STATISTICAL ANALYSIS AND EVALUATION OF WATER-QUALITY DATA FOR SELECTED STREAMS IN THE COAL AREA OF EAST-CENTRAL MONTANA

by John H. Lambing

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 83-4224

Prepared in cooperation with the
U.S. BUREAU OF LAND MANAGEMENT and the
MONTANA DEPARTMENT OF FISH, WILDLIFE, AND PARKS

U.S. DEPARTMENT OF THE INTERIOR
March 3, 1849

Helena, Montana
December 1983

UNITED STATES DEPARTMENT OF THE INTERIOR

JAMES G. WATT, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

District Chief
U.S. Geological Survey
428 Federal Building
301 S. Park
Drawer 10076
Helena, MT 59626

Copies of this report can be
purchased from:

Open-File Services Section
Western Distribution Branch
U.S. Geological Survey
Box 25425, Federal Center
Denver, CO 80225
(303) 234-5888

CONTENTS

Page

ILLUSTRATIONS

ILLUSTRATIONS--Continued

TABLES

CONVERSION FACTORS

The following factors may be used to convert inch-pound units in this report to the International System of Units (SI).

Multiply inch-pound unit	By	To obtain SI unit
acre-foot	1,233	cubic meter
acre-foot per square mile	476.1	cubic meter per square kilometer
acre-foot per ton (acre-ft/ton)	1,359	cubic meter per megagram
acre-foot per year	1,233	cubic meter per year
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter (m)
gallon per minute (gal/min)	0.06309	cubic meter per second
inch (in.)	25.40	millimeter
mile (mi)	1.609	kilometer (km)
pound per cubic foot (lb/ft^3)	16.02	kilogram per cubic meter
square mile (mi^2)	2.590	square kilometer
ton (short, 2,000 pounds)	0.9072	megagram
ton (short) per day (ton/d)	0.9072	megagram per day
ton per square mile (ton/mi^2)	0.3503	megagram per square kilometer
ton per year	0.9072	megagram per year

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

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

National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called mean sea level. NGVD of 1929 is referred to as sea level in this report.

STATISTICAL ANALYSIS AND EVALUATION OF WATER-QUALITY DATA FOR SELECTED STREAMS IN THE COAL AREA OF EAST-CENTRAL MONTANA

by

John H. Lambing

ABSTRACT

To document and evaluate existing conditions of water quality prior to proposed coal development in east-central Montana, water-quality data were collected at 23 sites on selected streams from October 1975 through September 1981. The data were statistically summarized and regression equations were developed to define relationships between water-quality variables. Where applicable, measured water-quality conditions were compared to various water-use standards.

Water-quality data indicate that considerable temporal variability exists as a result of streamflow fluctuations during the annual flow cycle. Measured concentrations of dissolved solids ranged from 145 to 12,200 milligrams per liter. Concentrations commonly exceeded 1,000 milligrams per liter and thereby present a high to very high salinity hazard for irrigation. Streamflow of the area contains predominantly sodium and sulfate ions and generally constitutes a medium to very high sodium hazard for irrigation during intervals of base flow. The water in most streams is generally adequate for livestock consumption during base flow. The most favorable conditions for irrigation and livestock watering exist during intervals of direct runoff when the dissolved-solids concentration is diluted and calcium and bicarbonate compose a significant percentage of the ionic balance.

Concentrations of suspended sediment were extremely variable and had a direct correlation to water discharge. Measured suspended-sediment concentrations ranged from 4 to 23,000 milligrams per liter. Sediment-transport curves were developed for 18 of the study sites. Mean annual suspended-sediment loads were determined at five sites using the flow-duration, sediment-transport curve method. Mean annual sediment loads ranged from 1,010 to 72,700 tons. Corresponding mean annual yields at these sites ranged from 1.85 to 207 tons per square mile.

INTRODUCTION

Large supplies of low-sulfur coal underlie extensive areas in the northern Great Plains of east-central Montana. Consequently, this area is becoming increasingly important as a potential source of supply for meeting future energy needs. The coal in this region generally occurs near the land surface and currently (1982) is being extracted on a small scale by surface-mining methods. As a result of proposals for future coal mining in this area, active coal production is expected to expand.

The prospect of intensified development of coal has created public concern regarding impacts to the area's water resources. A primary concern is the quality of surface waters draining the mined coal fields. Extensive disruption of the land surface could affect either the water quality of streams directly, or the quality of ground water that eventually is discharged to the streams. In addition to actual mining operations, support activities related to the mine and population increases also could adversely affect surface-water quality.

An appraisal of the area's water resources as near to their premining condition as possible was considered essential when it became evident that mining might be conducted on a large scale. This report is the second evaluation of data obtained from a network of surface-water-quality stations that was initiated in 1975. It provides interpretations of water quality from an expanded data base (fig. 1). Funding for operation of the network was provided by the U.S. Geological Survey, the U.S. Bureau of Land Management, and the Montana Department of Fish, Wildlife, and Parks.

Purpose and scope

The purpose of this report is to summarize and evaluate water-quality data acquired from streams within the study area from October 1975 through September 1981. This report updates data collected at 9 stations during the initial study and provides new data for 14 stations. The additional data enable more comprehensive statistical analyses, including development of regression equations, to define relationships between water-quality variables. In addition to statistical analysis and evaluation, a principal objective of this report is to document baseline conditions to serve as a reference for assessing future changes in water quality.

Water samples were collected on a routine schedule for analysis of about 60 different water-quality variables. Six of the water-quality stations were operated in conjunction with continuous-record streamflow stations. The sites discussed in this report vary in the duration of record available, but most sites have a minimum data base of 2 years. The study period approximates premining conditions, but it does not necessarily represent undisturbed natural conditions. Other activities of man, primarily agriculture, have affected the land and drainage characteristics for some time. Station descriptions for each site are given in table 1 at the back of the report.

Previous work

Prior to 1975, only limited water-quality information was available for the larger streams in the study area and almost no data had been collected on the smaller streams. From October 1975 through September 1977, a network of nine data-collection stations was operated by the U.S. Geological Survey to periodically measure water quality. A summary of data collected during these 2 years (3 years for one station) and descriptions of water quality at each site were published in a report by McKinley (1979). That report represented the initial water-quality evaluation in the study area and included descriptions of physical conditions relating to drainage characteristics at individual stations. Information was also

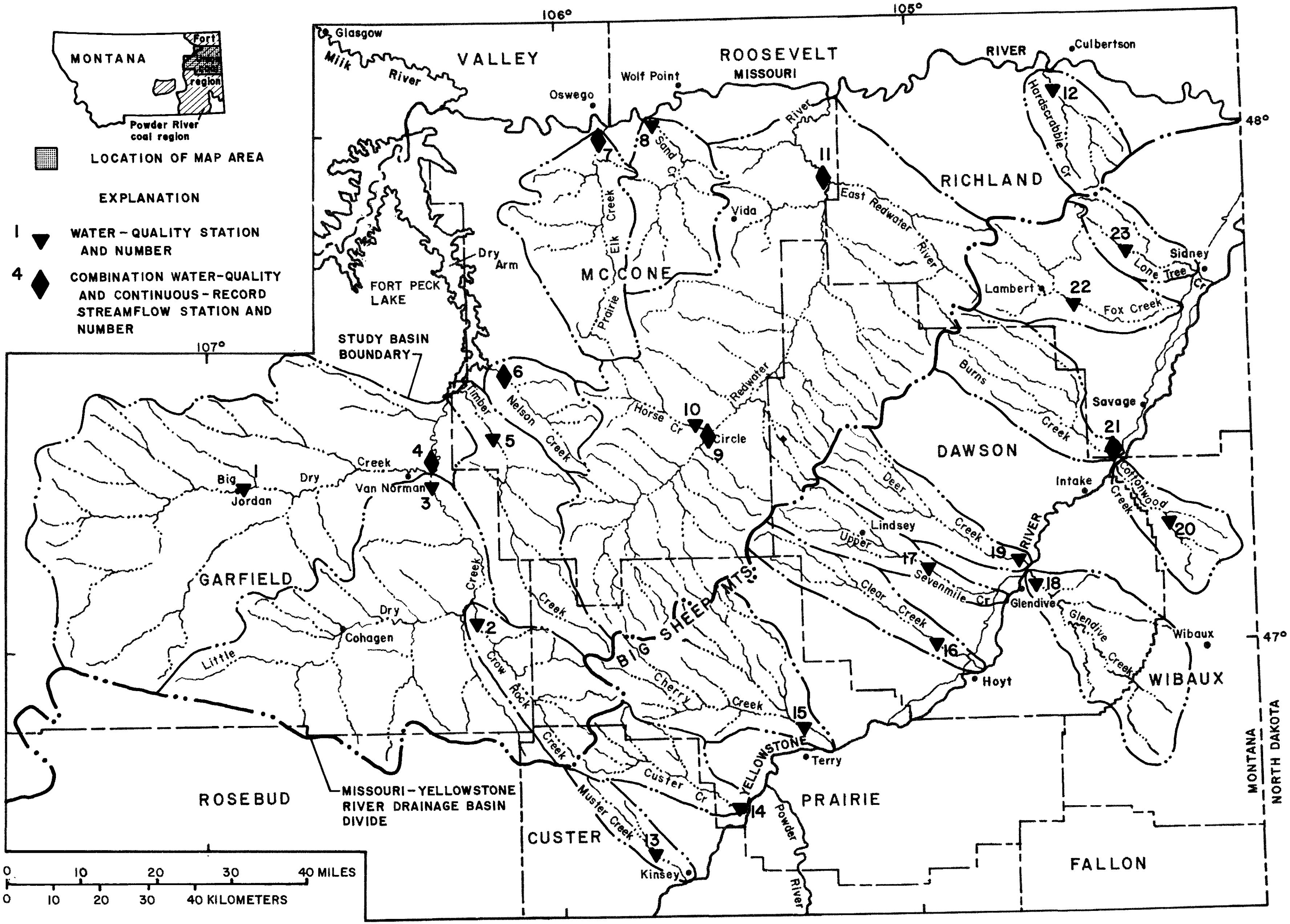

Figure 1.--Location of study area and water-quality stations. Coal-region boundaries from Trumbull (1960).

given on climate, geology, soils, and land use in the study area as well as some background information on the water-quality properties that were measured.

PHYSICAL SETTING

The study area (fig. 1) lies predominantly within the Fort Union coal region of east-central Montana. Most of the area is located between the Missouri and Yellowstone Rivers but also includes two small drainages east of the Yellowstone. The study area, in general, is bounded on the west by the Big Dry Creek drainage and on the east by the Montana-North Dakota border. The area encompasses all or parts of Garfield, McCone, Richland, Dawson, Prairie, Wibaux, Custer, and Rosebud Counties and comprises about 10,000 mi^2.

Climate

The climate is semiarid continental and is characterized by cold moist winters, cool moist springs, and warm dry summers and falls. Large ranges in daily and annual temperatures are typical. Minimum winter temperatures of about -30°F may occur, with January normally being the coldest month and having a mean daily temperature of 13°F. Maximum summer temperatures in excess of 100°F are common. July is generally the warmest month, with a mean daily temperature of 71°F. Mean annual temperature for the study area is 44°F (U.S. Department of Commerce, issued annually).

Most precipitation occurs in late spring and early summer, in response to dominating Pacific or Gulf Coast frontal systems. June is normally the wettest month, with a mean precipitation of about 3 in. Mean annual precipitation ranges from 11 to 15 in. throughout the study area (U.S. Department of Commerce, issued annually). Seasonal snowfall varies from 30 to 50 in., but seldom accumulates owing to frequent thaws caused by "chinook" winds. Localized thunderstorms commonly cause intense rainfall of short duration during the summer and fall. Extended intervals of drought on a regional basis often have severe effects on the environment.

Topography and drainage

Much of the land surface consists of gently rolling hills slightly eroded by intermittent streams. Locally, badlands have developed in easily erodable shale and siltstone. Major streams in the area flow on alluvial flood plains that are commonly bordered by remnants of alluvial terraces. Interstream divides characteristically are flat-topped ridges and buttes that may rise several hundred feet above the adjacent valleys. The natural vegetation of the region is generally sparse, but grass cover is usually adequate for cattle grazing on all but the steepest slopes. Dryland farming is practiced in the uplands and irrigation farming is practiced in the valleys, where soil and water permit.

Land-surface altitudes range from about 1,850 to 3,600 ft above sea level. The lowest area is in the northeast corner where the Missouri River flows from the study area, and the highest area is in the south-central part in the Big Sheep Mountains.

Twenty-one streams that are included in the network of stations flow into either the Missouri or the Yellowstone River directly or are secondary tributaries. Big Dry Creek, Little Dry Creek, and Crow Rock Creek drain the area south of Fort Peck Lake. These streams normally have periods of intermittent flow at the sampling stations, although Big Dry Creek is often perennial downstream from its confluence with Little Dry Creek. Timber and Nelson Creeks flow into Dry Arm of Fort Peck Lake from the southeast and are typically intermittent. Prairie Elk Creek, Sand Creek, Redwater River, and Hardscrabble Creek flow north and join the Missouri River downstream from Fort Peck Lake. Horse Creek is tributary to the Redwater River. Prairie Elk Creek and the Redwater River are normally perennial streams in their downstream reaches, whereas Sand, Horse, and Hardscrabble Creeks are intermittent.

Eleven streams in the study area flow directly into the Yellowstone River and generally have small drainage areas and intermittent flow. Muster and Custer Creeks flow southeast into the Yellowstone River upstream from the mouth of the Powder River. Cherry, Clear, Upper Sevenmile, Deer, Burns, Fox, and Lone Tree Creeks flow southeast and enter the Yellowstone River downstream from the Powder River. Glendive and Cottonwood Creeks drain areas east of the Yellowstone River and enter downstream from Glendive.

Hydrogeology

The hydrogeology of eastern Montana has been mapped and described by Stoner and Lewis (1980) and previously discussed for the study area by McKinley (1979). Coal resources of the area are located primarily in the Tongue River Member of the Fort Union Formation of Paleocene age. The approximate areal extent of known strippable coal deposits and the location of the one active mine are shown in figure 2.

The water quality of streams during base-flow conditions is largely dependent on the chemical character of ground-water inflow. Chemical data collected from wells in the study area (Slagle, 1983) indicate wide variability in ground-water quality depending on depth, time of contact with underlying formations, and aquifer mineralogy. A generalized conceptual model of the shallow ground-water system in southeastern Montana developed by Lee (1980) probably can be used to adequately describe the geochemistry of the shallow ground-water system in east-central Montana. The basic conclusions of this model are that recharge waters would tend to have small concentrations of dissolved solids and be dominated by calcium, magnesium, and bicarbonate ions, with significant amounts of sodium and sulfate. As the water percolates through the system, sodium and sulfate enrichment occurs and results in an increase of dissolved-solids concentration. Much of the sodium and sulfate is derived from the dissolution of sodium feldspars, pyrite, and gypsum combined with cation exchange reactions on clay minerals and subsequent reactions with calcite, dolomite, and aragonite. Mixing of water recharged through permeable clinker (overburden baked by coal combustion) may decrease dissolved-solids concentrations in some areas. At various points in the system, ground water dominated by sodium and sulfate may discharge as base flow to the streams.

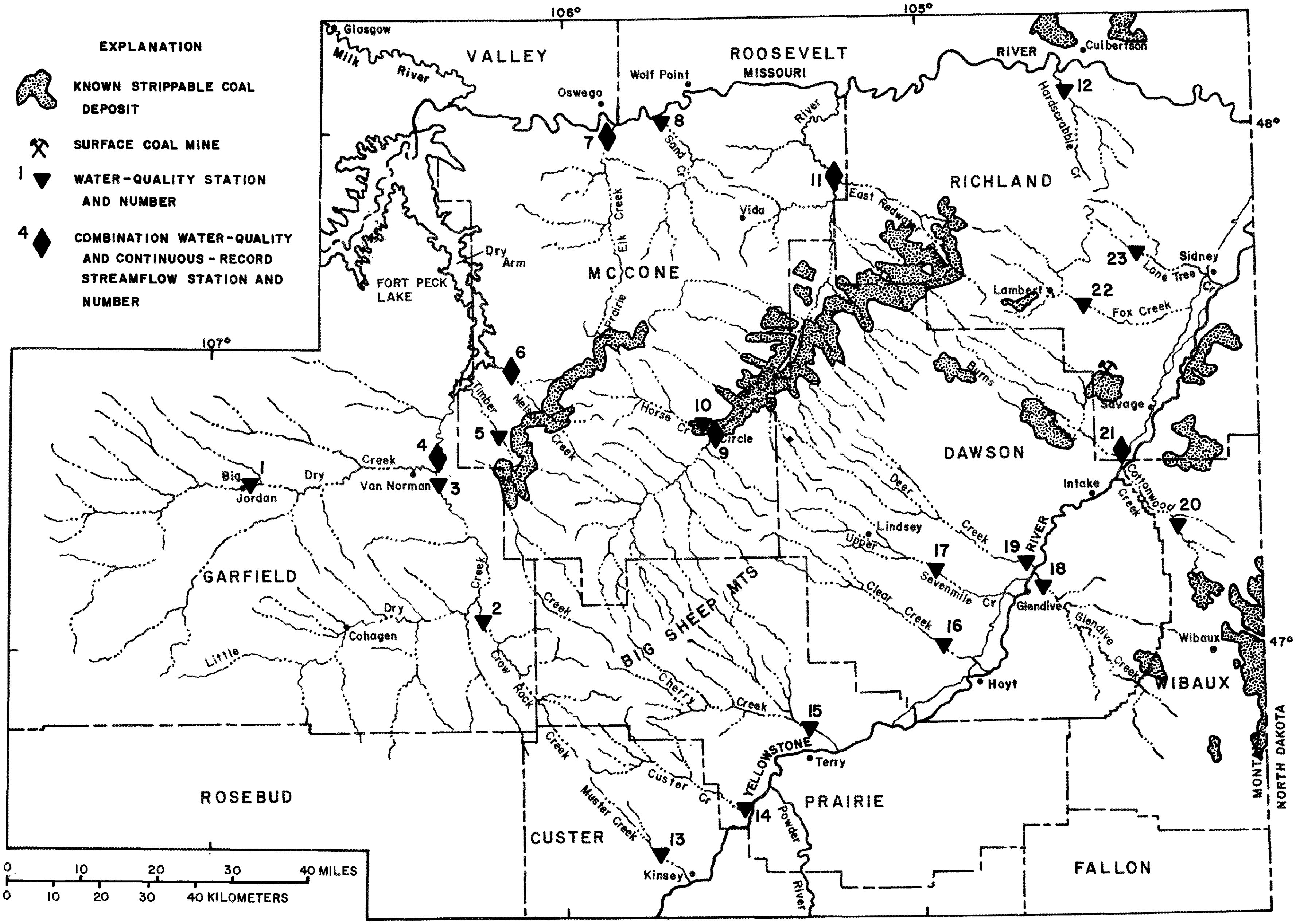

Figure 2.--Location of known strippable coal deposits in study area. Coal-deposit boundaries from U.S. Geological Survey (1974).

Soils

Soils in the area generally are shallow and derived primarily from the weathering of poorly consolidated sandstones, siltstones, and shales, mostly of the Fort Union Formation. Soil types range from sandy to clayey loam, with erodability depending largely on soil slope and grain size. In the broadest classification, soils in the area can be divided into residual, alluvial, or a combination of the two.

Residual soils reflect the character of the parent rock in both physical and chemical nature. These soils typically occur in upland areas such as slopes and ridges where the parent material is close to the surface. In the semiarid environment of the study area, the residual soils tend to be relatively coarse as a result of the dominating effect of physical rather than chemical weathering processes. Sandstones generally weather to sandy loams, which store little water and are of low to moderate salinity. Siltstones and shales, in contrast, weather to form silty-clay soils that are less well-drained and may contain large amounts of soluble salts. Sodium is commonly the dominant ion. Runoff from residual soils is generally rapid, especially in areas of sparse vegetation and high relief, and can produce severe erosion.

Alluvial soils are derived from materials that have been transported from a variety of sources and deposited on terraces, alluvial fans, and valley flood plains. The parent material is essentially the same as for residual soils, but the processes of fluvial transport and size sorting cause a more heterogeneous soil mixture. Alluvial soils are generally more permeable than silty-clay residual soils and are commonly well-leached of soluble salts except in poorly drained areas. Deposition of alluvial soils generally occurs in areas of gentle slope; consequently, the erosion hazard is normally small to moderate except in local areas where streams erode the banks.

Combination soils reflect the characteristics of both residual and alluvial soils. Consequently, such soils may vary widely with respect to permeability, salinity, and erosion hazard.

DATA COLLECTION

Samples for chemical and sediment analysis were collected at about 1-month intervals from perennial streams and periodically when flow was present from intermittent streams. Streamflow was measured at the time of sampling. Streams at several of the sites flowed only rarely and the data collected are meager.

An accurate assessment of water quality depends on samples being collected throughout the entire range of streamflow conditions within the given time frame. Therefore, sampling visits were programmed on a systematic schedule in an attempt to create a data base representative of the complete range of variability occurring throughout the annual flow cycle. Extreme conditions of streamflow, however, affected to some degree the time of sample collection. Low streamflows were generally sampled on a monthly schedule. Disruptions in sampling schedules sometimes occurred as attempts were made to sample high flows when possible. Consequently, the preferential sampling of high flows may have introduced some bias into the statistical analyses. In addition, because the study was short, the degree to which the data accurately characterize long-term conditions is uncertain.

Sample collection, pretreatment, and laboratory analysis were performed according to U.S. Geological Survey standard procedures, which are described in reports by Guy (1969), Guy and Norman (1970), U.S. Geological Survey (1977), and Skougstad and others (1979). Samples for suspended sediment were analyzed at the U.S. Geological Survey sedimentation laboratory in Worland, Wyoming. Samples for the analysis of chemical constituents were analyzed at the U.S. Geological Survey water-quality laboratory in Denver, Colorado.

STATISTICAL ANALYSIS OF WATER-QUALITY DATA

The water-quality data from which statistical analyses were made are published in annual water resources data reports of the U.S. Geological Survey (see References cited). The following sections describe the statistical concepts and techniques used in this study. The statistical techniques presented are empirical in nature but provide a means for identifying correlations between water-quality variables, which are commonly a result of functional relationships. Because the strengths of such relationships vary among individual streams, statistical tests are utilized to identify the variables that are significantly correlated. All statistical analyses were performed by computer programs available through SAS Institute, Inc.[1] (1979).

Regression models

A statistical technique commonly used to define the relationships between water-quality variables is the development of regression models. These models provide equations for estimating values of one variable (dependent) from known values of one or more other variables (independent) that are considered to be chemically or physically related. In this study, simple and multiple regression models were used to describe relationships between water-quality variables according to the following equations:

(simple linear regression)

$$Y = a + bX \qquad (1)$$

where

Y = dependent water-quality variable,
a = regression constant (y-intercept),
b = regression coefficient of the independent variable (slope), and
X = independent water-quality variable.

(multiple linear regression)

$$Y = a + b_1X_1 + b_2X_2 \qquad (2)$$

where

Y = dependent water-quality variable,
a = regression constant (y-intercept),
b_1 = partial regression coefficient of the first independent variable,
X_1 = first independent water-quality variable,
b_2 = partial regression coefficient of the second independent variable, and
X_2 = second independent water-quality variable.

---

[1] Use of firm names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

Simple and multiple regression summaries for water-quality variables are listed for 21 sites in table 2 at the back of the report. Regression analyses were not performed on two sites having less than the minimum sample size of four, which was an arbitrarily selected criterion. Also included in table 2 are descriptive statistics for values of water discharge, major constituents, and trace elements determined for each of the 23 sites. All descriptive statistics are reported to hundredths as a result of the computer-program format, which lacks provisions for correct significant figures.

The strengths of functional relationships are indicated in the regression summaries by the coefficient of determination (r^2), standard error of estimate, significance of the regression coefficients (b), and significance of the correlation coefficient (r). The coefficient of determination indicates the proportion of variance in the dependent variable that is explained by the regression equation and ranges from 0 to 1. Generally, the larger the coefficient of determination, the more meaningful is the regression relationship. The correlation coefficient indicates the degree to which the variation in the dependent variable is related to the variation in the independent variable(s). No relationship exists if the correlation coefficient is zero, whereas a perfect relationship exists if the correlation coefficient is -1 or +1. The standard error of estimate is the standard deviation of the observed values about the regression line. The greater the standard error of estimate, the less reliable is the prediction capability of the regression equation. The $\alpha = 0.05$ significance of the partial regression coefficient indicates a 95-percent likelihood that the regression coefficient is not equal to zero. The $\alpha = 0.05$ significance of the correlation coefficient indicates a 95-percent likelihood that a non-zero relationship exists between the dependent and independent variables.

Two sets of simple linear regressions were developed for each major constituent using specific conductance and stream discharge separately as independent variables. These two independent variables were chosen because of their generally strong relationships to constituent concentrations. The better of the two equations was selected, based on the coefficients of determination, and included in table 2. In an attempt to improve the regression analyses, conductance and stream discharge were used concurrently to produce multiple linear regressions. The results are given in table 2. Adding a second independent variable into the regression equation commonly resulted in an increase in the coefficient of determination. Although improvements over simple regressions generally occurred, in many instances they were not large.

The tests for significance used in linear regression analysis are based on the assumptions that values for the dependent and independent variables are linearly related and that deviations of the dependent variable about the regression line (residuals) are normally distributed. In addition, it is important for the array of values of the dependent variables to have homogeneous variance along the regression line. If these assumptions are not satisfied, transformation of the data into logarithms can sometimes be used to attain linearity or uniform variance about the regression line. The large number of stations and variables precluded thorough examination of all the data to determine if any transformations might be needed. Therefore, simple and multiple regression equations in table 2 are based on untransformed data.

Application of regression models

Regression models can be used to estimate or predict water-quality characteristics for specific stream sites. By entering measured values of the independent variable(s) into the regression equation, values of the dependent variable can be estimated. Regression equations also may be utilized to calculate amounts of specific constituents transported by a stream (defined as the load). Constituent loads can be calculated using water discharge and estimated constituent concentrations. Discharge can be obtained either from a direct measurement or from a stage-discharge rating for the specific stream site. Once the concentration of the desired constituent has been estimated, loading can be computed using the equation:

$$L_c = 0.0027\, Q \cdot C_c \qquad (3)$$

where

L_c = constituent load, in tons per day;
0.0027 = unit conversion constant;
Q = water discharge, in cubic feet per second; and
C_c = estimated constituent concentration, in milligrams per liter.

When instantaneous values of water discharge are used in the loading equation, they may be correctly applied only for predicting instantaneous loads. Improvement in the accuracy of daily loading values can be obtained when a continuous record of streamflow is available, from which a mean discharge for the day of sampling can be determined. Monthly and annual constituent loads can be calculated either directly from daily mean streamflow records and concentrations from daily samples, or indirectly from flow-duration statistics and estimated constituent concentrations.

Regression models developed from adequate baseline water-quality data can be useful in assessing the impacts of land-use changes. Deviation from established regression equations may indicate alteration of water quality resulting from man's activities. Regression analysis, therefore, can be used to detect significant changes in water quality that might warrant more intensive investigation of specific variables.

Limitations of regression models

When applying regression models, certain statistical limitations need to be considered. A high degree of correlation does not necessarily imply a cause- and-effect relationship between the independent and dependent variables. However, some physical relationship between the variables is preferable for the results to be considered meaningful (Riggs, 1968). Application of the regression equations is valid only for a specific stream site and only within the range of data used to develop the equations. To test the continuing adequacy of an equation, periodic check samples may be necessary to identify major departures from the original relationship.

The accuracy of a regression model is typically judged on the basis of the standard error of the estimate and the coefficient of determination. Large standard errors of estimate are commonly the result of nonlinear relationships or insufficient data. Small values of coefficients of determination may indicate that one or more of the independent variables are not strongly related to the dependent variable. In addition, the regression models can be applied correctly only in defining the effects of independent variables found significant for each model. These limitations are important to consider when assessing the predictive capability of regression equations.

EVALUATION OF WATER-QUALITY DATA

Description of all aspects of water quality is difficult because of the large number of variables involved and the lack of a simple quantitative means to assess the relative importance of each variable. As a result, it is common practice to compare measured values of water-quality variables to standards that have been established to judge the suitability of water for various uses. Water that is suitable for a particular use may not necessarily be suitable for other uses.

By convention, water-quality variables are divided into physical, chemical, and biological categories. In this study, emphasis was placed on the physical and chemical aspects of water quality. Under each category, individual water-quality variables or variable groups are discussed. Each discussion includes a brief definition of the variable, a reference to water-use standards where applicable, and a description of its occurrence in the study area.

Physical properties

Physical properties of water are characteristics that are directly affected by processes relating to climatic or landform conditions. The major physical properties measured in this study include water temperature, streamflow, and suspended sediment.

Water temperature

Water temperature directly affects various physical, chemical, and biological processes that occur in a body of water. Temperature also controls many physiological processes of aquatic organisms including growth and reproduction rates and bacterial oxidation of organic matter. In addition, water temperature is an important factor in the solubility of some chemical compounds and gases, with solubility of dissolved oxygen being especially important to most aquatic species. Although temperature standards exist for various water uses, comparisons from the study area are difficult because of the lack of continuous temperature data to fully define daily and seasonal fluctuations. As a general reference, limits for maximum water temperatures ranging from 75°F (23.9°C) to 80°F (26.7°C) have been recommended by the National Technical Advisory Committee (1968) for successful spawning and egg development of various warm-water fishes.

Available data indicate that water temperatures follow seasonal and diel cycles in response to solar insolation and ambient air temperature. Stream depth affects to some degree extremes of temperature occurring throughout the day; deeper streams show less variation than shallow streams. Most perennial streams are ice covered and at 0°C during the winter. Stream temperatures in the summer reach maximums within the range of 20° to 31°C.

