WATER TYPE AND SUITABILITY OF OKLAHOMA SURFACE WATERS FOR PUBLIC SUPPLY AND IRRIGATION

PART 2: SALT FORK ARKANSAS RIVER AND CIMARRON RIVER BASINS THROUGH 1978

U.S. GEOLOGICAL SURVEY
WATER-RESOURCES INVESTIGATIONS 81-39

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Water-quality data in the Salt Fork Arkansas and Cimarron River basins are examined for water type and suitability for public water supply and for irrigation use. The classification of water type is based on the relation of the major ions -- calcium, magnesium, sodium, carbonate/bicarbonate, sulfate, and chloride -- to each other within the range of measured specific conductance. The evaluation of suitability for use as a public supply is based on the concentration levels and distribution of selected constituents. The Wilcox irrigation classification scheme is used to relate sodium concentrations and the salinity distribution to the use of the water for irrigation. The possibility of boron phytotoxic effects is discussed where data are available.

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OKLAHOMA WATER RESOURCES BOARD

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CONVERSION FACTORS

Inch-pound units used in this report may be converted to International System (SI) of units by the following conversion factors:

MULTIPLY INCH-POUND UNIT	BY	TO OBTAIN SI UNIT
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
degree Fahrenheit (°F)	(°F -32)5/9	degree Celsius (°C)

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PART 2: SALT FORK ARKANSAS AND CIMARRON RIVER BASINS THROUGH 1978

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ABSTRACT

Water-quality data in the Salt Fork Arkansas and Cimarron River basins within Oklahoma, through 1978, were examined for water type and suitability for public water supply and irrigation use. Of 76 stations with available data, 32 stations or 42 percent were considered to have sufficient data for analysis. The classification of water type was based on the relation of the major ions: calcium, magnesium, sodium, carbonate, bicarbonate, sulfate, and chloride to each other within the range of measured specific conductance. The suitability for use as a public supply was based on the concentration distribution of selected constituents. The constituents selected were those with maximum contaminant levels established by regulation, or constituents for which recommended maximum limits have been established and for which historic data are available. The irrigation classification method of Wilcox was used to relate sodium, calcium, and magnesium concentrations and the salinity distribution to the use of the water for irrigation. Where data were available, the chance of phytotoxic effects by boron was discussed.

INTRODUCTION

Surface-water-quality data for Oklahoma have been collected and published on a regular basis for the past 30 years. These data represent 2,733 station-years of record from 527 stations (Stoner, 1977). These data consist of tabulations of water-quality analyses of varying suites of constituents, but the data are not readily usable to water planners and managers. The purpose of this report is to summarize the data at selected stations to provide information on water type, water-quality trends, and suitability for use as public and irrigation supplies. A water-quality report on selected Oklahoma surface waters that is of a more general statistical nature has recently been published (Kurklin, 1979). A statistical summary of streamflow records is provided in a report by Mize (1975); therefore, streamflow data were not included in this report.

ACKNOWLEDGMENTS

Water-quality data in Oklahoma have been collected and published on a cooperative basis with many Federal, State, county, district, and city agencies during the past 30 years. Two of the principal cooperators are the Oklahoma Water Resources Board and the U.S. Army Corps of Engineers. The author thanks all of the agencies, past and present, for their part in the collection of surface-water-quality data in Oklahoma.

STATION SELECTION

The stations included in this report were selected using two criteria. First, stations listed in the report by Stoner (1977) were eliminated if less than 10 samples had been collected and if the stations had not been operated during 1976-78. Statistical analysis of data from less than 10 samples generally is inadequate to determine frequencies and variations during the annual hydrologic cycle. Second, only data in the U.S. Geological Survey's WATSTORE (National Water Data Storage and Retrieval System) were used. WATSTORE was accessed for each station to determine data availability. A deletion of stations was made from WATSTORE information using the same criterion of less than 10 samples. Very few of the selected stations had 10 analyses for each of the selected water-quality constituents. Most of the stations lacked data on the toxic metals -- arsenic, cadmium, chromium, lead, and mercury.

STATION ORDER

In order to reduce the physical size of the report and to make it more useable on a regional and hydrologic basis to water planners and managers, the report has been divided into five parts. The river basins included within each part are as follows:

Part 1: Arkansas River Mainstem and Verdigris, Neosho, and Illinois River basins (Stoner, 1981).

Part 2: Salt Fork Arkansas and Cimarron River basins.

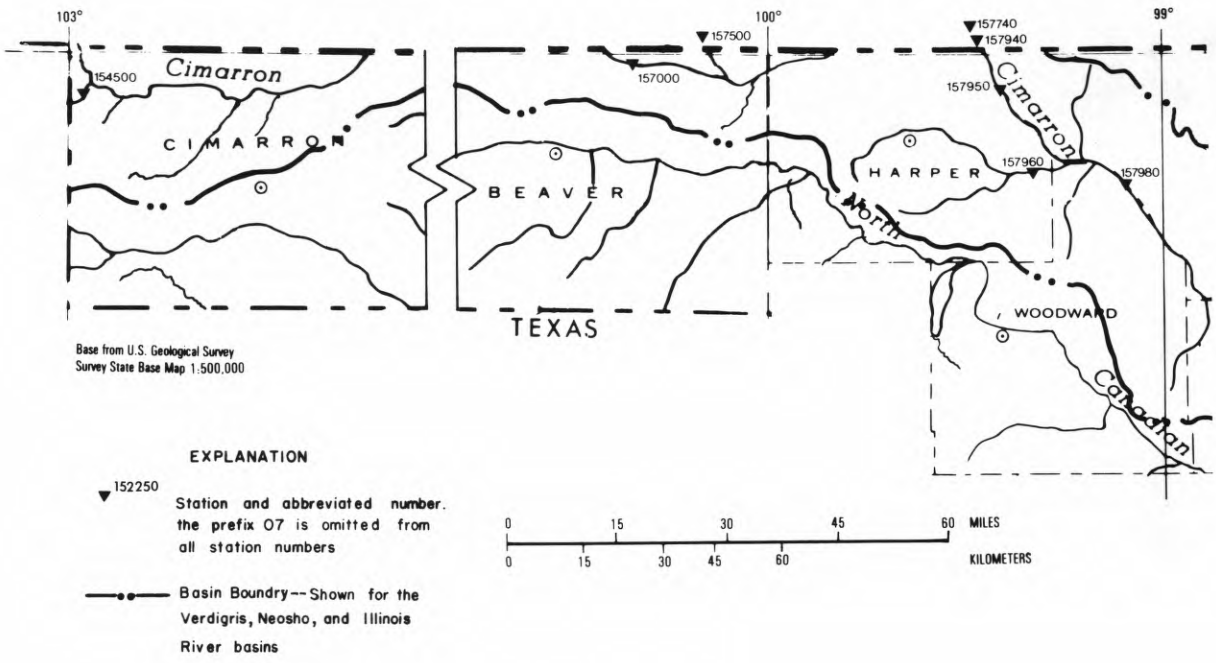
Part 3: Canadian, North Canadian, and Deep Fork River basins.

Part 4: Red River Mainstem and North Fork Red River basin.

Part 5: Washita River basin.

Within each part the stations are grouped by river basin. All rivers and streams within Oklahoma are tributary to either the Arkansas River or the Red River. Mainstem stations are those stations on the Arkansas or Red River or are on streams whose basins are directly tributary to the Arkansas or Red River and are too small to be listed as a separate basin. The stations are arranged in alphabetical order within each basin or mainstem designation. Where more than one station on a stream is reported, those stations are arranged in downstream order.

The location of each station is shown in figure 1, and the stations are identified by their station numbers. All of the assigned station numbers in Oklahoma begin with the digits 07. These two digits are omitted from the station numbers shown in figure 1. For example, station number 07151550 is shown in figure 1 as 151550. A listing of the stations by number that provides cross-indexing of stations shown in figure 1 with their station summaries is provided in table 3, which follows the station summaries.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Base from U.S. Geological Survey
Survey State Base Map 1:500,000
EXPLANATION
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Station and abbreviated number. the prefix 07 is omitted from all station numbers
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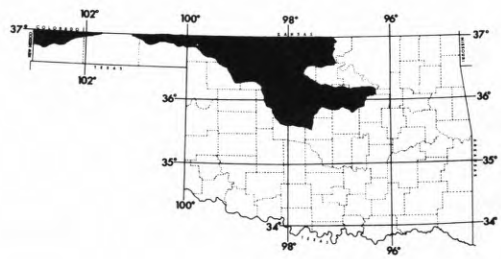
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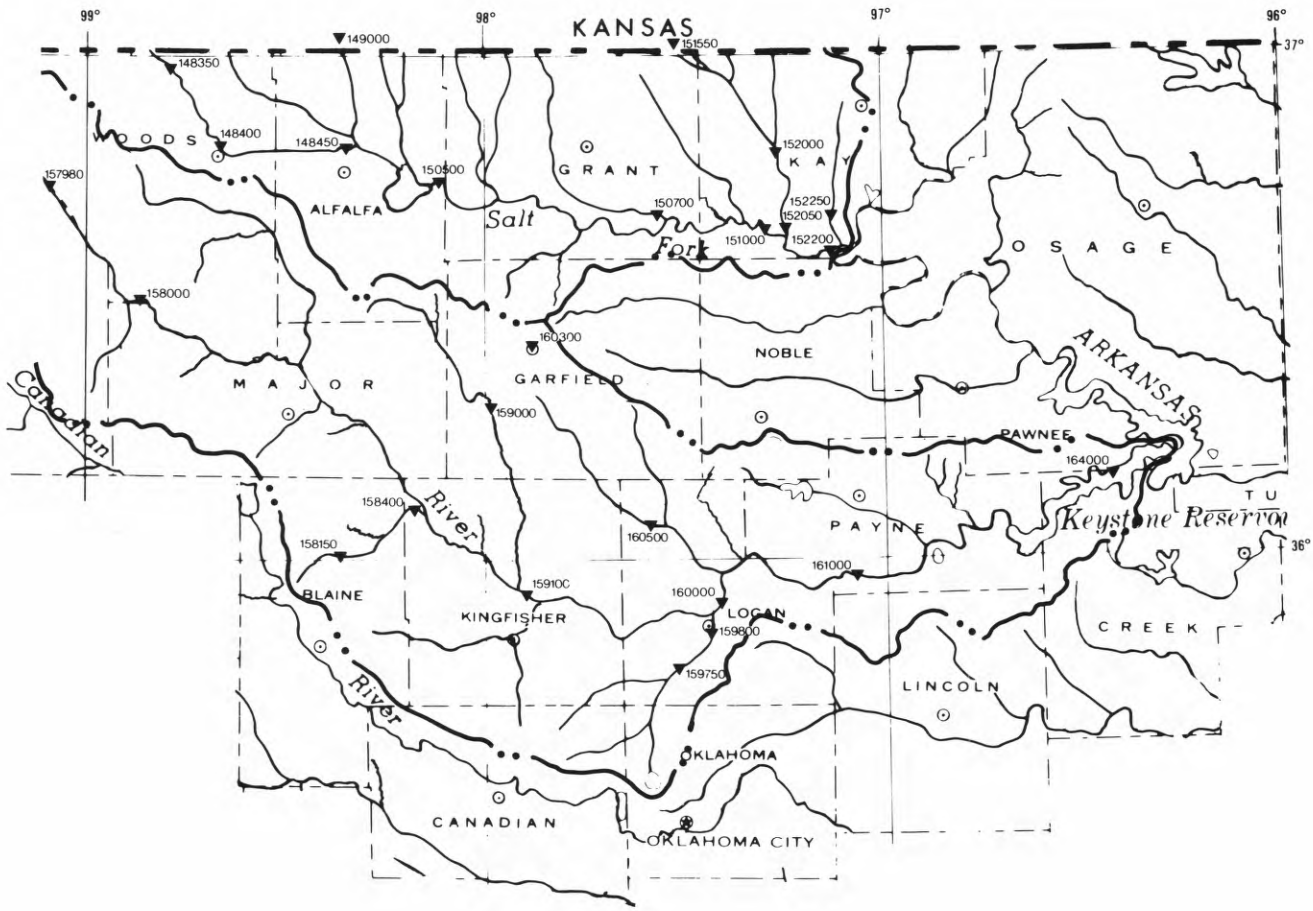
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152200
ALFALFA
Salt
Fork
OSAGE
158000
160300
NOBLE
ARKANSAS
MAJOR
GARFIELD
159000
Canadian
PAWNEE
164000
158400
River
160500
PAYNE
Keystone Reservoir
158150
161000
159100
160000
BLAINE
KINGFISHER
LOGAN
159800
CREEK
159750
LINCOLN
River
OKLAHOMA
CANADIAN
OKLAHOMA CITY

DATA PRESENTATION

Each station summary is in the following format:

1. Station location.
2. Drainage area.
3. Period of water-quality record.
4. Pertinent remarks if any.
5. A discussion of water types.
6. Trend analysis where sufficient current data are available.
7. A discussion of water quality related to use as a public water supply.
8. A discussion of water quality related to use for irrigation.
9. Two tables; one providing the univariate statistics for the selected constituents, and one showing the frequency distribution for the constituents.
10. Plots of the specific conductance versus the major cation ratios and the major anion ratios.
11. An irrigation diagram.

The selection of water-quality constituents was based on their significance to water use for public supply and irrigation. Dissolved solids as determined by the residue on evaporation at 180° Celsius method was included because it is a measure of the total amount of dissolved material present in the water.

The data are discussed in the summaries on a per value basis rather than a percentage of time basis. For some stations the percentage of values can be thought of as the percentage of time. However, when the period of record is less than 3 years or the number of values is less than 40, care needs to be taken in assuming this relationship. The data were analyzed using the Statistical Analysis System 1976 version (SAS-76), developed by Barr and others (1976), and the Supplemental Library (Helwig, 1977).

EXPLANATION OF STATION SUMMARY

Location

The location for each station is given in at least three ways: (1) by latitude (lat) and longitude (long); (2) by the township, range, and section; and (3) by distance and direction from local geographic features such as bridges, tributary streams, and towns. The location also is described, where information is available, by river mile, the distance the station is upstream from the mouth of the stream.

Drainage Area

The drainage area of a stream at a specific location is that area, measured in a horizontal plane, enclosed by a topographic divide from which direct surface runoff from precipitation normally drains by gravity into the river upstream from the specified point. Drainage-area values given include all closed basins, or noncontributing areas, within the area unless otherwise noted.

Period of Record

The period of record in this report is the period of water-quality record by water year--that is, the 12-month period ending September 30. The water year is designated by the calendar year in which it ends and includes 9 of the 12 months. The period of record for the water-quality data used in this report includes all available WATSTORE data through the 1978 water year. A water year was included in the period of record when at least one sample was available for that water year.

Water Type

Water can be typed according to the percentage of each of the major ions in solution. For example, if the calcium and sulfate ions are predominant, the water would be described as calcium sulfate type. In this report a cation or anion was considered to be a predominant ion if it constituted at least 50 percent of its respective cation or anion group. The major cations, calcium, magnesium, sodium, and potassium, which are electropositive, and the major anions, carbonate, bicarbonate, chloride, and sulfate, which are electronegative, generally constitute more than 95 percent of the total ions in solution.

Ordinarily the concentration of the potassium ion is very small in relation to the sodium ion concentration. Potassium is grouped with the sodium because of its small concentration and because it is chemically similar to sodium; and the ions are referred to as sodium rather than sodium plus potassium.

The relationship between the carbonate and bicarbonate ions is pH dependent. Both carbonate and bicarbonate ions are considered to be present in solution when the pH is greater than 8.3, and when the pH is equal to or less than 8.3 only the bicarbonate ion is considered present. Because the relation between pH and specific conductance at each station was not determined, the carbonate and bicarbonate ions are referred to as carbonate/bicarbonate.

The concentration and relationship of the major ions in solution will, to a large extent, be determined by the geology of the terrane through which the water flowed and how the constituents in the water reacted to mixing with other waters.

Cation and Anion Ratio Plots

The cation ratio plot presents the ratio of each major cation, expressed in meq/L (milliequivalents per liter), to the sum of the major cations, in meq/L, plotted versus the specific conductance. The anion ratio plot was prepared in the same manner using the major anions. Each ion ratio plot requires complete data for all major cations or all major anions. In many instances, an analysis with complete anion data will not have complete cation data. Some confusion in the comparison of the ion ratio plots can result from the different data requirements for the cation and anion plots. However, to provide as complete a water-quality summary as possible, all data that met the various plotting requirements were included. These plots were constructed to determine whether the ionic distributions changed with changes in the total concentration of dissolved materials. Example plots of the cation and anion ratios are shown in figures 2 and 3.

Trend

Trend analyses were made to determine whether the concentration of a constituent was increasing (positive trend) or decreasing (negative trend) with time. Only data collected after October 1, 1960, were used in the trend analyses. This was done because of the format in which SAS stores the dates and because it was believed that 18 years was a sufficient time span to adequately determine the presence of trend. Trend analysis was made only for those stations that had current data (data from 1976, 1977, or 1978 water years) because trend analyses based on historical data could be misleading. Trend analysis is significant because it indicates what is occurring in the present, and what possible effects may occur in the future.

Plots, not included in this report, of dissolved solids, hardness, sulfate, and chloride concentrations versus time were generated where current data were available. The plots were examined to determine if there were data for a minimum time span, 5 years, to make a statistical test for trend and to see if there were any indication of trend. The test chosen for trend analysis

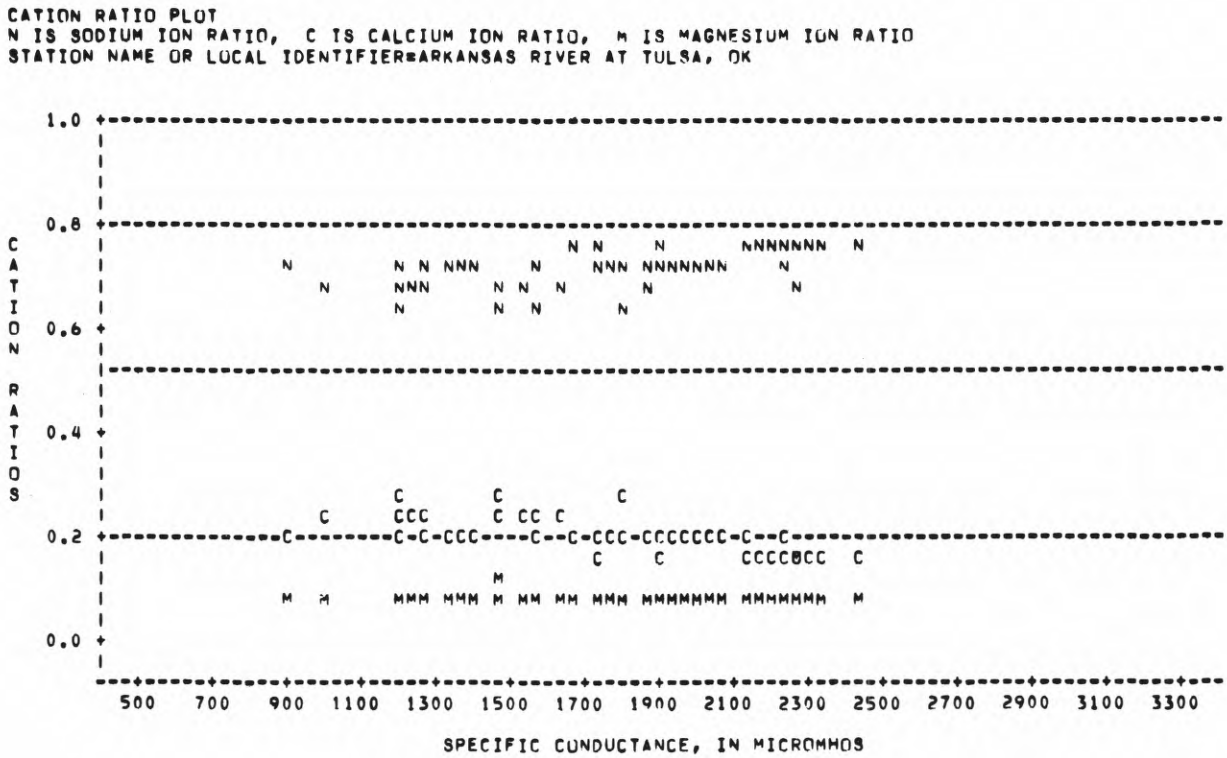

Figure 2.- Cation ratio plot for Arkansas River at Tulsa, Oklahoma.

