8	8	--
460120	DENR	Minimum	--	--	--	--	--	<0.01	<0.01	--
		Median	--	--	--	--	--	0.025	<0.01	--
		Maximum	--	--	--	--	--	0.05	0.05	--
		N	--	--	--	--	--	8	8	--
460122	DENR	Minimum	--	--	--	--	--	<0.01	<0.01	--
		Median	--	--	--	--	--	0.07	0.11	--
		Maximum	--	--	--	--	--	0.58	0.6	--
		N	--	--	--	--	--	20	20	--
460123	DENR	Minimum	--	--	--	--	--	0.01	0.01	--
		Median	--	--	--	--	--	0.03	0.065	--
		Maximum	--	--	--	--	--	0.11	0.39	--
		N	--	--	--	--	--	18	18	--
460652	DENR	Minimum	<0.01	--	0.08	--	--	0.01	0.05	--
		Median	0.125	--	0.9	--	--	0.17	--	--
		Maximum	1.6	--	2.04	--	--	95	0.05	--
		N	58	--	36	--	--	139	2	--
460658	DENR	Minimum	<0.01	--	<0.02	--	--	<0.01	<0.01	--
		Median	<0.01	--	0.03	--	--	0.02	<0.01	--
		Maximum	0.08	--	0.18	--	--	0.37	<1	--
		N	68	--	32	--	--	95	10	--
460659	DENR	Minimum	<0.01	--	0.32	11.98	--	<0.01	<0.01	--
		Median	0.12	--	1.085	--	--	0.14	0.175	--
		Maximum	0.52	--	4.9	12.25	--	1.08	1.38	--
		N	63	--	40	2	--	153	28	--

Table 13. Summary statistics for selected nutrients from the U.S. Environmental Protection Agency STORET water-quality database–Continued

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USGS, U.S. Geological Survey. mg/L, milligrams per liter; N, number of observations]

Station	Agency	Statistic	Nitrogen, nitrite dissolved (mg/L as N)	Nitrogen, NO_2+ NO_3 dissolved (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as N)	Nitrogen, ammonia + organic dissolved (mg/L as N)	Phosphorus dissolved (mg/L as P)	Phosphorus ortho, dissolved (mg/L as P)	Cyanide, total (mg/L as Cn)	Cyanide, dissolved (mg/L as Cn)
460660	DENR	Minimum	<0.01	--	0.11	7.34	--	<0.01	<0.01	--
		Median	0.06	--	0.94	--	--	0.18	0.02	--
		Maximum	0.34	--	3.3	8.72	--	0.48	0.07	--
		N	62	--	40	2	--	129	5	--
460675	DENR	Minimum	<0.01	--	<0.03	--	--	<0.01	--	--
		Median	<0.01	--	0.07	--	--	0.02	--	--
		Maximum	0.04	--	0.48	--	--	0.06	--	--
		N	23	--	20	--	--	38	--	--
460684	DENR	Minimum	--	--	--	--	--	0.05	<0.01	--
		Median	--	--	--	--	--	0.225	0.05	--
		Maximum	--	--	--	--	--	0.34	2.23	0.43
		N	--	--	--	--	--	12	53	1
460685	DENR	Minimum	--	--	--	--	--	0.06	<0.01	--
		Median	--	--	--	--	--	0.32	0.04	--
		Maximum	--	--	--	--	--	0.41	3.9	0.39
		N	--	--	--	--	--	17	54	1
460686	DENR	Minimum	--	--	--	--	--	<0.01	<0.01	--
		Median	--	--	--	--	--	0.02	<0.01	--
		Maximum	--	--	--	--	--	0.03	0.04	<0.02
		N	--	--	--	--	--	16	56	1
460689	DENR	Minimum	<0.01	--	--	--	--	<0.01	--	--
		Median	<0.01	--	--	--	--	0.01	--	--
		Maximum	0.02	--	<0.03	--	--	0.04	--	--
		N	36	--	1	--	--	104	--	--
460900	DENR	Minimum	<0.01	--	<0.02	--	--	<0.01	--	--
		Median	<0.01	--	0.03	--	--	0.01	--	--
		Maximum	0.1	--	0.08	--	--	0.06	--	--
		N	55	--	31	--	--	109	--	--
06436170	USGS	Minimum	--	--	--	--	--	--	--	0.14
		Median	--	--	--	--	--	--	--	--
		Maximum	--	6.7	--	0.7	0.03	--	3.37	3.07
		N	--	1	--	1	1	--	1	2