Streamflow

Streamflow is composed of water that reaches the stream by direct overland runoff of precipitation and snowmelt, and by ground-water discharge that sustains base flow. Because changes in streamflow magnitude and source affect the concentrations of constituents in water, values of stream discharge are commonly used in regression analyses. Flow patterns within the study area are characteristic of prairie streams. From mid-summer through winter, base-flow conditions predominate and many streams go dry. Perennial flow is common only in the downstream reaches of some of the larger drainages, where ground-water storage is sufficient to contribute water through the alluvium. Intense rainstorms can produce rapid increases in discharge during the base-flow period, but these rains commonly are localized and of short duration. Storm runoff is generally of short duration and streams quickly recede to base flow. Sustained prairie runoff most commonly occurs in late winter through early summer owing to a combination of snowmelt and frequent rainfall. A subsequent decrease in rainfall through the summer and an increase in evapotranspiration eventually cause many of the small streams to go dry. On some streams, these natural streamflow patterns are altered by irrigation diversions and impoundments for irrigation and livestock watering.

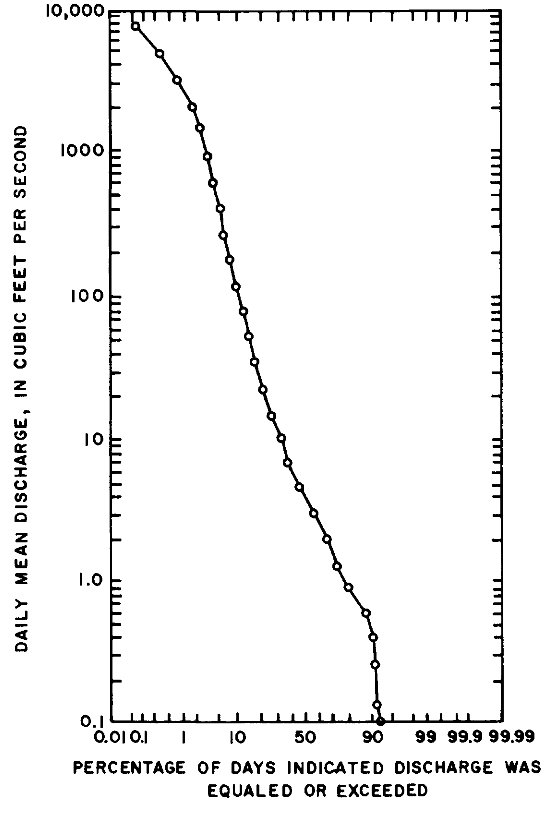

Figure 3.--Flow-duration curve for Big Dry Creek near Van Norman (station 4), 1978 and 1981 water years.

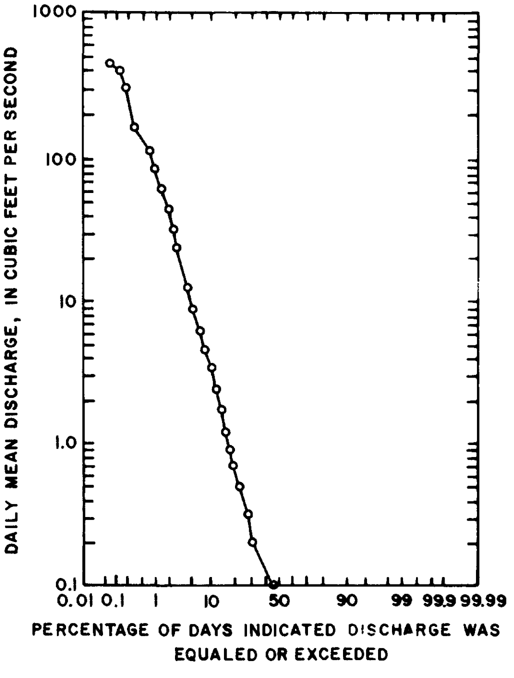

Figure 4.--Flow-duration curve for Nelson Creek near Van Norman (station 6), 1976-79 water years.

Continuous streamflow data have been collected at six of the study sites for varying numbers of years. These data were used to develop flow-duration curves (figs. 3-8), which are cumulative frequency curves showing the average percentage of time that specified discharges were equaled or exceeded in a given period. The accuracy with which these curves describe stream characteristics increases with the length of the data base from which they are constructed. Flow-duration curves presented herein are based on streamflow data for those years during which water-quality data were collected. Because of the short periods of study (2-7 years) for the six continuous-record streamflow stations, flow-duration curves for these sites can serve only as descriptions of short-term flow conditions.

Flow-duration curves provide a method for comparing flow characteristics of streams and estimating frequency probabilities of discharge-related water-quality properties. The steep slopes of the curves for the six stations denote highly variable flows derived largely from direct runoff, with generally small amounts of ground-water inflow storage in the drainage basins. In this study, flow-duration statistics were combined with sediment-transport curves to calculate mean annual suspended-sediment loads. Methods of computation are presented in the following section.

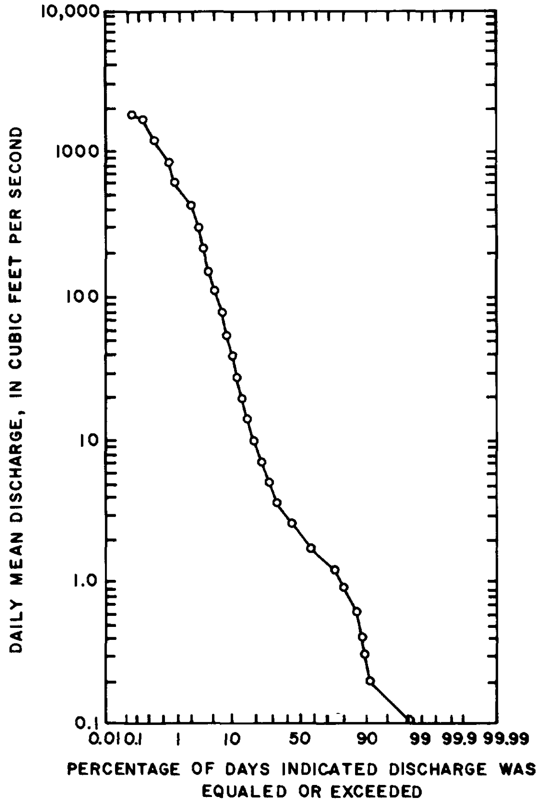

Figure 5.--Flow-duration curve for Prairie Elk Creek near Oswego (station 7), 1976-79 water years.

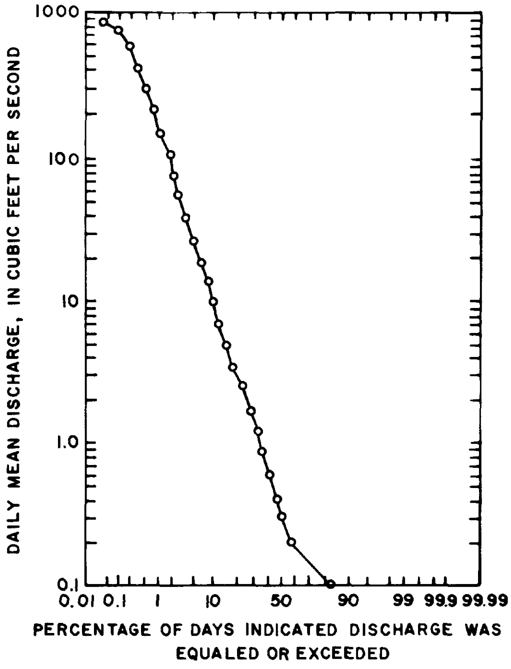

Figure 6.--Flow-duration curve for Redwater River at Circle (station 9), 1975-81 water years.

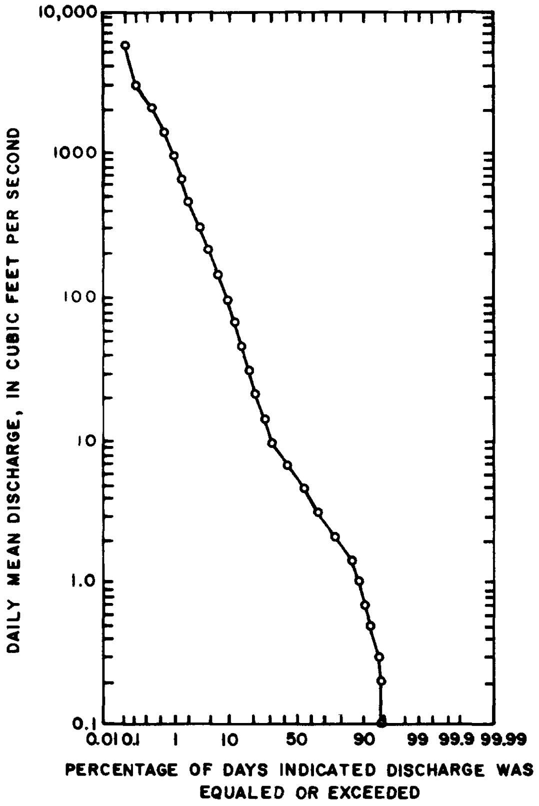

Figure 7.--Flow-duration curve for Redwater River near Vida (station 11), 1976-81 water years.

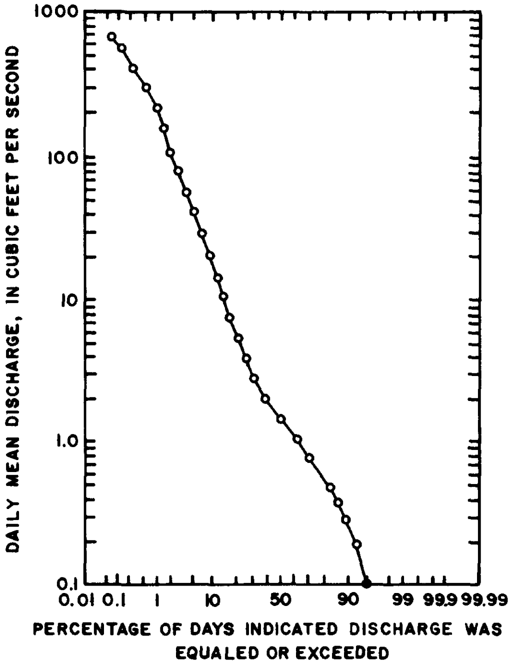

Figure 8.--Flow-duration curve for Burns Creek near Savage (station 21), 1976-79 water years.

Streamflow statistics for the six continuous-record streamflow stations are presented in table 3; the statistics correspond to the years when water-quality data were collected. Where the period of streamflow record is considerably longer than the water-quality study period, a comparison of water yields between the two periods is indicative of the degree to which short-term average discharges reflect long-term conditions. Mean annual water yields for Big Dry Creek near Van Norman and Burns Creek near Savage during the study period were considerably larger than the long-term average. In contrast, Redwater River at Circle had a slightly smaller mean annual water yield for the study period compared to that of the complete period of streamflow record. Water-yield comparisons for the other three streams is somewhat inconclusive owing to a lack of long-term streamflow data.

Suspended sediment

Suspended sediment is particulate material that is maintained in suspension by the upward forces of turbulent currents. (The suspended sediment measured in this study does not include bedload particles that reside on or move along the streambed.) Sediment transported by streams is derived from a combination of channel erosion and soil eroded by overland runoff. Variation in the availability of

Table 3.--*Streamflow statistics for continuous-record streamflow-gaging stations for years corresponding to period of water-quality data collection*

[ft^3/s, cubic feet per second]

Water year	Streamflow statistics	Big Dry Creek near Van Norman (station 4)	Nelson Creek near Van Norman (station 6)	Prairie Elk Creek near Oswego (station 7)	Redwater River at Circle (station 9)	Redwater River near Vida (station 11)	Burns Creek near Savage (station 21)
1975	Maximum daily (ft^3/s)	--	--	--	157	--	--
	Mean daily (ft^3/s)	--	--	--	2.90	--	--
	Annual yield (acre-feet)	--	--	--	2,100	--	--
1976	Maximum daily	--	93	959	142	2,270	90
	Mean daily	--	1.07	22.0	4.86	57.8	7.57
	Annual yield	--	780	16,010	3,530	41,950	5,490
1977	Maximum daily	--	154	76	9.6	24	43
	Mean daily	--	.63	3.33	.73	4.60	1.28
	Annual yield	--	453	2,410	525	3,330	928
1978	Maximum daily	10,700	445	1,800	900	2,990	700
	Mean daily	243	7.57	52.3	23.3	87.8	14.6
	Annual yield	175,800	5,480	37,860	16,880	63,600	10,580
1979	Maximum daily	--	351	996	865	5,810	568
	Mean daily	--	4.57	34.0	28.9	121	20.5
	Annual yield	--	3,310	24,620	20,910	87,930	14,860
1980	Maximum daily	--	--	--	6.4	50	--
	Mean daily	--	--	--	1.08	6.94	--
	Annual yield	--	--	--	784	5,040	--
1981	Maximum daily	219	--	--	1.5	369	--
	Mean daily	4.08	--	--	.27	9.31	--
	Annual yield	2,950	--	--	194	6,740	--
	Mean annual yield (water-quality study period).	89,400 (2 years)	2,510 (4 years)	20,220 (4 years)	6,420 (7 years)	34,700 (6 years)	7,960 (4 years)
	Mean annual yield (period of continuous streamflow record).	41,590 (38 years)	1,800 (6 years)	14,270 (6 years)	9,850 (43 years)	34,700 (6 years)	4,780 (16 years)

sediment for transport can be affected by factors such as topography, season, vegetative cover, land-use practices, and intensity and duration of rainfall.

Although water-quality standards have not been established for suspended sediment, large concentrations are detrimental to most water uses and to many aquatic organisms. Sediment can abrade and clog pumps used for irrigation, obstruct respiratory passages of flora and fauna, and blanket streambed habitat essential to benthic organisms and spawning beds of fish. Suspended sediment also affects stream chemical quality by functioning as a means of transport for sorbed chemical constituents such as nitrogen, phosphorus, organic substances, and many trace elements.

Concentrations of suspended sediment measured in the study area were extremely variable, ranging from 4 to 23,000 mg/L (milligrams per liter). The smallest mean concentration (18.8 mg/L) occurred at Clear Creek near Hoyt (station 16) and the largest (9,690 mg/L) at Muster Creek near Kinsey (station 13). The majority of samples from most stations had concentrations within the 50-200 mg/L range. Maximum concentrations of suspended sediment occurred at times of direct runoff when both channel scour and erosion from overland surfaces contributed sediment to the streams. Minimum concentrations generally occurred during base flow or during snowmelt runoff over partly frozen surfaces.

Suspended-sediment concentrations can be extremely variable depending on climatic and land-use conditions during and preceding each streamflow condition sampled. Stream hydraulics and particle size are important factors affecting the resultant net deposition (aggradation) or removal (degradation) of sediment from a stream channel. Generally, more than 90 percent of the suspended material in the study area is smaller than sand (less than 0.062 millimeter in diameter). Fine sediment particles are easily suspended by the fluid forces in natural streams and tend to move out of the basin (Guy, 1970). In contrast, coarse sediment particles resist suspension and may be transported only short distances during high flows or in reaches of sufficient velocity. In general, aggradation is believed to be more common than degradation because of increased erosion resulting from various land-use practices. The acceleration of natural erosion rates commonly produces more sediment than the stream system is capable of removing.

The quantity of sediment transported by a stream is termed the sediment load. Flowing streams almost always transport some sediment, but by far the largest suspended-sediment concentrations and loads occur during storm runoff. In some instances, relatively short-term intense runoff can transport the bulk of the sediment load for the entire year.

If a sufficient number of suspended-sediment measurements is available, a sediment-transport curve (linear regression) can be constructed that describes the variation in sediment load with stream discharge at a specific site. Instantaneous sediment loads were calculated according to equation 3 using values of stream discharge and suspended-sediment concentrations measured during sampling visits. Inspection of plots of suspended-sediment loads versus stream discharge indicated a wide scatter of data points with poor correlation. Transformation of the data into logarithms improved the linear relationship and generally resulted in a regression equation having a larger correlation coefficient.

The general form of a log-transformed linear regression equation is

$$\log Y = \log a + b \log X \tag{4}$$

where

Y = dependent water-quality variable (suspended-sediment load),
a = regression constant (y-intercept),
b = regression coefficient (slope), and
X = independent water-quality variable (stream discharge).

Statistical summmaries for suspended-sediment load are presented in table 4. Because regressions for suspended-sediment load are in logarithmic form, the stan-

Table 4.--*Statistical summary of suspended-sediment load*

		Descriptive					Regression[1] $\log Q_{ss} = \log a + b \log Q$			
			Suspended-sediment load, in tons per day							
Station number (fig. 1)	Station name	Sample size	Minimum value	Maximum value	Mean	Standard deviation	Regression constant	Regression coefficient	Coefficient of determination	Standard error of estimate (log units)
1	Big Dry Creek at Jordan	3	0.09	5.30	1.85	2.99	*	*	*	*
2	Crow Rock Creek near Cohagen.	11	.00	34.0	6.17	12.64	-0.845	1.10	0.921	0.476
3	Little Dry Creek near Van Norman.	9	.04	2,330	518.81	1,021.22	-.550	1.62	.896	.603
4	Big Dry Creek near Van Norman.	1	2.70	2.70	2.70	--	*	*	*	*
5	Timber Creek near Van Norman.	22	.02	59.0	9.01	17.87	-.486	1.17	.959	.212
6	Nelson Creek near Van Norman.	24	.01	509	61.25	130.85	-.138	1.36	.873	.501
7	Prairie Elk Creek near Oswego.	45	.00	15,600	1,017.31	3,123.61	-.379	1.46	.865	.594
8	Sand Creek near Wolf Point.	9	.06	1,550	239.38	503.18	.192	1.45	.931	.497
9	Redwater River at Circle	75	.00	3,720	50.66	429.43	-.668	1.07	.899	.353
10	Horse Creek near Circle	16	.00	70.0	4.72	17.42	-.886	1.12	.895	.359
11	Redwater River near Vida	69	.00	8,710	318.43	1,512.40	-.913	1.26	.934	.299
12	Hardscrabble Creek near Culbertson.	8	.00	4.70	.66	1.64	*	*	*	*
13	Muster Creek near Kinsey	11	2.90	820	125.60	243.55	1.29	.842	.745	.443
14	Custer Creek near Kinsey	14	.01	703	109.90	210.44	-.242	1.49	.770	.863
15	Cherry Creek near Terry	30	.00	1,680	99.72	381.20	-.927	1.30	.899	.581
16	Clear Creek near Hoyt	18	.00	6.40	.70	1.57	-1.45	1.09	.914	.338
17	Upper Sevenmile Creek near Lindsay.	19	.00	207	12.29	47.35	-1.31	1.19	.911	.375
18	Glendive Creek near Glendive.	33	.02	36,000	1,255.30	6,250.33	.179	1.41	.910	.530
19	Deer Creek near Glendive	15	.00	2,740	222.02	711.52	-.768	1.25	.924	.471
20	Cottonwood Creek near Intake.	20	.00	238	12.26	53.14	-1.02	1.15	.912	.460
21	Burns Creek near Savage	46	.02	1,320	31.84	194.31	-.708	1.15	.894	.302
22	Fox Creek near Lambert	2	.01	.06	.03	.04	*	*	*	*
23	Lone Tree Creek near Sidney.	9	.00	.05	.01	.02	*	*	*	*

[1] Q, Water discharge, in cubic feet per second (independent variable)
Q_{ss}, suspended-sediment load, in tons per day (dependent variable)
a, regression constant (y-intercept)
b, regression coefficient (slope)

Correlation coefficient, which is the square root of the coefficient of determination, is significant at $\alpha = 0.05$ for all reported regression equations.

*Regressions not attempted because of insufficient sample size or limited range of measured stream discharge.

dard error of estimate is also given in logarithmic form. In addition, because the logarithm of 0 is undefined, a constant of 0.001 was added to measured sediment loads at those stations where values of 0.00 ton/d were reported. This addition prevented omission of small sediment loads from the computer-generated logarithmic regressions.

Sediment-transport curves (figs. 9-13) were developed for 18 of the water-quality sites. The station number for each curve corresponds to the map number in figure 1. No attempt was made to develop a curve for those stations having fewer than five suspended-sediment samples or having a limited range of measured discharge values. Curves for several stations are grouped together on each graph on the basis of drainage area size. This grouping is strictly an arbitrary means to provide a comparison of the general sediment-transporting characteristics of streams. Segregating data on the basis of season, storm type, or particle size may reveal more meaningful relationships for those stations having sufficient data points. Regression equations for the sediment-transport curves for selected study sites are given in table 4, along with coefficients of determination and standard errors of estimate.

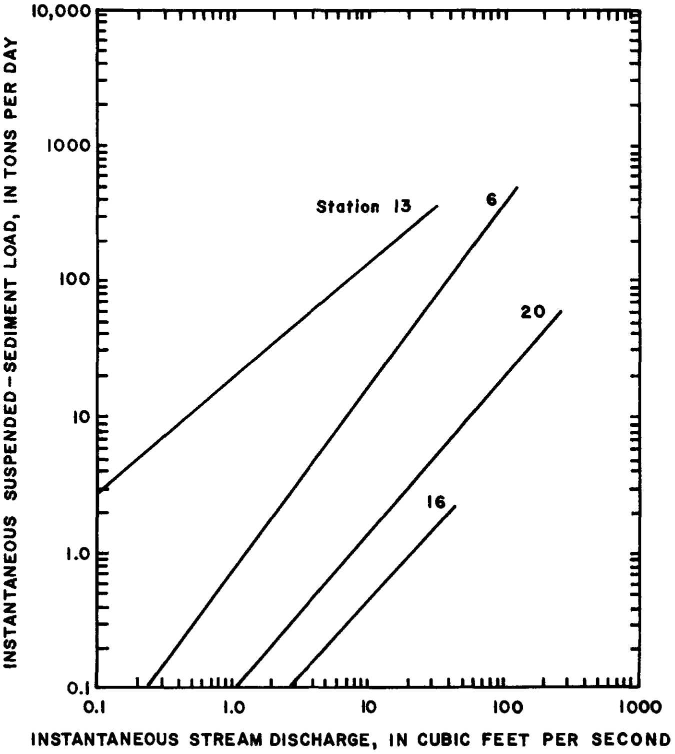

Figure 9.--Sediment-transport curves for stations with drainage areas equal to or less than 100 square miles.

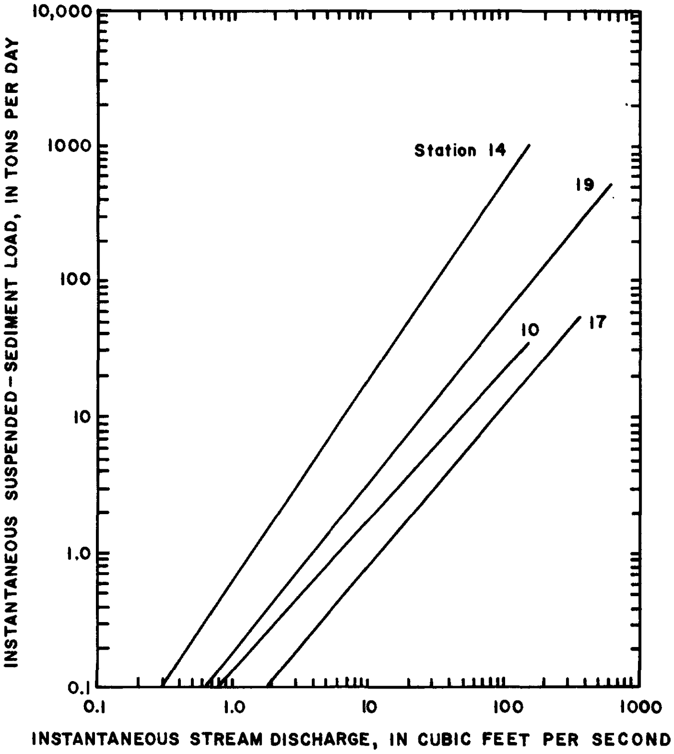

Figure 10.--Sediment-transport curves for stations with drainage areas of 100-200 square miles.

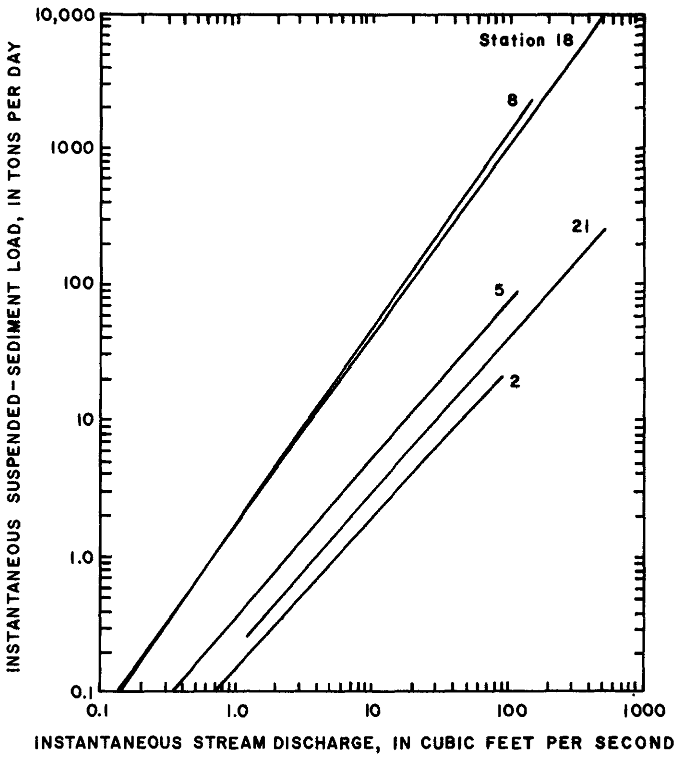

Figure 11.--Sediment-transport curves for stations with drainage areas of 200-300 square miles.

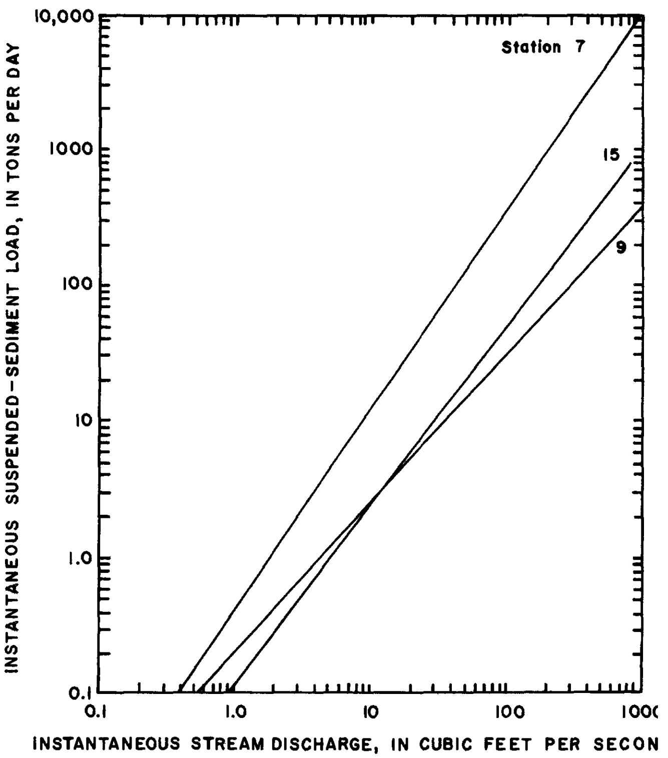

Figure 12.--Sediment-transport curves for stations with drainage areas of 300-600 square miles

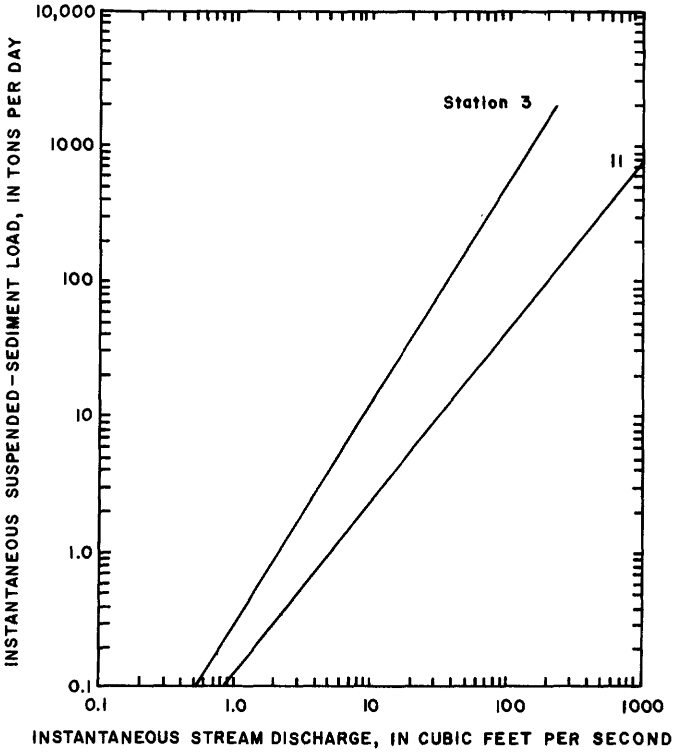

Figure 13.--Sediment-transport curves for stations with drainage areas larger than 600 square miles.

The estimation of mean annual sediment loads is possible when a continuous record of streamflow is available to develop flow-duration curves. Sediment-transport curves can be combined with flow-duration data to compute sediment load-duration data from which mean annual sediment loads are calculated (Miller, 1951).

A sample computation for estimating mean annual sediment loads is given in table 5. The procedure is based on methods described by Miller (1951) and is the same as that used in a recent sediment evaluation by Litke (1983) of streams in southeastern Montana. The steps are as follows: (A) Water discharges, Q_e, for various percentages of time, t, are taken from flow-duration tables or graphs. (B) Sediment loads, Q_{ss}, for each corresponding water discharge are determined from the sediment-transport curve. (C) Mean sediment loads, $Q_{ss}(av)$, for each time interval are calculated as a mean of the sediment loads at the end points of each interval. (D) Each mean sediment load is multiplied by the time interval (expressed as a percentage of the total time) for which it occurs $[(\Delta t \div 100) \times Q_{ss}(av) = Q_{ss}(d)]$; percentage intervals are chosen such that these products are as close to equal as possible. (E) The products are totaled to give a mean suspended-sediment load in tons per day. (F) This total is then multiplied by 365 days to give the mean annual suspended-sediment load in tons.