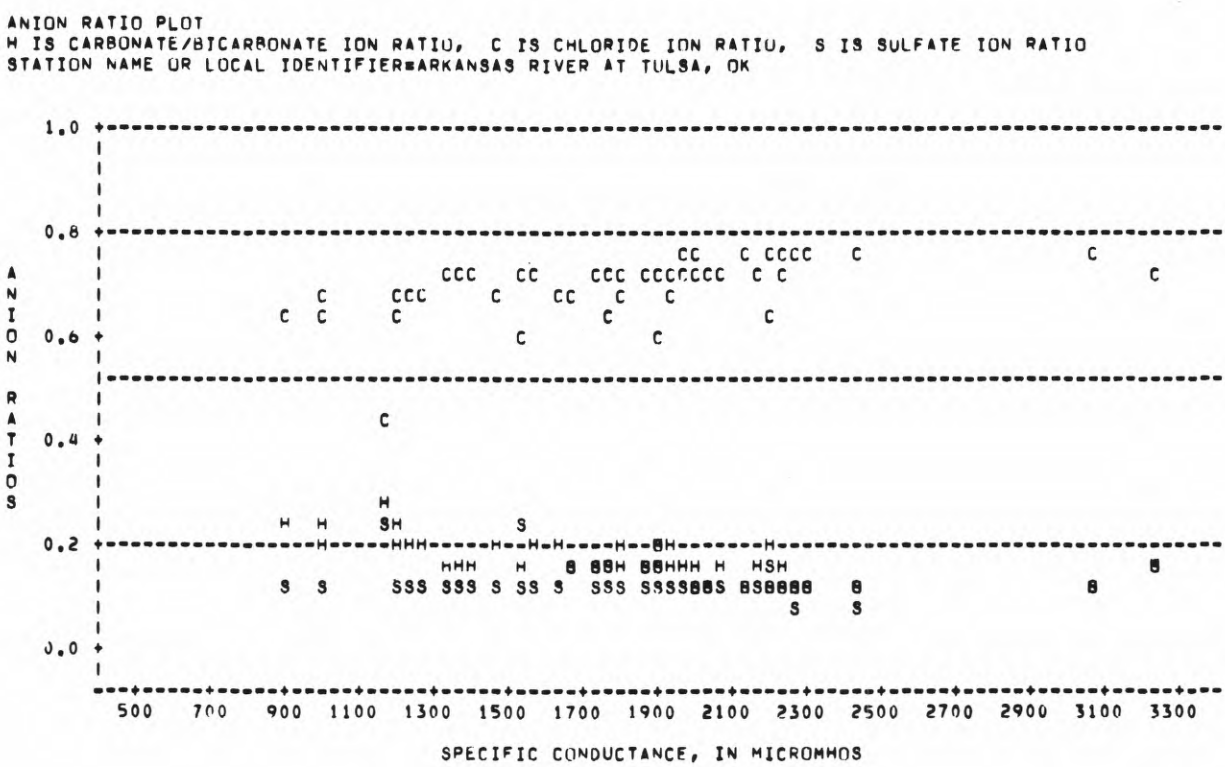

Figure 3.- Anion ratio plot for Arkansas River at Tulsa, Oklahoma.

was a Spearman's rho technique and is fully described by Conover (1971). The test is two sided and indicates whether a trend, if any, is positive or negative. The test was made for the four constituents at the 95-percent probability level. The technique does not indicate the cause of a trend, only that a trend is or is not occurring. A trend may be the result of an extended period of drought or a period of much precipitation.

Public Water Supply

This section includes a discussion of water hardness, constituents for which maximum concentrations have been recommended, and constituents for which maximum contaminant levels have been established by regulation. Where adequate data were available, an evaluation was made as to the suitability for use as a public supply. Suitability for use as a public supply is based on available water-quality criteria and is an evaluation of the fitness of the water for its intended use. Water evaluated as unsuitable because a water-quality constituent(s) exceeds established criteria may or may not be acceptable for use by the population to be supplied. The acceptability of water for public supply depends a great deal on the availability, or more importantly, the non-availability of a more suitable supply source. In many parts of the United States, particularly in the arid West, the public water supply is accepted by the majority of the population served even though the concentrations of such constituents as sulfate and chloride commonly exceed the recommended limits, simply because a more suitable source is not available. Because the acceptability of a water supply depends on many factors other than the water quality, no evaluation of acceptability was made. All evaluations of the suitability for use were based on the water as a raw untreated source and do not reflect any evaluation of suitability after treatment. However, these evaluations need to be used with caution because, for many stations, the data were more than 10 years old and need to be updated to determine the existing water quality. Furthermore, important data were missing for many stations, particularly the toxic metals. The suitability evaluations were provided to show whether the existing data indicated a constituent concentration which might preclude the use of the water for public supply.

Hardness

Hardness was included because, in relation to public water supply, it is one of the most noticeable water-quality characteristics. No maximum hardness concentration has been recommended because hardness is not generally considered a human health hazard. As hardness increases the efficiency of soaps and detergents decreases. When the concentration of hardness is large, deposition or scaling occurs, thereby reducing the efficiency of hot water tanks and restricting the flow of water in plumbing systems. Additional information on

hardness is given by Durfor and Becker (1964), and Hem (1970). The concentration of hardness is expressed as mg/L (milligrams per liter) as $CaCO_3$ (calcium carbonate). The hardness classification used in this report and given in the following table is that used by Durfor and Becker (1964, p. 27).

Hardness range (mg/L as $CaCO_3$)	Description
0 to 60	Soft
61 to 120	Moderately hard
121 to 180	Hard
Greater than 180	Very hard

Constituents with recommended maximum concentrations

Maximum concentrations for several water-quality constituents that have not had maximum contaminant levels set by regulation have been recommended by the National Academy of Sciences and National Academy of Engineering (1973). These constituents generally are not toxic to humans at their recommended limits. Particular constituents affect such qualities as color, taste, and odor; some may cause staining of clothes and plumbing fixtures; and others produce laxative effects in humans. The selected water-quality constituents in this group are chloride, sulfate, pH, and iron. Other components such as color, odor, oil and grease, silver, and zinc, were excluded because of the lack of analytical data. Following is a brief summary of reasons for selecting each constituent:

Chloride.--Affects taste. Normal water-treatment processes do not remove chloride.

Sulfate.--Affects taste and produces laxative effects. Normal water-treatment processes do not remove sulfate.

pH.--Contributes to the corrosion of plumbing and water distribution systems. The cost of treatment for waters with pH in excess of the recommended limits may be uneconomical.

Iron.--Causes staining of plumbing fixtures and clothing, accumulation of deposits in water distribution systems, and objectional taste.

Data in the following table were taken from the National Academy of Sciences and National Academy of Engineering (1973) report.

Constituent	Recommended concentration limit(s)
Chloride	250 mg/L
Sulfate	250 mg/L
pH	5.0 and 9.0 units
Iron	300 ug/L

Constituents with maximum contaminant levels

The U.S. Environmental Protection Agency through the Safe Drinking Water Act (Public Law 93-523) announced regulations for maximum contaminant levels in public water supplies for certain constituents (U.S. Environmental Protection Agency, 1976). The constituents, fluoride, arsenic, cadmium, chromium, lead, and mercury are included in this report; however, barium, selenium, and silver were not selected because of the almost total lack of historic data. Nitrate-nitrogen was not selected because changes in analytical methods and onsite field preservation techniques have produced data that probably are not comparable.

The maximum contaminant level for fluoride is based on the annual average maximum daily air temperature at the water source and is tabulated below. The maximum contaminant levels for fluoride given in the following table are from the U.S. Environmental Protection Agency (1976).

Temperature (°F)	Maximum fluoride contaminant level (mg/L)
53.7 and below	2.4
53.8 to 58.3	2.2
58.4 to 63.8	2.0
63.9 to 70.6	1.8
70.7 to 79.2	1.6
79.3 to 90.5	1.4

Although the amount of data available at most stations was limited, the toxic metals were included because of their significance to human health. The following table lists the maximum contaminant levels established by regulation for the toxic metals, U.S. Environmental Protection Agency (1976).

Constituent	Maximum contaminant level (ug/L)
Arsenic	50
Cadmium	10
Chromium	50
Lead	50
Mercury	2.0

Irrigation

The irrigation section of each station summary is based primarily on the irrigation waters classification system developed by Wilcox (1955). This system describes the utility of waters for irrigation based on their respective salinity and sodium hazards. Where boron data were available an evaluation was made on the possible phytotoxic effects of this trace element, based on the information contained in the National Academy of Sciences and National Academy of Engineering report (1973).

Salinity and sodium hazard classification

The Wilcox classification system depicts a salinity hazard based on the specific conductance, and a sodium hazard based on the SAR (sodium adsorption ratio). The SAR is based on the ratio of sodium to calcium and magnesium and expresses the relative activity of sodium ion in exchange reactions with soil. Complete discussions of the SAR and the method for its computation are provided in Hem (1970) and Wilcox (1955).

The following descriptions of the effects of the different salinity and sodium hazard classes are taken directly from Wilcox (1955).

"Low-salinity water (C1) can be used for irrigation with most crops on most soils, with little likelihood that a salinity problem will develop. Some leaching is required, but this occurs under normal irrigation practices except in soils of extremely low permeability.

Medium-salinity water (C2) can be used if a moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most instances with special practices for salinity control.

High-salinity water (C3) cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected.

Very high salinity water (C4) is not suitable for irrigation under ordinary conditions but may be used occasionally under very special circumstances. The soils must be permeable, drainage must be adequate, irrigation water must be applied in excess to provide considerable leaching, and very salt-tolerant crops should be selected."

"Low sodium water (S1) can be used for irrigation on almost all soils with little danger of the development of harmful levels of exchangeable sodium. However, sodium-sensitive crops, such as stone-fruit trees and avocados, may accumulate injurious concentrations of sodium.

Medium-sodium water (S2) will present an appreciable sodium hazard in fine textured soils of high cation-exchange capacity, especially under low-leaching conditions, unless gypsum is present in the soil. This water may be used on coarse textured or organic soils that have good permeability.

High-sodium water (S3) may produce harmful levels of exchangeable sodium in most soils and will require special soil management--good drainage, high leaching, and additions of organic matter. Gypsiferous soils may not develop harmful levels of exchangeable sodium from such waters.

Very high sodium water (S4) is generally unsatisfactory for irrigation purposes except at low and perhaps medium salinity where the solution of calcium from the soil or the use of gypsum or other amendments may make the use of this water feasible."

Additional information on the effect of salinity and sodium on water use for irrigation is given by Wilcox (1955) and the National Academy of Sciences and National Academy of Engineering (1973).

Irrigation diagram

An irrigation diagram is included for each station where sufficient data were available. On the diagram the SAR of a sample is plotted against its specific conductance and the appropriate salinity and sodium hazards are determined (example, fig. 4). In the irrigation diagram the salinity hazard is along the horizontal axis and ranges from C1 to C4. All specific conductance values given in this report are in micromhos per centimeter at 25 degrees Celsius and are hereafter abbreviated as umho. The specific-conductance ranges for the salinity hazard classes are: less than 250 umho, low salinity hazard; 250 to 750 umho, medium salinity hazard; 751 to 2,250 umho, high salinity hazard; and greater than 2,250 umho, very high salinity hazard. The sodium hazard is along the vertical axis and the class breakpoints S1 through S4 vary with the specific conductance and are delineated by the sloping lines.

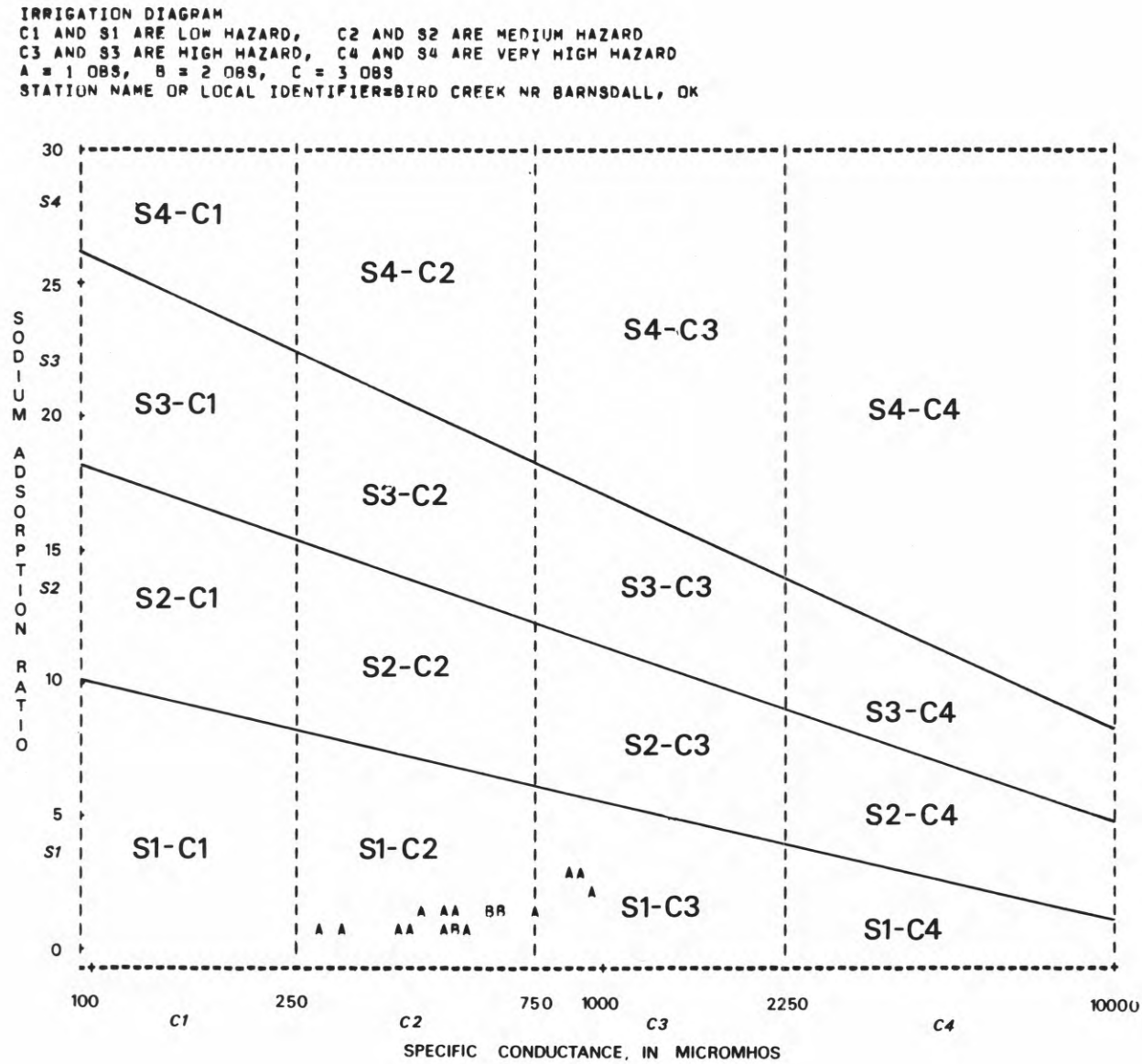

Figure 4.- Irrigation diagram for Bird Creek near Barnsdall, Oklahoma.

Boron

Boron has long been recognized as a phytotoxic trace element. The recommended maximum boron concentrations for use on all soils from the National Academy of Sciences and National Academy of Engineering (1973) report are: boron sensitive plants, 750 ug/L (micrograms per liter); boron semitolerant plants, 1,000 ug/L; and boron tolerant plants, 2,000 ug/L. The relative boron tolerances of certain plants are shown in table 1. This table was taken directly from the Wilcox (1955) report and lists many plants that are not native to or commercially grown in Oklahoma; however, it is possible that most or all of these plants may be grown in Oklahoma on a non-commercial basis.

Table 1.--Relative boron tolerance of certain plants

[From Wilcox (1955). In each group, the plants first named are considered as more tolerant; the last named, more sensitive]

Tolerant	Semitolerant	Sensitive
Athel (Tamerix aphylla)	Sunflower (native)	Pecan
Asparagus	Potato	Walnut (Black; and Persian or English)
Palm (Phoenix canariensis)	Cotton (Acala and Pima)	Jerusalem artichoke
Date Palm (P. dactylifera)	Tomato	Navy bean
Sugar beet	Sweet pea	American Elm
Mangel	Radish	Plum
Garden beet	Field pea	Pear
Alfalfa	Ragged robin rose	Apple
Gladiolus	Olive	Grape (Sultaninia and Malaga)
Broad bean	Barley	Kadota fig
Onion	Wheat	Persimmon
Turnip	Corn	Cherry
Cabbage	Milo	Peach
Lettuce	Oat	Apricot
Carrot	Zinnia	Thornless blackberry
	Pumpkin	Orange
	Bell pepper	Avocado
	Sweet potato	Grapefruit
	Lima bean	Lemon

Univariate Statistics

The station summaries show the univariate statistics for each constituent. The units of concentration in the summary are those units that have already been described for the constituents. The standard deviation, skewness, and kurtosis were not computed for constituents with less than 10 values. When only one value was available for a constituent, that value is listed in the mean column. In many instances the number of values for one constituent are two to three or more times greater than the number of values for another constituent. Therefore, comparison of statistics, particularly minimums and maximums, between constituents needs to be done with care.

The following are brief descriptions of the headings in the univariate statistics summary for each station.

N.--The number of values available for the period of record for that constituent.

MEAN.--The arithmetic average, except for pH which is the median or middle value.

MIN.--The minimum value recorded.

MAX.--The maximum value recorded.

STD.--The standard deviation of the constituent distribution.

SKEW.--The skewness of the constituent distribution. Skewness is a measure of the asymmetry of the distribution of the data when compared to the symmetrical normal distribution. Detailed information on the theory, use, and computational methods for the skewness and kurtosis (described in the next section) are given by Fisher (1973) and Snedecor (1956). A positive value for the skewness statistic indicates there are more values smaller than the mean than values greater than the mean, and for negative skewness values the converse is true (fig. 5). Although the statistic computed for the skewness cannot be used to determine the shape of the distribution, the skewness statistic can indicate whether the distribution curve is significantly different from a normal distribution. If the sample distribution is significantly different, tests that are based on normality are not applicable. The 95-percent probability range, plus and minus, for skewness for various sample sizes is shown in table 2. As an example: For a sample size of 100, if the skewness statistic greatly exceeded plus or minus 0.47, the distribution is not considered normal at the 95-percent probability level.

KURT.--The kurtosis of the sample distribution. Kurtosis is a measure of the deviation of the sample distribution from the normal distribution. In general, kurtosis measures the relative peakness or flatness of the sample distribution curve with respect to the normal distribution. A positive kurtosis indicates peakness and a negative kurtosis indicates flatness (fig. 6). Values for the 95-percent probability limits for kurtosis for selected sample sizes are given in table 2.