Table 13. Summary statistics for selected nutrients from the U.S. Environmental Protection Agency STORET water-quality database–Continued

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USGS, U.S. Geological Survey. mg/L, milligrams per liter; N, number of observations]

Station	Agency	Statistic	Nitrogen, nitrite dis-solved (mg/L as N)	Nitrogen, NO_2+ NO_3 dis-solved (mg/L as N)	Nitrogen, ammo-nia dis-solved (mg/L as N)	Nitrogen, ammo-nia + organic dis-solved (mg/L as N)	Phos-phorus dis-solved (mg/L as P)	Phos-phorus ortho, dis-solved (mg/L as P)	Cyanide, total (mg/L as Cn)	Cyanide, dis-solved (mg/L as Cn)
06436180	USGS	Minimum	<0.01	<0.005	<0.01	0.2	<0.002	0.16	0	<0.01
		Median	0.035	6.4	0.02	0.7	0.1855	0.205	0.09	0.03
		Maximum	0.08	11	0.06	44	0.435	0.28	6.23	6.12
		N	4	74	40	74	74	4	47	121
06436190	USGS	Minimum	--	--	--	--	--	--	<0.01	<0.01
		Median	--	--	--	--	--	--	0.035	0.03
		Maximum	--	--	--	--	--	--	5.61	3.66
		N	--	--	--	--	--	--	10	10
442134103441901	USGS	Minimum	--	--	--	--	--	--	<0.01	< 0.01
		Median	--	--	--	--	--	--	--	--
		Maximum	--	0.49	--	0.3	0	--	<1	<0.01
		N	--	1	--	1	1	--	2	2
442135103442001	USGS	Minimum	--	--	--	--	--	--	14.6	0.23
		Median	--	--	--	--	--	--	15.3	14.1
		Maximum	--	19	--	1.7	0.24	--	16	15
		N	--	1	--	1	1	--	2	3
442320103422301	USGS	Minimum	--	5.4	--	--	--	--	--	--
		Median	--	--	--	--	--	--	--	--
		Maximum	0.03	6.3	0.03	0.8	0.21	0.05	0.11	0.1
		N	1	2	1	1	1	1	1	1
442322103423701	USGS	Minimum	--	5.4	--	--	--	--	--	--
		Median	--	--	--	--	--	--	--	--
		Maximum	--	6.7	0.05	1.5	0.32	1.2	--	0.01
		N	--	2	1	1	1	1	--	1
442330103421501	USGS	Minimum	--	--	--	--	--	--	<1	0.03
		Median	--	--	--	--	--	--	--	--
		Maximum	--	--	--	--	--	--	2.6	2.4
		N	--	--	--	--	--	--	2	2
442825103373001	USGS	Minimum	--	--	--	--	--	--	0.04	0.04
		Median	--	--	--	--	--	--	--	--
		Maximum	--	--	--	--	--	--	<1	0.21
		N	--	--	--	--	--	--	2	2

Table 14. Summary statistics for selected minor and trace constituents from the U.S. Environmental Protection Agency STORET water-quality database

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency. µg/L, micrograms per liter; <, less than; --, no data available; N, number of observations]

Station	Agency	Statistic	Antimony, dissolved (µg/L as Sb)	Arsenic total (µg/L as As)	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)
46MN31	DENR	Minimum	--	17.1	--	--	--	--
		Median	--	34.85	--	--	--	--
		Maximum	--	59.8	--	--	--	--
		N	--	8	--	--	--	--
46MN32	DENR	Minimum	--	<5	<5	--	--	--
		Median	--	5.15	<5	--	--	--
		Maximum	--	188.1	7	--	--	--
		N	--	16	7	--	--	--
46MN33	DENR	Minimum	--	<5	<5	--	--	--
		Median	--	<5	<5	--	--	--
		Maximum	--	26.1	6	--	--	--
		N	--	16	7	--	--	--
46MN34	DENR	Minimum	--	<5	<5	--	--	--
		Median	--	<5	<5	--	--	--
		Maximum	--	51.4	11	--	--	--
		N	--	16	7	--	--	--
46MN35	DENR	Minimum	--	<5	--	--	--	--
		Median	--	<5	--	--	--	--
		Maximum	--	7.9	--	--	--	--
		N	--	8	--	--	--	--
46MN38	DENR	Minimum	--	<5	--	--	--	--
		Median	--	7.3	--	--	--	--
		Maximum	--	15	--	--	--	--
		N	--	8	--	--	--	--
46MN39	DENR	Minimum	--	<5	--	--	--	--
		Median	--	<5	--	--	--	--
		Maximum	--	9.2	--	--	--	--
		N	--	8	--	--	--	--
460116	DENR	Minimum	--	13	--	--	--	--
		Median	--	59.3	--	--	--	--
		Maximum	--	1,110	--	--	--	--
		N	--	37	--	--	--	--