Table 5.--*Sample computation of estimated mean annual suspended-sediment load by flow-duration, sediment-transport curve method for Redwater River at Circle*

[Parameter abbreviations: t, percentage of time; Qe, stream discharge (cubic feet per second) equaled or exceeded; Qss, suspended-sediment load (tons per day); Δt, interval between succeeding percentages of time; Qss(av), mean suspended-sediment load for time interval (tons per day); Qss(d), sediment load multiplied by time interval]

Parameter	t	Qe	Qss	Δt	Qss(av)	Qss(d)
	0.0	[1]900	311	--	--	--
	.10	815	280	0.10	296	0.296
	.15	720	245	.05	262	.131
	.20	640	216	.05	230	.115
	.30	490	162	.10	189	.189
	.40	390	127	.10	144	.144
	.50	330	106	.10	116	.116
	.70	250	79.0	.20	92.5	.185
	.90	200	62.2	.20	70.6	.141
	1.20	150	45.8	.30	54.0	.162
	1.60	125	37.6	.40	41.7	.167
	2.10	94	27.8	.50	32.7	.164
	2.80	60	17.2	.70	22.5	.158
	3.80	39	10.8	1.00	14.0	.140
	5.60	25	6.73	1.80	8.77	.158
	8.60	14	3.62	3.00	5.18	.155
	14.0	5.9	1.43	5.40	2.53	.137
	30.0	1.6	.355	16.0	.892	.143
	60.0	.19	.036	30.0	.196	.059
	100	.000	.000	40.0	.018	.007
						2.767 x 365 = 1,010

[1] maximum daily stream discharge for study period.

Computed mean annual sediment loads and yields are given in table 6 for five of the six stations in this study where streamflow was recorded continuously. Big Dry Creek near Van Norman lacked a sufficient number of suspended-sediment samples to develop the necessary sediment-transport curve. No comparison of results between the above method and direct calculation of loading from daily sediment samples was possible in this study. The error reported by Litke (1983) of the sediment-rating curve, flow-duration method was ± 20 percent for the streams in southeastern Montana. Although the error percentages do not necessarily apply to the streams of east-central Montana, they indicate that this method is probably adequate to assess relative magnitudes of sediment loads in the study area.

Table 6.--*Computed mean annual suspended-sediment loads and yields for continuous-record streamflow-gaging stations*

Station number (fig. 1)	Station name	Drainage area (square miles)	Mean annual load (tons)	Mean annual yield (tons per square mile)	Mean annual yield (acre-feet per square mile)
6	Nelson Creek near Van Norman	100	5,190	51.9	0.040
7	Prairie Elk Creek near Oswego	352	72,700	207	.159
9	Redwater River at Circle	547	1,010	1.85	.001
11	Redwater River near Vida	1,970	11,500	5.84	.004
21	Burns Creek near Savage	233	1,580	6.78	.005

Dividing mean annual load by drainage area upstream from the sampling site gives an annual basin sediment yield, in tons per square mile. The yield results are based on sediment loads transported past the stations and are mathematically reduced to a sediment loss per square mile. These yields, however, do not imply uniform erosion rates throughout the basin. An additional distinction to be made is that sediment yield is not the same as erosion. Sediment yield represents only that fraction of eroded sediment which is actually transported out of the basin by the stream. The sediment yields can be converted to volume form by assuming an average density of 60 lb/ft^3 for sediment based on estimates from other studies (Miller, 1951; U.S. Bureau of Reclamation, 1949). This value gives a conversion factor of 0.00077 acre-ft/ton to convert tons per year to acre-feet per year.

Computed mean annual sediment loads varied widely, from 1,010 tons at Redwater River at Circle (station 9) to 72,700 tons at Prairie Elk Creek near Oswego (station 7). The corresponding range in mean annual sediment yield is 1.85 to 207 ton/mi^2. The geographic variation in sediment yield is presented in figure 14. Most of the variability probably can be attributed to the short study period as well as to differences in geology, topography, and runoff. Whereas the Redwater River in the vicinity of Circle flows through gently rolling hills and has a wide flood plain, Prairie Elk Creek dissects easily erodable shaly sandstones in badlands near its mouth. In addition, flow-duration curves indicate that Prairie Elk Creek has a larger frequency of flows capable of transporting available sediment supplies.

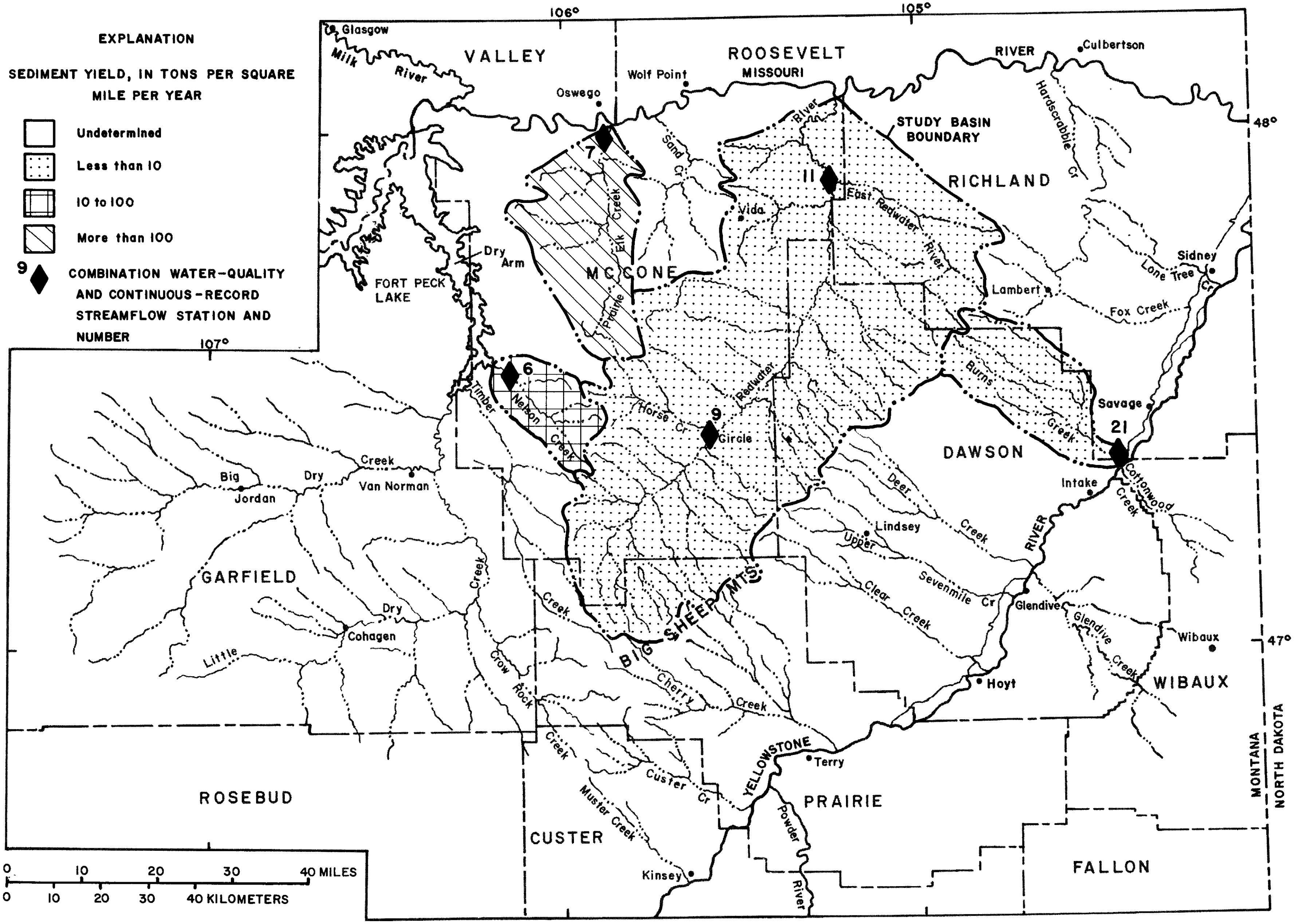

Figure 14.--Geographic variation in sediment yield for selected drainage basins.

Sediment yields can be affected by upstream reservoirs, which trap part of the transported sediment. Numerous stock ponds exist on many of the tributary drainages and the magnitude of their effect is difficult to assess. Incomplete mapping of parts of the study area prevented an adequate determination of the area draining into reservoirs. However, it is reasonable to assume that the sediment-contributing drainage area upstream from sampling sites is somewhat less than the total area reported. Consequently, reported mean annual yields probably underestimate actual values.

Federal mining laws mandate that mine discharges contain less than 45 mg/L of suspended sediment. Because sampled mean sediment concentrations for almost all the study streams exceeded this value, properly designed mine drainage systems probably will not grossly impact sediment yields. However, erosion and sediment yield from disturbed areas outside the controlled drainages could be significant, especially during large-scale runoff periods.

Chemical properties

Chemical properties measured in this study include dissolved solids (major ions), dissolved oxygen, nutrients, and trace elements. Also included are measurements of specific conductance, pH and biochemical oxygen demand, which are not truly chemical constituents but are representative of the chemical characteristics of the water.

Dissolved solids

Dissolved solids is the sum of all constituents dissolved in water ("dissolved" in this report refers to those particles small enough to pass through a filter having pores 0.45 micrometer in diameter). Most dissolved solids in natural waters occur as ions and, from a practical sense, dissolved-solids values represent the combined concentrations of the major ions in solution. The major ions in streams in the study area consist of the cations calcium, magnesium, sodium, and potassium, and the anions bicarbonate and carbonate (as represented by total alkalinity), sulfate, and chloride. Silica is commonly included in the major-ion category although it is non-ionic at the pH of most natural waters (6.0-8.5).

Numerous water-use standards have been established for dissolved-solids concentrations (salinity). Those standards pertaining to domestic drinking water, livestock water, and irrigation water are of primary concern in the study area.

Secondary drinking water standards established by the U.S. Environmental Protection Agency (1979) specify that dissolved-solids concentrations should not exceed 500 mg/L if more suitable supplies are available. However, larger concentrations likely can be consumed without harmful physiological effects.

Livestock raising is a major industry throughout the area and water consumption by stock is an important consideration. The consumption of highly mineralized waters by stock can cause such physiological disturbances as gastrointestinal symptoms, hindered lactation and reproduction, and even death. The ability of livestock to tolerate various amounts of dissolved solids is dependent upon the type of livestock as well as the period of adjustment to increased amounts. Poultry, pigs, horses, cattle, and sheep in respective order have increasing degrees of tolerance to salinity. A salinity classification describing the suitability of Montana waters for stock consumption (McKee and Wolf, 1971) is shown below:

Category	Range of dissolved-solids concentration, in milligrams per liter
Good	Less than 2,500
Fair	2,500-3,500
Poor	3,500-4,500
Unfit	More than 4,500

Dissolved solids are essential for plant growth, but excessive concentrations can be harmful. Salinity hazards from dissolved solids are an important consideration for irrigation waters and are somewhat dependent on factors such as crop type, soil type, and drainage conditions. Excessive concentrations of dissolved solids can result in adverse osmotic effects (prevention of water uptake), toxic effects, and indirect effects through changes in soil structure, permeability, and aeration. The upper limit for suitable crop growth is considered to be near 1,000 mg/L (McKee and Wolf, 1971). The following classification modified from the U.S. Salinity Laboratory Staff (1954) is commonly used for irrigation waters.

Salinity hazard	Range of dissolved-solids concentration, in milligrams per liter
Low	Less than 170
Medium	170-500
High	500-1,500
Very High	More than 1,500

Concentrations of dissolved solids varied considerably both with time and areally throughout the study area as a result of geologic differences and varying conditions of streamflow. Measured values ranged from 145 mg/L at Cherry Creek near Terry (station 15) to 12,200 mg/L at Horse Creek near Circle (station 10).

Small concentrations typically occurred during direct runoff from either rainfall or snowmelt when water was routed quickly into the stream channels with little opportunity for leaching of minerals from the soil. The larger quantities of water available during times of runoff have a diluting effect, which decreases the dissolved solids to concentrations more favorable for stock consumption and irrigation. Dissolved-solids concentrations for most stations during intervals of sustained runoff were generally within the range of 150 to 600 mg/L.

The largest dissolved-solids concentrations were usually measured during late summer when streamflow consisted primarily of ground-water inflow containing large concentrations of minerals leached from subsurface materials. The pool-riffle configuration of many of the streams results in numerous ponded reaches that are subject to significant water loss by evaporation and transpiration by riparian vegetation. These water losses during extended dry intervals further increased the dissolved-solids concentrations.

Base-flow concentrations of dissolved solids generally were within the range of 1,000 to 3,000 mg/L, but at times exceeded 5,000 mg/L. These concentrations represent a high to very high salinity hazard; consequently, the water would be considered marginal or unsuitable for irrigation during base flow. Dissolved-solids concentrations indicate that the water generally is suitable for livestock consumption. However, concentrations in excess of recommended limits occasionally occur during extended dry intervals in some streams.

Chemical-constituent diagrams (fig. 15) illustrate temporal and areal variability of dissolved-solids concentrations within the study area. The difference in the diameters between the base-flow and direct-runoff diagrams indicates the range of dissolved-solids concentrations measured throughout the annual flow cycle. Percentages of individual major ions (based on milliequivalents per liter) illustrate differences between the chemical character of base flow and direct runoff.

Major cations

Sodium, calcium, magnesium, and potassium were the cations measured in the greatest concentrations throughout the study area. Sodium concentrations were commonly largest in comparison to the other cations, especially during base flow. In general, sodium concentrations were larger in the western half of the study area than in the eastern half. Concentrations of all the major cations varied appreciably among stations as well as temporally in response to streamflow fluctuations. Increases in streamflow caused by direct runoff generally reduced concentrations through dilution.

Calcium and magnesium are the principal constituents that account for water hardness which, simply stated, is the soap-consuming capacity of water. Although hardness is not reported in the tables, large values of either or both of these cations have a direct relationship to hardness. Based on concentrations measured in the study area, water in the streams would be classified as hard to very hard (Durfor and Becker, 1964).

Large concentrations of sodium in water present a hazard to soils by causing an accumulation of exchangeable sodium ions, resulting in a soil of reduced permeability and poor tilth. Calcium and magnesium in proper proportions in the soil maintain a favorable physical condition for root and water penetration. However, sodium in excess of 50 percent can cause an ion-exchange process whereby calcium and magnesium are released from soil particles and replaced by sodium (Hem, 1970). This accumulation of sodium ions not only damages soil structure by reducing permeability, but may eventually cause the pH to increase to the extent that alkali soils are created (McKee and Wolf, 1971). Consequently, the alkali (sodium) hazard would be high for irrigation waters containing a large sodium content. An index of the sodium hazard, or the tendency of the irrigation water to form exchangeable sodium in the soil, is the sodium-adsorption ratio (SAR). It is defined by the U.S. Salinity Laboratory Staff (1954) as

$$\mathrm{SAR}=\frac{(\mathrm{Na}^{+})}{\sqrt{\dfrac{(\mathrm{Ca}^{+2})+(\mathrm{Mg}^{+2})}{2}}} \tag{5}$$

where ion concentrations are expressed in milliequivalents per liter.

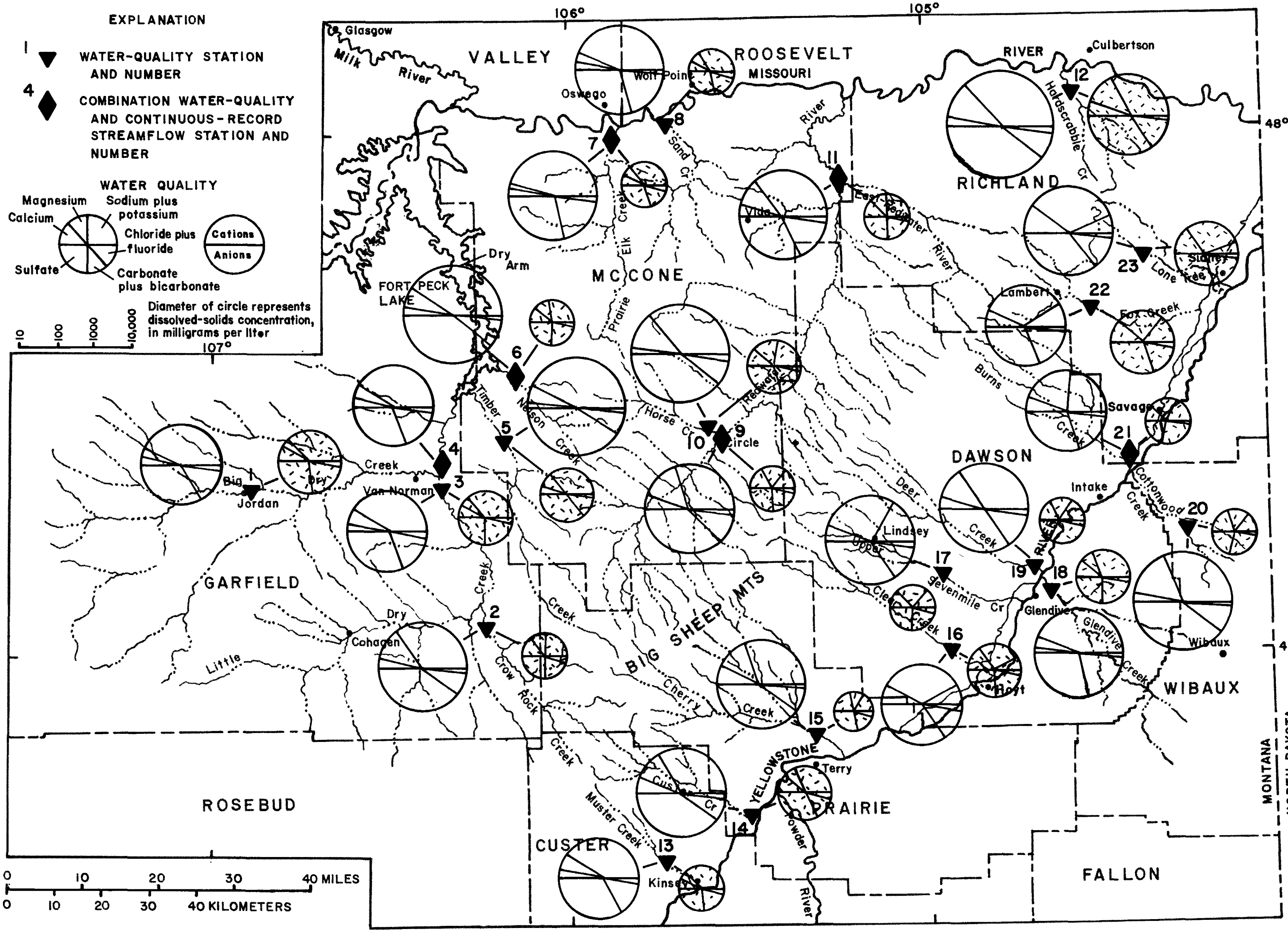

Figure 15.--Chemical-constituent diagrams of dissolved solids during typical base-flow and direct-runoff conditions. Diagrams show relative percentages of ions for base flow (open circles) and direct runoff (stippled circles).

The sodium hazard varies with the salinity of the water. For the purpose of irrigation, the Salinity Laboratory has established the general SAR classification listed below for waters with a high to very high salinity hazard. Consideration must be given to soil type, however, as soil stress becomes progressively greater with finer soil textures that drain poorly and are less apt to be leached of soluble salts.

SAR value	Alkali (sodium) hazard
0-4	Low
4-9	Medium
9-14	High
14-Above	Very High

During base flow, the sodium hazard is generally high to very high for streams in the western part of the study area and low to medium for streams in the eastern half.

Ion percentages (fig. 15) show that sodium was present in significant proportions at most stations, regardless of streamflow conditions. Sodium was often the dominant cation during base-flow conditions, commonly exceeding 50 percent of the cationic balance. Streams in the western part of the study area generally had the largest sodium percentages. Few streams had calcium or magnesium as the dominant cation during base flow. Direct-runoff conditions typically resulted in an increase in the percentage of calcium, with a subsequent decrease in sodium. The percentage of magnesium was relatively constant throughout the range of streamflow. During intervals of increased streamflow, percentages of calcium and magnesium would often be nearly equivalent to or exceed the percentage of sodium. Potassium constituted only a small fraction of the cationic balance at all magnitudes of streamflow.

Major anions

Sulfate and carbonate plus bicarbonate were the anions measured in the largest concentrations within the study area. Bicarbonate and carbonate anions are represented in table 2 by total alkalinity. Alkalinity is a measure of the ability of water to neutralize acid by the uptake of hydrogen ions by carbonate and bicarbonate. For waters with a pH of 8.3 or less, essentially all alkalinity is caused by the bicarbonate anion, whose concentration can be approximated by dividing alkalinity by 0.82.

Ion percentages (fig. 15) indicate that sulfate was often the dominant anion during base-flow conditions, commonly exceeding 50 percent of the anionic balance. Although rarely dominant during base flows, carbonate plus bicarbonate were usually present in significant proportions. Runoff conditions had a diluting effect on anion concentrations and resulted in nearly equivalent percentages of both sulfate and carbonate plus bicarbonate at many stations. Chloride and fluoride percentages were consistently small and showed little variation with stream discharge.

Sulfate concentrations during base-flow periods commonly approached or exceeded limits established for both human and livestock consumption. Secondary drinking water standards (U.S. Environmental Protection Agency, 1979) recommend a maximum limit for sulfate of 250 mg/L for human consumption. A threshold limit for cattle consumption is 1,000 mg/L (McKee and Wolf, 1971). Measured concentrations of carbonate plus bicarbonate would not pose any serious problem for either irrigation or livestock use.

Specific conductance

Specific conductance is a measure of the ability of water to conduct an electrical current as a result of ionized material in solution. Therefore, specific conductance gives an indication of the concentration of ions (dissolved solids) in the water. As the concentration of dissolved solids increases, conductance also increases in a proportional manner such that a reasonably well defined relationship can be determined. For the study area streams, dissolved-solids concentrations (in milligrams per liter) generally were in the range of 0.6 to 0.8 of the specific-conductance values (in micromhos per centimeter at 25°C).

In addition to dissolved solids, the concentrations of the major individual ions usually correlate well with specific conductance as a result of their large relative contribution to electrical conductivity. Consequently, their concentrations can also be estimated reasonably well from regressions with specific conductance. Less-dominant ions and suspended sediment generally exhibit poor correlation with specific conductance.

Hydrogen-ion concentration (pH)

The pH of water gives an indication of whether the water is acidic or basic. Although pH is reported as the negative logarithm (base-10) of the hydrogen-ion activity in moles per liter, it can be considered to be approximately equal to the hydrogen-ion concentration. A pH of 7 represents neutral water, whereas values greater than 7 represent basic conditions and values less than 7 represent acidic conditions.

Carbon dioxide in the atomosphere typically causes rain and snow to be slightly acidic. Water percolating through subsurface materials can undergo extensive pH changes depending on the minerals contacted. River water in areas not affected by pollution generally has a pH between 6.5 and 8.5 (Hem, 1970). However, pH values can be somewhat larger than 8.5 during periods of photosynthesis by aquatic plants when a considerable amount of carbon dioxide is utilized. Values less than 6.5 can be caused by industrial activities, including coal mining, in which the weathering of iron sulfides and subsequent reactions can create acid conditions. The pH can affect the solubilities of certain compounds, thus causing a transition between the dissolved and suspended states.

In this study, measured pH values ranged from 7.2 to 9.5. The smaller pH values were generally associated with direct runoff when the water was affected by the acidic nature of rain and snow. Small pH values were also evident during the cold winter months when streams were often ice covered and aquatic photosynthesis was limited. The larger pH values were commonly measured during base flow when the water consisted primarily of seepage of ground water that was affected by the mineralogy of aquifers. Photosynthesis by aquatic plants through the summer probably accounted for much of the increase in pH values.

Mining is presently conducted on a small scale in the study area and no evidence exists that would indicate any significant effects on pH by mining activities. In addition, alkalinities of streams in the study area generally are large, thereby providing a considerable buffering capacity to neutralize acidic effluent that might be discharged into streams. Expanded mining operations, poor mining practices, and effluent reaching streams through the ground-water system could alter pH values of streams in the study area.

Dissolved oxygen

Oxygen dissolved in surface waters is essential to most aquatic organisms and is the single most important constituent that allows a stream to purify itself of wastes. Concentrations of dissolved oxygen fluctuate in response to many factors such as water temperature, barometric pressure, reaeration at the water surface, chemical oxidation-reduction reactions, photosynthetic production of oxygen, and respiration of aquatic flora and fauna.

Considerable information regarding dissolved-oxygen requirements for aquatic life has been documented, but few standards exist for other water uses. Minimum concentrations of oxygen necessary to sustain fish life are dependent upon species and age of the fish, prior acclimation to small concentrations, and concentrations of certain trace elements and other gases in the water. For productive warm-water fisheries, McKee and Wolf (1971) recommend that dissolved-oxygen concentrations do not become less than 5 mg/L for extended periods throughout the day.

Dissolved-oxygen concentrations at stations in the study area ranged from 2.0 to 15.2 mg/L. Despite this wide variation, most values throughout the year were within 80-110 percent of saturation. Many of the smallest values were associated with ice conditions, which prevented reaeration at the water surface while oxygen was being consumed by organic decomposition. Oxygen depletions also occurred to a lesser degree at times of direct runoff when organic material was washed from land surfaces and oxidized in the streams. Some of the largest fluctuations of dissolved oxygen occurred on a diurnal basis during the summer when aquatic plant growth was at a maximum. The smallest values measured were during the early morning after night-long respiration by aquatic organisms had reduced the oxygen supply. Values above saturation were typically measured during the late afternoon following day-long photosynthesis that produced oxygen in excess of that consumed.

Biochemical oxygen demand

The biochemical oxygen demand (BOD) is a measure of the organic load of a stream in terms of the amount of dissolved oxygen consumed by bacteria during biochemical decomposition. Large values of BOD represent a potential for oxygen depletion to levels below that necessary to support desirable aquatic species. In this study, BOD refers to the amount of oxygen required by bacteria to oxidize the organic material present in the water over a period of 5 days while the sample was maintained at a constant temperature of 20°C.

Mean BOD values ranged from about 2 to 4 mg/L. Values greater than 7 mg/L were measured only rarely and were generally associated with overland runoff that flushed organic materials from soil surfaces into the streams. The smaller BOD values were generally measured at low to medium streamflows. However, several moderately large values measured during summer base flows may have been the result of cattle wastes introduced at watering sites.

Nutrients

Various forms of nitrogen and phosphorus are recognized as major nutrients for aquatic plants. In sufficient concentrations, they can cause biological enrichment (eutrophication), resulting in extensive algal growths. Many other elements and compounds are also essential for aquatic plants. However, unlike nitrogen and phosphorus, they rarely become exhausted to the point that they limit growth. Potential sources of nitrogen and phosphorus in water are decomposing organic materials in the soil, domestic and animal wastes, and agricultural fertilizers. Additional sources of phosphorus are the mineral apatite and phosphate detergents. Although nutrient enrichment occurs naturally in water, the rate of enrichment is commonly accelerated by man's activities.

Nitrogen

Nitrogen is originally derived from the atmosphere by the action of nitrogen-fixing bacteria and algae. Nitrogen commonly occurs in ammonia, organic, nitrite, and nitrate forms. Nitrogen compounds tend to sorb onto sediments, especially clays and organic debris, and are largely transported in the suspended phase. Therefore, unfiltered samples consisting of a water-sediment mixture were analyzed to determine "total" concentrations of ammonia, organic, and nitrite plus nitrate nitrogen. The sum of these species (total nitrogen) accounts for essentially all nitrogen transported in both the dissolved and suspended phases. To avoid excessive growths of plants and algae, Müller (1953) suggested that total-nitrogen concentrations be less than 0.6 mg/L.

Concentrations of total nitrogen varied considerably both spatially and temporally among the stations. Mean concentrations ranged from 0.60 mg/L at Clear Creek near Hoyt (station 16) to 6.9 mg/L at Muster Creek near Kinsey (station 13), which indicates nutrient-enriched waters. Concentrations of the individual nitrogen species fluctuated considerably throughout the annual flow cycle at each station. Increased stream discharge with accompanying increased sediment concentrations generally resulted in larger concentrations of all the nitrogen species. Organic nitrogen almost always accounted for the greatest proportion of the total nitrogen measured. The proportion of nitrite plus nitrate nitrogen many times showed a considerable increase during spring runoff and may have corresponded to fertilizer application in fields. Ammonia occasionally comprised an increased percentage of the total nitrogen content during the winter when organic matter was decomposing under the ice. Although seasonal variations were not clearly evident, nitrogen uptake by plants during growing periods presumably had some effect on nitrogen concentrations in the streams.

Phosphorus

Total phosphorus concentrations in natural water are commonly small and generally less than total-nitrogen concentrations. The most common forms of phosphorus in water are probably the phosphate anions. Unlike nitrogen, the atmosphere does not replenish phosphorus. Consequently, phosphorus is more readily exhausted by aquatic plant growth than is nitrogen and most often is the limiting nutrient. Large phosphorus concentrations may result in nuisance growths of algae that could generate enough organic matter to cause serious oxygen depletion upon decomposition. Maximum contaminant levels have not been established for phosphorus in natural waters; however, a desired goal for the control of accelerated eutrophication in streams is 0.1 mg/L total phosphorus (MacKenthun, 1973).

Fluctuations of total phosphorus concentrations throughout the annual flow cycle were similar to those of total nitrogen. As with nitrogen, overland runoff and increases in suspended-sediment concentrations generally resulted in increased concentrations of total phosphorus. Mean concentrations of total phosphorus ranged from 0.03 mg/L at Clear Creek near Hoyt (station 16) to 2.3 mg/L at Muster Creek near Kinsey (station 13). The maximum concentration measured in the study area was 8.5 mg/L at Little Dry Creek near Van Norman (station 3). Those stations having maximum concentrations of total phosphorus in excess of 3.0 mg/L were also the only stations having maximum suspended-sediment concentrations greater than 10,000 mg/L.

Trace elements

Trace elements are substances which generally occur in small concentrations and typically are reported in micrograms per liter. Many trace elements are essential for aquatic plants and are nontoxic to plants and animals at concentrations normally found in natural waters. However, large concentrations can sometimes result from natural processes and more commonly from industrial wastes and mining activities.