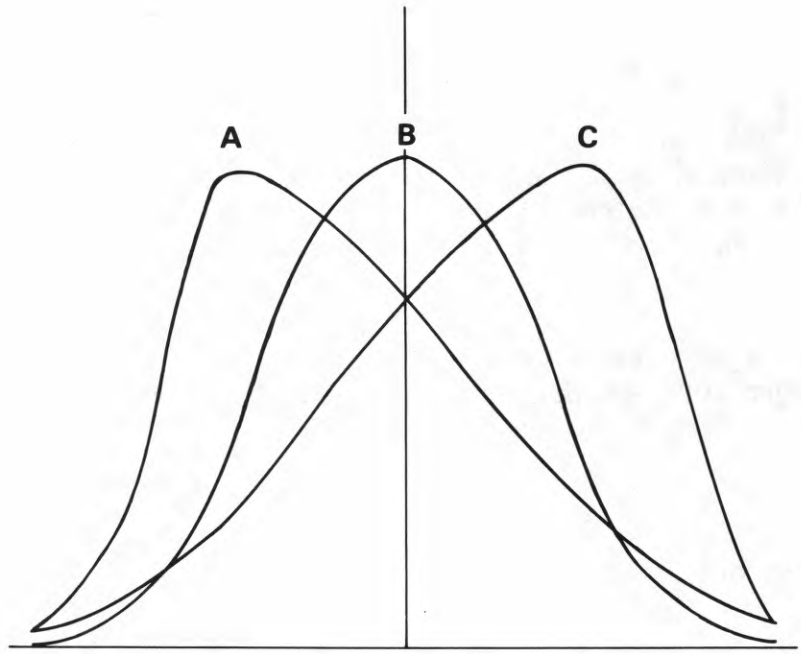

Figure 5 - Skewness and the normal distribution. Curve A is positive skewness, curve B is normal distribution, and curve C is negative skewness.

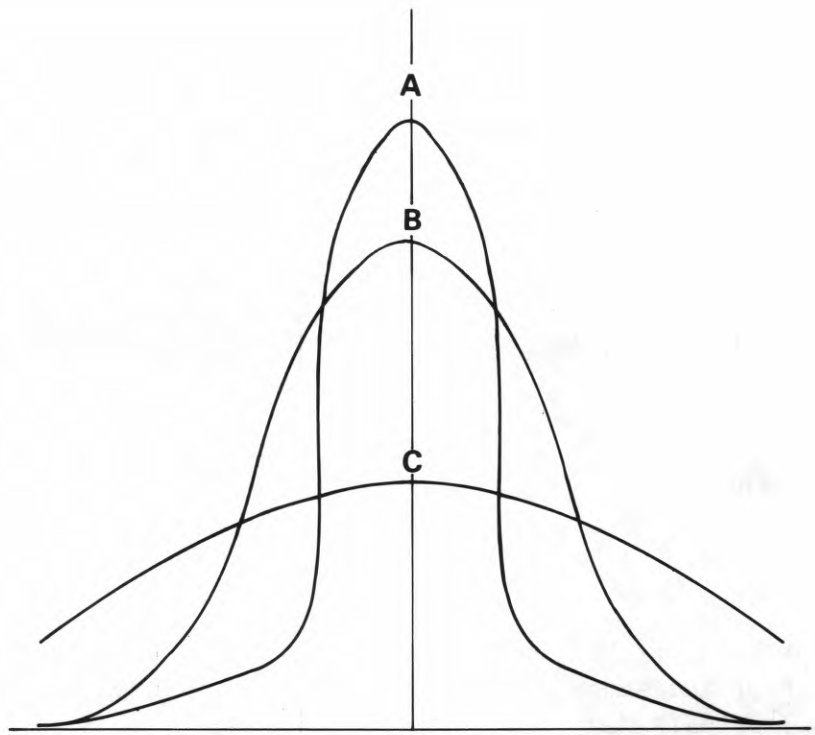

Figure 6 - Kurtosis and the normal distribution. Curve A is positive kurtosis, curve B is normal distribution, and curve C is negative kurtosis.

Table 2.--Ninety-five percent probability limits for skewness and kurtosis for selected sample sizes

Sample size	95 percent of probability limits (plus or minus)	
	Skewness	Kurtosis
10	1.35	2.61
25	.91	1.77
50	.66	1.30
75	.54	1.07
100	.47	.94
150	.39	.77
200	.34	.67
300	.28	.55
400	.24	.48
500	.21	.43
600	.20	.39
700	.18	.36

Frequency Distribution

The frequency distribution table shows selected percentile concentrations from the cumulative frequency distributions of constituents for which 10 or more values were available. The concentration units in the table are the same as previously described for the constituents. The percentile concentrations in the table are explained in the following example: The concentration shown in the 25th percentile column is that concentration for which 25 percent of the samples had concentrations less than or equal to the column value.

STATION NUMBERING SYSTEM

Stations numbers are assigned in a downstream sequence so that as one progresses downstream the numbers become larger. Station numbers on a tributary are assigned on a rank-order basis. Station numbers on a first-rank tributary are assigned so that the numbers are larger than any number assigned to an upstream station on the mainstem and are smaller than any station number assigned to a station downstream on the mainstem. The station numbers on the tributary are assigned in the same downstream method as on the mainstem. A first-rank tributary is one that flows directly into the mainstem, a second-rank tributary is one which flows into a first-rank tributary, and so on for the greater ranked tributaries. The numbering system is followed from the mainstem up through the greater ranked tributaries, first rank, second rank, third rank, and so on.

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STATION SUMMARIES

All constituent values except for pH and specific conductance are for the dissolved phase. Specific conductance and pH are measured on unfiltered samples. The values for the standard deviation, skewness, and kurtosis for pH represent the distribution of the pH values and not the distribution of the hydrogen ion concentrations and were computed from the arithmetic mean of the pH values.

The units of concentration for selected constituents in the following station summaries are as follows:

Milligrams per liter (mg/L) - Dissolved solids, total hardness, chloride, sulfate, and fluoride.
Micrograms per liter (ug/L) - Iron, arsenic, cadmium, chromium, lead, mercury, and boron.
Micromhos per centimeter at 25 degrees Celsius (umho) - Specific conductance.
Standard units - pH.
Unitless - SAR.

SALT FORK ARKANSAS RIVER BASIN

07152250 - Bois d'Arc Creek near Ponca City, Okla.

LOCATION.--Lat 36°41'20", long 97°07'08", in SW¼NW¼ sec. 32, T.26 N., R.2 E., Kay County, at bridge on old U.S. Highway 60, 1 mi southwest of Ponca City.

DRAINAGE AREA.--Not determined.

PERIOD OF RECORD.--1953, 1958 to 1963.

WATER TYPE.--When the specific conductance was greater than 400 umho, which accounted for 95 percent of the samples, the water was calcium-sulfate type. Calcium was the predominant cation in samples for which the specific conductance measured less than or equal to 400 umho; however, there was no predominant anion.

TREND.--No current data were available.

PUBLIC WATER SUPPLY.--Ninety-two percent of the hardness values were greater than 180 mg/L and the average hardness was 654 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum chloride concentration of 250 mg/L was exceeded by 3 percent of the chloride values, and the recommended maximum sulfate concentration of 250 mg/L was exceeded by 73 percent of the sulfate values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum sulfate concentration was exceeded, this water is probably not suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from medium to very high with 85 percent of the samples having a high salinity hazard. The sodium hazard ranged from low to medium with 97 percent of the SAR values equivalent to a low sodium hazard. No boron data were available.

07152250 - Bois d'Arc Creek near Ponca City, Okla.--Continued

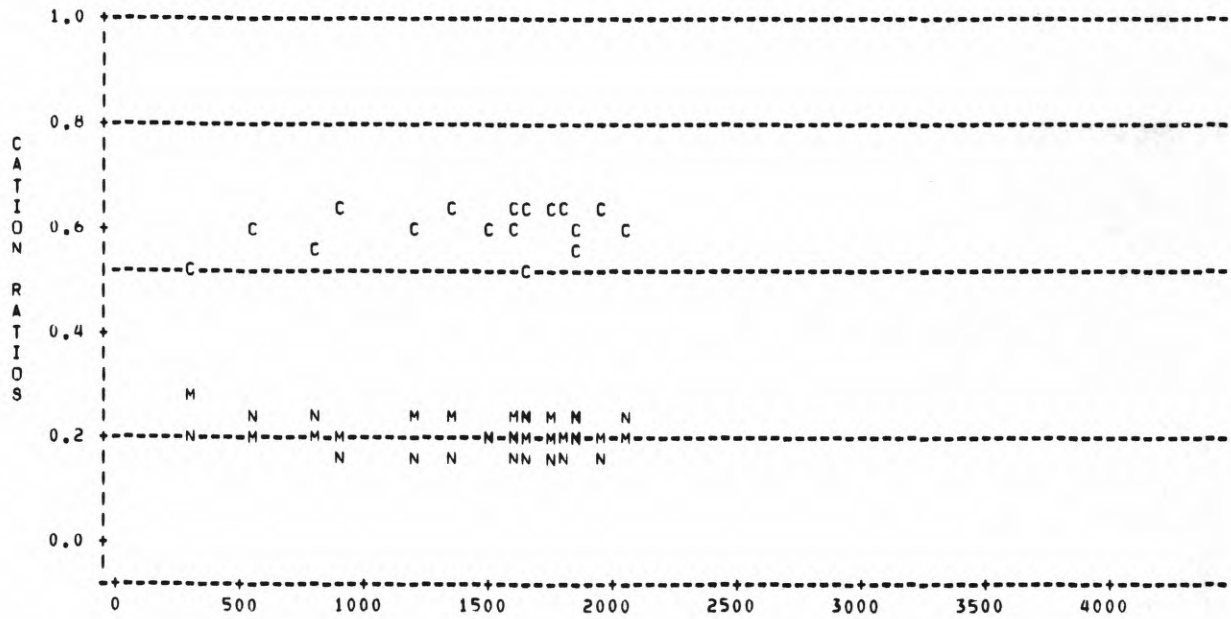
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	35	1503	278	3990	642	1.18	5.84
Dissolved solids	34	1080	164	1530	401	-1.00	-.37
pH	35	7.8	7.3	8.6	.3	.44	-.45
Total hardness	35	654	104	975	262	-.79	-.73
Chloride	35	136	18	1170	184	5.51	31.77
Sulfate	34	464	29	705	208	-.83	-.83
Iron	0						
Fluoride	6	.3	.3	.3			
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	34	1.5	0.6	5.0	0.8	3.36	15.18
Boron	0						

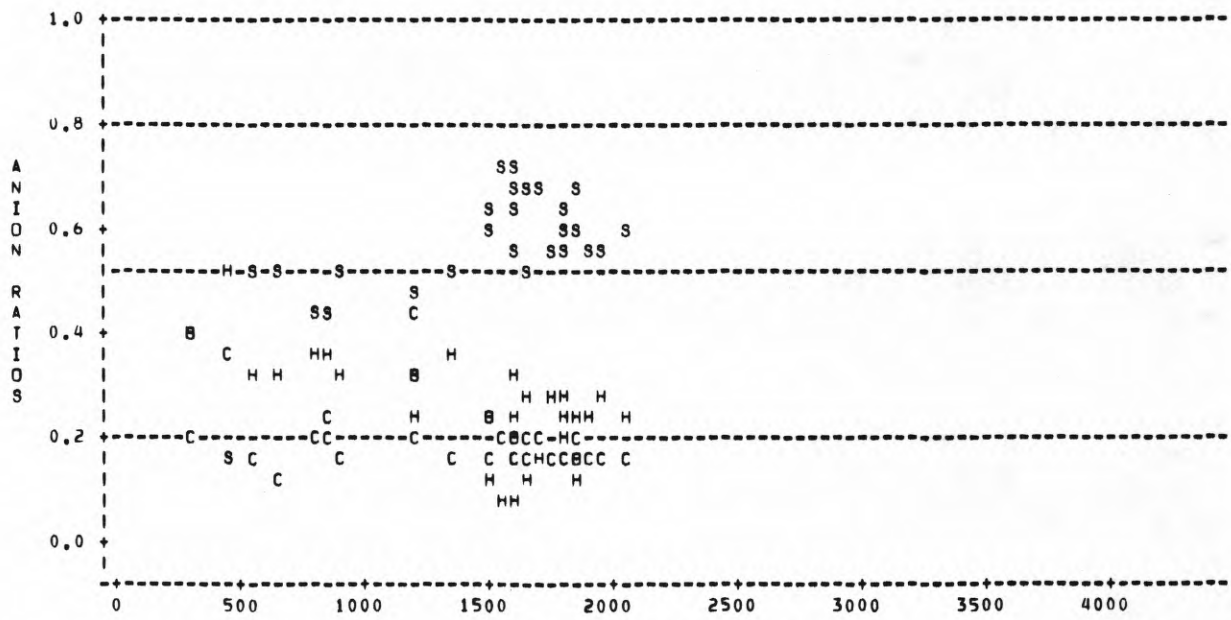
FREQUENCY DISTRIBUTION

CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	588	1134	1587	1792	1865
Dissolved solids	382	706	1217	1380	1438
pH	7.4	7.6	7.8	8.0	8.3
Total hardness	244	364	735	856	905
Chloride	36	82	116	130	142
Sulfate	148	222	555	619	649
Iron					
Fluoride					
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	0.7	1.0	1.3	1.6	1.7
Boron					

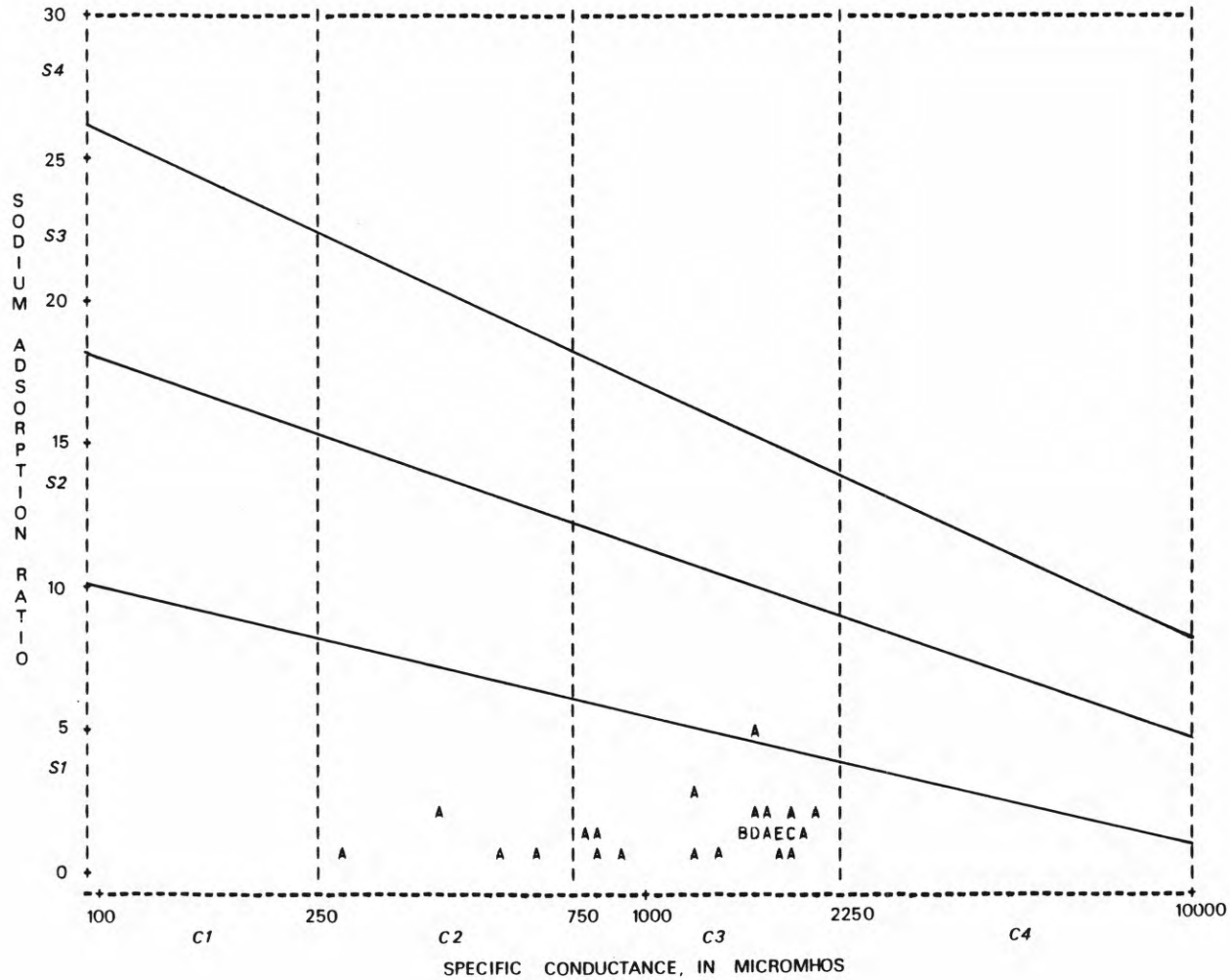
CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=BOIS D ARC CREEK NR PONCA CITY, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=BOIS D ARC CREEK NR PONCA CITY, OK



IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=BOIS D ARC CREEK NR PONCA CITY, OK



SALT FORK ARKANSAS RIVER BASIN

07151550 - Chikaskia River near Drury, Kans.

LOCATION.--Lat 37°08'00", long 97°36'00", in SW¼NE¼ sec. 1, T.35 S., R.2 W., Sumner County, at bridge on U.S. Highway 81, 0.3 mi west of Drury.

DRAINAGE AREA.--Not determined.

PERIOD OF RECORD.--1960 to 1961.

WATER TYPE.--When the specific conductance was less than 640 umho, which accounted for 92 percent of the samples, the water was generally a calcium carbonate/bicarbonate type. The data indicate the water was sodium chloride type for specific conductance greater than 640 umho.

TREND.--No current data were available.

PUBLIC WATER SUPPLY.--Seventy-five percent of the hardness values were greater than 180 mg/L and the average hardness was 208 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum chloride concentration of 250 mg/L was exceeded by 4 percent of the chloride values. The maximum fluoride concentration of 1.8 mg/L was very close to the maximum contaminant level for the average maximum daily air temperature for this area. No toxic metal data were available. Based on the data, this water is probably suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from medium to high with 92 percent of the samples having a medium salinity hazard. The sodium hazard ranged from low to medium with 96 percent of the SAR values equivalent to a low sodium hazard. No boron data were available.