Chromium, dissolved (μg/L as Cr)	Copper, dissolved (μg/L as Cu)	Iron, total recover-able (μg/L as Fe)	Iron, dissolved (μg/L as Fe)	Lead, dissolved (μg/L as Pb)	Manga-nese, total recover-able (μg/L as Mn)	Manga nese, dissolved (μg/L as Mn)	Mercury, dissolved (μg/L as Hg)	Selenium, dissolved (μg/L as Se)	Silver, dissolved (μg/L as Ag)	Zinc, dissolved (μg/L as Zn)
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	8.19	--	--	--	--	--	--	--
--	--	--	1	--	--	--	--	--	--	--

Table 14. Summary statistics for selected minor and trace constituents from the U.S. Environmental Protection Agency STORET water-quality database—Continued

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency. µg/L, micrograms per liter; <, less than; --, no data available; N, number of observations]

Station	Agency	Statistic	Antimony, dissolved (µg/L as Sb)	Arsenic total (µg/L as As)	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)
460118	DENR	Minimum	--	<5	--	--	--	--
		Median	--	11.25	--	--	--	--
		Maximum	--	56.3	--	--	--	--
		N	--	24	--	--	--	--
460119	DENR	Minimum	--	<5	--	--	--	--
		Median	--	21.7	--	--	--	--
		Maximum	--	120	--	--	--	--
		N	--	8	--	--	--	--
460120	DENR	Minimum	--	13.3	--	--	--	--
		Median	--	23.25	--	--	--	--
		Maximum	--	94.2	--	--	--	--
		N	--	8	--	--	--	---
460122	DENR	Minimum	--	<5	--	--	--	--
		Median	--	14.2	--	--	--	--
		Maximum	--	30.4	--	--	--	--
		N	--	20	--	--	--	--
460123	DENR	Minimum	--	<5	--	--	--	--
		Median	--	11.8	--	--	--	--
		Maximum	--	25.7	--	--	--	--
		N	--	18	--	--	--	--
460652	DENR	Minimum	--	790	--	--	--	--
		Median	--	--	--	--	--	--
		Maximum	--	800	--	--	--	--
		N	--	2	--	--	--	--
460658	DENR	Minimum	--	<5	--	--	--	--
		Median	--	10.4	--	--	--	--
		Maximum	--	26.3	--	--	--	--
		N	--	10	--	--	--	--
460659	DENR	Minimum	--	<5	--	--	--	--
		Median	--	15.1	--	--	--	--
		Maximum	--	63.2	--	--	--	--
		N	--	28	--	--	--	--

Chromium, dissolved (µg/L as Cr)	Copper, dissolved (µg/L as Cu)	Iron, total recover-able (µg/L as Fe)	Iron, dissolved (µg/L as Fe)	Lead, dissolved (µg/L as Pb)	Manga-nese, total recover-able (µg/L as Mn)	Manga nese, dissolved (µg/L as Mn)	Mercury, dissolved (µg/L as Hg)	Selenium, dissolved (µg/L as Se)	Silver, dissolved (µg/L as Ag)	Zinc, dissolved (µg/L as Zn)
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
---	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	---	---	--	---	--	--	--	--	---	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	---	--	---	---	--	--	--	--	--
--	--	--	<0.02	--	30	<20	--	--	--	--
--	--	--	0.35	--	50	50	--	--	--	--
--	--	--	1.26	--	150	90	--	--	--	--
--	--	--	31	--	8	31	--	--	--	--
--	--	--	--	--	<20	--	--	--	--	--
--	--	--	--	--	60	--	--	--	--	--
--	--	--	--	--	280	--	--	--	--	--
--	--	--	--	--	37	--	--	--	--	--
--	--	--	0.09	--	--	<10	--	--	--	--
--	--	--	0.855	--	--	<20	--	--	--	--
--	--	--	3.24	--	30	140	--	--	--	--
--	--	--	36	--	1	36	--	--	--	--