Some trace elements are only moderately soluble in water, but sorb strongly to sediment particles in a manner similar to the nutrients. Other trace elements that are more soluble may undergo transitions between the dissolved and suspended phases in response to various stream conditions, primarily pH. For this reason, both filtered water and unfiltered water-sediment mixtures were analyzed to determine dissolved and total recoverable concentrations, respectively. Total recoverable concentrations refer to values obtained by a digestion process which liberates sorbed elements from the sediment without breaking down the mineral components of the sediment. Boron and vanadium occur almost exclusively in the dissolved phase and were not analyzed for total recoverable concentration.

Standards established for trace-element concentrations are related primarily to the toxic potential to human, animal, and plant life. Maximum limits vary considerably, depending on whether the water is to be used for domestic consumption, livestock watering, irrigation, or maintenance of aquatic life. Some concentrations that have been established by various agencies as maximum limits for the safe or optimal usage of water are listed in table 7. It is sometimes uncertain whether limits are to be applied to dissolved or total recoverable concentrations. Where water is used for domestic supplies, settling and other required treatment methods would remove much of the particulate matter, leaving primarily dissolved material. Where limits apply to ingestion of water by livestock, total recoverable concentrations are applicable.

Ranges in dissolved and total recoverable concentrations of trace elements at individual stations are presented in table 2. Maximum values for several trace elements occurred at concentrations less than the detection limit of the applied

Table 7.--*Water-use standards for selected trace elements*

Trace element	Concentration[1], in micrograms per liter, for indicated use: Domestic water supply	Livestock consumption	Irrigation	Aquatic life
Aluminum	--	5,000^d	--	100^c
Arsenic	50^a	--	100^c	--
Beryllium	--	--	100^c	--
Boron	--	--	750^c	--
Cadmium	10^a	50^d	--	--
Chromium	50^a	--	--	100^c
Copper	1,000^b	--	--	--
Iron	300^b	--	--	1,000^c
Lead	50^a	100^d	--	30^d
Lithium	--	--	2,500^d	--
Manganese	50^b	--	200^d	--
Mercury	2.0^a	10^d	--	--
Molybdenum	--	--	10^d	--
Nickel	--	--	200^d	--
Selenium	10^a	50^d	20^d	--
Vanadium	--	100^d	100^d	--
Zinc	5,000^b	25,000^d	--	--

[1] a, primary drinking water standard of U.S. Environmental Protection Agency (1977a);
b, secondary drinking water standard of U.S. Environmental Protection Agency (1979);
c, quality criteria of U.S. Environmental Protection Agency (1977b); and
d, quality criteria of National Academy of Sciences and National Academy of Engineers (1973).

analysis. In these instances, a less than (<) value is reported rather than an actual concentration. Although some obscurity may exist as to where the true maximum lies, comparison of the detection limit with the water-quality standard may give insight into whether or not a standard was exceeded.

Concentrations of dissolved trace elements measured during the study in places exceeded recommended limits given in table 7. Various limits for dissolved aluminum, boron, cadmium, iron, lead, and manganese were surpassed at several stations, primarily during base flow. Generally, however, concentrations of dissolved trace elements measured in the study area indicate little risk to most water uses during much of the year.

Limits presented for domestic water supply in table 7 include both primary and secondary drinking water standards (U.S. Environmental Protection Agency, 1977a, 1979). Dissolved cadmium and lead exceeded primary standards only rarely, but dissolved iron and manganese exceeded secondary drinking water standards more frequently. Dissolved iron concentrations in excess of secondary standards are common in many eastern Montana streams. Secondary standards, however, primarily relate to esthetic properties and pose no significant health hazard. None of the measured concentrations of dissolved trace elements exceeded limits recommended for livestock consumption. Dissolved boron, however, commonly exceeded the recommended limit for irrigation at nine stations. Boron is essential to plant growth, but is highly toxic to many crops at concentrations only slightly above optimum, especially in waters used for long-term irrigation on sensitive crops. Dissolved aluminum and lead were measured occasionally in excess of limits for the protection of aquatic life.

Total recoverable concentrations of the trace elements analyzed exceeded criteria limits infrequently, although at times by significant amounts. Maximum concentrations of aluminum, cadmium, chromium, iron, lead, manganese, and nickel surpassed some limits at several stations. However, concentrations measured in most samples collected throughout the year were generally less than established limits. Large total recoverable concentrations were almost always associated with increased streamflows transporting substantial amounts of sediment. The data indicate that aluminum and iron strongly sorb to sediment particles, with total recoverable concentrations often increasing significantly during runoff. Other elements that tend to be moderately sorbed to sediment are copper, manganese, nickel, lead, and zinc. Of the trace elements for which livestock consumption limits are given, only total recoverable concentrations of aluminum and lead occurred in excess of such limits commonly enough to be of concern for direct ingestion.

Comparison of selected water-quality conditions among stations

To provide a quick and general appraisal of water quality within the study area, the frequency of occurrence of selected water-quality conditions is shown in table 8. The conditions listed at the top of the table relate primarily to previously discussed standards for domestic drinking water, livestock water, and irrigation water. For each station the lower numeral is the number of analyses for the particular water-quality property; the upper numeral indicates the number of times that a value met the given condition. The distribution of values within each set of conditions can be used to evaluate the suitability of stream water for a particular use or to make comparisons of water quality between stations.

Table 8.--*Water-quality appraisal chart*

[Lower numeral, number of times sampled; upper numeral, number of times sample was greater or less than stated value. Abbreviations: °C, degrees Celsius; SAR, sodium-adsorption ratio; N, nitrogen; P, phosphorus; Fe, iron; Mn, manganese; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; >, greater than]

Station number (fig. 1)	Condition																	Station name
	>25°C temperature	Suspended sediment			Dissolved solids			>14 SAR	>50 percent sodium	Sulfate		>8.5 pH	<5 mg/L dissolved oxygen	>0.6 mg/L total N	>0.1 mg/L total P	>300 µg/L dissolved Fe	>50 µg/L dissolved Mn	
		<20 mg/L	<100 mg/L	>5,000 mg/L	<500 mg/L	<1,000 mg/L	>4,500 mg/L			<250 mg/L	>1,000 mg/L							
1	0 4	0 3	2 3	0 3	0 3	1 3	0 3	1 3	3 3	0 4	0 4	0 4	0 3	4 4	2 4	0 3	1 3	Big Dry Creek at Jordan
2	1 11	4 11	6 11	0 11	3 10	5 10	0 10	1 10	8 10	3 10	4 10	2 10	1 10	10 10	2 10	0 10	0 5	Crow Rock Creek near Cohagen
3	2 10	0 9	3 9	1 9	1 9	2 9	0 9	5 9	9 9	2 10	3 10	3 10	0 9	10 10	4 10	1 9	0 9	Little Dry Creek near Van Norman
4	0 3	0 1	0 1	0 1	0 1	0 1	0 1	1 1	1 1	0 3	1 3	2 3	0 3	2 3	0 1	0 1	0 1	Big Dry Creek near Van Norman
5	0 21	0 22	7 22	0 22	1 18	1 18	4 18	9 20	20 20	0 19	13 19	9 20	0 19	18 20	2 20	0 20	2 9	Timber Creek near Van Norman
6	0 27	0 24	3 24	2 24	3 24	8 24	5 24	11 25	25 25	3 25	14 25	4 26	0 24	16 26	12 26	1 25	2 9	Nelson Creek near Van Norman
7	6 46	0 45	9 45	5 45	5 42	13 42	0 42	23 43	43 43	10 44	1 44	25 46	1 42	27 46	17 46	5 43	4 11	Prairie Elk Creek near Oswego
8	1 9	0 9	0 9	2 9	2 8	4 8	0 8	6 9	9 9	2 9	0 9	6 9	0 8	9 9	6 9	1 9	2 9	Sand Creek near Wolf Point
9	3 79	3 75	43 75	0 75	2 76	3 76	0 76	10 78	69 78	1 78	70 78	17 78	4 77	66 77	6 78	0 78	7 15	Redwater River at Circle
10	1 17	2 16	12 16	0 16	2 15	2 15	5 15	7 16	13 16	1 16	13 16	7 16	0 15	16 16	2 15	0 16	3 6	Horse Creek near Circle
11	3 69	2 69	43 69	0 69	2 67	8 67	0 67	16 67	65 67	2 69	44 69	31 69	1 68	57 68	11 69	1 68	4 17	Redwater River near Vida
12	0 8	1 8	5 8	0 8	0 8	0 8	6 8	7 8	8 8	0 8	7 8	3 8	0 8	8 8	3 8	0 8	1 2	Hardscrabble Creek near Culbertson
13	1 11	0 11	0 11	7 11	3 7	6 7	0 7	1 8	8 8	4 8	0 8	0 9	0 9	8 8	8 8	1 8	0 6	Muster Creek near Kinsey
14	2 14	1 14	5 14	2 14	2 13	4 13	0 13	1 13	13 13	2 13	4 13	3 13	0 13	9 13	5 12	0 13	0 7	Custer Creek near Kinsey
15	0 33	10 30	27 30	0 30	2 33	3 33	0 33	0 33	30 33	2 33	23 33	0 33	0 33	11 33	3 33	0 33	0 8	Cherry Creek near Terry
16	0 18	12 18	18 18	0 18	1 17	7 17	0 17	0 17	0 17	2 17	0 17	0 17	0 17	5 17	0 17	0 17	0 7	Clear Creek near Hoyt
17	2 19	9 19	18 19	0 19	1 17	2 17	0 17	0 17	0 17	1 17	4 17	0 17	0 16	4 17	1 16	0 17	1 7	Upper Sevenmile Creek near Lindsay
18	6 33	0 33	4 33	5 33	6 31	11 31	0 31	22 31	31 31	7 32	0 32	25 33	0 31	28 32	20 33	13 31	0 10	Glendive Creek near Glendive
19	1 15	1 15	10 15	0 15	2 13	2 13	0 13	0 13	12 13	2 13	4 13	1 13	0 13	9 13	2 13	0 13	0 5	Deer Creek near Glendive
20	2 21	6 20	18 20	0 20	1 21	4 21	0 21	1 21	17 21	1 21	14 21	3 21	1 21	20 21	3 21	0 21	5 8	Cottonwood Creek near Intake
21	3 46	2 46	24 46	0 46	5 46	9 46	0 46	0 46	11 46	5 46	0 46	5 46	0 46	13 46	5 46	0 46	0 14	Burns Creek near Savage
22	0 2	0 2	1 2	0 2	0 2	1 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	2 2	1 2	0 2	1 1	Fox Creek near Lambert
23	0 9	5 9	9 9	0 9	0 9	2 9	0 9	0 9	0 9	0 9	0 9	0 9	0 9	9 9	1 9	0 9	0 1	Lone Tree Creek near Sidney

SUMMARY

This report represents results of a data-collection program designed to document baseline surface-water-quality conditions prior to possible large-scale coal production in east-central Montana. Descriptive statistics for major constituents and trace elements summarize the results of water-quality data collected at 23 sites on selected streams. Where applicable, measured water-quality conditions are compared to recommended water-use standards to aid in evaluating the suitability of water for specific uses.

Simple and multiple linear regressions were developed for major constituents at 21 sites where sufficient data existed. Linear regression also was used to develop sediment-transport curves from log-transformed data at 18 sites. The regression equations are useful for estimating constituent values from known values of the independent variable(s) and for comparing water-quality characteristics between stations. However, the equations are valid only within the range of data used to develop the equation. In addition, regression equations with small coefficients of determination may indicate that one or more of the independent variables are not strongly related to the dependent variable.

Water-quality properties measured in the study area generally showed a large range of values among stations and with time. Temporal variability resulted primarily from changes in streamflow, which ranged from base flows sustained by ground-water inflow to high flows resulting from precipitation runoff. Areal differences among stations, which can be attributed to differences in geology, soil type, or land-use practices, were generally less pronounced than variation associated with the annual flow cycle.

Measured concentrations of suspended sediment were extremely variable, ranging from 4 to 23,000 mg/L. The smallest mean concentration (18.8 mg/L) occurred at Clear Creek near Hoyt (station 16) and the largest (9,690 mg/L) at Muster Creek near Kinsey (station 13). Maximum concentrations of suspended sediment were measured at times of direct runoff when sediment was eroded from both overland and channel sources. The increased sediment concentrations during periods of direct runoff were generally associated with increased concentrations of sorbed nutrients and trace elements.

Flow-duration curves were developed for six of the stream sites where continuous streamflow data were collected. The flow-duration curves were based on data from years when water-quality samples were taken. Mean annual suspended-sediment loads were calculated by the flow-duration, sediment-transport curve method for the five sites that had a sufficient number of sediment samples. Computed mean annual sediment loads ranged from 1,010 tons at Redwater River at Circle (station 9) to 72,700 tons at Prairie Elk Creek near Oswego (station 7). These loads correspond to a range in mean annual sediment yield of 1.85 to 207 ton/mi^2.

Measured concentrations of dissolved solids ranged from 145 mg/L at Cherry Creek near Terry (station 15) to 12,000 mg/L at Horse Creek near Circle (station 10). Small dissolved-solids concentrations were associated with runoff from rainfall or snowmelt. Large concentrations were typical of base-flow conditions, reflecting ground-water contribution. Streams sampled within the study area had water containing principally sodium and sulfate ions during most of the year when base flows were predominant. At times of medium and high streamflows the relative proportions of calcium and bicarbonate increased, occasionally to levels equivalent to those of sodium and sulfate. Magnesium percentages were relatively constant throughout the range of streamflow.

Concentrations of dissolved solids commonly exceeded 1,000 mg/L. Consequently, the use of stream water for irrigation would be marginal or unsuitable except during periods of direct runoff when the dissolved solids would be diluted. In addition, the dominance of sodium during most flows increases the risk of crop damage from irrigation. Dissolved-solids concentrations generally are suitable for livestock consumption. However, concentrations in excess of stockwater standards may exist during extended dry intervals when ground-water inflow and water loss through evapotranspiration cause an increase in dissolved-solids concentration.

Mean concentrations of total nitrogen ranged from 0.60 mg/L at Clear Creek near Hoyt to 6.9 mg/L at Muster Creek near Kinsey. Mean concentrations of total phosphorus ranged from 0.03 mg/L at Clear Creek near Hoyt to 2.3 mg/L at Muster Creek near Kinsey. Although total phosphorus concentrations were considerably smaller than those of total nitrogen, patterns of fluctuation throughout the annual flow cycle were similar. The measured nitrogen and phosphorus concentrations are indicative of nutrient-enriched waters.

Except for dissolved iron and manganese, concentrations of dissolved trace elements seldom exceeded domestic water-supply standards. No dissolved trace elements were measured in excess of limits recommended for livestock consumption. However, total recoverable concentrations of aluminum and lead during runoff conditions surpassed livestock-consumption limits frequently enough to be of concern. Dissolved boron commonly exceeded the recommended limit for long-term irrigation of sensitive crops at several sites. Dissolved aluminum and lead were measured occasionally in concentrations larger than limits for the protection of aquatic life.

REFERENCES CITED

Durfor, C. N., and Becker, Edith, 1964, Public water supplies of the 100 largest cities in the United States, 1962: U.S. Geological Survey Water-Supply Paper 1812, 364 p.

Guy, H. P., 1969, Laboratory theory and methods for sediment analysis: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 5, Chapter C1, 58 p.

______1970, Fluvial sediment concepts: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter C1, 55 p.

Guy, H. P., and Norman, V. W., 1970, Field methods for measurement of fluvial sediment: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter C2, 59 p.

Hem, J. D., 1970, Study and interpretation of the chemical characteristics of natural water [2d ed]: U.S. Geological Survey Water-Supply Paper 1473, 363 p.

Lee, R. W., 1980, Geochemistry of water in the Fort Union Formation of the northern Powder River Basin, southeastern Montana: U.S. Geological Survey Water-Supply Paper 2076, 17 p.

Litke, D. W., 1983, Suspended sediment in selected streams of southeastern Montana: U.S. Geological Survey Water-Resources Investigations 82-4087, 52 p.

MacKenthun, K. M., 1973, Eutrophication and biological associations, *in* Environmental phosphorus handbook: New York, John Wiley and Sons, p. 613-632.

McKee, J. E., and Wolf, H. W., 1971, Water quality criteria [2d ed]: California State Water Quality Control Board, Publication 3-A, 548 p.

McKinley, P. W., 1979, Water quality of selected streams in the coal area of east-central Montana: U.S. Geological Survey Water-Resources Investigations 78-142, 49 p.

Miller, C. R., 1951, Analysis of flow duration, sediment rating curve method of computing sediment yield: U.S. Bureau of Reclamation, 15 p.

Müller, W., 1953, Nitrogen content and pollution of streams: Gesundheitsing, v. 74, p. 256.

National Academy of Sciences and National Academy of Engineers, 1973 [1974], Water quality criteria, 1972: Washington, D.C., U.S. Government Printing Office, 594 p.

National Technical Advisory Committee, 1968, Water-quality criteria: Washington, D.C., Federal Water Pollution Control Administration, U.S. Department of the Interior, 234 p.

Riggs, H. C., 1968, Some statistical tools in hydrology: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 4, Chapter A1, 39 p.

SAS Institute, Inc., 1979, SAS user's guide, 1979 edition: Raleigh, N. C., 494 p.

Skougstad, M. W., Fishman, M. J., Friedman, L. C., Erdman, D. E., and Duncan, S. S., 1979, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 5, Chapter A1, 625 p.

Slagle, S. E., 1983, Water resources of the Fort Union coal region, east-central Montana: U.S. Geological Survey Water-Resources Investigations Report 83-4151, 39 p.

Stoner, J. D., and Lewis, B. D., 1980, Hydrogeology of the Fort Union coal region, eastern Montana: U.S. Geological Survey Miscellaneous Investigations Map I-1236, 2 sheets.

Trumbull, James, 1960, Coal fields of the United States, exclusive of Alaska: U.S. Geological Survey Coal Map, sheet 1, scale 1:500,000.

U.S. Bureau of Reclamation, 1949, Sedimentation survey of Tongue River Reservoir: Hydrology Division, 35 p.

U.S. Department of Commerce, issued annually, Climatological data, Montana.

U.S. Environmental Protection Agency, 1977a; National interim primary drinking water regulations: Office of Water Supply, EPA-570/9-76-003, 159 p.

______1977b, Quality criteria for water, 1976: Washington, D.C., U.S. Government Printing Office, 256 p.

______1979, National secondary drinking water regulations: Federal Register, v. 44, no. 140, July 19, p. 42195-42202.

U.S. Geological Survey, issued annually since 1965, Water resources data for Montana: Helena, Mont., Water Resources Division.

______1974, Stripping coal deposits of the northern Great Plains, Montana, Wyoming, North Dakota, and South Dakota: U.S. Geological Survey Miscellaneous Field Studies Map MF-590, 1 sheet.

______1977, National handbook of recommended methods for water data acquisition, Chapter 5, Chemical and physical quality of water and sediment: 193 p.

U.S. Salinity Laboratory Staff, 1954, Diagnosis and improvement of saline and alkali soils: U.S. Department of Agriculture Handbook 60, 160 p.

DATA

Table 1.--*Station descriptions*

(Number to left of station name is the same as shown on fig. 1; number to right is formal Geological Survey station number)

Station 1 BIG DRY CREEK AT JORDAN, MONT. (06130680)

LOCATION.--Lat 47°18'56", long 106°54'33", in SW¼NE¼SW¼ sec. 17, T. 18 N., R. 38 E., Garfield County, Hydrologic Unit 10040105, at bridge on State Highway 200 at Jordan.

Station 2 CROW ROCK CREEK NEAR COHAGEN, MONT. (06130935)

LOCATION.--Lat 47°03'45", long 106°14'11", in SE¼SE¼ sec. 11, T. 15 N., R. 23 E., Garfield County, Hydrologic Unit 10040106, on county road 2.6 mi (4.2 km) upstream from mouth, and 16.5 mi (26.6 km) north of Rock Springs.

Station 3 LITTLE DRY CREEK NEAR VAN NORMAN, MONT. (06130950)

LOCATION.--Lat 47°20'22", long 106°21'47", in NE¼NE¼NE¼ sec. 9, T. 18 N., R. 42 E., Garfield County, Hydrologic Unit 10040106, at bridge on State Highway 200, 0.8 mi (1.3 km) upstream from mouth, 1.5 mi (2.4 km) southeast of Van Norman.

Station 4 BIG DRY CREEK NEAR VAN NORMAN, MONT. (06131000)

LOCATION.--Lat 47°20'58", long 106°21'26", in NW¼SE¼NW¼ sec. 3, T. 18 N., R. 42 E., Garfield County, Hydrologic Unit 10040105, on left bank 900 ft (270 m) downstream from Little Dry Creek, 3.2 mi (5.1 km) northeast of Van Norman Post Office, and 26 mi (42 km) east of Jordan.

Station 5 TIMBER CREEK NEAR VAN NORMAN, MONT. (06131120)

LOCATION.--Lat 47°24'20", long 106°10'25", in E½ sec. 13, T. 19 N., R. 43 E., McCone County, Hydrologic Unit 10040104, at bridge on State Highway 24, and 11.8 mi (19.0 km) northeast of Van Norman.

Station 6 NELSON CREEK NEAR VAN NORMAN, MONT. (06131200)

LOCATION.--Lat 47°32'08", long 106°09'11", in SW¼NW¼ sec. 36, T. 21 N., R. 43 E., McCone County, Hydrologic Unit 10040104, on left bank at upstream side of bridge on State Highway 24, 1.5 mi (2.4 km) upstream from Fort Peck Lake, and 19 mi (30 km) northeast of Van Norman.

Station 7 PRAIRIE ELK CREEK NEAR OSWEGO, MONT. (06175540)

LOCATION (REVISED).--Lat 47°59'54", long 105°52'02", in SE¼SE¼ sec. 14, T. 26 N., R. 45 E., McCone County, Hydrologic Unit 10060001, on left bank 460 ft (140 m) downstream from bridge on FAS Highway 528, 0.9 mi (1.4 km) upstream from mouth, and 4 mi (6 km) south of Oswego.

Table 1.--*Station descriptions*--Continued

Station 8 SAND CREEK NEAR WOLF POINT, MONT. (06175580)

LOCATION.--Lat 48°00'52", long 105°42'34", in SE¼SE¼SE¼ sec. 12, T. 26 N., R. 46 E., McCone County, Hydrologic Unit 10060001, on county road bridge, 2.8 mi (4.5 km) upstream from mouth and 6.5 mi (10.5 km) southwest of Wolf Point.

Station 9 REDWATER RIVER AT CIRCLE, MONT. (06177500)

LOCATION.--Lat 47°24'51", long 105°34'30", in SW¼SW¼ sec. 11, T. 19 N., R. 48 E., McCone County, Hydrologic Unit 10060002, on left bank at Circle, 1 mi (2 km) upstream from Horse Creek, and at mile 110.2 (177.3 km).

Station 10 HORSE CREEK NEAR CIRCLE, MONT. (06177520)

LOCATION.--Lat 47°25'29", long 105°36'54", in NW¼NW¼ sec. 9, T. 19 N., R. 48 E., McCone County, Hydrologic Unit 10060002, at road bridge on FAS Highway 252, 1.0 mi (1.6 km) northwest of Circle and 2.5 mi (4.0 km) upstream from mouth.

Station 11 REDWATER RIVER NEAR VIDA, MONT. (06177825)

LOCATION.--Lat 47°54'07", long 105°12'54", in SW¼ sec. 24, T. 25 N., R. 50 E., McCone County, Hydrologic Unit 10060002, on right bank at downstream side of bridge on FAS Highway 201, 400 ft (122 m) downstream from East Redwater River, 13.7 mi (22.0 km) northeast of Vida Post Office, and at mile 30.6 (49.2 km).

Station 12 HARDSCRABBLE CREEK NEAR CULBERTSON, MONT. (06185150)

LOCATION.--Lat 48°04'38", long 104°43'50", in NE¼NW¼SW¼ sec. 23, T. 27 N., R. 55 E., Richland County, Hydrologic Unit 10060005, on county road bridge 5.2 mi (8.4 km) southeast of Blair, 6.8 mi (10.9 km) upstream from mouth, and 7 mi (11 km) southwest of Culbertson.

Station 13 MUSTER CREEK NEAR KINSEY, MONT. (06309079)

LOCATION.--Lat 46°37'05", long 105°45'08", in NW¼SW¼SE¼ sec. 13, T. 10 N., R. 47 E., Custer County, Hydrologic Unit 10100004, on right bank, at bridge on Caprock Road, 5.8 mi (9.3 km) northwest of Kinsey.

Station 14 CUSTER CREEK NEAR KINSEY, MONT. (06309145)

LOCATION.--Lat 46°42'03", long 105°29'14", in NE¼NW¼NW¼ sec. 19, T. 11 N., R. 50 E., Prairie County, Hydrologic Unit 10100001, on right bank, at prairie trail ford and just upstream from railroad bridge, about 0.8 river mile (1.3 km) upstream from mouth, and 12.0 mi (19.3 km) northeast of Kinsey.

Station 15 CHERRY CREEK NEAR TERRY, MONT. (06326555)

LOCATION.--Lat 46°51'00", long 105°19'27", in NE¼SE¼SE¼ sec. 25, T. 13 N., R. 50 E., Prairie County, Hydrologic Unit 10100004, on right bank, upstream side of State Highway 253 bridge, 0.4 mi (0.6 km) upstream from Dry Creek and 4.0 mi (6.4 km) north of Terry.

Table 1.--*Station descriptions*--Continued

Station 16 CLEAR CREEK NEAR HOYT, MONT. (06326953)

LOCATION.--Lat 47°00'05", long 104°56'31", on common line between sec. 1, T. 14 N., R. 53 E., and sec. 6, T. 14 N., R. 54 E., Dawson County, Hydrologic Unit 10100004, at county road 6.5 mi (10.5 km) northwest of Hoyt.

Station 17 UPPER SEVENMILE CREEK NEAR LINDSAY, MONT. (06326995)

LOCATION.--Lat 47°08'17", long 104°56'40", in NW¼NE¼NE¼ sec. 24, T. 16 N., R. 53 E., Dawson County, Hydrologic Unit 10100004, at bridge on gravel road, 0.6 mi (1.0 km) south of State Highway 200, and 11.5 mi (18.5 km) west-northwest of Glendive.

Station 18 GLENDIVE CREEK NEAR GLENDIVE, MONT. (06327850)

LOCATION.--Lat 47°07'16", long 104°39'51", in SE¼NW¼NW¼ sec. 29, T. 16 N., R. 56 E., Dawson County, Hydrologic Unit 10100004, on frontage road bridge, 1.2 mi (1.9 km) east of Glendive, and 2.4 mi (3.9 km) upstream from mouth.

Station 19 DEER CREEK NEAR GLENDIVE, MONT. (06328000)

LOCATION.--Lat 47°09'44", long 104°42'08", in NE¼NW¼ sec. 12, T. 16 N., R. 55 E., Dawson County, Hydrologic Unit 10100004, at bridge on Montana Highway 16, 3.8 mi (6.1 km) north of Glendive.

Station 20 COTTONWOOD CREEK NEAR INTAKE, MONT. (06329000)

LOCATION.--Lat 47°14'50", long 104°18'15", in E½ sec. 14, T. 17 N., R. 58 E., Wibaux County, Hydrologic Unit 1010004, 16.2 mi (26.1 km) southeast of Intake, and 26 mi (41.8 km) north of Wibaux.

Station 21 BURNS CREEK NEAR SAVAGE, MONT. (06329200)

LOCATION.--Lat 47°22'20", long 104°25'46", in NE¼SE¼SE¼ sec. 27, T. 19 N., R. 57 E., Richland County, Hydrologic Unit 10100004, on right bank 1,000 ft (305 m) upstream from bridge on State Highway 16, 7 mi (11 km) southwest of Savage, and at mile 2.1 (3.4 km).

Station 22 FOX CREEK NEAR LAMBERT, MONT. (06329520)

LOCATION.--Lat 47°38'44", long 104°30'27", at south end of section line between secs. 22 and 23, T. 22 N., R. 56 E., Richland County, Hydrologic Unit 10100004, on county road bridge, 6.1 mi (9.8 km) southeast of Lambert, and 11 mi (18 km) northwest of Crane.

Station 23 LONE TREE CREEK NEAR SIDNEY, MONT. (06329540)

LOCATION.--Lat 47°44'48", long 104°19'48", on east-west section line between secs. 18 and 19, T. 23 N., R. 58 E., Richland County, Hydrologic Unit 10100004, on county road bridge, 0.2 mi (0.3 km) upstream from North Fork, and 7.7 mi (12.4 km) northwest of Sidney.

Table 2.--*Statistical summary of water-quality data for each station*

Abbreviations:

ft^3/s	cubic feet per second
micromhos	micromhos per centimeter at 25° Celsius
°C	degrees Celsius
NTU	nephelometric turbidity unit
mg/L	milligrams per liter
µg/L	micrograms per liter
$CaCO_3$	calcium carbonate
<	less than indicated detection limit

(Table 2 continues on the following pages.)

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1):	1	Station No. (USGS):	06130680	Station name:	Big Dry Creek at Jordan, Mont.