07151550 - Chikaskia River near Drury, Kans.--Continued

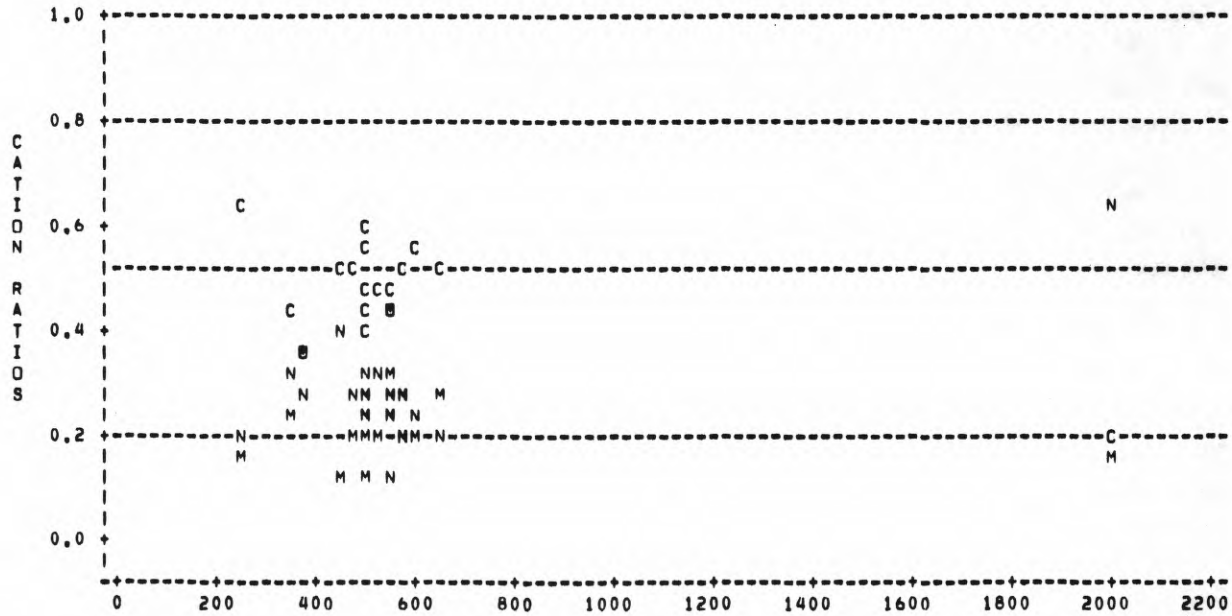
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	25	589	259	1990	315	3.95	17.72
Dissolved solids	24	349	162	1190	188	4.18	19.40
pH	25	8.3	7.5	8.7	0.3	-1.30	3.09
Total hardness	24	208	104	360	53	.63	1.85
Chloride	24	49	11	450	86	4.85	23.69
Sulfate	24	56	11	195	33	3.44	15.29
Iron	0						
Fluoride	12	0.5	0.3	1.8	0.4	3.16	10.49
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	24	1.2	0.5	6.2	1.1	4.57	21.84
Boron	0						

FREQUENCY DISTRIBUTION

CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	365	495	533	577	622
Dissolved solids	220	285	324	357	376
pH	7.9	8.2	8.3	8.5	8.6
Total hardness	137	180	202	244	249
Chloride	21	29	33	36	39
Sulfate	28	43	53	60	65
Iron					
Fluoride	0.1	0.2	0.3	0.4	0.5
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	0.6	0.9	1.0	1.1	1.3
Boron					

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CHIKASKIA R NR DRURY, KS



ANION RATIO PLOT
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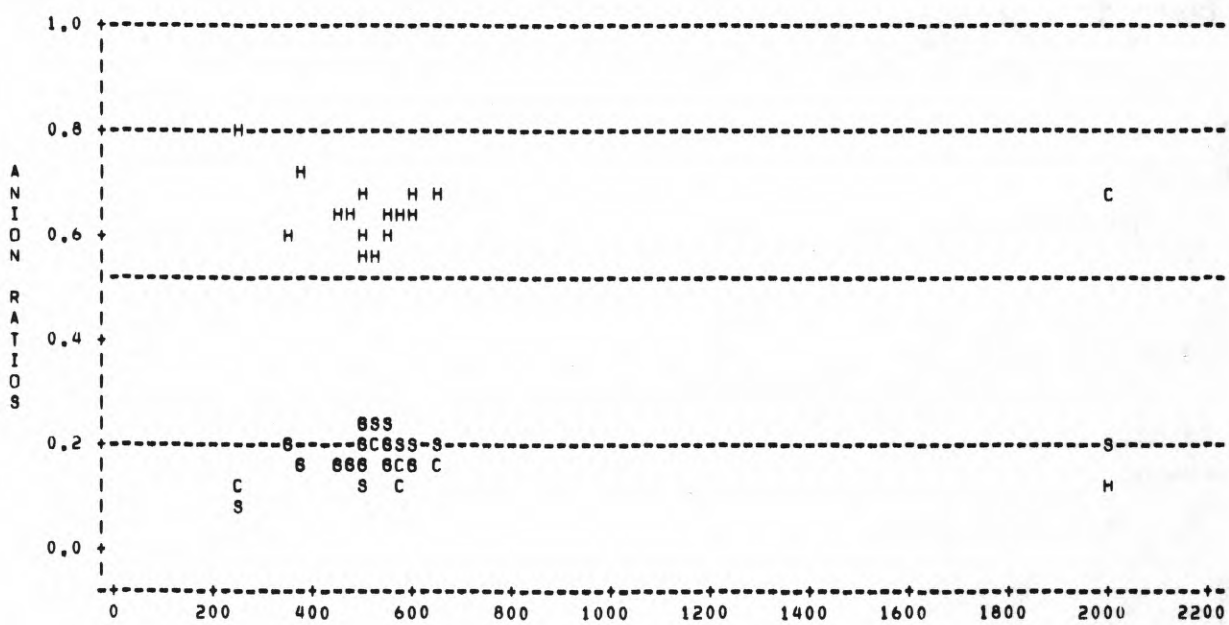
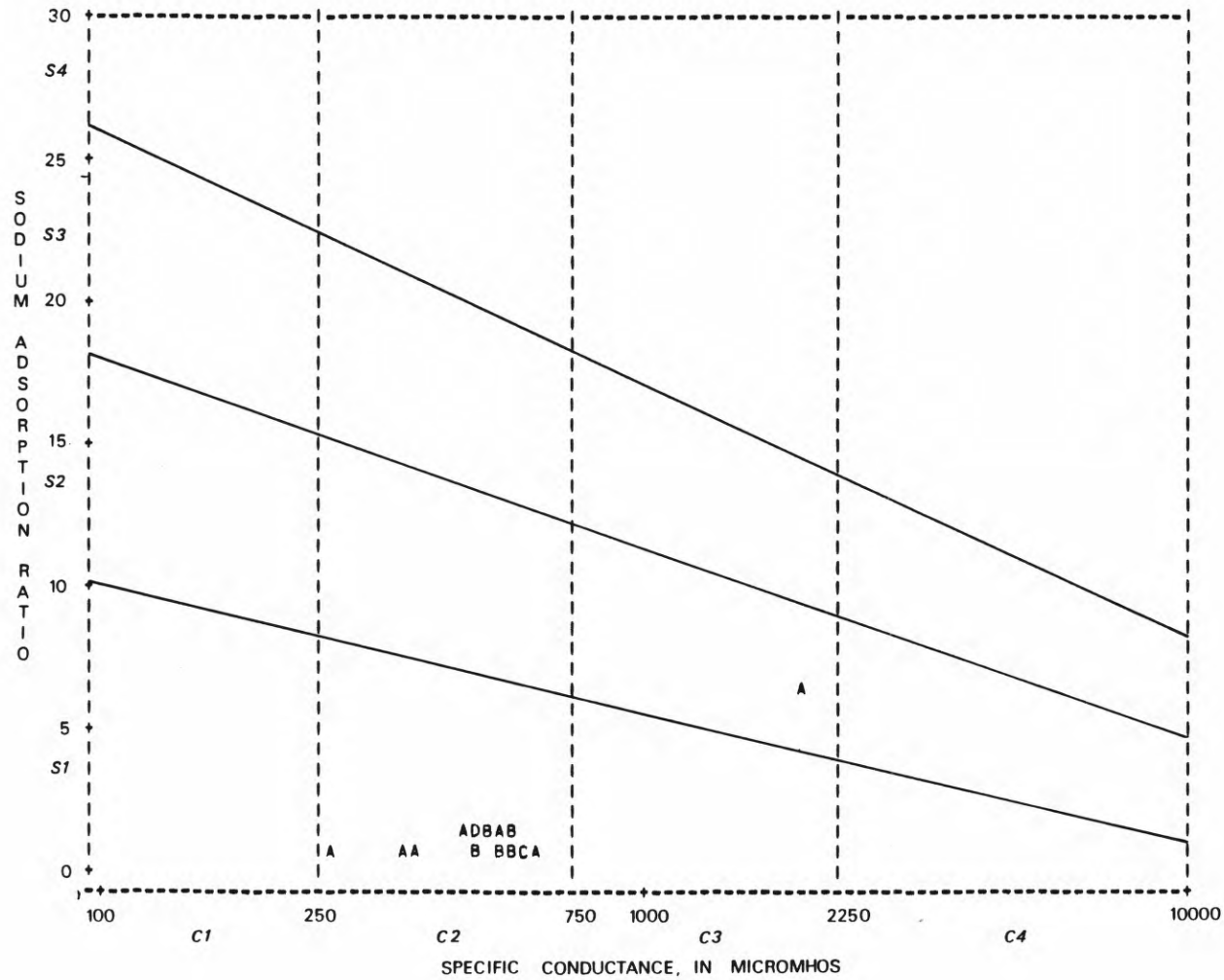
STATION NAME OR LOCAL IDENTIFIER=CHIKASKIA R NR DRURY, KS



IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=CHIKASKIA R NR DRURY, KS



SALT FORK ARKANSAS RIVER BASIN

07152000 - Chikaskia River near Blackwell, Okla.

LOCATION.--Lat 36°48'31", long 97°16'39", in NE¼NW¼ sec. 23, T.27 N., R.1 W., Kay County, at St. Louis-San Francisco Railway Co. bridge at northeast edge of Blackwell, 0.2 mi downstream from Bitter Creek, and at mile 28.2.

DRAINAGE AREA.--1,859 mi^2.

PERIOD OF RECORD.--1952 to 1963, 1976 to 1978.

WATER TYPE.--When the specific conductance was greater than 500 umho, which accounted for 88 percent of the samples, the water was sodium chloride type. For specific conductance less than 500 umho, the water was calcium carbonate/bicarbonate type.

TREND.--The current period of record is insufficient, less than 5 years, to perform trend analyses.

PUBLIC WATER SUPPLY.--Eighty-four percent of the hardness values were greater than 180 mg/L and the average hardness was 424 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum chloride concentration of 250 mg/L was exceeded by 31 percent of the chloride values and the recommended maximum sulfate concentration of 250 mg/L was exceeded by 5 percent of the sulfate values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum chloride concentration was exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from low to very high with 74 percent of the samples in the high or very high salinity hazard classes. The sodium hazard ranged from low to very high with 92 percent of the SAR values equivalent to a low or medium sodium hazard. The data indicate that phytotoxic effects from boron should not occur.

07152000 - Chikaskia River near Blackwell, Okla.--Continued

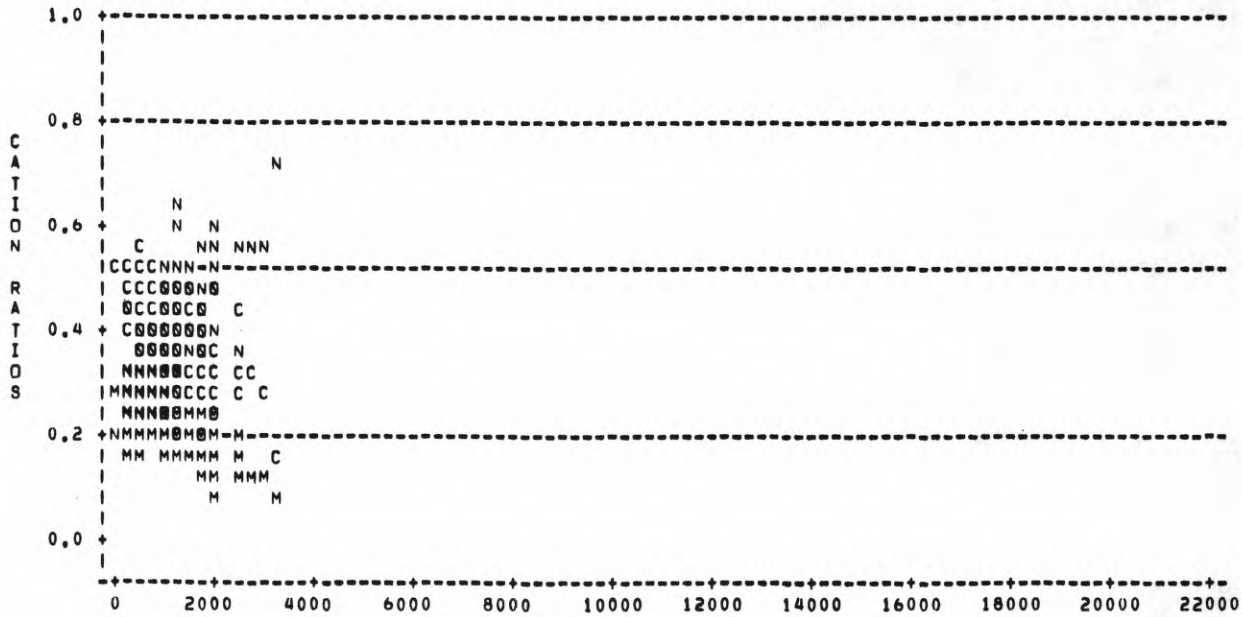
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	425	1557	114	21200	2224	5.56	37.62
Dissolved solids	329	799	95	7580	831	4.43	25.04
pH	384	8.1	6.6	8.9	0.3	-.93	1.67
Total hardness	416	424	48	4260	457	4.89	30.07
Chloride	423	369	3.0	7690	788	6.10	44.71
Sulfate	310	105	14	570	72	2.40	9.08
Iron	0						
Fluoride	26	0.3	0.1	0.6	0.1	0.48	0.25
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	372	2.6	0.4	22	2.0	4.17	27.98
Boron	23	228	90	460	113	.67	-.54

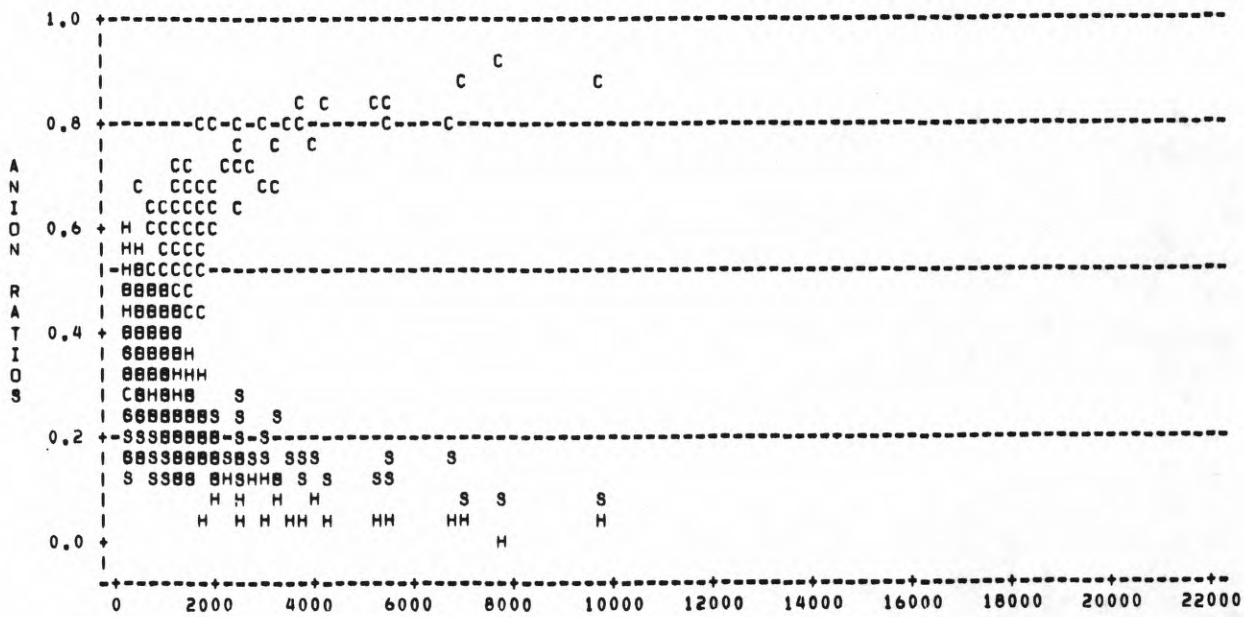
FREQUENCY DISTRIBUTION

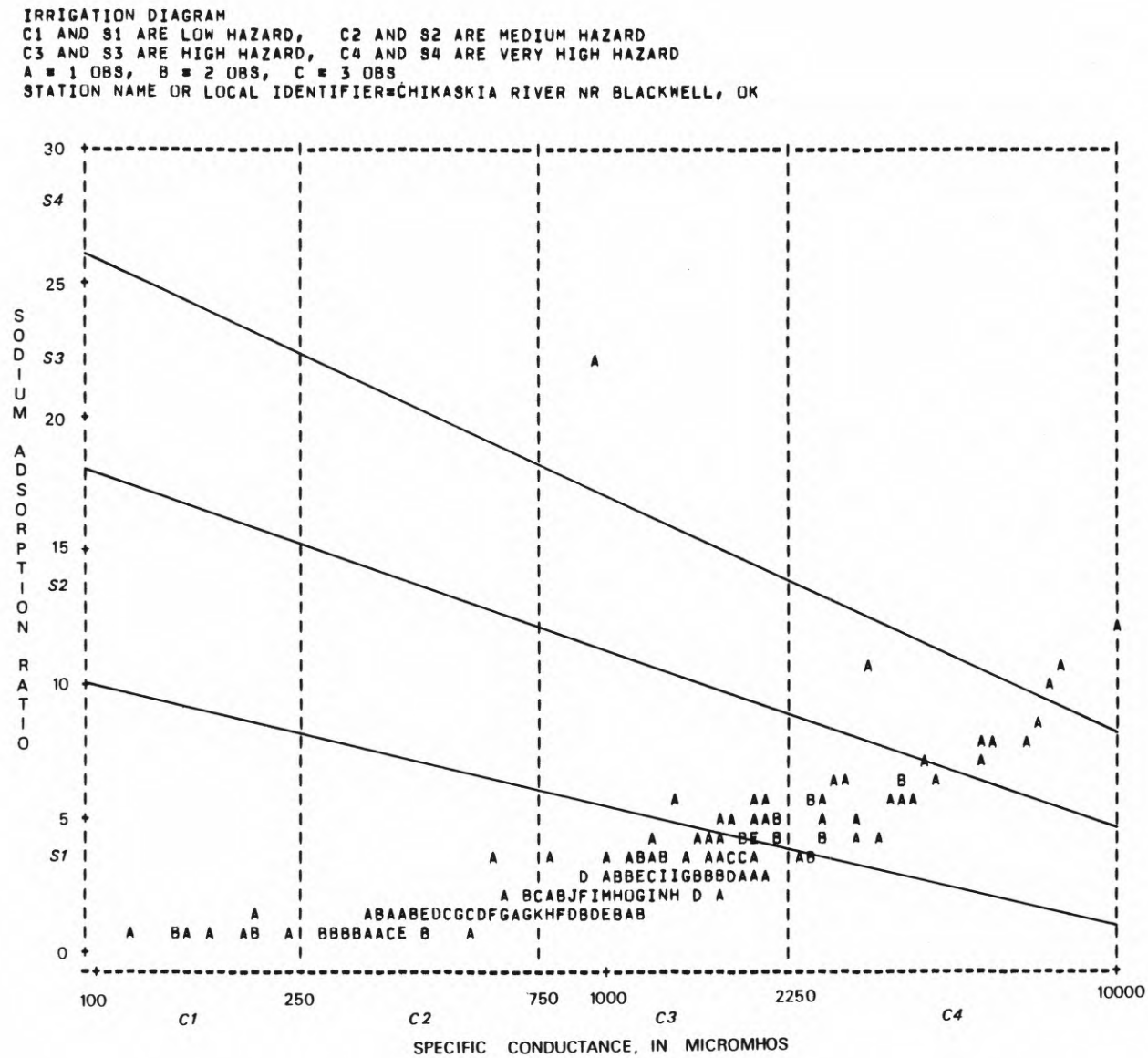
CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	419	740	1066	1415	2490
Dissolved solids	259	442	630	820	1131
pH	7.6	7.9	8.1	8.3	8.4
Total hardness	151	240	336	435	594
Chloride	56	110	180	296	585
Sulfate	40	59	92	131	173
Iron					
Fluoride	0.1	0.2	0.3	0.3	0.4
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	1.1	1.5	2.0	2.9	4.5
Boron	93	125	198	292	407

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CHIKASKIA RIVER NR BLACKWELL, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CHIKASKIA RIVER NR BLACKWELL, OK




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=CHIKASKIA RIVER NR BLACKWELL, OK
SODIUM ADSORPTION RATIO
30
S4
25
S3
20
15
S2
10
5
S1
0
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

SALT FORK ARKANSAS RIVER BASIN

07152050 - Chikaskia River near Tonkawa, Okla.

LOCATION.--Lat 36°40'55", long 97°15'40", in SW¼SW¼ sec. 36, T.26 N., R.1 W., Kay County, at bridge on U.S. Highway 60, 2 mi east of Tonkawa.

DRAINAGE AREA.--Not determined.

PERIOD OF RECORD.--1948, 1951, 1958 to 1963.

WATER TYPE.--When the specific conductance was greater than 400 umho, which accounted for 94 percent of the samples, the water was generally chloride type. There was no predominant anion for specific conductance less than 400 umho and no predominant cation for specific conductance less than 1,500 umho. Data from upstream stations indicate that at this station the cation sodium may become predominant as the specific conductance increases.

TREND.--No current data were available.