Table 14. Summary statistics for selected minor and trace constituents from the U.S. Environmental Protection Agency STORET water-quality database—Continued

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency. µg/L, micrograms per liter; <, less than; --, no data available; N, number of observations]

Station	Agency	Statistic	Antimony, dissolved (µg/L as Sb)	Arsenic total (µg/L as As)	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)
460660	DENR	Minimum	--	27.5	--	--	--	--
		Median	--	32.7	--	--	--	--
		Maximum	--	340	--	--	--	--
		N	--	5	--	--	--	--
460675	DENR	Minimum	--	--	--	--	--	--
		Median	--	--	--	--	--	--
		Maximum	--	--	--	--	--	--
		N	--	--	--	--	--	--
460684	DENR	Minimum	--	6.4	--	--	--	--
		Median	--	44.5	--	--	--	--
		Maximum	--	34,000	--	--	--	--
		N	--	64	--	--	--	--
460685	DENR	Minimum	--	<5	--	--	--	--
		Median	--	38.6	--	--	--	--
		Maximum	--	50,000	--	--	--	--
		N	--	66	--	--	--	--
460686	DENR	Minimum	--	<5	--	--	--	--
		Median	--	13	--	--	--	--
		Maximum	--	130	--	--	--	--
		N	--	67	--	--	--	--
460900	DENR	Minimum	--	--	--	--	--	--
		Median	--	--	--	--	--	--
		Maximum	--	--	--	--	--	--
		N	--	--	--	--	--	--
460550	USFS	Minimum	--	<5	--	--	--	--
		Median	--	--	--	--	--	--
		Maximum	--	20	--	--	--	--
		N	--	2	--	--	--	--
460568	USFS	Minimum	--	--	--	--	--	--
		Median	--	--	--	--	--	--
		Maximum	--	--	--	--	--	--
		N	--	--	--	--	--	--

Chromium, dissolved (μg/L as Cr)	Copper, dissolved (μg/L as Cu)	Iron, total recover-able (μg/L as Fe)	Iron, dissolved (μg/L as Fe)	Lead, dissolved (μg/L as Pb)	Manga-nese, total recover-able (μg/L as Mn)	Manga nese, dissolved (μg/L as Mn)	Mercury, dissolved (μg/L as Hg)	Selenium, dissolved (μg/L as Se)	Silver, dissolved (μg/L as Ag)	Zinc, dissolved (μg/L as Zn)
--	--	--	0.12	--	--	<10	--	--	--	--
--	--	--	0.445	--	--	30	--	--	--	--
--	--	--	1.36	--	50	70	--	--	--	--
--	--	--	36	--	1	36	--	--	--	--
--	--	--	--	--	<20	--	--	--	--	--
--	--	--	--	--	60	--	--	--	--	--
--	--	--	--	--	1,490	--	--	--	--	--
--	--	--	--	--	23	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	60	--	--	<10	--	--	--	--	--
--	--	--	--	--	20	--	--	--	--	--
--	--	100	--	--	100	--	--	--	--	--
--	--	2	--	--	48	--	--	--	--	--
--	--	<20	--	--	<50	--	--	--	--	--
--	--	<600	--	--	<50	--	--	--	--	--
--	--	<200	--	--	50	--	--	--	--	--
--	--	7	--	--	7	--	--	--	--	--
--	--	0	--	--	0	--	--	--	--	--
--	--	160	--	--	95	--	--	--	--	--
--	--	900	--	--	200	--	--	--	--	--
--	--	8	--	--	8	--	--	--	--	--

Table 14. Summary statistics for selected minor and trace constituents from the U.S. Environmental Protection Agency STORET water-quality database—Continued

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency. µg/L, micrograms per liter; <, less than; --, no data available; N, number of observations]