	DESCRIPTIVE STATISTICS				
Variable	Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	4	0.20	7.40	2.22	3.46
Specific conductance (micromhos)	4	1020.00	2250.00	1517.50	568.18
pH (units)	4	7.90	8.50	8.22	0.28
Temperature (°C)	4	1.50	23.50	13.00	9.08
Turbidity (NTU)	4	35.00	7400.00	1903.75	3664.49
Oxygen, dissolved (mg/L)	3	7.20	11.60	9.20	2.23
Oxygen, dissolved (percent)	3	90.00	94.00	91.67	2.08
Biochemical oxygen demand (mg/L)	0	--	--	--	--
Calcium, dissolved (mg/L)	3	24.00	34.00	29.67	5.13
Magnesium, dissolved (mg/L)	3	8.20	20.00	14.40	5.92
Sodium, dissolved (mg/L)	4	190.00	460.00	302.50	120.38
Sodium (percent)	3	80.00	85.00	82.67	2.52
Sodium-adsorption ratio	3	8.50	15.00	11.83	3.25
Potassium, dissolved (mg/L)	3	4.30	5.80	5.27	0.84
Alkalinity, total as $CaCO_3$ (mg/L)	4	210.00	354.00	280.75	63.55
Sulfate, dissolved (mg/L)	4	260.00	790.00	500.00	221.36
Chloride, dissolved (mg/L)	4	4.20	11.00	7.58	3.42
Fluoride, dissolved (mg/L)	3	0.20	0.30	0.27	0.06
Silica, dissolved (mg/L)	3	0.90	8.00	3.80	3.72
Dissolved solids, calculated (mg/L)	3	628.00	1540.00	1089.33	456.09
Nitrogen, NO_2+NO_3 total (mg/L as N)	4	0.01	5.20	1.35	2.57
Nitrogen, ammonia total (mg/L as N)	4	0.01	0.05	0.03	0.02
Nitrogen, organic total (mg/L as N)	4	0.61	5.40	1.93	2.32
Nitrogen, total (mg/L as N)	4	0.62	11.00	3.38	5.09
Phosphorus, total (mg/L as P)	4	0.07	6.80	1.79	3.34
Sediment, suspended (mg/L)	3	68.00	263.00	136.33	109.81

	DISSOLVED		
Variable	Number of samples	Minimum value	Maximum value
Aluminum (μg/L)	3	30	140
Arsenic (μg/L)	3	1	1
Beryllium (μg/L)	3	<10	<10
Boron (μg/L)	3	110	180
Cadmium (μg/L)	3	0	<2
Chromium (μg/L)	3	0	<20
Copper (μg/L)	3	2	20
Iron (μg/L)	3	70	130
Lead (μg/L)	3	0	4
Lithium (μg/L)	3	10	40
Manganese (μg/L)	3	7	70
Mercury (μg/L)	3	<.5	<.5
Molybdenum (μg/L)	3	1	2
Nickel (μg/L)	3	3	6
Selenium (μg/L)	3	1	1
Vanadium (μg/L)	3	.5	2.3
Zinc (μg/L)	3	<20	30

Period of record: Water years 1976-77 (discontinued)

REGRESSION SUMMARY								
SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3]		Coefficient of determination[2]	Standard error of estimate
					Q	K		
--	--	--	--	--	--	--	--	--
Q		.279	591	--	--	--	--	--
K		.602	.213				.637	.287
--	--	--	--	--	--	--	--	--
K		.227	3940				.775	3010
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
-18.1 K	.211	.994*	11.0	-3.41	-2.07	.205*	.997*	11.4
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
115 K	.109	.952*	17.1			*	.997	6.19
-68.6 K	.375	.925*	74.2				.965	71.8
K		.881	1.44				.888	198
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
K		.226	2.77				.788	2.05
Q		.512	.0156				.587	.0203
K		.269	2.43				.787	1.85
K		.250	5.39				.782	4.12
K		.230	3.59				.778	2.73
--	--	--	--	--	--	--	--	--

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable

[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at $\alpha = 0.05$

[3] Asterisk denotes that partial regression coefficient is significant at $\alpha = 0.05$

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
2	1,600	200,000
2	1	48
2	10	20
--	--	--
2	<20	<20
2	20	330
2	20	440
2	2,000	270,000
2	200	400
2	30	180
2	250	4,100
2	<.5	.7
2	1	1
2	50	450
2	1	2
--	--	--
2	20	1,100

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 2 Station No. (USGS): 06130935 Station name: Crow Rock Creek near Cohagen, Mont.

Variable	DESCRIPTIVE STATISTICS Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	11	0.00	97.00	13.99	29.57
Specific conductance (micromhos)	10	397.00	4650.00	2058.70	1520.24
pH (units)	10	7.80	8.60	8.21	0.28
Temperature (°C)	11	0.00	26.50	13.45	10.75
Turbidity (NTU)	0	--	--	--	--
Oxygen, dissolved (mg/L)	10	3.40	12.40	9.14	2.68
Oxygen, dissolved (percent)	10	42.00	134.00	95.80	27.10
Biochemical oxygen demand (mg/L)	0	--	--	--	--
Calcium, dissolved (mg/L)	10	23.00	110.00	56.90	26.59
Magnesium, dissolved (mg/L)	10	9.60	130.00	51.56	44.33
Sodium, dissolved (mg/L)	10	42.00	880.00	359.70	301.49
Sodium (percent)	10	44.00	73.00	63.30	11.19
Sodium-adsorption ratio	10	1.80	14.00	7.63	4.38
Potassium, dissolved (mg/L)	10	4.10	15.00	10.31	3.31
Alkalinity, total as $CaCO_3$ (mg/L)	10	86.00	480.00	243.60	140.59
Sulfate, dissolved (mg/L)	10	110.00	2200.00	857.00	744.85
Chloride, dissolved (mg/L)	10	0.20	19.00	6.49	5.16
Fluoride, dissolved (mg/L)	10	0.10	0.20	0.13	0.05
Silica, dissolved (mg/L)	10	0.20	8.80	3.55	3.23
Dissolved solids, calculated (mg/L)	10	262.00	3600.00	1489.80	1193.37
Nitrogen, NO_2+NO_3 total (mg/L as N)	10	0.01	0.27	0.09	0.09
Nitrogen, ammonia total (mg/L as N)	10	0.01	0.53	0.11	0.16
Nitrogen, organic total (mg/L as N)	10	0.64	2.50	1.25	0.53
Nitrogen, total (mg/L as N)	10	0.84	2.50	1.42	0.46
Phosphorus, total (mg/L as P)	10	0.02	0.22	0.07	0.06
Sediment, suspended (mg/L)	11	10.00	298.00	80.91	89.11

Variable	DISSOLVED Number of samples	Minimum value	Maximum value
Aluminum (µg/L)	5	10	<100
Arsenic (µg/L)	5	1	3
Beryllium (µg/L)	5	1	<10
Boron (µg/L)	10	110	1100
Cadmium (µg/L)	5	0	16
Chromium (µg/L)	5	0	<20
Copper (µg/L)	5	0	<10
Iron (µg/L)	10	10	150
Lead (µg/L)	5	0	29
Lithium (µg/L)	5	2	40
Manganese (µg/L)	5	20	40
Mercury (µg/L)	5	<.1	.1
Molybdenum (µg/L)	5	1	<10
Nickel (µg/L)	5	0	2
Selenium (µg/L)	5	0	<1
Vanadium (µg/L)	5	.0	<6.0
Zinc (µg/L)	5	0	20

Period of record: Water years 1978-81 (discontinued)

REGRESSION SUMMARY

SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3] Q	Partial regression coefficient[3] K	Coefficient of determination[2]	Standard error of estimate
--	--	--	--	--	--	--	--	--
Q		.266	1380	--	--	--	--	--
7.88 K	.00016	.725*	.158	7.98	-.00261	.00013*	.783*	.150
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
Q		.0907	2.71				.108	2.87
K		.234	25.2				.234	26.9
--	--	--	--	--	--	--	--	--
22.7 K	.0166	.902*	8.82	26.7	-.110	.0155*	.914	8.84
-7.37 K	.0286	.964*	8.97	-9.83	.0668	.0293*	.965*	9.38
-46.0 K	.197	.987*	36.1	-52.4	.173	.199*	.987*	38.2
53.6 K	.00472	.411*	9.10				.475	9.19
2.14 K	.00267	.855*	1.77	2.75	-.0164	.00249*	.865*	1.83
7.21 K	.00151	.478*	2.54				.478	2.71
63.6 K	.0874	.894*	48.6	82.9	-.523	.0820*	.904*	49.5
-145 K	.487	.987*	90.1	-188	1.16	.499*	.989*	89.9
.292 K	.00301	.786*	2.53	.112	.00488	.00306*	.787*	2.70
.0831 K	2.28	.513*	.0358			*	.529	.0376
K		.377	2.70				.426	2.78
-119 K	.782	.991*	118	-155	.979	.792*	.992*	122
.0462 Q	.00259	.763*	.0471	.103	.00200*	-2.32*	.873*	.0368
.0320 Q	.00514	.922*	.0487	.0448	.00500*	-5.22	.924*	.0515
Q		.132	.521				.209	.532
K		.168	.445				.172	.474
.0483 Q	.00167	.684*	.0371	.0348	.00181*	5.49	.697*	.0388
Q		.239	82.0				.231	90.3

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable

[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at $\alpha = 0.05$

[3] Asterisk denotes that partial regression coefficient is significant at $\alpha = 0.05$

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
--	--	--
5	2	4
5	0	10
--	--	--
5	0	8
5	0	20
5	4	<20
--	--	--
5	4	51
5	9	40
5	40	160
5	<.1	.6
5	1	4
5	0	10
5	0	1
--	--	--
5	20	80

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 3
Station No. (USGS): 06130950
Station name: Little Dry Creek near Van Norman, Mont.

Variable	DESCRIPTIVE STATISTICS Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	10	0.12	224.00	33.15	69.93
Specific conductance (micromhos)	10	695.00	3420.00	2114.50	1091.67
pH (units)	10	7.90	8.80	8.36	0.31
Temperature (°C)	10	0.00	29.00	11.50	10.88
Turbidity (NTU)	10	10.00	8300.00	1099.50	2627.36
Oxygen, dissolved (mg/L)	9	8.10	12.60	10.02	1.58
Oxygen, dissolved (percent)	9	75.00	141.00	97.44	19.38
Biochemical oxygen demand (mg/L)	0	--	--	--	--
Calcium, dissolved (mg/L)	9	17.00	63.00	31.89	13.27
Magnesium, dissolved (mg/L)	9	6.50	46.00	27.57	15.82
Sodium, dissolved (mg/L)	10	120.00	760.00	437.00	240.88
Sodium (percent)	9	76.00	86.00	82.67	3.00
Sodium-adsorption ratio	9	6.10	21.00	14.06	4.85
Potassium, dissolved (mg/L)	9	3.70	12.00	7.38	2.55
Alkalinity, total as $CaCO_3$ (mg/L)	10	185.00	581.00	376.60	146.25
Sulfate, dissolved (mg/L)	10	160.00	1300.00	740.00	428.36
Chloride, dissolved (mg/L)	10	3.30	19.00	9.88	5.76
Fluoride, dissolved (mg/L)	9	0.20	0.40	0.31	0.09
Silica, dissolved (mg/L)	9	0.50	7.30	3.40	2.53
Dissolved solids, calculated (mg/L)	9	433.00	2460.00	1565.44	777.52
Nitrogen, NO_2+NO_3 total (mg/L as N)	10	0.07	1.20	0.47	0.37
Nitrogen, ammonia total (mg/L as N)	10	0.01	0.08	0.04	0.03
Nitrogen, organic total (mg/L as N)	10	0.34	8.60	1.94	2.59
Nitrogen, total (mg/L as N)	10	0.77	9.90	2.44	2.88
Phosphorus, total (mg/L as P)	10	0.02	8.50	1.15	2.68
Sediment, suspended (mg/L)	9	44.00	14000.00	2085.55	4634.63

Variable	DISSOLVED Number of samples	Minimum value	Maximum value
Aluminum (μg/L)	9	20	170
Arsenic (μg/L)	9	1	1
Beryllium (μg/L)	9	5	10
Boron (μg/L)	9	120	360
Cadmium (μg/L)	9	0	<2
Chromium (μg/L)	9	0	<20
Copper (μg/L)	9	2	20
Iron (μg/L)	9	10	510
Lead (μg/L)	9	0	5
Lithium (μg/L)	9	10	60
Manganese (μg/L)	9	8	30
Mercury (μg/L)	9	<.5	<.5
Molybdenum (μg/L)	9	1	3
Nickel (μg/L)	9	2	7
Selenium (μg/L)	9	1	1
Vanadium (μg/L)	9	.0	6.0
Zinc (μg/L)	9	0	20

Period of record: Water years 1976-77 (discontinued)

REGRESSION SUMMARY								
SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3] Q	Partial regression coefficient[3] K	Coefficient of determination[2]	Standard error of estimate
--	--	--	--	--	--	--	--	--
Q		.340	941	--	--	--	--	--
K		.0868	.314				.0893	.335
--	--	--	--	--	--	--	--	--
K		.271	2380				.285	2520
Q		.193	1.51				.212	1.62
Q		.0556	20.1				.0564	21.7
--	--	--	--	--	--	--	--	--
12.1 K	.00878	.492*	10.1				.499	10.9
-5.83 K	.0148	.985*	2.09	-5.84	.00010	.0148*	.985*	2.26
-26.9 K	.219	.989*	27.1	-43.2	.145	.225*	.990*	27.4
K		.295	2.69			*	.494	2.46
4.33 K	.00432	.887*	1.75	3.24	.00900	.00468*	.899*	1.78
3.71 K	.00163	.459*	2.00				.466	2.15
114 K	.124	.859*	58.3	88.8	.225	.133*	.867*	60.6
-80.2 K	.388	.977*	68.5	-59.5	-.184	.381*	.978*	72.3
.412 K	.00448	.721*	3.22	1.16	-.00667	.00423*	.726*	3.42
.165 K	6.46	.544*	.0670				.560	.0710
K		.417	2.06				.460	2.14
-80.0 K	.730	.989*	86.3	-105	.209	.738*	.989*	92.1
Q		.149	.362				.152	.386
K		.141	.0249				.156	.0264
K		.380	2.16				.426	2.22
K		.338	2.48				.390	2.55
K		.276	2.42				.287	2.56
K		.301	4140				.303	4470

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable

[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at α = 0.05

[3] Asterisk denotes that partial regression coefficient is significant at α = 0.05

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
5	280	170,000
5	1	50
5	10	10
--	--	--
5	2	20
5	0	280
5	20	470
5	360	270,000
5	73	500
5	40	200
5	40	4,600
5	<.5	1.2
4	1	4
5	50	450
5	1	1
--	--	--
5	0	1,200

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 4   Station No. (USGS): 06131000   Station name: Big Dry Creek near Van Norman, Mont.

	DESCRIPTIVE STATISTICS				
Variable	Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	3	1.50	3.00	2.43	0.81
Specific conductance (micromhos)	3	2550.00	3320.00	2863.33	404.52
pH (units)	3	7.90	8.80	8.47	0.49
Temperature (°C)	3	0.00	19.00	6.50	10.83
Turbidity (NTU)	1	100.00	100.00	100.00	--
Oxygen, dissolved (mg/L)	3	10.60	12.20	11.13	0.92
Oxygen, dissolved (percent)	3	79.00	122.00	97.33	22.19
Biochemical oxygen demand (mg/L)	0	--	--	--	--
Calcium, dissolved (mg/L)	3	37.00	47.00	40.67	5.51
Magnesium, dissolved (mg/L)	3	29.00	44.00	37.00	7.55
Sodium, dissolved (mg/L)	1	550.00	550.00	550.00	--
Sodium (percent)	1	81.00	81.00	81.00	--
Sodium-adsorption ratio	1	14.00	14.00	14.00	--
Potassium, dissolved (mg/L)	1	7.50	7.50	7.50	--
Alkalinity, total as $CaCO_3$ (mg/L)	3	420.00	470.00	440.00	26.46
Sulfate, dissolved (mg/L)	3	820.00	1400.00	1053.33	306.16
Chloride, dissolved (mg/L)	3	13.00	16.00	14.33	1.53
Fluoride, dissolved (mg/L)	1	0.30	0.30	0.30	--
Silica, dissolved (mg/L)	1	6.60	6.60	6.60	--
Dissolved solids, calculated (mg/L)	1	1890.00	1890.00	1890.00	--
Nitrogen, NO_2+NO_3 total (mg/L as N)	3	0.05	0.63	0.29	0.30
Nitrogen, ammonia total (mg/L as N)	3	0.05	0.19	0.10	0.08
Nitrogen, organic total (mg/L as N)	3	0.04	0.93	0.46	0.45
Nitrogen, total (mg/L as N)	3	0.29	1.20	0.86	0.50
Phosphorus, total (mg/L as P)	1	0.07	0.07	0.07	--
Sediment, suspended (mg/L)	1	336.00	336.00	336.00	--

	DISSOLVED		
Variable	Number of samples	Minimum value	Maximum value
Aluminum (µg/L)	1	20	20
Arsenic (µg/L)	1	2	2
Beryllium (µg/L)	1	<10	<10
Boron (µg/L)	1	230	230
Cadmium (µg/L)	1	<2	<2
Chromium (µg/L)	1	20	20
Copper (µg/L)	1	3	3
Iron (µg/L)	1	30	30
Lead (µg/L)	1	2	2
Lithium (µg/L)	1	40	40
Manganese (µg/L)	1	20	20
Mercury (µg/L)	1	.2	.2
Molybdenum (µg/L)	1	2	2
Nickel (µg/L)	1	2	2
Selenium (µg/L)	1	1	1
Vanadium (µg/L)	1	.0	.0
Zinc (µg/L)	1	30	30

Period of record: Water years 1978, 1981 (discontinued)

REGRESSION SUMMARY[1]								
SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant	Regression coefficient	Coefficient of determination	Standard error of estimate	Regression constant	Partial regression coefficient Q	Partial regression coefficient K	Coefficient of determination	Standard error of estimate
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--

[1] Insufficient samples to develop regressions

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
--	--	--
--	--	--
--	--	--
--	--	--
2	0	17
--	--	--
--	--	--
2	330	1100
2	0	3
--	--	--
2	40	70
2	<.1	.2
--	--	--
2	0	0
2	0	1
--	--	--
--	--	--

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1):	5	Station No. (USGS):	06131120	Station name:	Timber Creek near Van Norman, Mont.

Variable	Number of samples	DESCRIPTIVE STATISTICS Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	22	0.10	128.00	14.03	29.90
Specific conductance (micromhos)	20	765.00	7200.00	3948.25	1848.42
pH (units)	20	7.20	8.90	8.45	0.38
Temperature (°C)	21	0.00	23.50	11.76	8.30
Turbidity (NTU)	10	10.00	250.00	65.00	71.18
Oxygen, dissolved (mg/L)	19	6.50	12.20	9.42	1.64
Oxygen, dissolved (percent)	19	74.00	123.00	90.37	12.65
Biochemical oxygen demand (mg/L)	7	1.20	4.20	2.71	1.05
Calcium, dissolved (mg/L)	20	14.00	84.00	50.95	18.92
Magnesium, dissolved (mg/L)	20	14.00	180.00	94.45	46.30
Sodium, dissolved (mg/L)	20	120.00	1600.00	792.50	439.53
Sodium (percent)	20	60.00	84.00	74.95	5.45
Sodium-adsorption ratio	20	5.40	27.00	14.50	6.03
Potassium, dissolved (mg/L)	20	4.50	17.00	9.97	2.91
Alkalinity, total as $CaCO_3$ (mg/L)	20	98.00	960.00	503.35	238.11
Sulfate, dissolved (mg/L)	19	250.00	3300.00	1704.74	887.15
Chloride, dissolved (mg/L)	19	1.30	50.00	12.29	11.73
Fluoride, dissolved (mg/L)	18	0.10	1.00	0.43	0.23
Silica, dissolved (mg/L)	18	0.20	21.00	4.39	4.65
Dissolved solids, calculated (mg/L)	18	468.00	5530.00	3081.56	1514.88
Nitrogen, NO_2+NO_3 total (mg/L as N)	19	0.01	0.26	0.07	0.08
Nitrogen, ammonia total (mg/L as N)	20	0.01	0.22	0.06	0.05
Nitrogen, organic total (mg/L as N)	20	0.47	2.10	1.00	0.36
Nitrogen, total (mg/L as N)	19	0.59	2.10	1.08	0.36
Phosphorus, total (mg/L as P)	20	0.02	0.27	0.07	0.06
Sediment, suspended (mg/L)	22	45.00	518.00	166.68	109.68

Variable	DISSOLVED Number of samples	Minimum value	Maximum value
Aluminum (μg/L)	6	10	<100
Arsenic (μg/L)	9	1	5
Beryllium (μg/L)	9	10	10
Boron (μg/L)	20	190	2300
Cadmium (μg/L)	9	0	3
Chromium (μg/L)	9	0	<20
Copper (μg/L)	9	0	<20
Iron (μg/L)	20	10	180
Lead (μg/L)	9	0	16
Lithium (μg/L)	6	3	40
Manganese (μg/L)	9	10	100
Mercury (μg/L)	9	<.1	<.5
Molybdenum (μg/L)	6	1	4
Nickel (μg/L)	9	0	7
Selenium (μg/L)	9	<1	1
Vanadium (μg/L)	6	.0	3.4
Zinc (μg/L)	9	0	20

Period of record: Water years 1976-79 (discontinued)

REGRESSION SUMMARY								
SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3]		Coefficient of determination[2]	Standard error of estimate
					Q	K		
--	--	--	--	--	--	--	--	--
4410 Q	-30.0	.255*	1640	--	--	--	--	--
7.98 K	.00012	.337*	.317	8.08	-.00202	.00010*	.358*	.321
--	--	--	--	--	--	--	--	--
Q		.194	67.8				.196	72.4
Q		.0627	1.63				.0688	1.68
K		.0371	12.8				.0402	13.1
4.67 K	-.00066	.776*	.543	3.45	.0199	-.00036	.826*	.536
K		.0693	18.8				.0694	19.3
1.54 K	.0235	.882*	16.3	-6.73	.169	.0250*	.892*	16.1
-141 K	.237	.990*	45.9	-129	-.248	.234*	.990*	46.7
76.8 Q	-.123	.493*	3.99	72.0	-.0898*	.00111*	.598*	3.65
2.30 K	.00309	.896*	1.99	3.35	-.0214	.00291*	.906*	1.96
5.04 K	.00125	.632*	1.81	5.46	-.00869	.00118*	.638*	1.85
21.5 K	.122	.898*	78.3	72.0	-1.03	.113*	.911*	75.1
-216 K	.475	.975*	146	-313	3.09	.491*	.976*	144
.375 K	.00295	.215*	10.7				.223	11.0
.119 K	7.61	.376*	.187	.264	-.00435	5.10	.441*	.183
K		.115	4.51				.125	4.63
-284 K	.813	.991*	145	-375	2.72	.829*	.992*	145
.166 K	-2.59	.345*	.0660	.135	.00061	-2.05	.389*	.0657
.102 K	-1.19	.194*	.0460				.245	.0458
Q		.0429	.366				.0789	.369
K		.103	.350				.146	.352
K		.155	.0521				.165	.0533
283 K	-.0276	.205*	103				.211	106

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable

[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at $\alpha = 0.05$

[3] Asterisk denotes that partial regression coefficient is significant at $\alpha = 0.05$

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
3	700	6,000
6	1	9
6	10	10
--	--	--
5	0	<20
6	0	20
6	4	20
6	370	8,400
5	2	<200
3	7	30
6	50	260
6	<.1	<.5
3	3	7
6	4	50
6	1	2
--	--	--
6	20	50

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1):	6	Station No. (USGS):	06131200	Station name:	Nelson Creek near Van Norman, Mont.

	DESCRIPTIVE STATISTICS				
Variable	Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	27	0.03	125.00	15.78	34.05
Specific conductance (micromhos)	26	272.00	9200.00	3278.92	2563.12
pH (units)	26	7.30	8.80	8.23	0.35
Temperature (°C)	27	0.00	23.00	9.72	7.85
Turbidity (NTU)	18	20.00	18000.00	1315.83	4213.14
Oxygen, dissolved (mg/L)	24	6.20	11.00	8.95	1.57
Oxygen, dissolved (percent)	24	54.00	99.00	81.00	10.32
Biochemical oxygen demand (mg/L)	18	1.10	6.40	3.37	1.48
Calcium, dissolved (mg/L)	25	16.00	140.00	55.48	33.33
Magnesium, dissolved (mg/L)	25	5.60	230.00	79.97	73.91
Sodium, dissolved (mg/L)	25	37.00	2000.00	677.48	566.79
Sodium (percent)	25	55.00	84.00	72.28	8.34
Sodium-adsorption ratio	25	2.00	26.00	12.42	6.97
Potassium, dissolved (mg/L)	25	3.20	20.00	8.42	3.85
Alkalinity, total as $CaCO_3$ (mg/L)	26	63.00	1160.00	373.54	276.26
Sulfate, dissolved (mg/L)	25	76.00	4200.00	1537.84	1320.13
Chloride, dissolved (mg/L)	25	1.00	37.00	9.69	8.22
Fluoride, dissolved (mg/L)	24	0.10	1.20	0.35	0.23
Silica, dissolved (mg/L)	24	0.10	25.00	5.30	4.66
Dissolved solids, calculated (mg/L)	24	181.00	6960.00	2637.13	2180.74
Nitrogen, NO_2+NO_3 total (mg/L as N)	26	0.01	1.30	0.27	0.34
Nitrogen, ammonia total (mg/L as N)	26	0.01	0.12	0.05	0.03
Nitrogen, organic total (mg/L as N)	26	0.69	3.80	1.35	0.81
Nitrogen, total (mg/L as N)	26	0.87	5.00	1.65	1.06
Phosphorus, total (mg/L as P)	26	0.02	3.60	0.35	0.76
Sediment, suspended (mg/L)	24	64.00	23000.00	1512.62	4691.82

	DISSOLVED		
Variable	Number of samples	Minimum value	Maximum value
Aluminum (μg/L)	6	10	<100
Arsenic (μg/L)	9	1	2
Beryllium (μg/L)	9	10	10
Boron (μg/L)	26	70	1400
Cadmium (μg/L)	9	0	9
Chromium (μg/L)	9	0	<20
Copper (μg/L)	9	2	12
Iron (μg/L)	25	20	460
Lead (μg/L)	9	0	9
Lithium (μg/L)	6	7	50
Manganese (μg/L)	9	10	200
Mercury (μg/L)	9	<.1	.4
Molybdenum (μg/L)	6	1	3
Nickel (μg/L)	9	0	7
Selenium (μg/L)	9	<1	2
Vanadium (μg/L)	5	.0	2.5
Zinc (μg/L)	9	<20	30

Period of record: Water years 1976-79 (discontinued)

REGRESSION SUMMARY								
SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3] Q	Partial regression coefficient[3] K	Coefficient of determination[2]	Standard error of estimate
--	--	--	--	--	--	--	--	--
3820 Q	-33.6	.207*	2330	--	--	--	--	--
8.03 K	5.96	.189*	.323	8.11	-.00225	4.57	.228*	.322
--	--	--	--	--	--	--	--	--
K		.0419	4250				.0571	4360
Q		.0950	1.52				.101	1.56
Q		.0127	10.5				.0127	10.7
K		.133	1.42			*	.272	1.34
22.6 K	.00976	.571*	22.3	26.7	-.106	.00908*	.580*	22.6
-13.2 K	.0277	.933*	19.5	-19.3	.162	.0287*	.938*	19.3
-55.4 K	.218	.982*	76.8	-51.6	-.0981	.217*	.982*	78.5
75.1 Q	-.174	.543*	5.77	72.5	-.151*	.00066	.575*	5.68
4.15 K	.00246	.828*	2.95	5.66	-.0398*	.00220*	.859*	2.73
3.77 K	.00138	.853*	1.51	4.18	-.0108	.00131*	.861*	1.50
37.6 K	.102	.903*	87.7	45.8	-.226	.101*	.904*	89.3
-164 K	.506	.976*	208	-188	.648	.510*	.977*	211
-.294 K	.00297	.866*	3.07	-.612	.00837	.00302*	.867*	3.13
Q		.154	.220				.158	.225
K		.037	4.68				.072	4.70
-171 K	.827	.992*	196	-186	.377	.829*	.992*	200
.466 K	-5.92	.202*	.307	.409	.00158	-4.95	.223*	.310
Q		.139	.0315				.171	.0316
K		.0272	.814				.0531	.821
K		.0817	1.04				.0865	1.06
K		.0867	.742				.0943	.755
K		.0529	4770				.0585	4880

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable

[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at $\alpha = 0.05$

[3] Asterisk denotes that partial regression coefficient is significant at $\alpha = 0.05$

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
4	410	15,000
8	1	7
8	10	10
--	--	--
8	0	20
8	0	70
8	8	50
8	270	20,000
7	9	<200
5	20	40
8	80	550
8	<.1	.5
4	1	3
8	7	50
8	1	3
--	--	--
8	30	110

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 7 Station No. (USGS): 06175540 Station name: Prairie Elk Creek near Oswego, Mont.