PUBLIC WATER SUPPLY.--Eighty-five percent of the hardness values were greater than 180 mg/L and the average hardness was 308 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum chloride concentration of 250 mg/L was exceeded by 17 percent of the chloride values. No toxic metal data were available. Based on the data, this water is probably suitable for use as a public supply; however, a slightly salty taste could occur when the chloride concentration is greater than 250 mg/L.

IRRIGATION.--The salinity hazard ranged from low to very high with 79 percent of the samples having a high salinity hazard. All SAR values were equivalent to a low sodium hazard. No boron data were available.

07152050 - Chikaskia River near Tonkawa, Okla.--Continued

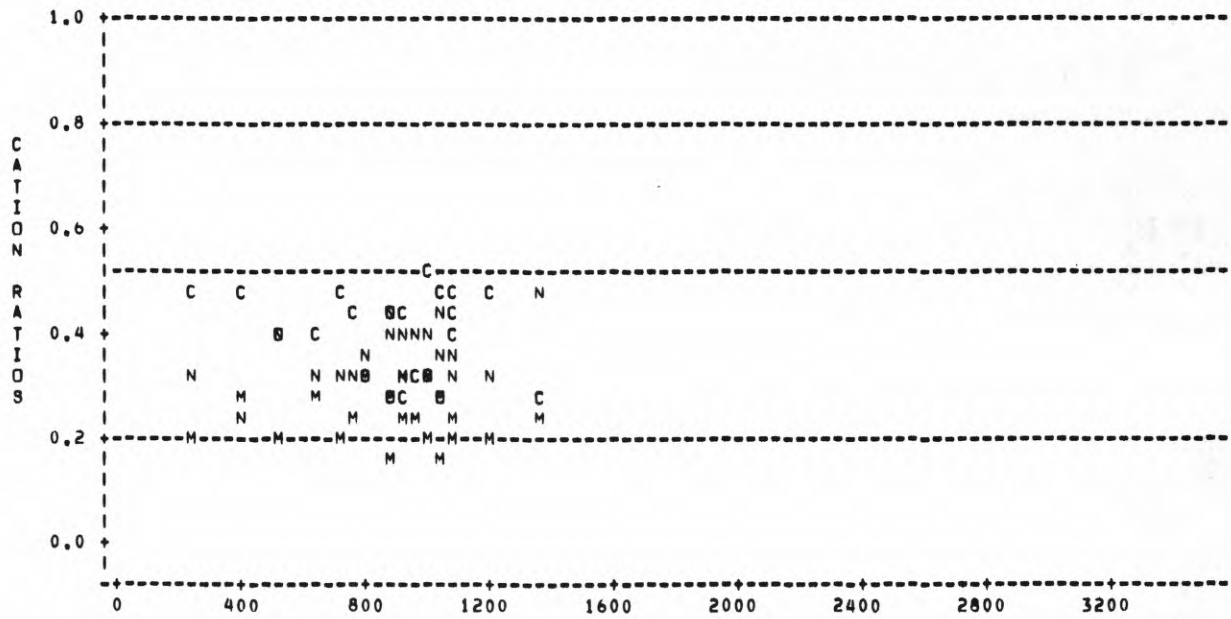
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	48	1039	237	3320	488	2.25	9.51
Dissolved solids	47	620	129	1190	227	.18	.57
pH	47	8.2	7.4	8.7	0.3	-.38	.27
Total hardness	48	308	78	665	117	.62	1.26
Chloride	48	185	22	890	133	3.44	16.60
Sulfate	47	101	19	215	41	.24	.58
Iron	0						
Fluoride	10	0.3	0.3	0.7	0.1	3.16	10.00
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	46	2.1	0.7	3.7	0.7	0.24	0.30
Boron	0						

FREQUENCY DISTRIBUTION

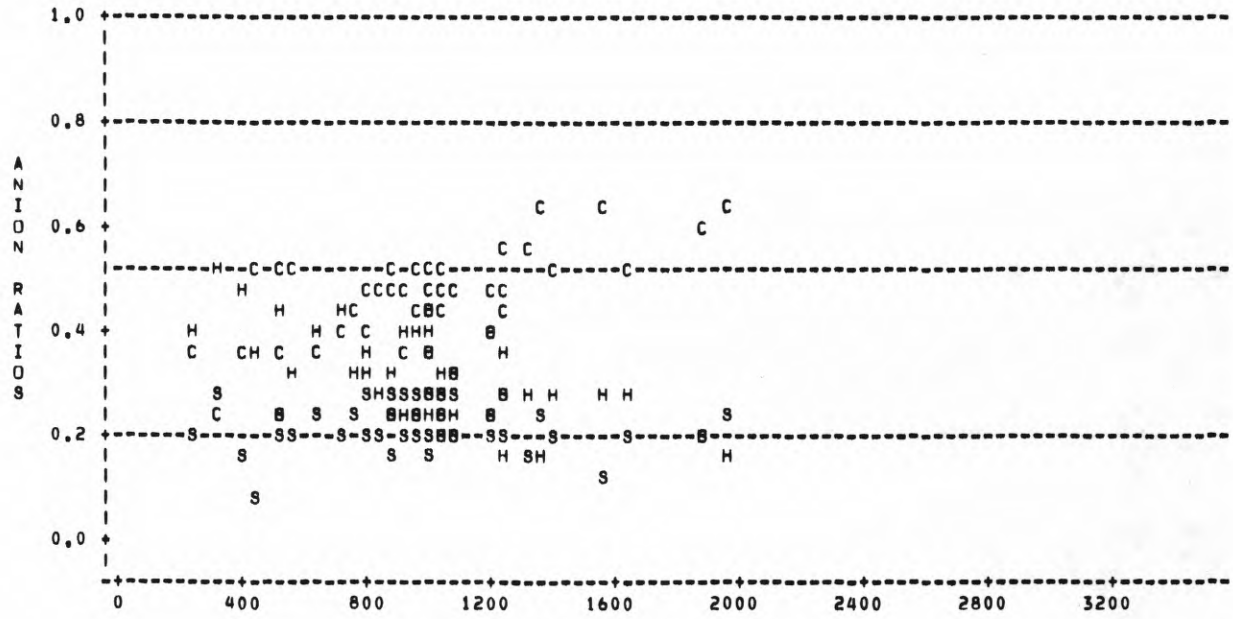
CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	499	800	989	1190	1424
Dissolved solids	301	486	639	701	888
pH	7.8	8.0	8.2	8.3	8.5
Total hardness	144	248	290	350	424
Chloride	77	126	165	192	285
Sulfate	42	76	100	126	143
Iron					
Fluoride	0.0	0.1	0.2	0.2	0.3
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	1.3	1.6	2.0	2.4	3.0
Boron					

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CHIKASKIA RIVER NR TONKAWA, OK

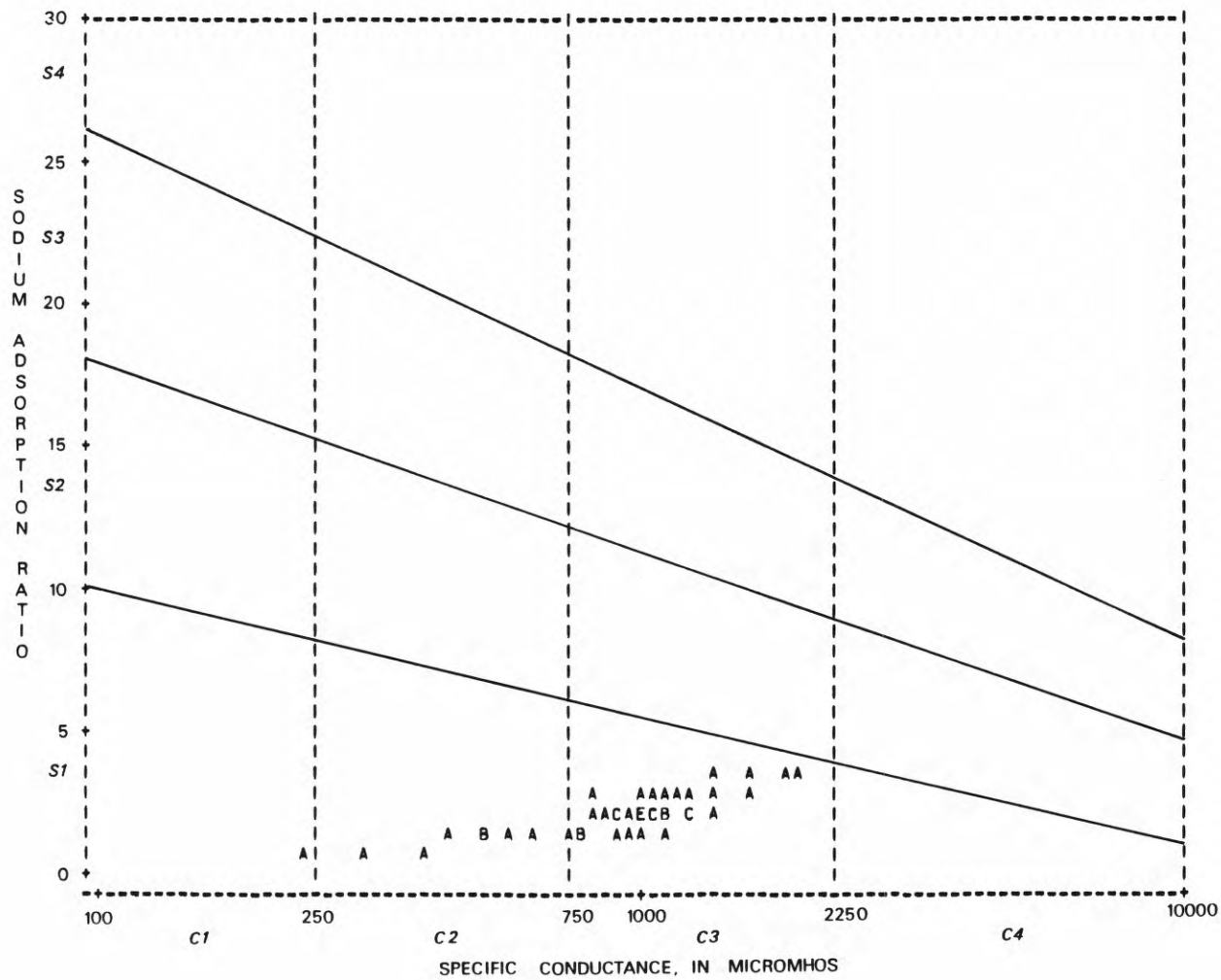


NOTE: 81 OBS HAD MISSING VALUES OR WERE OUT OF RANGE 2 OBS HIDDEN

ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CHIKASKIA RIVER NR TONKAWA, OK



IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=CHIKASKIA RIVER NR TONKAWA, OK



SALT FORK ARKANSAS RIVER BASIN

07149000 - Medicine Lodge River near Kiowa, Kans.

LOCATION.--Lat 37°02'17", long 98°28'04", in SE¼SW¼ sec. 36, T.34 S., R.11 W. Barber County, at bridge on State Highway 14, 200 ft downstream from the Atchison, Topeka, and Santa Fe Railway Co. bridge, 1.5 mi northeast of Kiowa, and at mile 22.2.

DRAINAGE AREA.--903 mi^2.

PERIOD OF RECORD.--1955 to 1957, 1960 to 1962, 1974 to 1978.

REMARKS.--Water-quality samples were collected prior to the 1978 water year by the Oklahoma District and were collected after the 1977 water year by the Kansas District, U.S. Geological Survey, Water Resources Division.

WATER TYPE.--When the specific conductance was greater than about 480 umho, which accounted for 96 percent of the samples, the water was calcium sulfate type. For specific conductance less than 480 umho, the water was calcium carbonate/bicarbonate type.

TREND.--Plots of dissolved solids, hardness, chloride, and sulfate concentrations versus time did not indicate any trend. However, the Spearman's rho for sulfate at the 95-percent probability level showed a trend of decreasing concentration. The Spearman's rhos for dissolved solids, hardness, and chloride at the 95-percent probability level showed no trend.

PUBLIC WATER SUPPLY.--Ninety-seven percent of the hardness values were greater than 180 mg/L and the average hardness was 401 mg/L. Generally, the hardness class for this water was very hard. The maximum recommended sulfate concentration of 250 mg/L was exceeded by 44 percent of the sulfate values. No toxic metal data were available. Because of the frequency by which the recommended maximum sulfate concentration was exceeded, this water may not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from low to high with 88 percent of the samples having a high salinity hazard. All SAR values were equivalent to a low sodium hazard. The data indicate that there should not be any phytotoxic effects from boron.

07149000 - Medicine Lodge River near Kiowa, Kans.--Continued

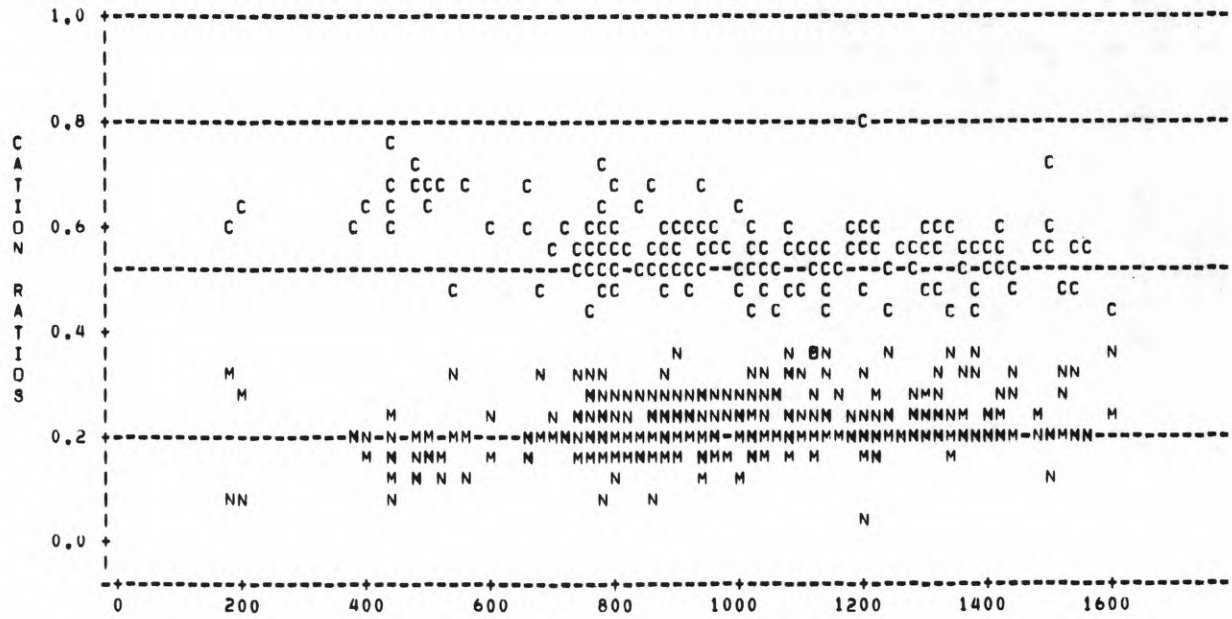
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	246	1001	182	1590	267	-0.08	0.04
Dissolved solids	205	682	115	1210	211	.11	-.28
pH	239	8.1	6.3	8.9	.3	-.98	3.23
Total hardness	224	401	100	800	120	.39	.15
Chloride	361	76	4.0	180	32	.65	.76
Sulfate	214	258	4.9	688	109	.67	.49
Iron	3	7	0	20			
Fluoride	50	.4	.1	.6	.1	-.26	1.89
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	211	1.3	0.1	2.4	0.4	-.17	0.57
Boron	22	174	0	520	121	.89	1.96

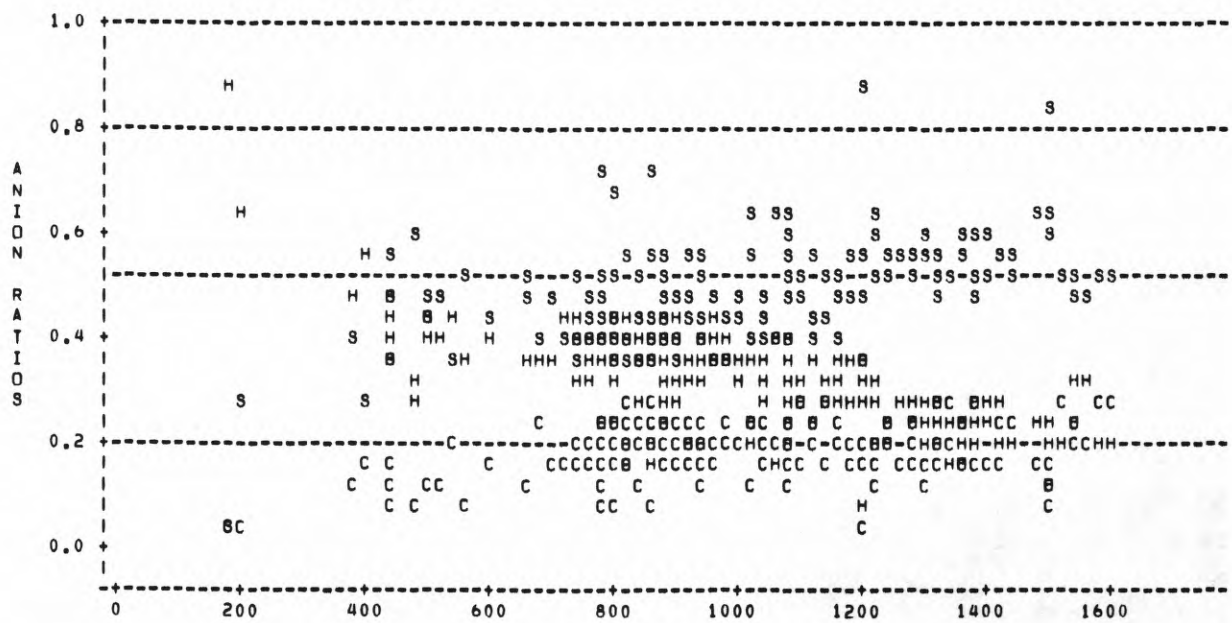
FREQUENCY DISTRIBUTION

CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	710	830	958	1190	1368
Dissolved solids	452	550	649	834	954
pH	7.6	7.9	8.1	8.2	8.4
Total hardness	268	320	379	470	566
Chloride	40	59	72	89	120
Sulfate	148	170	232	340	400
Iron					
Fluoride	0.2	0.3	0.4	0.4	0.5
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	0.8	1.1	1.3	1.5	1.9
Boron	6	95	160	215	302

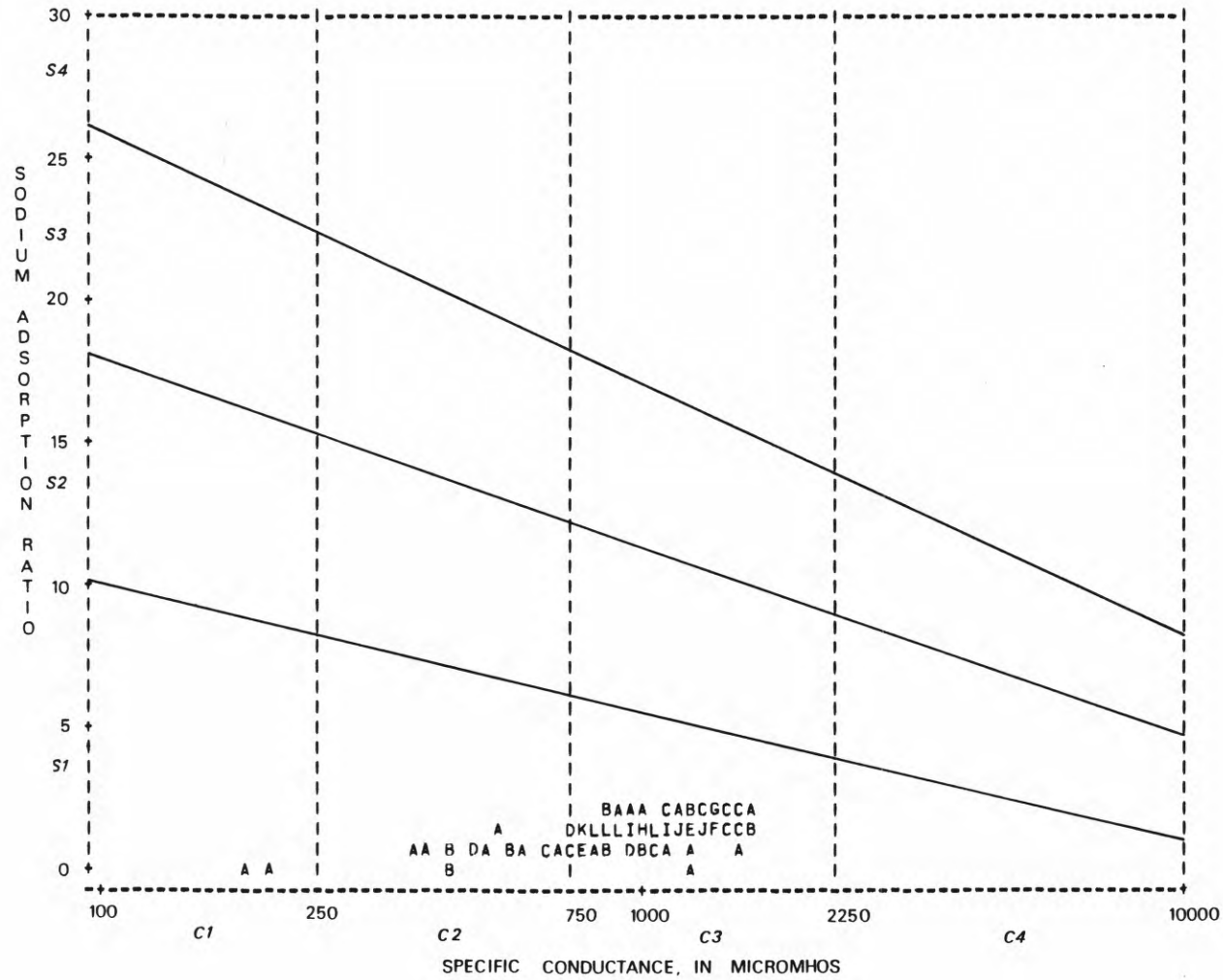
CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=MEDICINE LODGE R NR KIOWA, KS



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=MEDICINE LODGE R NR KIOWA, KS



IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=MEDICINE LODGE R NR KIOWA, KS



SALT FORK ARKANSAS RIVER BASIN

07150700 - Pond Creek near Lamont, Okla.