Station	Agency	Statistic	Antimony, dissolved (µg/L as Sb)	Arsenic total (µg/L as As)	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)
460600	USFS	Minimum	--	--	--	--	--	--
		Median	--	--	--	--	--	--
		Maximum	--	--	--	--	--	--
		N	--	--	--	--	--	--
460607	USFS	Minimum	--	5	--	--	--	--
		Median	--	5	--	--	--	--
		Maximum	--	20	--	--	--	--
		N	--	28	--	--	--	--
460608	USFS	Minimum	--	--	--	--	--	--
		Median	--	--	--	--	--	--
		Maximum	--	--	--	--	--	--
		N	--	--	--	--	--	--
460611	USFS	Minimum	--	--	--	--	--	--
		Median	--	--	--	--	--	--
		Maximum	--	--	--	--	--	--
		N	--	--	--	--	--	--
460613	USFS	Minimum	--	--	--	--	--	--
		Median	--	--	--	--	--	--
		Maximum	--	--	--	--	--	--
		N	--	--	--	--	--	--
460614	USFS	Minimum	--	--	--	--	--	--
		Median	--	--	--	--	--	--
		Maximum	--	<5	--	--	--	--
		N	--	1	--	--	--	--
460615	USFS	Minimum	--	<5	--	--	--	--
		Median	--	<5	--	--	--	--
		Maximum	--	23	--	--	--	--
		N	--	35	--	--	--	--
460616	USFS	Minimum	--	5	--	--	--	--
		Median	--	40	--	--	--	--
		Maximum	--	68	--	--	--	--
		N	--	21	--	--	--	--

Chromium, dissolved (µg/L as Cr)	Copper, dissolved (µg/L as Cu)	Iron, total recover-able (µg/L as Fe)	Iron, dissolved (µg/L as Fe)	Lead, dissolved (µg/L as Pb)	Manga-nese, total recover-able (µg/L as Mn)	Manga nese, dissolved (µg/L as Mn)	Mercury, dissolved (µg/L as Hg)	Selenium, dissolved (µg/L as Se)	Silver, dissolved (µg/L as Ag)	Zinc, dissolved (µg/L as Zn)
--	--	<20	--	--	<0.05	--	--	--	--	--
--	--	65	--	--	<50	--	--	--	--	--
--	--	120	--	--	<50	--	--	--	--	--
--	--	4	--	--	5	--	--	--	--	--
<1,000	--	80	--	--	<10	--	--	--	--	--
--	--	--	--	--	<50	--	--	--	--	--
<1,000	--	100	--	--	90	--	--	--	--	--
2	--	2	--	--	3	--	--	--	--	--
--	--	<20	--	--	<50	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	20	--	--	90	--	--	--	--	--
--	--	2	--	--	2	--	--	--	--	--
--	--	30	--	--	<50	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	80	--	--	<50	--	--	--	--	--
--	--	2	--	--	2	--	--	--	--	--
--	--	20	--	--	<50	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	80	--	--	70	--	--	--	--	--
--	--	2	--	--	2	--	--	--	--	--
--	--	50	--	--	<50	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	100	--	--	110	--	--	--	--	--
--	--	2	--	--	2	--	--	--	--	--
--	--	<0.02	--	--	<10	--	--	--	--	--
--	--	25	--	--	110	--	--	--	--	--
<1,000	--	120	--	--	130	--	--	--	--	--
1	--	4	--	--	4	--	--	--	--	--
--	--	40	--	--	<0.01	--	--	--	--	--
--	--	60	--	--	<50	--	--	--	--	--
--	--	100	--	--	90	--	--	--	--	--
--	--	3	--	--	3	--	--	--	--	--

Table 14. Summary statistics for selected minor and trace constituents from the U.S. Environmental Protection Agency STORET water-quality database—Continued

[Agency: DENR, South Dakota Department of Environment and Natural Resources; USFS, U.S. Forest Service; USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency. µg/L, micrograms per liter; <, less than; --, no data available; N, number of observations]