	DESCRIPTIVE STATISTICS				
Variable	Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	47	0.02	1630.00	101.63	309.35
Specific conductance (micromhos)	46	180.00	3200.00	1859.09	911.60
pH (units)	46	7.60	9.10	8.50	0.40
Temperature (°C)	46	0.00	30.50	10.88	10.36
Turbidity (NTU)	35	1.00	8400.00	1274.51	2575.67
Oxygen, dissolved (mg/L)	42	2.00	13.50	9.84	2.27
Oxygen, dissolved (percent)	42	16.00	124.00	93.05	20.01
Biochemical oxygen demand (mg/L)	33	0.70	7.80	2.85	1.93
Calcium, dissolved (mg/L)	44	6.30	72.00	27.00	14.53
Magnesium, dissolved (mg/L)	43	3.00	60.00	16.29	9.84
Sodium, dissolved (mg/L)	43	41.00	900.00	423.30	213.87
Sodium (percent)	43	59.00	96.00	83.88	8.75
Sodium-adsorption ratio	43	2.40	43.00	16.14	8.35
Potassium, dissolved (mg/L)	43	3.00	7.80	5.49	1.30
Alkalinity, total as $CaCO_3$ (mg/L)	46	66.00	1160.00	536.41	287.74
Sulfate, dissolved (mg/L)	44	42.00	1100.00	464.25	237.14
Chloride, dissolved (mg/L)	43	2.30	28.00	7.68	4.73
Fluoride, dissolved (mg/L)	44	0.10	1.20	0.69	0.30
Silica, dissolved (mg/L)	44	1.80	52.00	9.04	7.37
Dissolved solids, calculated (mg/L)	42	160.00	2380.00	1323.12	589.41
Nitrogen, NO_2+NO_3 total (mg/L as N)	44	0.01	3.20	0.34	0.71
Nitrogen, ammonia total (mg/L as N)	46	0.01	0.38	0.09	0.10
Nitrogen, organic total (mg/L as N)	46	0.00	9.80	1.41	2.00
Nitrogen, total (mg/L as N)	44	0.24	13.00	1.78	2.68
Phosphorus, total (mg/L as P)	46	0.01	5.30	0.52	1.04
Sediment, suspended (mg/L)	45	44.00	12600.00	1672.40	3403.83

	DISSOLVED		
Variable	Number of samples	Minimum value	Maximum value
Aluminum (µg/L)	8	10	540
Arsenic (µg/L)	11	1	4
Beryllium (µg/L)	11	10	10
Boron (µg/L)	46	60	1000
Cadmium (µg/L)	10	0	4
Chromium (µg/L)	11	0	<20
Copper (µg/L)	11	2	18
Iron (µg/L)	43	10	840
Lead (µg/L)	10	0	6
Lithium (µg/L)	8	50	190
Manganese (µg/L)	11	5	150
Mercury (µg/L)	9	<.1	.4
Molybdenum (µg/L)	8	1	5
Nickel (µg/L)	11	3	20
Selenium (µg/L)	11	<1	5
Vanadium (µg/L)	9	.0	49
Zinc (µg/L)	11	<20	130

Period of record: Water years 1976-79 (discontinued)

REGRESSION SUMMARY								
SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3] Q	Partial regression coefficient[3] K	Coefficient of determination[2]	Standard error of estimate
--	--	--	--	--	--	--	--	--
2010 Q	-1.53	.275*	785	--	--	--	--	--
8.12 K	.00021	.222*	.361	8.27	-.00035	.00015*	.276*	.352
--	--	--	--	--	--	--	--	--
3910 K	-1.51	.276*	2220	4550	-1.52	-1.78*	.306*	2210
K		.0200	2.28				.0257	2.30
80.4 K	.00673	.0960*	19.3				.0963	19.5
5.20 K	-.00136	.405*	1.54	4.86	.00077	-.00121*	.419*	1.55
17.3 K	.00503	.0915*	14.0				.0932	14.2
2.13 K	.00724	.405*	7.69	1.99	.00047	.00730*	.405*	7.78
-50.8 K	.243	.961*	42.7	-57.3	.0219	.245*	.962*	43.0
70.2 K	.00701	.479*	6.39	75.0	-.0162*	.00505*	.601*	5.66
.171 K	.00817	.716*	4.50	.304	-.00045	.00812*	.716*	4.56
K		.017	1.31				.021	1.32
-17.0 K	.298	.890*	96.7	-34.9	.0416	.305*	.891*	97.2
-12.2 K	.249	.883*	82.2	-14.2	.00457	.250*	.883*	83.2
4.26 K	.00176	.108*	4.52				.116	4.56
.195 K	.00026	.610*	.189	.106	.00019	.00030*	.641*	.183
Q		.026	7.36				.0779	7.25
-44.8 K	.689	.987*	69.1	-62.9	.0573	.697*	.987*	69.1
.935 K	-.00031	.158*	.656	1.19	-.00053	-.00042*	.198*	.647
.176 K	-4.91	.207*	.0885	.138	8.87	-3.32*	.265*	.0862
3.58 K	-.00117	.284*	1.71	3.66	-.00020	-.00120*	.285*	1.73
4.77 K	-.00157	.274*	2.31	5.10	-.00070	-.00170*	.279*	2.33
1.70 K	-.00063	.310*	.871	1.55	.00034	-.00057*	.318*	.876
5690 K	-2.14	.330*	2820	6410	-1.63	-2.44*	.346*	2820

---

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable

[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at α = 0.05

[3] Asterisk denotes that partial regression coefficient is significant at α = 0.05

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
6	1,600	160,000
11	1	80
10	10	10
--	--	--
11	0	20
11	0	290
11	3	490
11	830	250,000
11	2	400
8	40	260
11	90	3,500
11	.3	1.7
6	1	4
11	6	550
11	1	4
--	--	--
11	0	1,000

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 8 Station No. (USGS): 06175580 Station name: Sand Creek near Wolf Point, Mont.

	DESCRIPTIVE STATISTICS				
Variable	Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	9	0.20	165.00	27.17	54.42
Specific conductance (micromhos)	9	360.00	3230.00	1797.44	1079.29
pH (units)	9	8.00	9.20	8.68	0.41
Temperature (°C)	9	0.50	30.00	12.33	11.44
Turbidity (NTU)	9	30.00	5600.00	1315.56	1934.10
Oxygen, dissolved (mg/L)	8	7.40	12.80	10.07	2.38
Oxygen, dissolved (percent)	8	80.00	120.00	94.62	12.42
Biochemical oxygen demand (mg/L)	0	--	--	--	--
Calcium, dissolved (mg/L)	9	12.00	26.00	18.78	5.47
Magnesium, dissolved (mg/L)	9	4.50	24.00	12.61	8.07
Sodium, dissolved (mg/L)	9	52.00	820.00	410.22	276.67
Sodium (percent)	9	65.00	93.00	85.11	10.25
Sodium-adsorption ratio	9	3.10	32.00	17.09	9.73
Potassium, dissolved (mg/L)	9	4.90	7.50	5.80	0.96
Alkalinity, total as $CaCO_3$ (mg/L)	9	105.00	1370.00	600.33	444.93
Sulfate, dissolved (mg/L)	9	63.00	770.00	398.11	234.93
Chloride, dissolved (mg/L)	8	3.50	14.00	7.88	4.67
Fluoride, dissolved (mg/L)	9	0.20	2.10	1.09	0.77
Silica, dissolved (mg/L)	9	2.50	12.00	8.62	3.03
Dissolved solids, calculated (mg/L)	8	212.00	2480.00	1221.75	840.42
Nitrogen, NO_2+NO_3 total (mg/L as N)	9	0.01	2.60	0.65	0.86
Nitrogen, ammonia total (mg/L as N)	9	0.01	0.15	0.09	0.06
Nitrogen, organic total (mg/L as N)	9	0.73	4.10	2.04	1.33
Nitrogen, total (mg/L as N)	9	0.77	5.40	2.77	1.91
Phosphorus, total (mg/L as P)	9	0.04	1.80	0.58	0.61
Sediment, suspended (mg/L)	9	107.00	7010.00	2181.77	2679.80

	DISSOLVED		
Variable	Number of samples	Minimum value	Maximum value
Aluminum (μg/L)	9	10	1100
Arsenic (μg/L)	9	1	6
Beryllium (μg/L)	9	<10	<10
Boron (μg/L)	9	110	1100
Cadmium (μg/L)	9	0	<2
Chromium (μg/L)	9	0	30
Copper (μg/L)	9	3	28
Iron (μg/L)	9	40	310
Lead (μg/L)	9	0	12
Lithium (μg/L)	9	10	170
Manganese (μg/L)	9	8	260
Mercury (μg/L)	8	<.5	<.5
Molybdenum (μg/L)	8	1	7
Nickel (μg/L)	9	5	43
Selenium (μg/L)	8	<1	3
Vanadium (μg/L)	9	.4	4.0
Zinc (μg/L)	9	6	70

Period of record: Water years 1976-77 (discontinued)

REGRESSION SUMMARY

SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3] Q	Partial regression coefficient[3] K	Coefficient of determination[2]	Standard error of estimate
--	--	--	--	--	--	--	--	--
Q		.350	930	--	--	--	--	--
8.08 K	.00033	.770*	.210	8.09	-8.57	.00033*	.770*	.226
--	--	--	--	--	--	--	--	--
K		.0836	1980				.0895	2130
Q		.133	2.39				.380	2.22
Q		.332	11.0				.388	11.5
--	--	--	--	--	--	--	--	--
K		.0176	5.80				.0460	6.17
.349 K	.00682	.833*	3.53	-2.35	.0334	.00782*	.866*	3.41
-48.9 K	.255	.993*	24.8	-36.4	-.156	.251*	.994*	25.6
89.0 Q	-.144	.586*	7.05	79.8	-.0931	.00436	.723*	6.23
1.43 K	.00871	.933*	2.68	3.64	-.0273	.00790*	.949*	2.55
K		.083	.983				.281	.940
-122 K	.402	.950*	106	-122	-.00192	.402*	.950*	114
14.0 K	.214	.964*	47.6	-18.8	.406	.226*	.970*	47.2
.809 K	.00396	.958*	1.04	.0799	.00883	.00422*	.965*	1.03
-.157 K	.00069	.946*	.190	-.0764	-.00099	.00066*	.950*	.200
K		.164	2.96				.284	2.96
-69.4 K	.723	.985*	110	-89.7	.247	.731*	.985*	120
K		.259	.795				.374	.789
.167 K	-4.47	.722*	.0320	.210	-.00053*	-6.07*	.893*	.0215
K		.430	1.07				.504	1.08
5.01 K	-.00125	.499*	1.44				.499	1.56
K		.248	.570				.301	.594
K		.191	2580				.193	2780

[1] Q indicates discharge as independenc variable; K indicates specific conductance as independent variable

[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at $\alpha = 0.05$

[3] Asterisk denotes that partial regression coefficient is significant at $\alpha = 0.05$

TOTAL RECOVERABLE

Number of samples	Minimum value	Maximum value
4	3,000	42,000
4	1	57
3	10	10
--	--	--
4	0	<20
4	0	70
4	20	130
4	4,200	69,000
4	0	<200
4	60	150
4	190	1,400
4	<.5	<.5
4	1	5
4	50	180
4	1	3
--	--	--
4	30	300

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 9 Station No. (USGS): 06177500 Station name: Redwater River at Circle, Mont.

Variable	DESCRIPTIVE STATISTICS				
	Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	79	0.01	1060.00	24.60	131.11
Specific conductance (micromhos)	78	336.00	5800.00	3793.67	1040.36
pH (units)	78	7.20	8.90	8.29	0.33
Temperature (°C)	79	0.00	29.00	9.24	8.84
Turbidity (NTU)	45	2.00	460.00	28.58	67.67
Oxygen, dissolved (mg/L)	77	3.20	13.60	8.97	2.11
Oxygen, dissolved (percent)	77	24.00	119.00	82.47	19.67
Biochemical oxygen demand (mg/L)	43	0.40	6.00	2.29	1.26
Calcium, dissolved (mg/L)	78	24.00	190.00	94.97	31.72
Magnesium, dissolved (mg/L)	78	14.00	240.00	133.78	47.04
Sodium, dissolved (mg/L)	78	23.00	1100.00	643.12	209.42
Sodium (percent)	78	28.00	78.00	62.31	9.38
Sodium-adsorption ratio	78	0.90	17.00	10.03	3.21
Potassium, dissolved (mg/L)	78	3.80	15.00	10.04	2.11
Alkalinity, total as $CaCO_3$ (mg/L)	77	82.00	927.00	519.55	181.47
Sulfate, dissolved (mg/L)	78	91.00	2700.00	1608.09	518.57
Chloride, dissolved (mg/L)	78	1.80	30.00	16.00	5.87
Fluoride, dissolved (mg/L)	77	0.10	2.10	1.04	0.60
Silica, dissolved (mg/L)	77	0.70	51.00	7.24	6.19
Dissolved solids, calculated (mg/L)	76	216.00	4270.00	2835.33	817.79
Nitrogen, NO_2+NO_3 total (mg/L as N)	78	0.00	0.73	0.09	0.14
Nitrogen, ammonia total (mg/L as N)	77	0.00	0.86	0.10	0.17
Nitrogen, organic total (mg/L as N)	77	0.01	1.80	0.82	0.39
Nitrogen, total (mg/L as N)	77	0.09	2.00	1.00	0.43
Phosphorus, total (mg/L as P)	78	0.01	0.61	0.06	0.08
Sediment, suspended (mg/L)	75	12.00	1300.00	107.97	149.8

Variable	DISSOLVED		
	Number of samples	Minimum value	Maximum value
Aluminum (μg/L)	10	10	100
Arsenic (μg/L)	15	0	4
Beryllium (μg/L)	15	0	10
Boron (μg/L)	78	110	970
Cadmium (μg/L)	14	0	6
Chromium (μg/L)	15	0	<20
Copper (μg/L)	15	0	7
Iron (μg/L)	78	10	270
Lead (μg/L)	14	0	14
Lithium (μg/L)	10	10	73
Manganese (μg/L)	15	5	450
Mercury (μg/L)	15	<.1	.4
Molybdenum (μg/L)	10	1	9
Nickel (μg/L)	15	0	20
Selenium (μg/L)	14	0	2
Vanadium (μg/L)	10	.0	<9
Zinc (μg/L)	15	0	430

Period of record: Water years 1975-81

REGRESSION SUMMARY								
SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3]		Coefficient of determination[2]	Standard error of estimate
					Q	K		
--	--	--	--	--	--	--	--	--
3890 Q	-4.06	.266*	902	--	--	--	--	--
8.31 Q	-.00094	.138*	.311	8.29	-.00091*	4.22	.138*	.312
--	--	--	--	--	--	--	--	--
17.3 Q	.417	.944*	16.2	29.7	.406*	-.00360	.945*	16.2
8.88 Q	.00359	.0512*	2.07				.0526	2.09
K		.00702	19.8				.0103	20.0
2.17 Q	.00379	.239*	1.11	3.30	.00272*	-.00033	.271*	1.10
32.0 K	.0168	.312*	26.2	34.4	-.00881	.0162*	.313*	26.4
6.24 K	.0338	.561*	31.5	3.65	.00951	.0344*	.561*	31.7
-58.5 K	.184	.851*	81.2	-49.5	-.0328	.182*	.851*	81.6
63.3 Q	-.0400	.318*	7.80	52.7	-.0289*	.00268*	.392*	7.32
2.01 K	.00209	.488*	2.25	3.03	-.00372	.00185*	.507*	2.23
7.95 K	.00055	.0738*	2.06	8.36	-.00150	.00045	.0803*	2.07
187 K	.0873	.256*	158	258	-.259	.0703*	.282*	156
-165 K	.468	.879*	183	-209	.160	.478*	.880*	183
1.39 K	.00383	.470*	4.28	2.26	-.00318	.00362*	.474*	4.29
.207 K	.00022	.146*	.553	.357	-.00055	.00018*	.158*	.553
K		.0280	6.17				.0307	6.20
-55.1 K	.760	.956*	173	-45.1	-.0364	.758*	.956*	174
.0747 Q	.00050	.218*	.125	.111	.00046*	-9.03	.221*	.126
Q		.00918	.168				.0133	.170
Q		.0145	.394				.0166	.393
.971 Q	.00101	.0992*	.408	.880	.00111*	2.20	.104*	.411
.0433 Q	.00049	.662*	.0469	.0445	.00049*	-4.73	.666*	.0473
87.3 Q	1.11	.842	62.0	25.2	1.17*	.0161	.851*	61.1

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable

[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at α = 0.05

[3] Asterisk denotes that partial regression coefficient is significant at α = 0.05

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
9	100	1,400
17	1	6
17	0	10
--	--	--
17	0	20
17	0	40
17	2	60
17	270	11,000
17	2	<200
12	10	90
16	20	500
17	<.1	.6
11	2	12
17	0	50
17	0	1
--	--	--
15	20	260

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 10 Station No. (USGS): 06177520 Station name: Horse Creek near Circle, Mont.

Variable	DESCRIPTIVE STATISTICS Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	17	0.03	150.00	19.16	45.27
Specific conductance (micromhos)	16	489.00	13300.00	5270.50	3236.02
pH (units)	16	7.40	9.20	8.44	0.45
Temperature (°C)	17	0.00	27.00	12.56	9.01
Turbidity (NTU)	8	2.00	110.00	18.63	37.42
Oxygen, dissolved (mg/L)	15	5.50	14.60	9.54	2.41
Oxygen, dissolved (percent)	15	65.00	187.00	94.67	32.93
Biochemical oxygen demand (mg/L)	8	1.50	7.10	3.76	2.03
Calcium, dissolved (mg/L)	16	25.00	120.00	71.88	31.86
Magnesium, dissolved (mg/L)	16	20.00	510.00	210.56	134.83
Sodium, dissolved (mg/L)	16	45.00	3200.00	1026.31	802.47
Sodium (percent)	16	39.00	82.00	62.19	11.22
Sodium-adsorption ratio	16	1.60	29.00	12.68	7.57
Potassium, dissolved (mg/L)	16	6.50	30.00	13.46	5.95
Alkalinity, total as $CaCO_3$ (mg/L)	16	90.00	950.00	538.75	255.86
Sulfate, dissolved (mg/L)	16	140.00	7900.00	2630.00	1909.80
Chloride, dissolved (mg/L)	16	1.20	24.00	7.86	6.46
Fluoride, dissolved (mg/L)	15	0.10	0.50	0.27	0.13
Silica, dissolved (mg/L)	15	0.10	8.30	2.33	2.89
Dissolved solids, calculated (mg/L)	15	298.00	12200.00	4278.07	3082.25
Nitrogen, NO_2+NO_3 total (mg/L as N)	16	0.01	18.00	1.23	4.48
Nitrogen, ammonia total (mg/L as N)	16	0.01	0.35	0.08	0.10
Nitrogen, organic total (mg/L as N)	16	0.64	3.40	1.45	0.91
Nitrogen, total (mg/L as N)	16	0.76	21.00	2.71	4.93
Phosphorus, total (mg/L as P)	15	0.01	0.21	0.06	0.05
Sediment, suspended (mg/L)	16	12.00	173.00	67.31	46.28

Variable	DISSOLVED Number of samples	Minimum value	Maximum value
Aluminum (μg/L)	3	20	<100
Arsenic (μg/L)	6	1	27
Beryllium (μg/L)	6	<10	<10
Boron (μg/L)	16	130	3200
Cadmium (μg/L)	5	0	22
Chromium (μg/L)	6	0	<20
Copper (μg/L)	6	0	6
Iron (μg/L)	16	20	130
Lead (μg/L)	5	0	10
Lithium (μg/L)	3	10	110
Manganese (μg/L)	6	10	200
Mercury (μg/L)	6	<.1	.7
Molybdenum (μg/L)	3	1	1
Nickel (μg/L)	6	2	4
Selenium (μg/L)	6	<1	1
Vanadium (μg/L)	3	.4	1.8
Zinc (μg/L)	6	<20	20

Period of record: Water years 1977-79 (discontinued)

REGRESSION SUMMARY								
SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3]		Coefficient of determination[2]	Standard error of estimate
					Q	K		
--	--	--	--	--	--	--	--	--
6130 Q	-42.6	.374*	2650	--	--	--	--	--
7.85 K	.00011	.665*	.268	8.08	-.00345	8.25*	.746*	.242
--	--	--	--	--	--	--	--	--
4.78 Q	.700	.970*	6.97	-6.85	.773*	.00188*	.995*	3.18
Q		.0440	2.44				.0565	2.53
Q		.0339	33.6				.0394	34.9
Q		.156	2.02				.588	1.54
79.6 Q	-.380	.307*	27.5				.308	28.5
6.17 K	.0388	.866*	51.0	10.6	-.0672	.0382*	.867*	52.9
-261 K	.244	.970*	144	-411	2.25*	.264*	.981*	120
47.4 K	.00280	.651*	6.86	54.6	-.108*	.00185*	.777*	5.70
.993 K	.00222	.897*	2.51	1.41	-.00631	.00216*	.898*	2.59
4.96 K	.00161	.771*	2.95	4.25	.0107	.00171*	.775*	3.03
166 K	.0708	.801*	118	269	-1.56	.0571*	.851*	106
-446 K	.584	.978*	294	-697	3.76	.617*	.983*	266
-.393 K	.00157	.616*	4.14	-1.49	.0165	.00171*	.625*	4.25
.0819 K	3.52	.767*	.0674	.0913	-.00014	3.39*	.768*	.0700
5.51 K	-.00061	.493*	2.13	4.04	.0218	-.00041	.574*	2.03
-524 K	.914	.986*	380	-834	4.58	.954*	.989*	349
Q		.00581	4.62				.00582	4.79
.0571 Q	.00116	.264*	.0931				.272	.0961
.349 K	.00021	.552*	.632	.136	.00319	.00024*	.569*	.643
K		.0310	5.03				.0313	5.22
.0472 Q	.00077	.482*	.0398	.0311	.00088*	2.73	.498*	.0408
58.5 Q	.703	.318*	39.6		*		.341	42.0

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable

[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at α = 0.05

[3] Asterisk denotes that partial regression coefficient is significant at α = 0.05

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
1	2,700	2,700
4	2	28
4	<10	<10
--	--	--
3	0	2
4	0	20
4	2	<20
4	280	5,900
4	2	16
1	9	9
4	40	190
4	<.1	.5
1	4	4
4	2	10
4	1	2
--	--	--
4	20	30

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 11 Station No. (USGS): 06177825 Station name: Redwater River near Vida, Mont.

	DESCRIPTIVE STATISTICS				
Variable	Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	70	0.03	4560.00	172.94	677.14
Specific conductance (micromhos)	69	430.00	4950.00	3076.99	950.92
pH (units)	69	7.70	9.20	8.48	0.33
Temperature (°C)	69	0.00	27.00	10.43	9.63
Turbidity (NTU)	33	3.00	1000.00	61.09	179.22
Oxygen, dissolved (mg/L)	68	4.20	12.70	9.61	1.70
Oxygen, dissolved (percent)	68	54.00	126.00	89.47	13.97
Biochemical oxygen demand (mg/L)	34	0.40	7.10	2.36	1.62
Calcium, dissolved (mg/L)	68	21.00	140.00	53.79	22.18
Magnesium, dissolved (mg/L)	69	14.00	130.00	80.80	26.84
Sodium, dissolved (mg/L)	68	49.00	900.00	565.43	202.09
Sodium (percent)	67	43.00	80.00	70.16	7.25
Sodium-adsorption ratio	67	2.00	18.00	11.19	3.43
Potassium, dissolved (mg/L)	69	3.90	15.00	9.77	1.78
Alkalinity, total as $CaCO_3$ (mg/L)	69	98.00	850.00	517.97	165.94
Sulfate, dissolved (mg/L)	69	110.00	1800.00	1128.12	382.79
Chloride, dissolved (mg/L)	69	3.00	44.00	13.90	6.53
Fluoride, dissolved (mg/L)	69	0.10	1.00	0.54	0.18
Silica, dissolved (mg/L)	68	0.10	15.00	5.91	3.48
Dissolved solids, calculated (mg/L)	67	270.00	3490.00	2162.13	712.66
Nitrogen, NO_2+NO_3 total (mg/L as N)	68	0.00	1.20	0.13	0.22
Nitrogen, ammonia total (mg/L as N)	68	0.00	0.63	0.08	0.12
Nitrogen, organic total (mg/L as N)	68	0.14	4.40	0.90	0.62
Nitrogen, total (mg/L as N)	67	0.34	5.70	1.11	0.80
Phosphorus, total (mg/L as P)	69	0.01	0.72	0.07	0.11
Sediment, suspended (mg/L)	69	12.00	1700.00	133.10	243.7

	DISSOLVED		
Variable	Number of samples	Minimum value	Maximum value
Aluminum (μg/L)	10	10	<100
Arsenic (μg/L)	17	1	5
Beryllium (μg/L)	18	0	10
Boron (μg/L)	69	80	600
Cadmium (μg/L)	17	0	8
Chromium (μg/L)	18	0	<20
Copper (μg/L)	18	0	8
Iron (μg/L)	69	10	320
Lead (μg/L)	17	0	29
Lithium (μg/L)	10	10	90
Manganese (μg/L)	18	10	80
Mercury (μg/L)	18	<.1	<.5
Molybdenum (μg/L)	10	3	7
Nickel (μg/L)	18	0	7
Selenium (μg/L)	18	0	1
Vanadium (μg/L)	10	.0	5
Zinc (μg/L)	18	0	20

Period of record: Water years 1976-81

REGRESSION SUMMARY								
SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3]		Coefficient of determination[2]	Standard error of estimate
					Q	K		
--	--	--	--	--	--	--	--	--
3190 Q	-.789	.289*	808	--	--	--	--	--
8.51 Q	-.00018	.126*	.314	8.31	-.00014*	5.96	.146*	.313
--	--	--	--	--	--	--	--	--
31.7 Q	.207	.352*	147	197	.145*	-.0553	.401*	143
K		.0155	1.70				.0289	1.70
77.4 K	.00395	.0728*	13.6				.0728	13.7
2.16 Q	.00107	.152*	1.51	2.92	.00103	-.00025	.184*	1.53
26.4 K	.00866	.130*	21.4	27.7	-.00102	.00828*	.131*	21.6
7.03 K	.0240	.721*	14.3	7.31	-.00022	.0239*	.721*	14.4
-62.3 K	.205	.935*	52.0	-60.3	-.00154	.204*	.935*	52.4
53.9 K	.00534	.493*	5.20	59.9	-.00471*	.00360*	.621*	4.53
1.50 K	.00318	.781*	1.62	2.24	-.00058	.00297*	.790*	1.60
7.50 K	.00074	.156*	1.64	8.16	-.00052	.00055*	.182*	1.63
38.6 K	.156	.797*	75.3	54.2	-.0122	.151*	.799*	75.6
-74.1 K	.391	.942*	92.9	-84.3	.00804	.394*	.942*	93.5
.268 K	.00443	.416*	5.03	-.0144	.00022	.00451*	.417*	5.06
.117 K	.00014	.501*	.130	.172	-4.35	.00012*	.518*	.129
K		.00010	3.51				.00036	3.53
-62.5 K	.726	.960*	143	-57.5	-.00389	.725*	.960*	144
.118 Q	.00011	.106*	.206	.207	8.62	-2.79	.117*	.207
.260 K	-5.71	.213*	.106	.237	1.78	-5.06*	.219*	.106
.839 Q	.00042	.200*	.556	1.34	.00030*	-.00016	.243*	.545
1.02 Q	.00060	.242*	.699	1.77	.00041*	-.00023*	.299*	.677
.0532 Q	.00011	.449*	.0829	.186	8.18*	-4.17*	.540*	.0764
98.0 Q	.237	.398*	190	321	.182*	-.0697*	.451*	183

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable

[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at α = 0.05

[3] Asterisk denotes that partial regression coefficient is significant at α = 0.05

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
7	180	22,000
15	1	35
15	0	10
--	--	--
15	0	<20
14	0	40
15	2	40
15	240	35,000
15	0	<200
8	20	80
15	30	1,100
15	<.1	.4
7	1	6
15	0	200
15	0	8
--	--	--
15	0	130

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 12 Station No. (USGS): 06185150 Station name: Hardscrabble Creek near Culbertson, Mont.

	DESCRIPTIVE STATISTICS				
Variable	Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	8	0.02	14.00	1.93	4.88
Specific conductance (micromhos)	8	1670.00	12500.00	7758.75	3193.71
pH (units)	8	7.80	9.50	8.60	0.52
Temperature (°C)	8	0.00	24.50	12.50	9.91
Turbidity (NTU)	0	--	--	--	--
Oxygen, dissolved (mg/L)	8	7.00	14.50	10.39	2.36
Oxygen, dissolved (percent)	8	71.00	192.00	106.37	42.28
Biochemical oxygen demand (mg/L)	0	--	--	--	--
Calcium, dissolved (mg/L)	8	40.00	180.00	113.50	52.25
Magnesium, dissolved (mg/L)	8	38.00	420.00	276.00	122.09
Sodium, dissolved (mg/L)	8	240.00	2600.00	1688.75	747.71
Sodium (percent)	8	64.00	75.00	70.88	3.31
Sodium-adsorption ratio	8	6.30	25.00	18.66	5.96
Potassium, dissolved (mg/L)	8	9.60	26.00	15.58	5.84
Alkalinity, total as $CaCO_3$ (mg/L)	8	210.00	840.00	638.75	220.48
Sulfate, dissolved (mg/L)	8	600.00	6200.00	4287.50	1913.44
Chloride, dissolved (mg/L)	8	8.30	120.00	34.54	36.24
Fluoride, dissolved (mg/L)	8	0.10	0.60	0.40	0.15
Silica, dissolved (mg/L)	8	1.20	9.70	3.66	2.58
Dissolved solids, calculated (mg/L)	8	1080.00	9890.00	6811.25	2926.04
Nitrogen, NO_2+NO_3 total (mg/L as N)	8	0.00	0.48	0.08	0.17
Nitrogen, ammonia total (mg/L as N)	8	0.03	0.92	0.22	0.29
Nitrogen, organic total (mg/L as N)	8	1.10	5.10	2.24	1.26
Nitrogen, total (mg/L as N)	8	1.10	6.50	2.53	1.68
Phosphorus, total (mg/L as P)	8	0.04	0.39	0.12	0.12
Sediment, suspended (mg/L)	8	5.00	384.00	131.12	124.49

	DISSOLVED		
Variable	Number of samples	Minimum value	Maximum value
Aluminum (μg/L)	--	--	--
Arsenic (μg/L)	2	3	9
Beryllium (μg/L)	2	0	1
Boron (μg/L)	8	160	1700
Cadmium (μg/L)	2	0	1
Chromium (μg/L)	2	0	10
Copper (μg/L)	2	3	7
Iron (μg/L)	8	50	210
Lead (μg/L)	2	0	6
Lithium (μg/L)	--	--	--
Manganese (μg/L)	2	10	150
Mercury (μg/L)	2	<.1	.2
Molybdenum (μg/L)	--	--	--
Nickel (μg/L)	2	3	3
Selenium (μg/L)	2	0	0
Vanadium (μg/L)	--	--	--
Zinc (μg/L)	2	7	20

Period of record: Water year 1981 (discontinued)

REGRESSION SUMMARY

SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3] Q	Partial regression coefficient[3] K	Coefficient of determination[2]	Standard error of estimate
--	--	--	--	--	--	--	--	--
8740 Q	-508	.603*	2170	--	--	--	--	--
Q		.408	.428				.408	.469
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
K		.0648	2.46				.0970	2.65
Q		.0620	44.2				.0916	47.7
--	--	--	--	--	--	--	--	--
Q		.254	48.8				.276	52.6
-9.27 K	.0368	.925*	36.1	24.6	-3.05	.0332*	.931*	38.0
-85.8 K	.229	.954*	172	50.7	-12.3	.214*	.957*	184
72.0 Q	-.576	.718*	1.90	67.9	-.336	.00047	.800*	1.75
4.81 K	.00179	.917*	1.86	8.35	-.318	.00141*	.944*	1.67
K		.293	5.30			*	.654	4.06
209 K	.0554	.644*	142	411	-18.2	.0338	.708*	141
-86.1 K	.564	.885*	700	525	-54.9	.499*	.893*	741
K		.136	36.4				.136	39.9
.448 Q	-.0249	.647	.0970	.284	-.0154	1.88	.710*	.0964
2.70 Q	.498	.888*	.932	1.06	.593*	.00019	.909*	.918
13.8 K	.876	.914*	925	949	-84.0	.776*	.922*	966
.0164 Q	.0330	.943*	.0427	.0259	.0324*	-1.09	.943*	.0467
.104 Q	.0582	.951*	.0694	.0603	.0607*	5.01	.953*	.0750
1.78 Q	.236	.835*	.552	.00919	.339*	.00020*	.941*	.363
1.89 Q	.328	.906*	.557	.101	.432*	.00021*	.966*	.366
.0726 Q	.0227	.916*	.0362	.0112	.0262*	7.02	.931*	.0359
K		.00223	134				.00365	147

---

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable

[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at $\alpha = 0.05$

[3] Asterisk denotes that partial regression coefficient is significant at $\alpha = 0.05$

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
--	--	--
2	3	8
2	0	0
--	--	--
2	0	0
2	0	10
2	6	11
2	120	3,600
2	5	6
--	--	--
2	20	220
2	.2	.2
--	--	--
2	4	5
2	0	0
--	--	--
2	20	40

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 13 Station No. (USGS): 06309079 Station name: Muster Creek near Kinsey, Mont.