LOCATION.--Lat 36°40'55", long 97°33'55", in SE¼SW¼ sec. 31, T.26 N., R.3 W., Grant County, at bridge on U.S. Highway 60, 0.5 mi south of Lamont.

DRAINAGE AREA.--Not determined.

PERIOD OF RECORD.--1951 to 1955, 1958 to 1959, 1962.

WATER TYPE.--When the specific conductance was greater than 500 umho and less than 1,600 umho, which accounted for 72 percent of the samples, the water was generally sodium carbonate/bicarbonate type. For specific conductance less than 500 umho, which accounted for 22 percent of the samples, the water was carbonate/bicarbonate type without a predominant cation. Cation data were not available for specific conductance greater than 1,600 umho. No anion was predominant for specific conductance greater than 1,600 umho.

TREND.--No current data were available.

PUBLIC WATER SUPPLY.--Sixty-two percent of the hardness values were greater than 180 mg/L and the average hardness was 216 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum chloride concentration of 250 mg/L was exceeded by 3 percent of the chloride values and the recommended maximum sulfate concentration of 250 mg/L was exceeded by 4 percent of the sulfate values. No toxic metal data were available. Based on the data, this water would probably be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from low to high with 56 percent of the samples having a high salinity hazard. The sodium hazard ranged from low to medium with 90 percent of the SAR values equivalent to a low sodium hazard. No boron data were available.

07150700 - Pond Creek near Lamont, Okla.--Continued

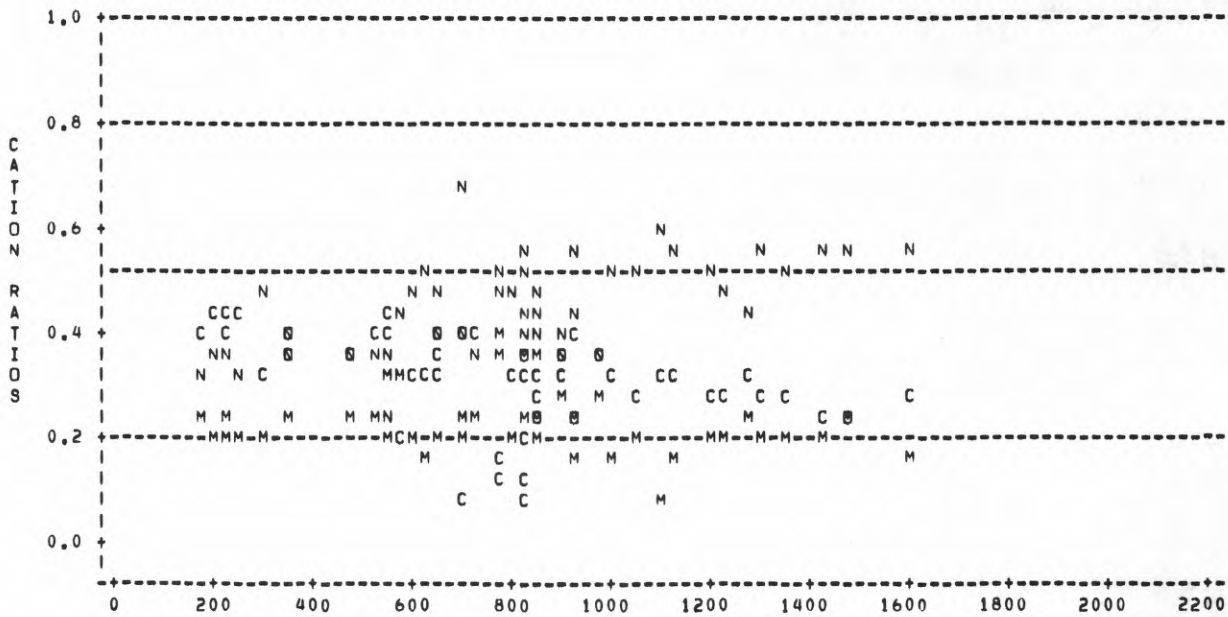
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	67	831	163	1860	431	0.47	-0.39
Dissolved solids	14	637	191	1160	340	.43	-1.34
pH	65	8.0	7.0	8.8	.3	-.39	.40
Total hardness	68	216	22	412	98	-.08	-.79
Chloride	67	81	0.0	292	66	1.22	.94
Sulfate	27	72	7.0	260	65	1.55	1.89
Iron	0						
Fluoride	0						
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	58	2.9	0.7	9.4	1.7	1.54	3.36
Boron	0						

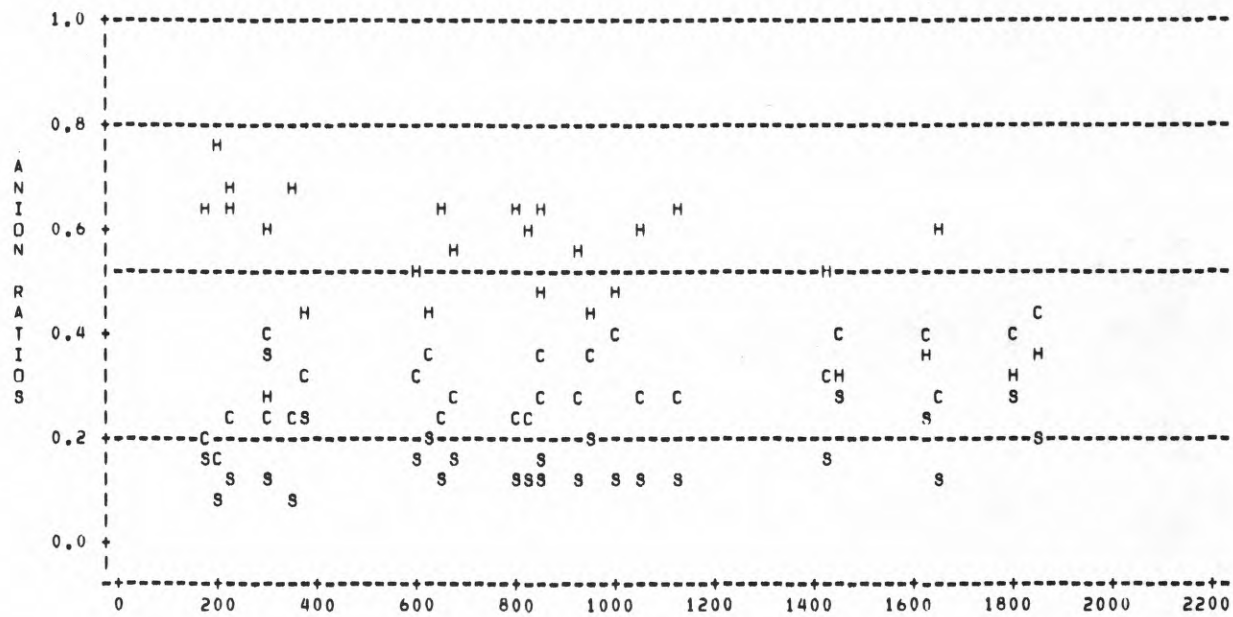
FREQUENCY DISTRIBUTION

CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	250	536	816	1052	1436
Dissolved solids	205	367	505	896	1038
pH	6.9	7.7	8.0	8.3	8.5
Total hardness	67	150	224	280	344
Chloride	17	36	52	114	169
Sulfate	11	23	54	74	188
Iron					
Fluoride					
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	0.9	1.8	2.5	3.6	4.7
Boron					

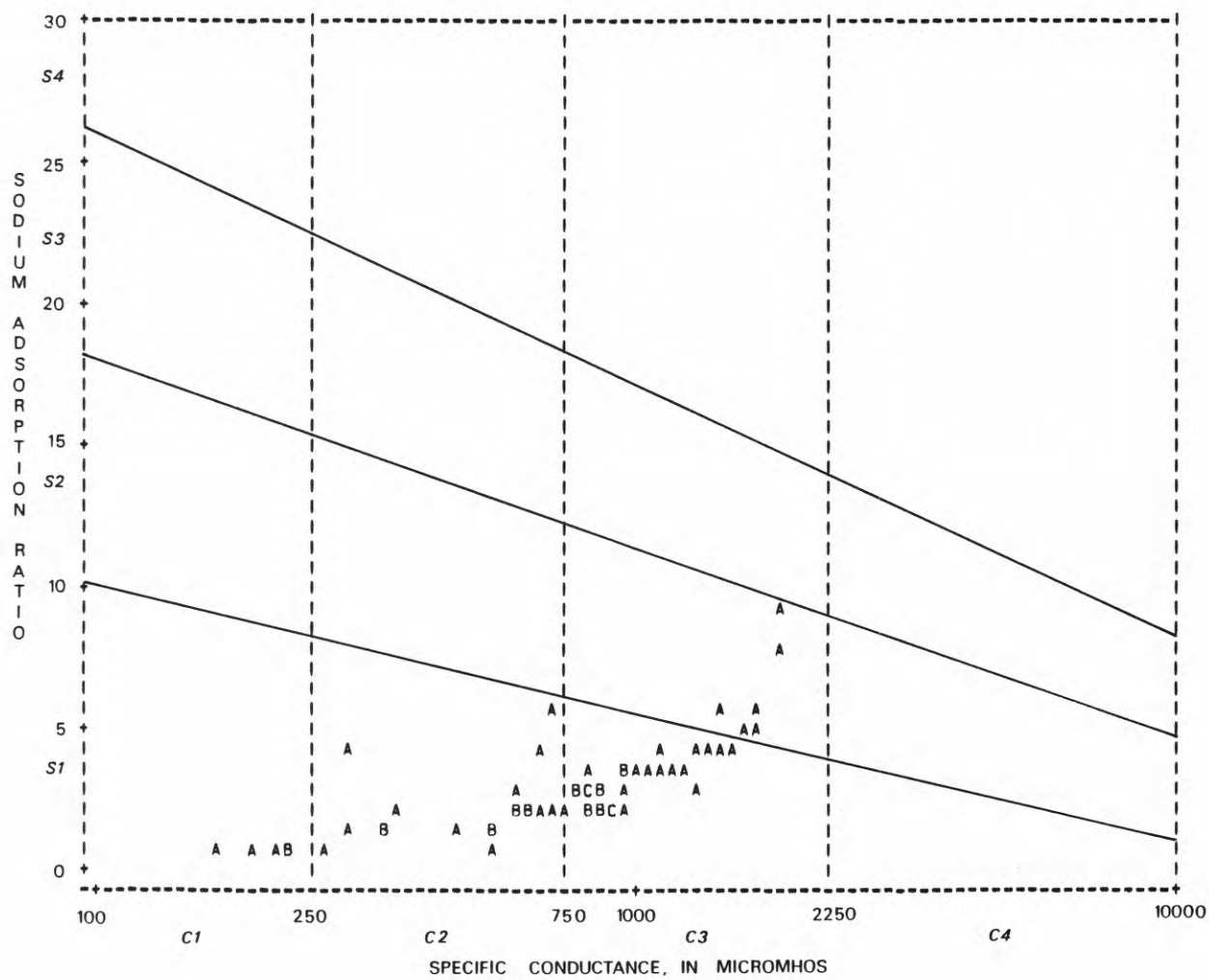
CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=POND CREEK NR LAMONT, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=POND CREEK NR LAMONT, OK



IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=POND CREEK NR LAMONT, OK



SALT FORK ARKANSAS RIVER BASIN

07148350 - Salt Fork Arkansas River near Winchester, Okla.

LOCATION.--Lat 36°57'45", long 98°46'55", in NE¼SE¼ sec. 26, T.29 N., R.13 W., Woods County, at county road bridge, 1 mi northeast of Winchester, 2.5 mi upstream from Greenwood Creek, 4.9 mi downstream from Yellowstone Creek, 5 mi downstream from State line, 19 mi northwest of Alva, and at mile 156.2.

DRAINAGE AREA.--856 mi^2.

PERIOD OF RECORD.--1960 to 1962, 1976 to 1977.

WATER TYPE.--When the specific conductance was less than about 3,000 umho, which accounted for 94 percent of the samples, the water was calcium sulfate type. Data indicate the water was sodium chloride type for specific conductance greater than 3,000 umho.

TREND.--The current period of record is insufficient, less than 5 years, to perform trend analyses.

PUBLIC WATER SUPPLY.--All of the hardness values were greater than 180 mg/L and the average hardness was 906 mg/L. The hardness class for this water was very hard. The recommended maximum chloride concentration of 250 mg/L was exceeded by 36 percent of the chloride values and the recommended maximum sulfate concentration of 250 mg/L was exceeded by 95 percent of the sulfate values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum chloride and sulfate concentrations were exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from medium to very high with 99 percent of the samples having a high or very high salinity hazard. The sodium hazard ranged from low to medium with 98 percent of the SAR values equivalent to a low sodium hazard. The concentration for 20 percent of the boron values exceeded the recommended limit of 750 ug/L for boron sensitive plants. The data indicate that phytotoxic effects could occur in some boron semitolerant plants.

07148350 - Salt Fork Arkansas River near Winchester, Okla.--Continued

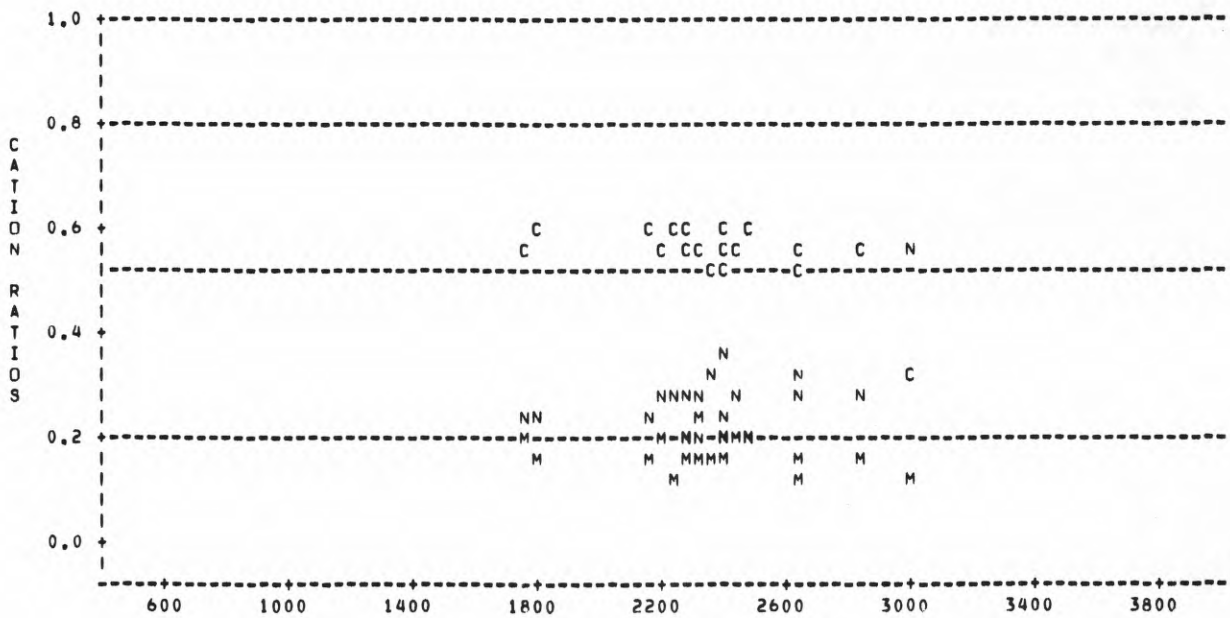
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	112	2144	700	4000	608	-0.02	0.95
Dissolved solids	81	1641	490	2320	447	-.85	-.13
pH	113	7.9	7.0	8.4	.3	-.68	.72
Total hardness	111	906	280	1440	234	-.58	.15
Chloride	113	210	24	600	110	.53	.83
Sulfate	94	775	47	1340	252	-.60	.45
Iron	0						
Fluoride	18	0.4	0.2	0.8	0.1	0.55	2.51
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	74	1.8	0.3	6.5	0.9	1.65	7.63
Boron	19	487	110	1000	240	.70	-.35

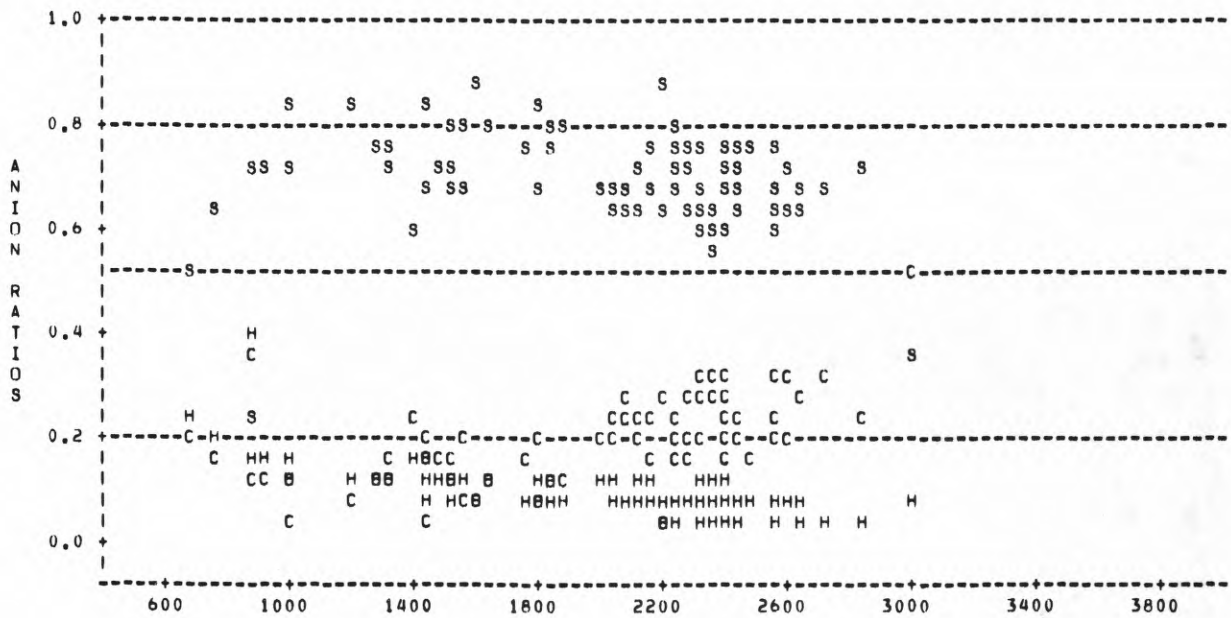
FREQUENCY DISTRIBUTION

CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	1314	1780	2230	2440	2716
Dissolved solids	996	1285	1785	1977	2119
pH	7.5	7.7	7.9	8.0	8.2
Total hardness	584	773	929	1063	1160
Chloride	56	109	208	280	324
Sulfate	438	598	790	952	1060
Iron					
Fluoride	0.2	0.3	0.5	0.5	0.5
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	0.7	1.0	1.8	2.3	2.7
Boron	227	290	415	603	821