Station	Agency	Statistic	Antimony, dissolved (µg/L as Sb)	Arsenic total (µg/L as As)	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Boron, dissolved (µg/L as B)	Cadmium, dissolved (µg/L as Cd)
06436170	USGS	Minimum	--	--	9	--	--	--
		Median	--	--	--	--	--	--
		Maximum	1	37	9.4	--	--	<10
		N	1	1	2	--	--	1
06436180	USGS	Minimum	<1	18	<1	29	40	<1
		Median	2	47	24	60	100	<1
		Maximum	11	1,900	81	83	140	<10
		N	76	74	122	40	52	112
06436190	USGS	Minimum	--	31	24	--	--	<1
		Median	--	62	35	--	--	--
		Maximum	--	110	75	--	--	<10
		N	--	10	10	--	--	10
442134103441901	USGS	Minimum	--	--	3	--	--	--
		Median	--	--	--	--	--	--
		Maximum	<1	8	3	--	--	<10
		N	1	1	2	--	--	1
442135103442001	USGS	Minimum	--	60	28	--	--	<1
		Median	--	--	36	--	--	<10
		Maximum	5	67	39	--	--	<10
		N	1	2	3	--	--	3
442330103421501	USGS	Minimum	--	44	13	--	--	<10
		Median	--	52	13.5	--	--	--
		Maximum	--	60	14	--	--	<10
		N	--	2	2	--	--	2
442825103373001	USGS	Minimum	--	33	21	--	--	<1
		Median	--	--	--	--	--	--
		Maximum	--	96	35	--	--	<10
		N	--	2	2	--	--	2
SD-0000159-1	EPA	Minimum	--	--	--	--	--	--
		Median	--	--	--	--	--	--
		Maximum	--	<50	--	--	--	--
		N	--	1	--	--	--	--

Chromium, dissolved (μg/L as Cr)	Copper, dissolved (μg/L as Cu)	Iron, total recoverable (μg/L as Fe)	Iron, dissolved (μg/L as Fe)	Lead, dissolved (μg/L as Pb)	Manganese, total recoverable (μg/L as Mn)	Manganese, dissolved (μg/L as Mn)	Mercury, dissolved (μg/L as Hg)	Selenium, dissolved (μg/L as Se)	Silver, dissolved (μg/L as Ag)	Zinc, dissolved (μg/L as Zn)
--	6	--	53	--	--	140	<0.1	<2	--	<3
--	--	--	--	--	--	--	--	--	--	--
<10	100	3,150	100	<50	240	180	<0.2	3	<10	<10
1	2	1	2	1	1	2	2	2	1	2
<1	--	28.9	<3	<1	<10	<1	<0.1	<1	<1	<3
<10	--	1,700	17	<10	180	54	<0.1	<2	<1	8
300	--	202,000	230	<50	6,720	753	<0.5	<50	<10	180
123	--	77	121	87	77	123	119	88	87	123
<4	<2	450	4	5	89	56	<0.2	<1	<3	<3
--	<50	650	<50	<50	187.5	132	<0.2	<2	<10	<10
<10	350	16,000	88	50	582	285	<0.2	<20	10	10
10	10	9	10	10	10	10	9	10	10	10
--	2	--	13	--	--	39	<0.1	<2	--	3
--	--	--	--	--	--	--	--	--	--	--
<10	<50	650	<50	50	60	45	<0.2	2	<10	<10
1	2	1	2	1	1	2	2	2	1	2
<10	16	1,750	63	<50	195	68	<0.1	2.7	<10	<30
--	150	--	150	--	--	165	<0.2	--	--	50
<10	350	2,500	200	<50	360	315	<0.2	3	<10	72
2	3	2	3	2	2	3	3	2	2	3
<10	50	2,600	<50	<50	240	165	<0.2	<2	<10	<10
--	--	--	--	--	--	--	--	--	--	--
<10	100	2,850	50	<50	240	240	<3	<2	<10	<10
2	2	2	2	2	2	2	2	2	2	2
<10	<50	800	<50	<5	226	12	<0.2	<2	<10	<10
--	--	--	--	--	--	--	--	--	--	--
<10	50	3,760	50	<50	285	285	<0.2	<20	<10	<10
2	2	2	2	2	2	2	2	2	2	2
--	--	60	--	--	--	--	--	--	--	--
--	--	126	--	--	--	--	--	--	--	--
--	--	145	--	--	--	--	--	--	--	--
--	--	3	--	--	--	--	--	--	--	--