	DESCRIPTIVE STATISTICS				
Variable	Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	11	0.09	32.00	5.97	9.75
Specific conductance (micromhos)	9	300.00	1610.00	914.67	449.91
pH (units)	9	8.00	8.50	8.32	0.14
Temperature (°C)	11	0.00	28.00	12.27	10.00
Turbidity (NTU)	0	--	--	--	--
Oxygen, dissolved (mg/L)	9	6.50	12.80	10.11	2.54
Oxygen, dissolved (percent)	9	76.00	109.00	95.78	8.84
Biochemical oxygen demand (mg/L)	0	--	--	--	--
Calcium, dissolved (mg/L)	8	6.10	32.00	18.13	10.33
Magnesium, dissolved (mg/L)	8	1.70	16.00	7.45	5.26
Sodium, dissolved (mg/L)	8	49.00	310.00	156.12	76.91
Sodium (percent)	8	71.00	93.00	80.12	8.01
Sodium-adsorption ratio	8	3.40	18.00	8.85	4.58
Potassium, dissolved (mg/L)	8	0.40	7.20	4.24	2.04
Alkalinity, total as $CaCO_3$ (mg/L)	8	76.00	220.00	159.25	59.40
Sulfate, dissolved (mg/L)	8	69.00	620.00	282.38	183.68
Chloride, dissolved (mg/L)	8	1.40	22.00	5.71	6.73
Fluoride, dissolved (mg/L)	8	0.10	0.70	0.30	0.20
Silica, dissolved (mg/L)	8	3.50	15.00	7.74	3.94
Dissolved solids, calculated (mg/L)	7	185.00	1090.00	561.29	313.06
Nitrogen, NO_2+NO_3 total (mg/L as N)	8	0.46	3.90	1.90	1.33
Nitrogen, ammonia total (mg/L as N)	8	0.01	0.23	0.11	0.07
Nitrogen, organic total (mg/L as N)	8	1.10	17.00	4.88	5.22
Nitrogen, total (mg/L as N)	8	1.90	18.00	6.88	5.39
Phosphorus, total (mg/L as P)	8	0.17	6.30	2.33	2.21
Sediment, suspended (mg/L)	11	1080.00	21700.00	9689.09	6836.09

	DISSOLVED		
Variable	Number of samples	Minimum value	Maximum value
Aluminum (μg/L)	6	20	680
Arsenic (μg/L)	6	1	3
Beryllium (μg/L)	6	1	<10
Boron (μg/L)	8	30	150
Cadmium (μg/L)	6	0	8
Chromium (μg/L)	6	0	<20
Copper (μg/L)	6	0	43
Iron (μg/L)	8	50	720
Lead (μg/L)	6	0	36
Lithium (μg/L)	6	7	20
Manganese (μg/L)	6	2	11
Mercury (μg/L)	5	<.1	.1
Molybdenum (μg/L)	6	1	<10
Nickel (μg/L)	6	0	10
Selenium (μg/L)	6	1	7
Vanadium (μg/L)	6	1	<6
Zinc (μg/L)	6	3	98

Period of record: Water years 1978-80 (discontinued)

REGRESSION SUMMARY								
SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3] Q	Partial regression coefficient[3] K	Coefficient of determination[2]	Standard error of estimate
--	--	--	--	--	--	--	--	--
Q		.414	368	--	--	--	--	--
K		.135	.139				.335	.131
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
K		.249	2.35				.256	2.53
K		.0388	9.27				.0506	9.95
--	--	--	--	--	--	--	--	--
K		.459	8.21				.565	8.05
-.385 K	.00934	.543*	3.84				.563	4.11
6.36 K	.179	.929*	22.1	23.1	-.775	.165*	.937*	22.9
Q		.323	7.11				.409	7.28
Q		.380	3.90				.380	4.27
K		.107	2.09				.125	2.26
75.6 K	.0916	.550*	43.1				.630	42.8
-82.0 K	.434	.964*	37.5	-141	2.73	.480*	.981*	30.1
Q		.140	6.74				.166	7.27
Q		.254	.187				.285	.200
Q		.250	3.68				.309	3.87
-15.4 K	.697	.991*	32.4	-6.14	-.443	.689*	.991*	35.9
-.315 K	.00238	.730*	.749	-.309	-.00026	.00238*	.730*	.820
Q		.155	.0649				.417	.0591
K		.0548	5.48				.160	5.66
K		.193	5.23				.294	5.36
K		.246	2.08				.297	2.20
K		.214	6570				.248	6940

---

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable

[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at $\alpha = 0.05$

[3] Asterisk denotes that partial regression coefficient is significant at $\alpha = 0.05$

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
--	--	--
6	2	42
6	0	10
--	--	--
6	0	9
6	40	260
6	70	440
--	--	--
5	40	190
6	30	300
6	440	6,100
7	<.1	1.0
6	0	3
6	47	400
6	1	8
--	--	--
6	170	1,600

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1):	14	Station No. (USGS):	06309145	Station name:	Custer Creek near Kinsey, Mont.

Variable	Number of samples	DESCRIPTIVE STATISTICS Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	14	0.07	154.00	21.86	47.74
Specific conductance (micromhos)	13	500.00	3420.00	2031.15	999.48
pH (units)	13	8.00	8.60	8.34	0.21
Temperature (°C)	14	0.00	28.50	16.54	10.76
Turbidity (NTU)	0	--	--	--	--
Oxygen, dissolved (mg/L)	13	6.90	13.80	9.45	2.36
Oxygen, dissolved (percent)	13	75.00	113.00	99.38	9.69
Biochemical oxygen demand (mg/L)	0	--	--	--	--
Calcium, dissolved (mg/L)	13	14.00	140.00	71.08	41.49
Magnesium, dissolved (mg/L)	13	4.50	83.00	40.09	27.87
Sodium, dissolved (mg/L)	13	73.00	590.00	357.23	182.17
Sodium (percent)	13	57.00	89.00	69.54	8.24
Sodium-adsorption ratio	13	3.30	14.00	8.95	3.25
Potassium, dissolved (mg/L)	13	3.50	11.00	7.48	2.17
Alkalinity, total as $CaCO_3$ (mg/L)	13	84.00	510.00	275.08	114.62
Sulfate, dissolved (mg/L)	13	160.00	1500.00	834.62	478.22
Chloride, dissolved (mg/L)	13	1.30	26.00	6.14	6.28
Fluoride, dissolved (mg/L)	13	0.10	0.70	0.35	0.18
Silica, dissolved (mg/L)	13	3.30	11.00	6.57	2.27
Dissolved solids, calculated (mg/L)	13	328.00	2560.00	1493.00	765.02
Nitrogen, NO_2+NO_3 total (mg/L as N)	13	0.01	3.20	0.78	0.97
Nitrogen, ammonia total (mg/L as N)	13	0.01	7.00	0.75	1.97
Nitrogen, organic total (mg/L as N)	13	0.25	3.40	1.20	0.96
Nitrogen, total (mg/L as N)	13	0.32	12.00	2.70	3.25
Phosphorus, total (mg/L as P)	12	0.01	4.20	0.67	1.25
Sediment, suspended (mg/L)	14	10.00	18900.00	2748.14	5716.46

Variable	Number of samples	DISSOLVED Minimum value	Maximum value
Aluminum (μg/L)	7	10	100
Arsenic (μg/L)	7	1	3
Beryllium (μg/L)	7	1	<10
Boron (μg/L)	13	50	420
Cadmium (μg/L)	6	0	<2
Chromium (μg/L)	7	0	10
Copper (μg/L)	7	0	20
Iron (μg/L)	13	10	250
Lead (μg/L)	6	0	50
Lithium (μg/L)	7	7	60
Manganese (μg/L)	7	6	43
Mercury (μg/L)	6	<.1	.1
Molybdenum (μg/L)	7	1	<10
Nickel (μg/L)	7	0	13
Selenium (μg/L)	7	<1	4
Vanadium (μg/L)	7	.0	<10
Zinc (μg/L)	7	0	<20

Period of record: Water years 1978-80

REGRESSION SUMMARY

SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3] Q	Partial regression coefficient[3] K	Coefficient of determination[2]	Standard error of estimate
--	--	--	--	--	--	--	--	--
2350 Q	-13.9	.475*	756	--	--	--	--	--
8.40 Q	-.00255	.374*	.170	8.10	-.00079	.00013	.571*	.148
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
8.65 Q	.0344	.521*	1.70	8.61	.0346*	1.55	.521*	1.79
Q		.0208	10.0				.0430	10.4
--	--	--	--	--	--	--	--	--
-6.56 K	.0382	.848*	16.9	-23.4	.182	.0444*	.873*	16.2
-12.4 K	.0258	.859*	10.9	-26.6	.154	.0311*	.898*	9.75
-9.30 K	.180	.980*	26.7	3.05	-.134	.176*	.981*	27.5
Q		.147	7.95	85.8	-.151*	-.00626*	.450*	6.70
10.1 Q	-.0503	.585*	2.19	9.88	-.0489*	9.88	.585*	2.30
3.66 K	.00188	.744*	1.15	4.44	-.00837	.00159*	.763*	1.16
313 Q	-1.65	.505*	84.3	284	-1.48	.0123	.511*	87.8
-133 K	.476	.991*	46.4	-217	.910*	.507*	.996*	33.1
K		.099	6.23				.115	6.47
Q		.233	.165				.319	.163
Q		.253	2.05				.300	2.08
-57.3 K	.763	.994*	59.9	-64.3	.0754	.766*	.994*	62.8
K		.163	.924	3.07	-.0162*	-.00094*	.522*	.732
K		.120	1.93		*	*	.406	1.66
K		.145	.926				.239	.916
K		.193	3.05	10.5	-.0525*	-.00322*	.528*	2.44
K		.160	1.20	3.50	-.0197*	-.00120*	.505*	.972
K		.202	5510	16700	-91.0*	-5.75*	.507*	4540

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable

[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at α = 0.05

[3] Asterisk denotes that partial regression coefficient is significant at α = 0.05

TOTAL RECOVERABLE

Number of samples	Minimum value	Maximum value
--	--	--
6	1	20
6	0	10
--	--	--
5	0	3
6	10	370
6	6	350
--	--	--
5	7	270
6	20	180
6	60	3,200
7	<.1	.9
6	0	4
6	4	390
6	1	8
--	--	--
6	30	1,200

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 15 Station No. (USGS): 06326555 Station name: Cherry Creek near Terry, Mont.

Variable	DESCRIPTIVE STATISTICS				
	Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	33	0.01	823.00	32.40	145.27
Specific conductance (micromhos)	33	212.00	3400.00	2544.30	789.23
pH (units)	33	7.80	8.50	8.13	0.19
Temperature (°C)	33	0.00	25.00	10.26	9.15
Turbidity (NTU)	11	1.00	450.00	61.09	132.41
Oxygen, dissolved (mg/L)	33	6.20	12.20	9.72	1.81
Oxygen, dissolved (percent)	33	70.00	123.00	91.58	11.46
Biochemical oxygen demand (mg/L)	11	0.40	8.20	2.25	2.65
Calcium, dissolved (mg/L)	33	22.00	140.00	97.94	27.99
Magnesium, dissolved (mg/L)	33	6.20	120.00	76.67	24.67
Sodium, dissolved (mg/L)	33	16.00	540.00	398.64	137.49
Sodium (percent)	33	29.00	66.00	58.82	7.02
Sodium-adsorption ratio	33	0.80	9.20	7.15	2.01
Potassium, dissolved (mg/L)	33	5.10	11.00	8.07	1.58
Alkalinity, total as $CaCO_3$ (mg/L)	33	61.00	410.00	331.58	89.19
Sulfate, dissolved (mg/L)	33	47.00	1500.00	1054.76	362.55
Chloride, dissolved (mg/L)	33	1.90	23.00	10.21	4.18
Fluoride, dissolved (mg/L)	33	0.10	0.50	0.34	0.09
Silica, dissolved (mg/L)	33	4.00	13.00	9.24	2.25
Dissolved solids, calculated (mg/L)	33	145.00	2520.00	1850.00	595.94
Nitrogen, NO_2+NO_3 total (mg/L as N)	33	0.00	0.69	0.13	0.17
Nitrogen, ammonia total (mg/L as N)	33	0.01	0.40	0.07	0.09
Nitrogen, organic total (mg/L as N)	33	0.05	8.00	0.71	1.35
Nitrogen, total (mg/L as N)	33	0.12	8.60	0.91	1.46
Phosphorus, total (mg/L as P)	33	0.01	0.97	0.06	0.18
Sediment, suspended (mg/L)	30	6.00	2730.00	150.47	505.6

Variable	DISSOLVED		
	Number of samples	Minimum value	Maximum value
Aluminum (µg/L)	4	2	20
Arsenic (µg/L)	8	1	3
Beryllium (µg/L)	8	0	10
Boron (µg/L)	33	80	350
Cadmium (µg/L)	8	0	<2
Chromium (µg/L)	8	0	<20
Copper (µg/L)	8	0	9
Iron (µg/L)	33	10	150
Lead (µg/L)	8	0	6
Lithium (µg/L)	4	10	100
Manganese (µg/L)	8	20	50
Mercury (µg/L)	8	<.1	.1
Molybdenum (µg/L)	4	1	7
Nickel (µg/L)	8	0	11
Selenium (µg/L)	8	0	5
Vanadium (µg/L)	4	.0	1
Zinc (µg/L)	8	<3	20

Period of record: Water years 1978-81 (discontinued)

REGRESSION SUMMARY									
SIMPLE REGRESSION				MULTIPLE REGRESSION					
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3]		Coefficient of determination[2]	Standard error of estimate
					Q	K		
--	--	--	--	--	--	--	--	--
2640 Q	-3.43	.403*	617	--	--	--	--	--
Q		.0336	.186				.0614	.187
--	--	--	--	--	--	--	--	--
20.5 Q	.522	.950*	31.4	115	.417*	-.0401*	.986*	17.5
Q		.0288	1.81				.0289	1.84
Q		.00824	11.6				.0117	11.7
7.71 K	-.00268	.777*	1.32	6.47	.00255	-.00218*	.805*	1.31
12.6 K	.0337	.895*	9.23	11.5	.00318	.0341*	.895*	9.38
2.36 K	.0293	.872*	8.95	4.28	-.00584	.0287*	.873*	9.07
-26.3 K	.168	.919*	39.9	-27.3	.00293	.168*	.919*	40.5
60.1 Q	-.0398	.679*	4.04	53.8	-.0316*	.00239*	.722*	3.82
1.33 K	.00230	.806*	.901	2.11	-.00236	.00202*	.823*	.874
5.15 K	.00116	.330*	1.31	4.98	.00050	.00121*	.332*	1.33
70.8 K	.103	.824*	38.0	94.0	-.0702	.0948*	.832*	37.8
-75.5 K	.446	.934*	94.8	-94.6	.0578	.453*	.934*	96.1
2.01 K	.00324	.370*	3.37	2.30	-.00088	.00313*	.370*	3.43
.205 K	5.32	.234*	.0768	.247	-.00013	3.79	.263*	.0766
4.62 K	.00183	.408*	1.76	5.37	-.00227	.00156*	.421*	1.76
-31.5 K	.742	.958*	123	-35.5	.0123	.744*	.958*	125
.408 K	-.00011	.249*	.149	.442	-.00011	-.00012*	.254*	.151
.235 K	-6.63	.332*	.0751	.221	4.09	-6.15*	.334*	.0762
2.97 K	-.00089	.270*	1.17	3.76	-.00239	-.00117*	.310*	1.16
3.60 K	-.00106	.326*	1.22	4.38	-.00236	-.00134*	.358*	1.21
.475 K	-.00016	.490*	.132	.373	.00031	-.00013*	.526*	.130
1140 K	-.399	.392*	423	1110	.109	-.386*	.393*	431

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable

[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at α = 0.05

[3] Asterisk denotes that partial regression coefficient is significant at α = 0.05

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
--	--	--
5	1	17
5	0	<10
--	--	--
5	0	2
5	0	50
5	0	80
5	80	62,000
5	0	60
1	10	10
5	30	1,200
5	<.1	.1
--	--	--
5	1	53
5	0	2
--	--	--
5	10	230

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 16 Station No. (USGS): 06326953 Station name: Clear Creek near Hoyt, Mont.

	DESCRIPTIVE STATISTICS				
Variable	Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	18	0.03	45.00	9.22	12.56
Specific conductance (micromhos)	17	720.00	2050.00	1469.12	352.39
pH (units)	17	7.50	8.30	8.05	0.19
Temperature (°C)	18	0.00	21.50	10.25	8.15
Turbidity (NTU)	0	--	--	--	--
Oxygen, dissolved (mg/L)	17	6.40	15.20	10.15	2.26
Oxygen, dissolved (percent)	17	49.00	167.00	96.53	26.04
Biochemical oxygen demand (mg/L)	0	--	--	--	--
Calcium, dissolved (mg/L)	17	49.00	140.00	92.12	23.76
Magnesium, dissolved (mg/L)	17	43.00	160.00	94.47	31.27
Sodium, dissolved (mg/L)	17	44.00	150.00	112.65	28.80
Sodium (percent)	17	22.00	32.00	28.24	3.58
Sodium-adsorption ratio	17	1.10	2.60	2.03	0.39
Potassium, dissolved (mg/L)	17	4.30	8.10	6.61	1.20
Alkalinity, total as $CaCO_3$ (mg/L)	17	160.00	380.00	318.24	68.30
Sulfate, dissolved (mg/L)	17	220.00	890.00	520.00	182.93
Chloride, dissolved (mg/L)	17	3.70	9.90	7.35	1.55
Fluoride, dissolved (mg/L)	17	0.10	0.40	0.25	0.09
Silica, dissolved (mg/L)	17	6.10	15.00	10.71	2.45
Dissolved solids, calculated (mg/L)	17	481.00	1570.00	1036.18	282.92
Nitrogen, NO_2+NO_3 total (mg/L as N)	17	0.00	0.33	0.09	0.10
Nitrogen, ammonia total (mg/L as N)	17	0.00	0.13	0.03	0.04
Nitrogen, organic total (mg/L as N)	17	0.12	2.20	0.50	0.47
Nitrogen, total (mg/L as N)	17	0.14	2.60	0.60	0.57
Phosphorus, total (mg/L as P)	17	0.01	0.10	0.03	0.03
Sediment, suspended (mg/L)	18	4.00	79.00	18.83	17.09

		DISSOLVED	
Variable	Number of samples	Minimum value	Maximum value
Aluminum (µg/L)	7	10	<100
Arsenic (µg/L)	7	1	2
Beryllium (µg/L)	7	1	<10
Boron (µg/L)	17	90	360
Cadmium (µg/L)	7	0	4
Chromium (µg/L)	7	0	5
Copper (µg/L)	7	2	<10
Iron (µg/L)	17	10	70
Lead (µg/L)	7	0	36
Lithium (µg/L)	7	20	40
Manganese (µg/L)	7	10	50
Mercury (µg/L)	7	<.1	.1
Molybdenum (µg/L)	7	1	<10
Nickel (µg/L)	7	0	6
Selenium (µg/L)	7	0	3
Vanadium (µg/L)	7	.0	<6
Zinc (µg/L)	7	0	20

Period of record: Water years 1978-80 (discontinued)

REGRESSION SUMMARY								
SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3]		Coefficient of determination[2]	Standard error of estimate
					Q	K		
--	--	--	--	--	--	--	--	--
1590 Q	-15.6	.272*	311	--	--	--	--	--
K		.0503	.195				.142	.192
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
Q		.0950	2.22				.139	2.24
K		.0716	25.9				.136	25.9
--	--	--	--	--	--	--	--	--
-2.63 K	.0645	.915*	7.17	-20.3	.527*	.0737*	.964*	4.81
-28.8 K	.0839	.894*	10.5	-52.0	.688*	.0959*	.943*	7.95
8.32 K	.0710	.755*	14.7	35.6	-.812*	.0568*	.836*	12.5
29.8 Q	-.201	.437*	2.77	40.3	-.303*	-.00658*	.743*	1.94
2.25 Q	-.0280	.712*	.217	2.24	-.0279*	1.14	.712*	.225
6.13 Q	.0598	.343*	1.01	3.85	.0820*	.00143	.470*	.936
353 Q	-4.39	.574*	46.1	249	-3.37*	.0654	.657*	42.8
-197 K	.488	.884*	64.5	-329	3.94*	.557*	.931*	51.5
1.26 K	.00415	.887*	.539	1.89	-.0188	.00382*	.902*	.519
.298 Q	-.00564	.497*	.0691	.358	-.00622*	-3.74	.511*	.0705
Q		.179	2.30		*		.307	2.18
-118 K	.785	.957*	60.7	-193	2.24	.824*	.963*	58.1
.0379 Q	.00696	.693*	.0564	.175	.00562*	-8.60	.762*	.0514
.0129 Q	.00199	.370*	.0316	.0747	.00139	-3.88	.462*	.0302
.239 Q	.0326	.660*	.284	.793	.0272*	-.00035	.709*	.272
.276 Q	.0406	.714*	.313	1.16	.0320*	-.00055	.801*	.271
.117 K	-6.11	.489*	.0227	.0938	.00069	-4.91*	.540*	.0223
Q		.184	15.9				.158	8.26

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable
[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at $\alpha = 0.05$
[3] Asterisk denotes that partial regression coefficient is significant at $\alpha = 0.05$

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
--	--	--
6	1	4
6	0	<10
--	--	--
6	0	9
6	0	<20
6	2	29
--	--	--
6	4	92
6	20	50
6	10	60
6	<.1	.1
6	1	7
6	0	5
6	0	5
--	--	--
6	10	140

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 17 Station No. (USGS): 06326995 Station name: Upper Sevenmile Creek near Lindsay, Mont.

	DESCRIPTIVE STATISTICS				
Variable	Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	19	0.04	347.00	29.43	80.16
Specific conductance (micromhos)	17	380.00	3040.00	2157.06	640.12
pH (units)	17	7.90	8.40	8.10	0.15
Temperature (°C)	19	0.00	26.50	12.00	8.80
Turbidity (NTU)	0	--	--	--	--
Oxygen, dissolved (mg/L)	16	6.20	12.60	9.46	1.56
Oxygen, dissolved (percent)	16	66.00	136.00	94.62	15.26
Biochemical oxygen demand (mg/L)	0	--	--	--	--
Calcium, dissolved (mg/L)	17	29.00	150.00	112.18	28.14
Magnesium, dissolved (mg/L)	17	20.00	200.00	132.94	40.27
Sodium, dissolved (mg/L)	17	20.00	340.00	225.29	81.25
Sodium (percent)	17	21.00	42.00	35.76	5.67
Sodium-adsorption ratio	17	0.70	4.60	3.40	1.03
Potassium, dissolved (mg/L)	17	7.80	12.00	9.35	1.21
Alkalinity, total as $CaCO_3$ (mg/L)	17	98.00	460.00	356.94	89.09
Sulfate, dissolved (mg/L)	17	100.00	1400.00	897.06	307.51
Chloride, dissolved (mg/L)	17	2.00	14.00	9.05	2.72
Fluoride, dissolved (mg/L)	17	0.10	0.50	0.27	0.10
Silica, dissolved (mg/L)	17	4.60	13.00	9.75	2.26
Dissolved solids, calculated (mg/L)	17	247.00	2390.00	1611.06	499.54
Nitrogen, NO_2+NO_3 total (mg/L as N)	17	0.00	0.54	0.11	0.15
Nitrogen, ammonia total (mg/L as N)	17	0.00	0.15	0.03	0.05
Nitrogen, organic total (mg/L as N)	17	0.12	3.20	0.63	0.71
Nitrogen, total (mg/L as N)	17	0.20	3.20	0.74	0.76
Phosphorus, total (mg/L as P)	16	0.01	0.34	0.04	0.08
Sediment, suspended (mg/L)	19	4.00	221.00	36.95	48.48

	DISSOLVED		
Variable	Number of samples	Minimum value	Maximum value
Aluminum (μg/L)	7	0	<100
Arsenic (μg/L)	7	1	2
Beryllium (μg/L)	7	1	<10
Boron (μg/L)	17	80	340
Cadmium (μg/L)	7	0	8
Chromium (μg/L)	7	0	<20
Copper (μg/L)	7	2	25
Iron (μg/L)	17	10	100
Lead (μg/L)	7	0	66
Lithium (μg/L)	7	20	60
Manganese (μg/L)	7	10	90
Mercury (μg/L)	7	<.1	.5
Molybdenum (μg/L)	7	1	2
Nickel (μg/L)	7	0	5
Selenium (μg/L)	7	0	<1
Vanadium (μg/L)	7	.0	<10
Zinc (μg/L)	7	7	40

Period of record: Water years 1978-80 (discontinued)

REGRESSION SUMMARY								
SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3] Q	Partial regression coefficient[3] K	Coefficient of determination[2]	Standard error of estimate
--	--	--	--	--	--	--	--	--
2300 Q	-5.70	.550*	443	--	--	--	--	--
K		.0165	.149				.0327	.153
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
Q		.143	1.50				.143	1.55
K		.00510	15.8				.0292	16.1
--	--	--	--	--	--	--	--	--
21.4 K	.0421	.917*	8.36	34.2	-.0553	.0368*	.929*	8.00
9.78 K	.0571	.824*	17.5	26.3	-.0711	.0502*	.833*	17.6
-3.36 K	.106	.697*	46.2	28.7	-.138	.0927*	.706*	47.1
36.9 Q	-.0472	.481*	4.22	35.8	-.0443*	.00050	.482*	4.37
.810 K	.00120	.561*	.703	1.79	-.00420	.00080	.613*	.683
K		.101	1.18				.105	1.22
115 K	.112	.648*	54.6	213	-.419	.0715*	.717*	50.7
-64.2 K	.446	.861*	119	-52.9	-.0485	.441*	.861*	123
.871 K	.00379	.795*	1.27	1.44	-.00244	.00355*	.797*	1.31
.284 Q	-.00056	.225*	.0896				.253	.0910
K		.104	2.21				.105	2.29
49.2 K	.724	.861*	192	180	-.563	.670*	.865*	196
.497 K	-.00018	.594*	.0993	.470	.00012	-.00017*	.596*	.103
.139 K	-4.89	.435*	.0368	.124	6.62	-4.25	.441*	.0379
K		.0310	.721				.0315	.746
K		.121	.733				.121	.758
.0153 K	.00093	.962*	.0165	.0201	.00092*	-2.07	.962*	.0171
20.2 Q	.569	.884*	17.0	26.6	.561*	-.00223	.916*	15.5

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable

[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at $\alpha = 0.05$

[3] Asterisk denotes that partial regression coefficient is significant at $\alpha = 0.05$

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
--	--	--
5	1	2
5	0	10
--	--	--
5	0	8
5	0	20
5	3	23
--	--	--
5	3	73
5	9	70
5	20	180
5	<.1	.2
5	1	6
5	0	8
5	0	1
--	--	--
5	20	120

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 18 Station No. (USGS): 06327850 Station name: Glendive Creek near Glendive, Mont.