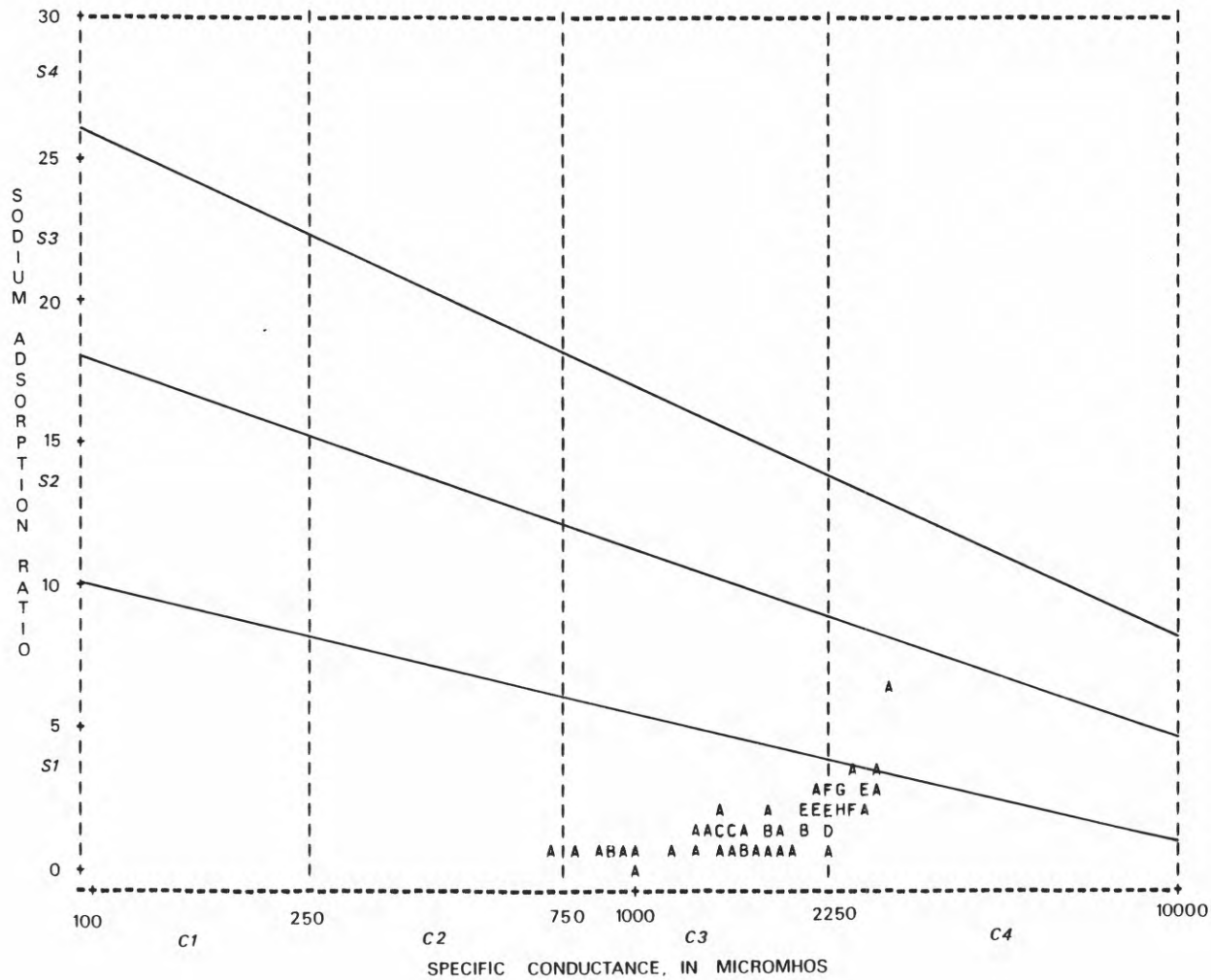
CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=SALT FORK ARKANSAS RIVER NR WINCHESTER, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=SALT FORK ARKANSAS RIVER NR WINCHESTER, OK



IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=SALT FORK ARKANSAS RIVER NR WINCHESTER, OK



SALT FORK ARKANSAS RIVER BASIN

07148400 - Salt Fork Arkansas River near Alva, Okla.

LOCATION.--Lat 36°48'45", long 98°38'50", in SW¼SW¼ sec. 18, T.27 N., R.13 W., Woods County, at bridge on U.S. Highway 281, 19 mi upstream from Medicine Lodge River, 1.0 mi northeast of Alva, and at mile 126.0.

DRAINAGE AREA.--1,009 mi^2.

PERIOD OF RECORD.--1950 to 1954, 1962, 1977 to 1978.

WATER TYPE.--When the specific conductance was greater than 1,600 umho, which accounted for 78 percent of the samples, the water was calcium sulfate type. For specific conductance less than 1,600 umho the water was sodium sulfate type.

TREND.--The current period of record is insufficient, less than 5 years, to perform trend analyses.

PUBLIC WATER SUPPLY.--Ninety-six percent of the hardness values were greater than 180 mg/L and the average hardness was 821 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum chloride concentration of 250 mg/L was exceeded by 24 percent of the chloride values and the recommended maximum sulfate concentration of 250 mg/L was exceeded by 97 percent of the sulfate values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum sulfate concentration was exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from medium to very high with 98 percent of the samples having a high or very high salinity hazard. All SAR values were equivalent to a low sodium hazard. No boron data were available.

07148400 - Salt Fork Arkansas River near Alva, Okla.--Continued

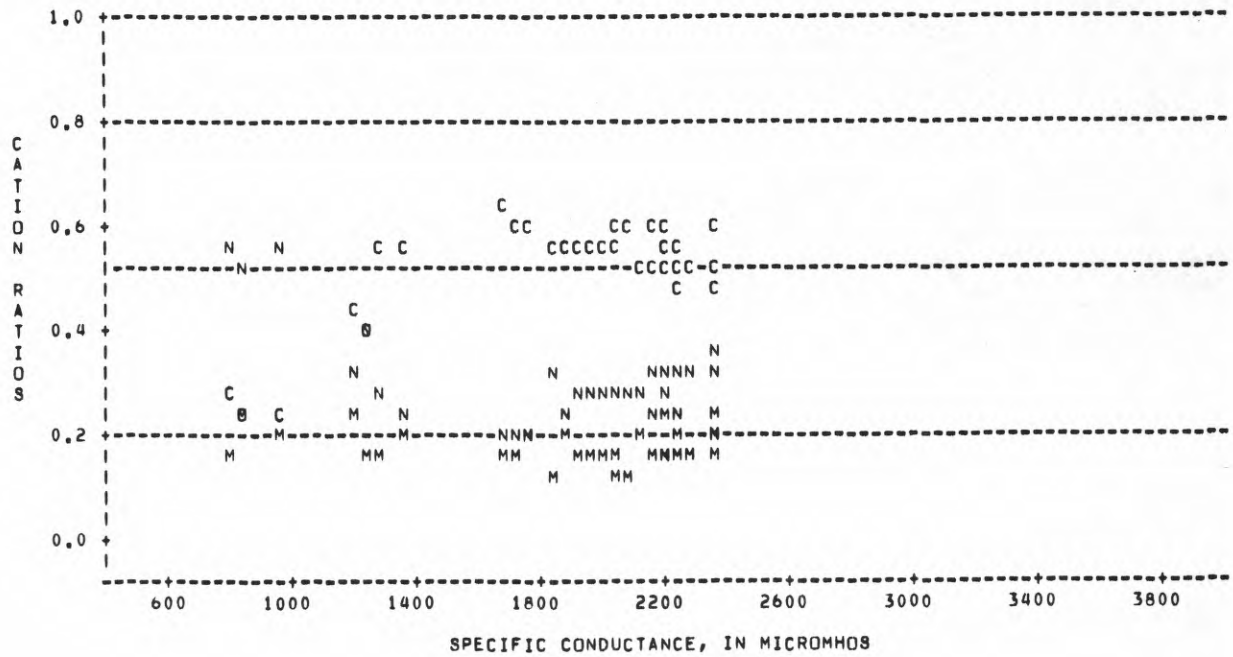
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	138	1949	627	4000	508	-0.17	1.55
Dissolved solids	95	1535	429	2370	383	-.71	.38
pH	113	7.8	6.9	8.6	.3	-.07	.42
Total hardness	110	821	164	1470	232	-.75	1.25
Chloride	134	175	23	430	90	.10	-.77
Sulfate	103	730	25	1300	209	-.36	1.46
Iron	0						
Fluoride	13	0.4	0.0	0.6	0.2	-.59	2.21
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	39	2.3	1.4	3.3	0.5	-.13	-.78
Boron	0						

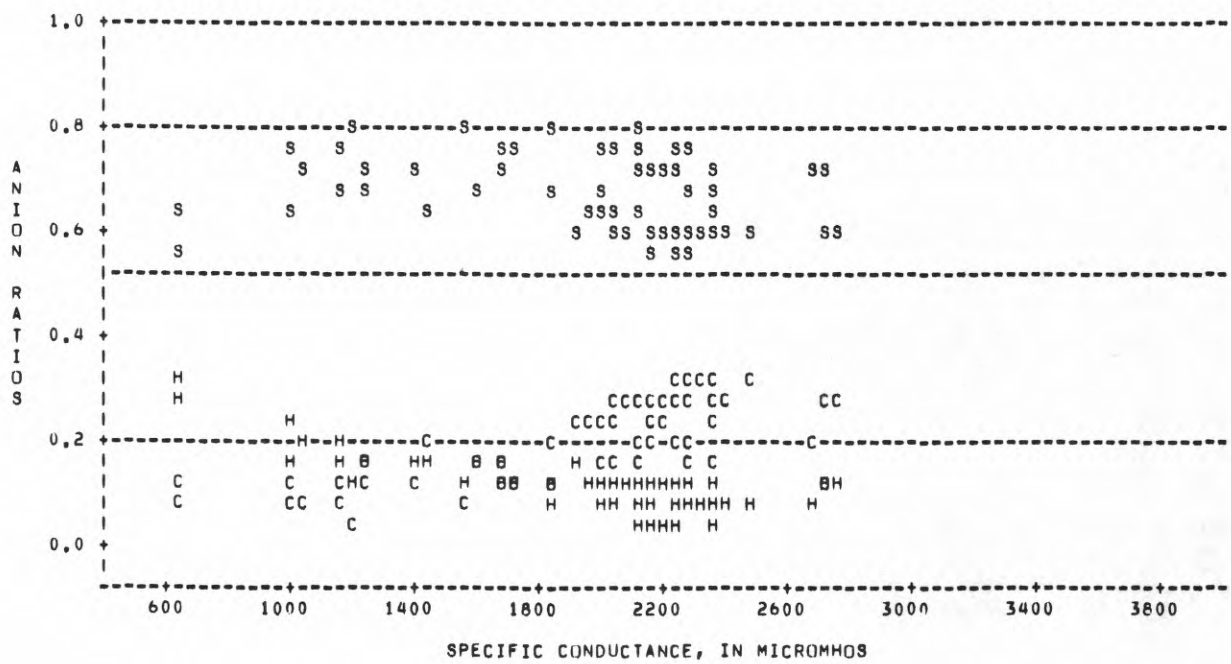
FREQUENCY DISTRIBUTION

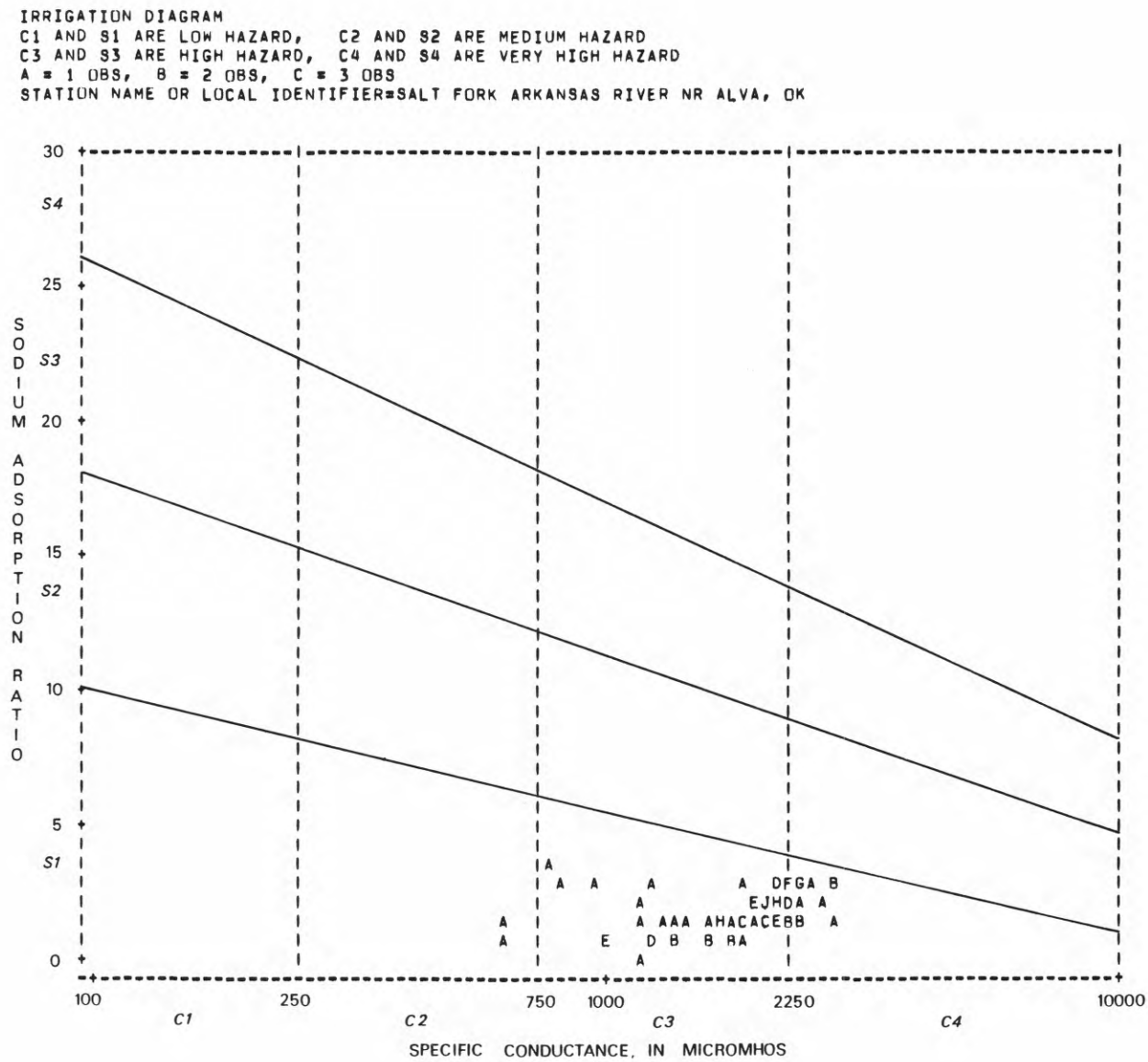
CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	1194	1682	2060	2272	2396
Dissolved solids	906	1351	1585	1771	1915
pH	7.4	7.7	7.8	8.0	8.2
Total hardness	498	742	853	935	1050
Chloride	50	108	170	250	286
Sulfate	450	652	727	845	948
Iron					
Fluoride	0.0	0.1	0.2	0.4	0.5
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	1.5	1.8	2.3	2.6	2.8
Boron					

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=SALT FORK ARKANSAS RIVER NR ALVA, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=SALT FORK ARKANSAS RIVER NR ALVA, OK




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=SALT FORK ARKANSAS RIVER NR ALVA, OK
SODIUM ADSORPTION RATIO
30
S4
25
S3
20
15
S2
10
5
S1
0
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

SALT FORK ARKANSAS RIVER BASIN

07148450 - Salt Fork Arkansas River near Ingersoll, Okla.

LOCATION.--Lat 36°49'18", long 98°21'35", in SW¼NW¼ sec. 14, T.27 N., R.11 W., Alfalfa County, at bridge on State Highways 8 and 58, 2.0 mi upstream from Medicine Lodge River, 2.5 mi northeast of Ingersoll, and at mile 120.3.

DRAINAGE AREA.--1,140 mi^2.

PERIOD OF RECORD.--1962, 1974 to 1978.

WATER TYPE.--When the specific conductance was greater than about 500 umho, which accounted for 99 percent of the samples, the water was calcium sulfate type. For specific conductance less than about 500 umho, the water was calcium type with no predominant anion.

TREND.--Plots of the dissolved solids, hardness, sulfate, and chloride concentrations versus time indicated a trend of increasing concentration only for chloride. The Spearman's rho for this constituent at the 95-percent probability level confirmed a positive trend. The Spearman's rho for sulfate at the 95-percent probability level indicated a negative trend. The Spearman's rhos for hardness and dissolved solids showed no trend.

PUBLIC WATER SUPPLY.--Ninety-nine percent of the hardness values were greater than 180 mg/L and the average hardness was 860 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum chloride concentration of 250 mg/L was exceeded by 20 percent of the chloride values and the recommended maximum sulfate concentration of 250 mg/L was exceeded by 95 percent of the sulfate values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum sulfate concentration was exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from medium to very high with 96 percent of the samples having a high or very high salinity hazard, specific conductance greater than 750 umho. All SAR values were equivalent to a low sodium hazard. None of the six boron concentrations exceeded the limit, 750 ug/L, for boron sensitive plants.