Variable	DESCRIPTIVE STATISTICS Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	33	0.02	1140.00	47.94	198.17
Specific conductance (micromhos)	33	305.00	3000.00	1797.36	837.14
pH (units)	33	7.90	9.10	8.73	0.37
Temperature (°C)	33	0.00	31.00	12.82	10.01
Turbidity (NTU)	9	20.00	2000.00	385.56	646.18
Oxygen, dissolved (mg/L)	31	6.50	13.00	10.19	1.95
Oxygen, dissolved (percent)	31	84.00	113.00	99.03	7.29
Biochemical oxygen demand (mg/L)	8	1.40	6.40	3.07	1.66
Calcium, dissolved (mg/L)	31	5.20	55.00	17.85	11.15
Magnesium, dissolved (mg/L)	31	0.50	35.00	10.05	8.90
Sodium, dissolved (mg/L)	31	61.00	700.00	420.68	216.42
Sodium (percent)	31	60.00	98.00	87.77	10.32
Sodium-adsorption ratio	31	3.60	61.00	22.31	13.35
Potassium, dissolved (mg/L)	32	2.80	12.00	6.21	2.24
Alkalinity, total as $CaCO_3$ (mg/L)	33	80.00	1030.00	566.82	314.21
Sulfate, dissolved (mg/L)	32	50.00	810.00	402.03	192.62
Chloride, dissolved (mg/L)	32	2.00	28.00	8.89	5.41
Fluoride, dissolved (mg/L)	31	0.10	1.40	0.72	0.37
Silica, dissolved (mg/L)	30	0.60	15.00	6.06	3.16
Dissolved solids, calculated (mg/L)	31	232.00	2060.00	1226.94	572.70
Nitrogen, NO_2+NO_3 total (mg/L as N)	32	0.01	4.30	0.47	0.87
Nitrogen, ammonia total (mg/L as N)	32	0.00	1.90	0.16	0.36
Nitrogen, organic total (mg/L as N)	32	0.00	18.00	2.10	3.36
Nitrogen, total (mg/L as N)	30	0.25	19.00	2.81	4.01
Phosphorus, total (mg/L as P)	33	0.03	4.30	0.50	0.81
Sediment, suspended (mg/L)	33	70.00	21800.00	2403.12	4459.3

Variable	DISSOLVED Number of samples	Minimum value	Maximum value
Aluminum (µg/L)	3	10	220
Arsenic (µg/L)	10	1	5
Beryllium (µg/L)	10	0	10
Boron (µg/L)	32	50	2000
Cadmium (µg/L)	10	0	9
Chromium (µg/L)	10	0	30
Copper (µg/L)	10	2	15
Iron (µg/L)	31	40	2000
Lead (µg/L)	10	0	16
Lithium (µg/L)	3	20	100
Manganese (µg/L)	10	10	30
Mercury (µg/L)	10	<.1	.6
Molybdenum (µg/L)	3	1	7
Nickel (µg/L)	10	0	7
Selenium (µg/L)	10	<1	2
Vanadium (µg/L)	3	1	1.5
Zinc (µg/L)	10	0	40

Period of record: Water years 1978-81 (discontinued)

REGRESSION SUMMARY

SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3]		Coefficient of determination[2]	Standard error of estimate
					Q	K		
--	--	--	--	--	--	--	--	--
1880 Q	-1.70	.162*	779	--	--	--	--	--
8.04 K	.00038	.763*	.181	8.09	-.00022	.00036*	.775*	.179
--	--	--	--	--	--	--	--	--
156 Q	1.65	.925*	189	862	1.10*	-.350*	.985*	92.5
12.4 K	-.00121	.272*	1.70	12.2	.00099	-.00111*	.281*	1.71
89.8 K	.00499	.332*	6.06	87.8	.00862	.00587*	.380*	5.94
2.56 Q	.00331	.632*	1.09				.646	1.17
Q		.018	11.2				.0202	11.4
K		.075	8.71				.0772	8.85
-47.9 K	.254	.977*	33.7	-56.8	.0372	.258*	.978*	33.5
73.3 K	.00782	.406*	8.09	72.1	.00512	.00834*	.415*	8.18
-.581 K	.0124	.612*	8.45	-1.02	.00184	.0126*	.613*	8.60
Q		.099	2.16				.112	2.18
-80.4 K	.360	.920*	90.1	-90.1	.0446	.364*	.921*	91.2
34.7 K	.202	.789*	90.0	32.1	.0114	.204*	.789*	91.5
1.10 K	.00429	.449*	4.08	1.25	-.00067	.00423*	.449*	4.15
.0105 K	.00039	.812*	.162	.0215	-4.73	.00038*	.813*	.165
K		.0399	3.15				.0465	3.19
-21.3 K	.677	.989*	59.8	-35.2	.0583	.683*	.990*	59.8
1.35 K	-.00048	.223*	.777	1.46	-.00050	-.00053*	.234*	.785
.490 K	-.00018	.176*	.334	.595	-.00047	-.00023*	.233*	.328
4.84 K	-.00152	.146*	3.16			*	.153	3.20
6.77 K	-.00224	.226*	3.59	7.36	-.00262	-.00250*	.241*	3.62
1.47 K	-.00054	.312*	.686	1.54	-.00031	-.00057*	.316*	.695
7630 K	-2.91	.284*	3860	6500	5.08	-2.42*	.339*	3740

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable

[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at $\alpha = 0.05$

[3] Asterisk denotes that partial regression coefficient is significant at $\alpha = 0.05$

TOTAL RECOVERABLE

Number of samples	Minimum value	Maximum value
1	4,600	4,600
8	1	12
8	0	10
--	--	--
8	0	2
8	0	90
8	4	210
8	130	93,000
8	0	59
--	--	--
8	10	1,800
6	<.1	.5
--	--	--
8	4	200
8	1	3
--	--	--
7	20	380

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 19 Station No. (USGS): 06328000 Station name: Deer Creek near Glendive, Mont.

Variable	DESCRIPTIVE STATISTICS Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	15	0.01	604.00	61.41	158.70
Specific conductance (micromhos)	13	310.00	3100.00	2190.00	832.40
pH (units)	13	7.90	8.60	8.33	0.20
Temperature (°C)	15	0.00	26.50	15.13	9.34
Turbidity (NTU)	0	--	--	--	--
Oxygen, dissolved (mg/L)	13	8.10	12.20	10.14	1.55
Oxygen, dissolved (percent)	13	89.00	122.00	103.46	7.96
Biochemical oxygen demand (mg/L)	0	--	--	--	--
Calcium, dissolved (mg/L)	13	20.00	110.00	83.62	28.90
Magnesium, dissolved (mg/L)	13	10.00	110.00	66.46	27.46
Sodium, dissolved (mg/L)	13	29.00	500.00	341.46	143.18
Sodium (percent)	13	39.00	68.00	58.08	7.48
Sodium-adsorption ratio	13	1.30	9.00	6.62	2.35
Potassium, dissolved (mg/L)	13	6.80	11.00	9.16	1.20
Alkalinity, total as $CaCO_3$ (mg/L)	13	130.00	550.00	354.62	113.92
Sulfate, dissolved (mg/L)	13	70.00	1200.00	843.08	353.96
Chloride, dissolved (mg/L)	13	2.30	23.00	14.38	5.79
Fluoride, dissolved (mg/L)	13	0.10	0.40	0.31	0.11
Silica, dissolved (mg/L)	13	3.00	9.70	7.72	1.88
Dissolved solids, calculated (mg/L)	13	238.00	2210.00	1580.00	612.37
Nitrogen, NO_2+NO_3 total (mg/L as N)	13	0.01	0.42	0.19	0.16
Nitrogen, ammonia total (mg/L as N)	13	0.00	0.17	0.03	0.05
Nitrogen, organic total (mg/L as N)	13	0.37	3.00	0.92	0.79
Nitrogen, total (mg/L as N)	13	0.39	3.40	1.13	0.92
Phosphorus, total (mg/L as P)	13	0.01	0.91	0.10	0.25
Sediment, suspended (mg/L)	15	17.00	1680.00	243.40	468.42

Variable	DISSOLVED Number of samples	Minimum value	Maximum value
Aluminum (µg/L)	5	3	60
Arsenic (µg/L)	5	1	3
Beryllium (µg/L)	5	1	10
Boron (µg/L)	13	60	330
Cadmium (µg/L)	4	0	4
Chromium (µg/L)	5	0	5
Copper (µg/L)	5	4	11
Iron (µg/L)	13	10	110
Lead (µg/L)	5	0	23
Lithium (µg/L)	5	20	70
Manganese (µg/L)	5	10	30
Mercury (µg/L)	5	<.1	<.1
Molybdenum (µg/L)	5	1	<10
Nickel (µg/L)	5	0	4
Selenium (µg/L)	5	<1	1
Vanadium (µg/L)	5	.0	<10
Zinc (µg/L)	5	5	20

Period of record: Water years 1978-80 (discontinued)

REGRESSION SUMMARY

SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3] Q	Partial regression coefficient[3] K	Coefficient of determination[2]	Standard error of estimate
--	--	--	--	--	--	--	--	--
2390 Q	-3.57	.503*	613	--	--	--	--	--
7.94 K	.00018	.554*	.141	8.06	-.00034	.00013	.594*	.141
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
K		.137	1.51				.144	1.58
K		.270	7.11				.302	7.29
--	--	--	--	--	--	--	--	--
16.0 K	.0309	.791*	13.8	22.1	-.0169	.0285*	.796*	14.3
3.67 K	.0287	.755*	14.2	5.19	-.00418	.0281*	.756*	14.9
-5.32 K	.158	.847*	58.4	16.8	-.0607	.150*	.850*	60.8
60.1 Q	-.0359	.631*	4.75	54.9	-.0282*	.00216	.660*	4.78
1.45 K	.00236	.697*	1.35	2.72	-.00349	.00187*	.727*	1.35
9.41 Q	-.00451	.383*	.988				.435	.992
99.2 K	.117	.726*	62.3	66.7	.0896	.129*	.735*	64.3
-37.4 K	.402	.894*	120	-14.4	-.0632	.393*	.894*	126
.513 K	.00633	.828*	2.51	.994	-.00132	.00615*	.829*	2.63
.0701 K	.00011	.656*	.0683	.0791	-2.47	.00011*	.656*	.0716
Q		.091	1.87				.0945	1.96
53.8 K	.697	.897*	205	96.1	-.116	.681*	.898*	214
K		.231	.145				.261	.149
.0202 Q	.00025	.788*	.0222	.0246	.00024*	-1.86	.789*	.0233
2.67 K	-.00080	.712*	.441	2.99	-.00087	-.00092*	.728*	.449
3.19 K	-.00094	.721*	.507	3.48	-.00079	-.00105*	.731*	.522
.0238 Q	.00147	.972*	.0428	.135	.00130*	-4.64*	.984*	.0336
67.7 Q	2.86	.940*	119	84.6	2.64*	-.0159	.988*	54.6

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable
[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at α = 0.05
[3] Asterisk denotes that partial regression coefficient is significant at α = 0.05

TOTAL RECOVERABLE

Number of samples	Minimum value	Maximum value
--	--	--
5	1	6
5	0	<10
--	--	--
5	0	8
5	0	30
5	2	70
--	--	--
5	2	50
5	20	70
5	20	980
5	<.1	.4
5	1	4
5	2	44
5	1	2
--	--	--
5	20	140

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 20 Station No. (USGS): 06329000 Station name: Cottonwood Creek near Intake, Mont.

	DESCRIPTIVE STATISTICS				
Variable	Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	21	0.01	258.00	15.93	55.96
Specific conductance (micromhos)	21	300.00	5180.00	3149.86	1478.79
pH (units)	21	7.30	8.90	8.18	0.39
Temperature (°C)	21	0.00	30.00	12.12	10.15
Turbidity (NTU)	6	2.00	150.00	30.67	58.65
Oxygen, dissolved (mg/L)	21	4.90	12.00	9.60	1.63
Oxygen, dissolved (percent)	21	36.00	141.00	96.38	24.61
Biochemical oxygen demand (mg/L)	7	1.00	6.10	2.76	1.78
Calcium, dissolved (mg/L)	21	25.00	170.00	94.38	44.98
Magnesium, dissolved (mg/L)	21	11.00	240.00	125.86	68.01
Sodium, dissolved (mg/L)	21	17.00	910.00	525.38	284.80
Sodium (percent)	21	24.00	77.00	56.52	11.12
Sodium-adsorption ratio	21	0.70	15.00	8.02	3.78
Potassium, dissolved (mg/L)	21	6.40	17.00	11.19	2.42
Alkalinity, total as $CaCO_3$ (mg/L)	21	80.00	680.00	390.48	172.35
Sulfate, dissolved (mg/L)	21	65.00	2700.00	1443.10	769.38
Chloride, dissolved (mg/L)	21	1.10	28.00	8.97	6.74
Fluoride, dissolved (mg/L)	21	0.10	1.50	0.36	0.31
Silica, dissolved (mg/L)	21	0.10	39.00	6.67	8.36
Dissolved solids, calculated (mg/L)	21	180.00	4300.00	2450.19	1242.62
Nitrogen, NO_2+NO_3 total (mg/L as N)	21	0.00	0.44	0.08	0.12
Nitrogen, ammonia total (mg/L as N)	21	0.00	0.82	0.12	0.21
Nitrogen, organic total (mg/L as N)	21	0.61	4.90	1.36	1.20
Nitrogen, total (mg/L as N)	21	0.63	6.10	1.54	1.37
Phosphorus, total (mg/L as P)	21	0.01	0.43	0.07	0.09
Sediment, suspended (mg/L)	20	6.00	342.00	57.05	73.13

	DISSOLVED		
Variable	Number of samples	Minimum value	Maximum value
Aluminum (µg/L)	2	10	<100
Arsenic (µg/L)	8	1	14
Beryllium (µg/L)	8	0	<10
Boron (µg/L)	21	110	1300
Cadmium (µg/L)	8	0	4
Chromium (µg/L)	8	0	10
Copper (µg/L)	8	0	6
Iron (µg/L)	21	20	270
Lead (µg/L)	8	0	4
Lithium (µg/L)	2	10	90
Manganese (µg/L)	8	20	150
Mercury (µg/L)	8	<.1	.4
Molybdenum (µg/L)	2	1	1
Nickel (µg/L)	8	0	7
Selenium (µg/L)	8	0	1
Vanadium (µg/L)	2	1.0	1.0
Zinc (µg/L)	8	0	20

Period of record: Water years 1978-81 (discontinued)

REGRESSION SUMMARY								
SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3]		Coefficient of determination[2]	Standard error of estimate
					Q	K		
--	--	--	--	--	--	--	--	--
3370 Q	-13.7	.269*	1300	--	--	--	--	--
7.70 K	.00015	.314*	.335	7.90	-.00247	.00010	.404*	.321
--	--	--	--	--	--	--	--	--
5.34 Q	.561	.996*	4.10	15.4	.525*	-.00281	.999*	2.60
Q		.142	1.55				.158	1.58
K		.115	23.7				.128	24.2
2.08 Q	.0160	.734*	1.01				.737	1.12
21.0 K	.0233	.587*	29.6	22.0	-.0133	.0231*	.588*	30.5
-9.35 K	.0429	.871*	25.1	-13.6	.0547	.0440*	.873*	25.6
-72.1 K	.190	.970*	50.5	-83.8	.151	.193*	.971*	51.3
58.8 Q	-.143	.516*	7.93	48.4	-.100*	.00308*	.639*	70.4
1.18 K	.00217	.722*	2.04	1.74	-.00717	.00203*	.730*	2.07
11.5 Q	-.0211	.239*	2.16				.272	2.17
61.5 K	.104	.803*	78.5	69.0	-.0967	.103*	.804*	80.5
-183 K	.516	.985*	97.5	-225	.537	.527*	.986*	96.5
K		.169	6.30				.184	6.41
K		.121	.299				.127	.306
K		.00589	8.55				.00629	8.78
-184 K	.836	.990*	126	-232	.618	.848*	.991*	126
.248 K	-5.31	.425*	.0938	.190	.00075	-3.84*	.513*	.0887
.442 K	-.00011	.533*	.145	.469	-.00036	-.00011*	.539*	.148
K		.0727	1.19				.159	1.16
K		.168	1.28			*	.223	1.27
.0448 Q	.00152	.870*	.0339	.0912	.00134*	-1.38*	.906*	.0296
37.8 Q	1.15	.815*	32.3	12.1	1.26*	.00778	.833*	31.6

[1] Q indicates discharge as independent variable, K indicates specific conductance as independent variable
[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at $\alpha = 0.05$
[3] Asterisk denotes that partial regression coefficient is significant at $\alpha = 0.05$

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
1	2,400	2,400
7	1	8
7	0	<10
--	--	--
7	0	2
7	0	20
7	1	13
7	140	6,200
7	0	27
1	9	9
7	40	210
7	<.1	.7
--	--	--
7	3	9
7	0	1
--	--	--
7	10	80

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 21 Station No. (USGS): 06329200 Station name: Burns Creek near Savage, Mont.

	DESCRIPTIVE STATISTICS				
Variable	Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	46	0.25	534.00	21.72	80.10
Specific conductance (micromhos)	46	375.00	2330.00	1600.54	423.64
pH (units)	46	7.50	8.80	8.28	0.29
Temperature (°C)	46	0.00	30.00	10.49	10.08
Turbidity (NTU)	34	3.00	95.00	28.26	23.61
Oxygen, dissolved (mg/L)	46	7.30	12.80	10.11	1.62
Oxygen, dissolved (percent)	46	64.00	127.00	95.09	11.79
Biochemical oxygen demand (mg/L)	33	0.20	6.90	1.83	1.81
Calcium, dissolved (mg/L)	46	25.00	91.00	62.41	16.25
Magnesium, dissolved (mg/L)	46	16.00	120.00	76.46	20.71
Sodium, dissolved (mg/L)	46	26.00	280.00	198.28	64.55
Sodium (percent)	46	26.00	56.00	45.91	6.88
Sodium-adsorption ratio	46	0.90	5.60	3.91	1.11
Potassium, dissolved (mg/L)	46	5.20	11.00	8.43	1.15
Alkalinity, total as $CaCO_3$ (mg/L)	46	98.00	653.00	429.80	115.49
Sulfate, dissolved (mg/L)	46	79.00	810.00	451.93	141.47
Chloride, dissolved (mg/L)	46	2.40	9.10	6.45	1.48
Fluoride, dissolved (mg/L)	46	0.10	0.70	0.49	0.17
Silica, dissolved (mg/L)	46	6.10	18.00	11.33	2.94
Dissolved solids, calculated (mg/L)	46	222.00	1620.00	1075.57	297.25
Nitrogen, NO_2+NO_3 total (mg/L as N)	46	0.01	0.55	0.07	0.09
Nitrogen, ammonia total (mg/L as N)	46	0.01	0.13	0.03	0.03
Nitrogen, organic total (mg/L as N)	46	0.09	3.30	0.54	0.51
Nitrogen, total (mg/L as N)	46	0.10	3.60	0.62	0.58
Phosphorus, total (mg/L as P)	46	0.01	0.46	0.05	0.07
Sediment, suspended (mg/L)	46	10.00	916.00	114.37	130.91

	DISSOLVED		
Variable	Number of samples	Minimum value	Maximum value
Aluminum (µg/L)	12	10	<100
Arsenic (µg/L)	14	1	3
Beryllium (µg/L)	14	<10	10
Boron (µg/L)	46	20	510
Cadmium (µg/L)	14	0	8
Chromium (µg/L)	14	0	<20
Copper (µg/L)	14	0	4
Iron (µg/L)	46	10	290
Lead (µg/L)	14	0	8
Lithium (µg/L)	12	10	60
Manganese (µg/L)	14	10	50
Mercury (µg/L)	14	<.1	<.5
Molybdenum (µg/L)	12	1	4
Nickel (µg/L)	14	0	6
Selenium (µg/L)	14	<1	3
Vanadium (µg/L)	11	.0	2.2
Zinc (µg/L)	14	0	30

Period of record: Water years 1976-79 (discontinued)

REGRESSION SUMMARY								
SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3] Q	Partial regression coefficient[3] K	Coefficient of determination[2]	Standard error of estimate
--	--	--	--	--	--	--	--	--
1670 Q	-3.06	.334*	350	--	--	--	--	--
7.97 K	.00020	.0841*	.277				.086	.280
--	--	--	--	--	--	--	--	--
22.0 Q	.601	.265*	20.6	6.88	.727*	.00856	.276*	20.7
K		.0393	1.61				.0420	1.63
K		.0120	11.9				.0121	12.0
5.70 K	-.00244	.403*	1.42	6.28	-.00286	-.00276*	.418*	1.42
16.2 K	.0289	.566*	10.8	12.8	.0176	.0308*	.571*	10.9
3.25 K	.0457	.876*	7.39	3.33	-.00040	.0457*	.876*	7.47
-27.8 K	.141	.859*	24.5	-17.5	-.0522	.136*	.862*	24.5
27.4 K	.0116	.508*	4.88	32.3	-.0252*	.00882*	.566*	4.64
.389 K	.00220	.706*	.608	.821	-.00220	.00196*	.722*	.597
6.19 K	.00140	.267*	.993	6.92	-.00369	.00099*	.311*	.974
29.7 K	.250	.841*	46.6	58.8	-.148	.234*	.848*	46.1
-35.9 K	.305	.833*	58.5	-50.4	.0737	.313*	.834*	58.9
2.02 K	.00277	.631*	.907	2.66	-.00324	.00241*	.651*	.891
.0500 K	.00028	.496*	.119	.124	-.00038	.00023*	.518*	.118
6.16 K	.00323	.216*	2.64	6.60	-.00222	.00298*	.218*	2.66
-12.9 K	.680	.939*	74.0	-1.87	-.0561	.674*	.940*	74.8
.303 K	-.00014	.417*	.0723	.274	.00015	-.00013*	.427*	.0724
.0638 K	-2.11	.0932*	.0282				.0937	.0285
1.46 K	-.00058	.227*	.456	1.26	.00101	-.00047*	.244*	.456
1.82 K	-.00075	.305*	.485	1.61	.00109	-.00063*	.321*	.485
.0285 Q	.00082	.832*	.0297	.0826	.00072*	-3.24*	.857*	.0278
82.1 Q	1.49	.826*	55.3	-49.1	1.73*	.0787*	.869*	48.5

---

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable

[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at α = 0.05

[3] Asterisk denotes that partial regression coefficient is significant at α = 0.05

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
6	100	1,700
8	1	6
7	10	10
--	--	--
8	0	<20
8	0	20
8	0	20
8	300	19,000
8	0	<200
6	20	50
8	20	430
7	<.1	<.5
5	1	5
8	0	50
8	1	5
--	--	--
8	20	80

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 22 Station No. (USGS): 06329520 Station name: Fox Creek near Lambert, Mont.

	DESCRIPTIVE STATISTICS				
Variable	Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	2	0.02	1.00	0.51	0.69
Specific conductance (micromhos)	2	1080.00	2030.00	1555.00	671.75
pH (units)	2	7.70	8.20	7.95	0.35
Temperature (°C)	2	1.50	18.00	9.75	11.67
Turbidity (NTU)	0	--	--	--	--
Oxygen, dissolved (mg/L)	2	8.60	10.00	9.30	0.99
Oxygen, dissolved (percent)	2	78.00	98.00	88.00	14.14
Biochemical oxygen demand (mg/L)	0	--	--	--	--
Calcium, dissolved (mg/L)	2	73.00	140.00	106.50	47.38
Magnesium, dissolved (mg/L)	2	66.00	140.00	103.00	52.33
Sodium, dissolved (mg/L)	2	72.00	160.00	116.00	62.23
Sodium (percent)	2	25.00	27.00	26.00	1.41
Sodium-adsorption ratio	2	1.50	2.30	1.90	0.57
Potassium, dissolved (mg/L)	2	10.00	10.00	10.00	0.00
Alkalinity, total as CaCO$_3$ (mg/L)	2	200.00	460.00	330.00	183.85
Sulfate, dissolved (mg/L)	2	410.00	770.00	590.00	254.56
Chloride, dissolved (mg/L)	2	6.60	22.00	14.30	10.89
Fluoride, dissolved (mg/L)	2	0.10	0.20	0.15	0.07
Silica, dissolved (mg/L)	2	11.00	14.00	12.50	2.12
Dissolved solids, calculated (mg/L)	2	775.00	1530.00	1152.50	533.87
Nitrogen, NO$_2$+NO$_3$ total (mg/L as N)	2	0.00	0.13	0.07	0.09
Nitrogen, ammonia total (mg/L as N)	2	0.07	0.12	0.10	0.04
Nitrogen, organic total (mg/L as N)	2	1.00	1.40	1.20	0.28
Nitrogen, total (mg/L as N)	2	1.10	1.60	1.35	0.35
Phosphorus, total (mg/L as P)	2	0.05	0.16	0.11	0.08
Sediment, suspended (mg/L)	2	21.00	151.00	86.00	91.92

	DISSOLVED		
Variable	Number of samples	Minimum value	Maximum value
Aluminum (μg/L)	--	--	--
Arsenic (μg/L)	1	2	2
Beryllium (μg/L)	1	1	1
Boron (μg/L)	2	120	260
Cadmium (μg/L)	1	1	1
Chromium (μg/L)	1	0	0
Copper (μg/L)	1	3	3
Iron (μg/L)	2	30	70
Lead (μg/L)	1	0	0
Lithium (μg/L)	--	--	--
Manganese (μg/L)	1	310	310
Mercury (μg/L)	1	.1	.1
Molybdenum (μg/L)	--	--	--
Nickel (μg/L)	1	1	1
Selenium (μg/L)	1	0	0
Vanadium (μg/L)	--	--	--
Zinc (μg/L)	1	5	5

Period of record: Water year 1981 (discontinued)

REGRESSION SUMMARY[1]								
SIMPLE REGRESSION				MULTIPLE REGRESSION				
					Partial regression coefficient			
Regression constant	Regression coefficient	Coefficient of determination	Standard error of estimate	Regression constant	Q	K	Coefficient of determination	Standard error of estimate
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--

[1] Insufficient samples to develop regressions

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
--	--	--
1	3	3
1	0	0
--	--	--
1	0	0
1	0	0
1	5	5
1	840	840
1	4	4
--	--	--
1	330	330
1	.2	.2
--	--	--
1	0	0
1	0	0
--	--	--
1	10	10

Table 2.--*Statistical summary of water-quality data for each station*--Continued

Station No. (fig. 1): 23 Station No. (USGS): 06329540 Station name: Lone Tree Creek near Sidney, Mont.

Variable	DESCRIPTIVE STATISTICS				
	Number of samples	Minimum value	Maximum value	Mean	Standard deviation
Discharge, instantaneous (ft^3/s)	9	0.01	0.50	0.12	0.15
Specific conductance (micromhos)	9	895.00	2100.00	1605.22	440.75
pH (units)	9	7.90	8.40	8.13	0.16
Temperature (°C)	9	0.00	20.00	9.67	9.09
Turbidity (NTU)	0	--	--	--	--
Oxygen, dissolved (mg/L)	9	7.10	13.20	10.83	1.84
Oxygen, dissolved (percent)	9	83.00	127.00	101.44	17.76
Biochemical oxygen demand (mg/L)	0	--	--	--	--
Calcium, dissolved (mg/L)	9	71.00	170.00	117.33	37.19
Magnesium, dissolved (mg/L)	9	62.00	160.00	129.89	40.14
Sodium, dissolved (mg/L)	9	29.00	80.00	62.22	19.35
Sodium (percent)	9	12.00	16.00	13.78	1.39
Sodium-adsorption ratio	9	0.60	1.10	0.94	0.18
Potassium, dissolved (mg/L)	9	4.10	12.00	8.01	2.56
Alkalinity, total as $CaCO_3$ (mg/L)	9	170.00	410.00	284.44	91.94
Sulfate, dissolved (mg/L)	9	340.00	790.00	646.67	188.28
Chloride, dissolved (mg/L)	9	6.90	18.00	10.91	3.84
Fluoride, dissolved (mg/L)	9	0.10	0.20	0.13	0.05
Silica, dissolved (mg/L)	8	0.70	16.00	7.43	4.86
Dissolved solids, calculated (mg/L)	9	637.00	1450.00	1152.67	318.97
Nitrogen, NO_2+NO_3 total (mg/L as N)	9	0.00	0.12	0.03	0.05
Nitrogen, ammonia total (mg/L as N)	9	0.05	0.21	0.11	0.06
Nitrogen, organic total (mg/L as N)	9	0.56	2.00	1.09	0.43
Nitrogen, total (mg/L as N)	9	0.65	2.10	1.22	0.44
Phosphorus, total (mg/L as P)	9	0.01	0.13	0.04	0.04
Sediment, suspended (mg/L)	9	4.00	88.00	25.67	27.14

Variable	DISSOLVED		
	Number of samples	Minimum value	Maximum value
Aluminum (µg/L)	--	--	--
Arsenic (µg/L)	1	1	1
Beryllium (µg/L)	1	1	1
Boron (µg/L)	9	100	310
Cadmium (µg/L)	1	1	1
Chromium (µg/L)	1	10	10
Copper (µg/L)	1	2	2
Iron (µg/L)	9	10	80
Lead (µg/L)	1	0	0
Lithium (µg/L)	--	--	--
Manganese (µg/L)	1	10	10
Mercury (µg/L)	1	.1	.1
Molybdenum (µg/L)	--	--	--
Nickel (µg/L)	1	2	2
Selenium (µg/L)	1	0	0
Vanadium (µg/L)	--	--	--
Zinc (µg/L)	1	6	6

Period of record: Water year 1981 (discontinued)

REGRESSION SUMMARY								
SIMPLE REGRESSION				MULTIPLE REGRESSION				
Regression constant[1]	Regression coefficient	Coefficient of determination[2]	Standard error of estimate	Regression constant	Partial regression coefficient[3] Q	Partial regression coefficient[3] K	Coefficient of determination[2]	Standard error of estimate
--	--	--	--	--	--	--	--	--
Q		.124	441	--	--	--	--	--
K		.0580	.164				.066	.176
--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--
K		.374	1.55			*	.604	1.33
K		.199	17.0				.289	17.3
--	--	--	--	--	--	--	--	--
1.03 K	.0725	.738*	20.4	-9.39	32.8	.0765*	.754*	21.3
-6.94 K	.0852	.876*	15.1	6.09	-41.0	.0802*	.898*	14.8
-.784 K	.0393	.799*	9.27	8.30	-28.6	.0357*	.845*	8.79
Q		.399	1.16				.417	1.23
.465 K	.00030	.529*	.133	.641	-.553	.00023*	.725*	.110
K		.110	2.58				.120	2.77
.270 K	.177	.720*	52.0	-14.9	47.8	.183*	.726*	55.6
9.22 K	.397	.864*	74.2	50.7	-131	.381*	.874*	77.1
1.10 K	.00611	.493*	2.92			*	.507	3.11
Q		.0907	.0510				.0998	.0548
K		.207	4.68				.606	3.61
6.13 K	.714	.974*	54.9	29.1	-72.2	.705*	.975*	58.0
.191 K	-9.91	.805*	.0230	.178	-9.41	.0406*	.820*	.0238
.276 K	-.00010	.558*	.0432				.581	.0454
Q		.00906	.455				.0117	.490
K		.0130	.465				.0145	.501
.0202 Q	.185	.611*	.0245	.0749	.153*	-3.17	.738*	.0217
K		.215	25.7				.317	25.9

[1] Q indicates discharge as independent variable; K indicates specific conductance as independent variable

[2] Asterisk denotes that correlation coefficient, which is the square root of the coefficient of determination, is significant at α = 0.05

[3] Asterisk denotes that partial regression coefficient is significant at α = 0.05

TOTAL RECOVERABLE		
Number of samples	Minimum value	Maximum value
--	--	--
1	1	1
1	0	0
--	--	--
1	1	1
1	10	10
1	3	3
1	200	200
1	3	3
--	--	--
1	20	20
--	--	--
--	--	--
1	3	3
1	0	0
--	--	--
1	10	10