07148450 - Salt Fork Arkansas River near Ingersoll, Okla.--Continued

UNIVARIATE STATISTICS

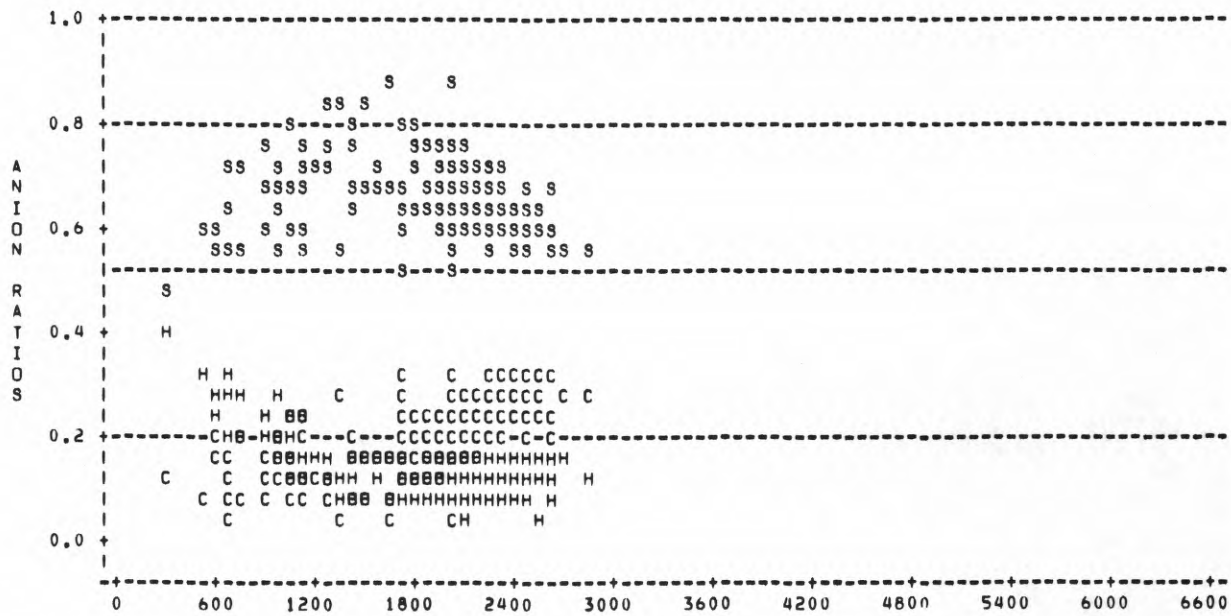
CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	292	2019	289	6000	588	0.70	9.00
Dissolved solids	248	1546	188	2330	412	-1.26	.99
pH	289	8.0	7.0	8.7	0.3	-.39	.10
Total hardness	244	860	120	1300	219	-1.20	1.31
Chloride	247	181	12	370	82	-.32	-.76
Sulfate	248	713	64	1170	193	-1.31	1.40
Iron	0						
Fluoride	7	0.4	0.4	0.4			
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	188	2.0	0.3	3.1	0.7	-.63	-.32
Boron	6	377	240	550			

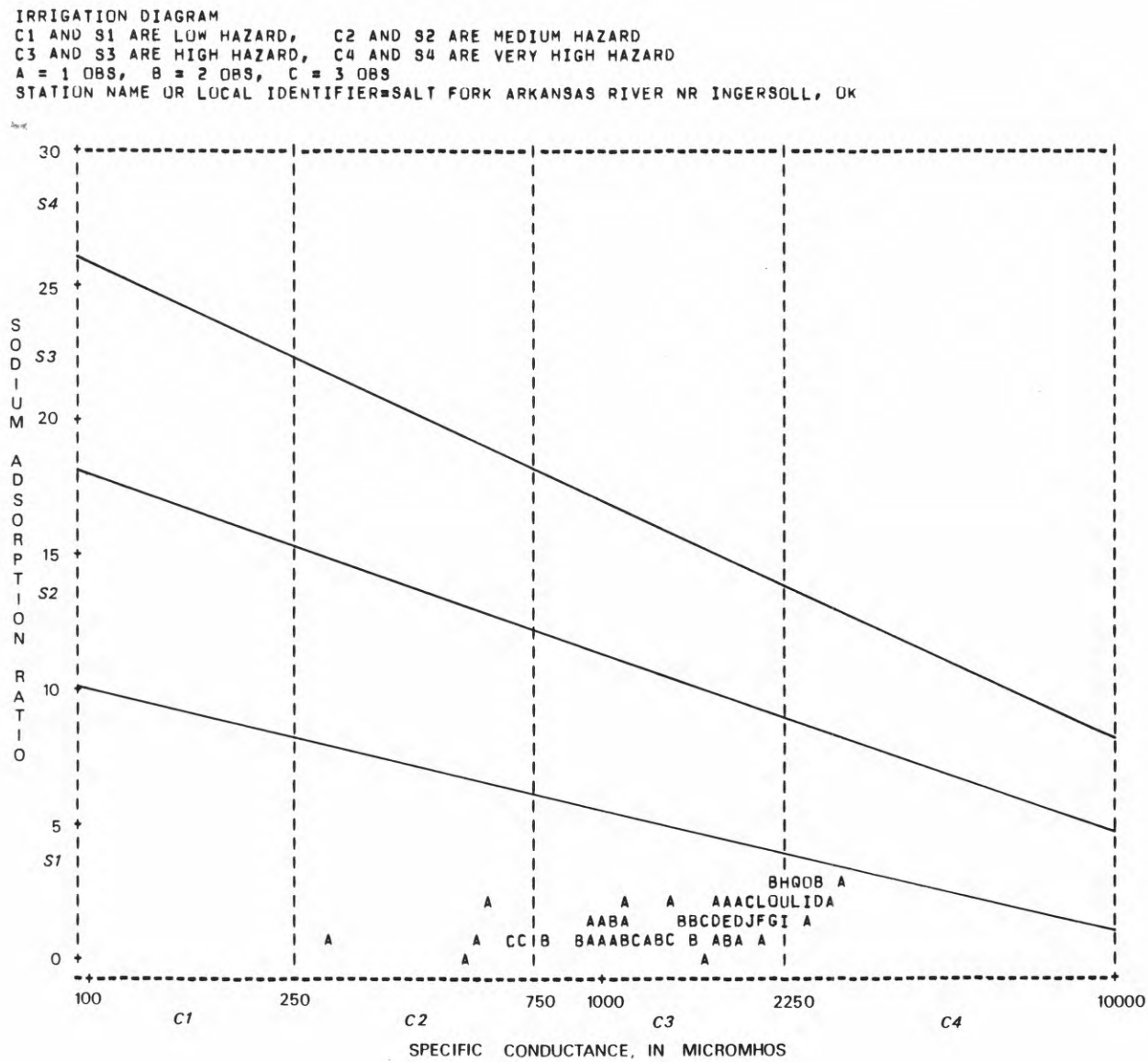
FREQUENCY DISTRIBUTION

CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	1112	1770	2150	2340	2486
Dissolved solids	850	1410	1690	1830	1901
pH	7.5	7.8	8.0	8.2	8.3
Total hardness	466	805	910	990	1069
Chloride	49	120	190	240	280
Sulfate	376	650	770	835	887
Iron					
Fluoride					
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	0.8	1.6	2.0	2.4	2.8
Boron					

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=SALT FORK ARKANSAS RIVER NR INGERSOLL, OK

ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=SALT FORK ARKANSAS RIVER NR INGERSOLL, OK




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=SALT FORK ARKANSAS RIVER NR INGERSOLL, OK
SODIUM ADSORPTION RATIO
30
S4
25
S3
20
15
S2
10
5
S1
0
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

SALT FORK ARKANSAS RIVER BASIN

07150500 - Salt Fork Arkansas River near Jet, Okla.

LOCATION.--Lat 36°45'11", long 98°07'44", in NE¼NE¼ sec. 11, T.26 N., R.9 W., Alfalfa County, at county road bridge 0.6 mi downstream from Great Salt Plains Dam, 4 mi upstream from Wagon Creek, 6 mi northeast of Jet, and at mile 102.7.

DRAINAGE AREA.--3,202 mi^2, of which 8 mi^2 is probably noncontributing.

PERIOD OF RECORD.--1951 to 1963, 1965 to 1978.

WATER TYPE.--The water was sodium chloride type throughout the range of measured specific conductance.

TREND.--Plots of dissolved solids, hardness, chloride, and sulfate concentrations versus time did not indicate any trend. The Spearman's rhos for these constituents at the 95-percent probability level also did not indicate any trend.

PUBLIC WATER SUPPLY.--Ninety-nine percent of hardness values were greater than 180 mg/L and the average hardness concentration was 720 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum sulfate concentration of 250 mg/L was exceeded by 93 percent of the sulfate values, and the recommended maximum chloride concentration of 250 mg/L was exceeded by more than 99 percent of the chloride values. The recommended maximum pH value of 9.0 was exceeded by less than 1 percent of the pH values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum sulfate and chloride concentrations were exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from high to very high with 99 percent of the samples having a very high salinity hazard, specific conductance greater than 2,250 umho. The sodium hazard ranged from low to very high with about 90 percent of the SAR values equivalent to a very high sodium hazard. The data indicate that phytotoxic effects from boron should not occur. However, due to the small number of boron values, 28, and the occurrence of significant concentrations of boron, 8 percent of the values were greater than 500 ug/L, the possibility does exist that boron concentrations could reach phytotoxic levels.

07150500 - Salt Fork Arkansas River near Jet, Okla.--Continued

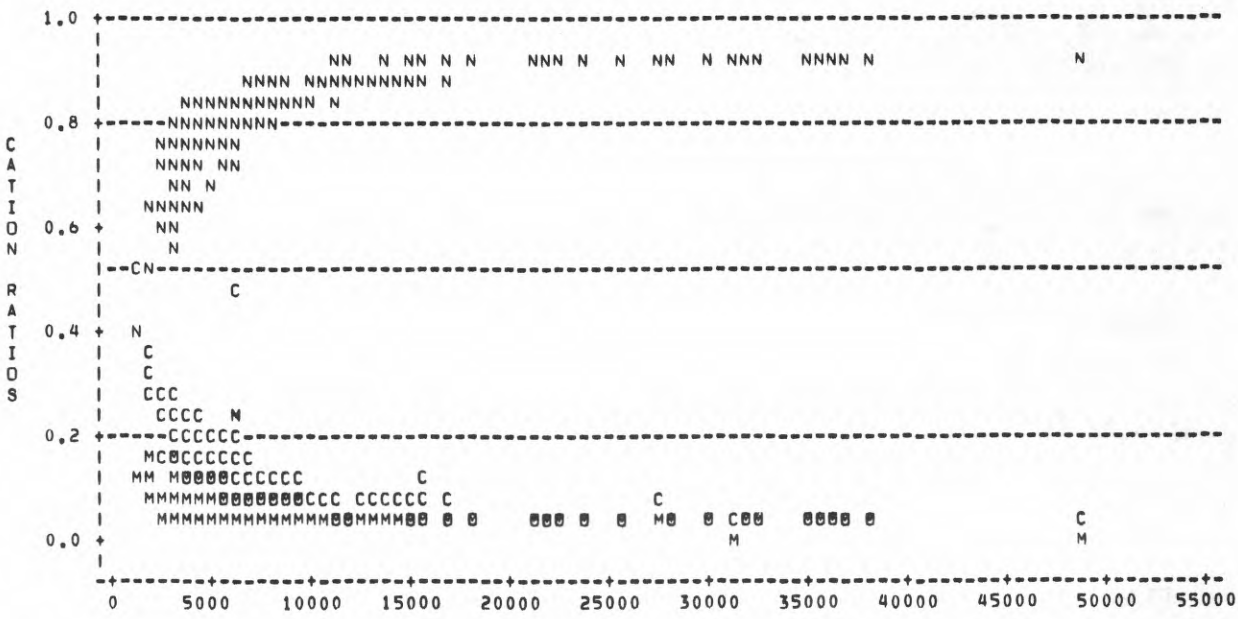
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	662	10987	1170	49000	7292	1.70	3.39
Dissolved solids	535	6290	1050	34600	4543	2.42	7.85
pH	594	7.9	6.4	9.8	0.4	-.85	.95
Total hardness	562	720	120	12900	581	16.67	346.39
Chloride	624	3576	150	19000	2750	1.81	3.95
Sulfate	538	502	44	1800	197	2.35	8.08
Iron	0						
Fluoride	30	0.2	0.0	0.4	0.2	-.26	-1.66
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	470	34	2.3	125	21	1.11	1.33
Boron	28	243	0	620	173	.54	-.56

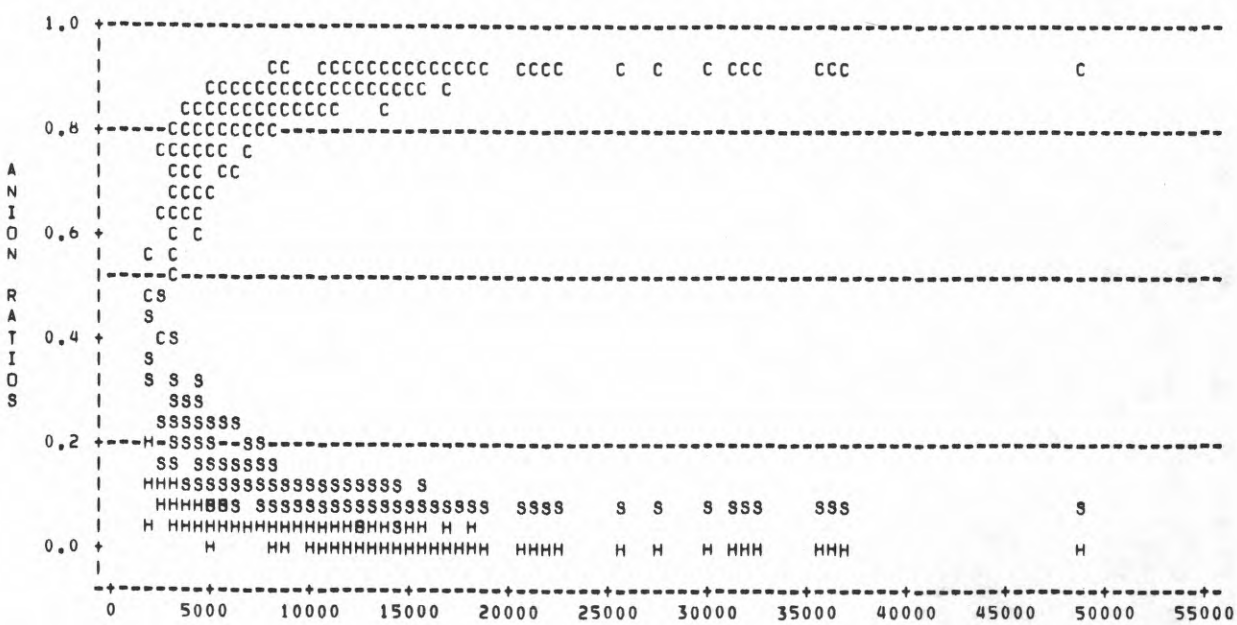
FREQUENCY DISTRIBUTION

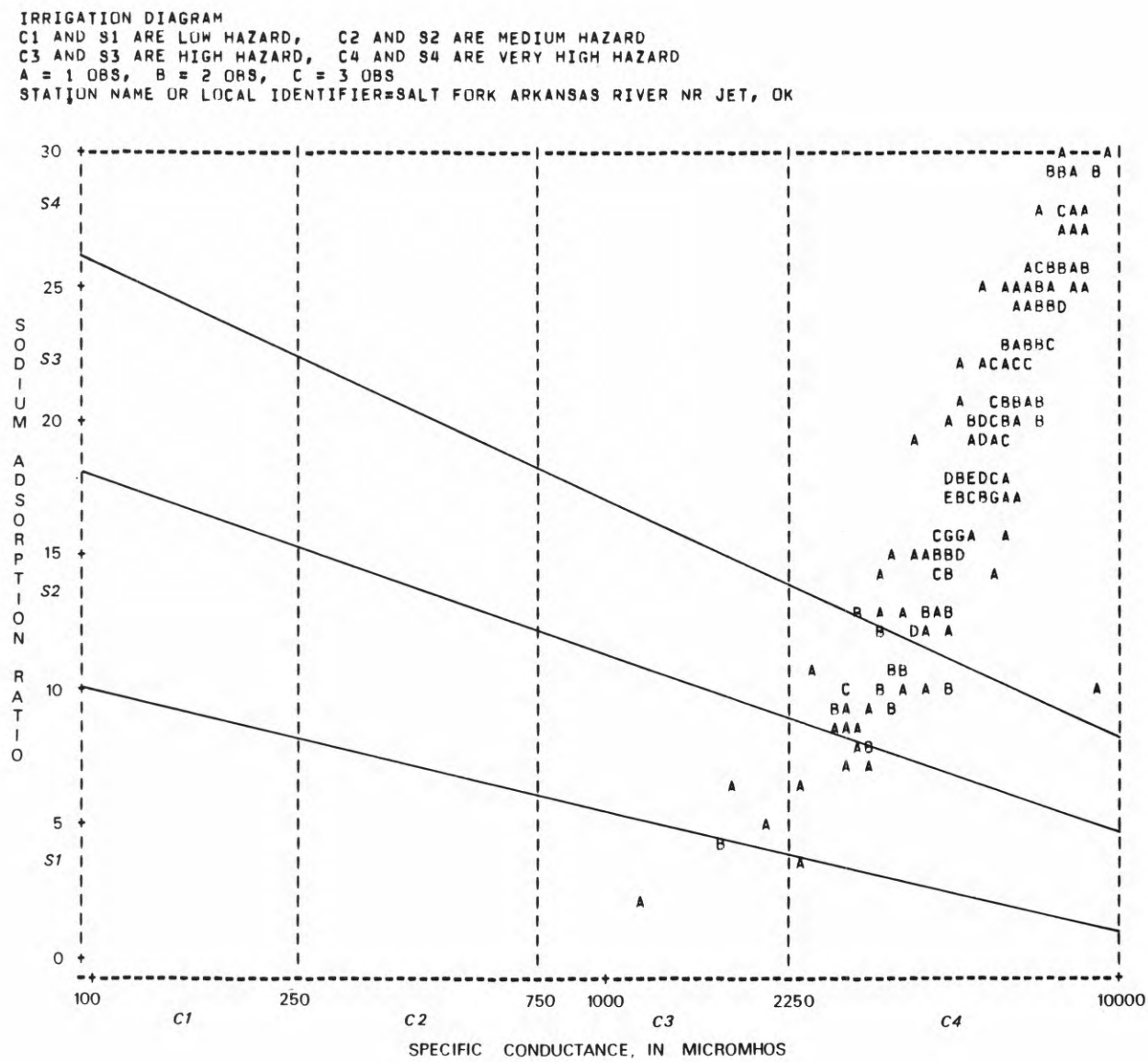
CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	4472	5715	9230	13875	19721
Dissolved solids	2655	3249	4825	7888	10550
pH	7.2	7.5	7.9	8.2	8.4
Total hardness	457	530	620	778	1000
Chloride	1134	1600	3000	4600	6880
Sulfate	339	392	450	559	700
Iron					
Fluoride	0.0	0.0	0.2	0.3	0.3
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	12	18	29	46	60
Boron	25	95	190	370	460

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=SALT FORK ARKANSAS RIVER NR JET, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=SALT FORK ARKANSAS RIVER NR JET, OK




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=SALT FORK ARKANSAS RIVER NR JET, OK
SODIUM ADSORPTION RATIO
30
25
20
15
10
5
0
S4
S3
S2
S1
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

SALT FORK ARKANSAS RIVER BASIN

07151000 - Salt Fork Arkansas River at Tonkawa, Okla.

LOCATION.--Lat 36°40'13", long 97°18'33", in NW¼SE¼ sec. 4, T.25 N., R.1 W., Kay County, at bridge on U.S. Highway 77 in Tonkawa, 4 mi downstream from Thompson Creek, 7.8 mi upstream from Chikaskia River, and at mile 33.8.

DRAINAGE AREA.--4,528 mi^2, of which 8 mi^2 is probably noncontributing.

PERIOD OF RECORD.--1948, 1952 to 1963, 1968 to 1978.

WATER TYPE.--The water was sodium chloride type throughout the range of measured specific conductance.

TREND.--Plots of dissolved solids, hardness, chloride, and sulfate concentration versus time indicated trends of increasing concentration for dissolved solids, hardness, and chloride. The Spearman's rhos for all four constituents at the 95-percent probability level indicated positive trends.

PUBLIC WATER SUPPLY.--Ninety-two percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 426 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum sulfate concentration of 250 mg/L was exceeded by 74 percent of the sulfate values and the recommended maximum chloride concentration of 250 mg/L was exceeded by 94 percent of the chloride values. The recommended maximum pH value of 9.0 was exceeded by less than 0.5 percent of the pH values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum sulfate and chloride concentrations were exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from low to very high with 77 percent of the samples having a very high salinity hazard. The sodium hazard ranged from low to very high with approximately 65 percent of the SAR values equivalent to a very high sodium hazard. One percent of the boron values exceeded the recommended limit, 750 ug/L, for boron sensitive plants.

07151000 - Salt Fork Arkansas River at Tonkawa, Okla.--Continued

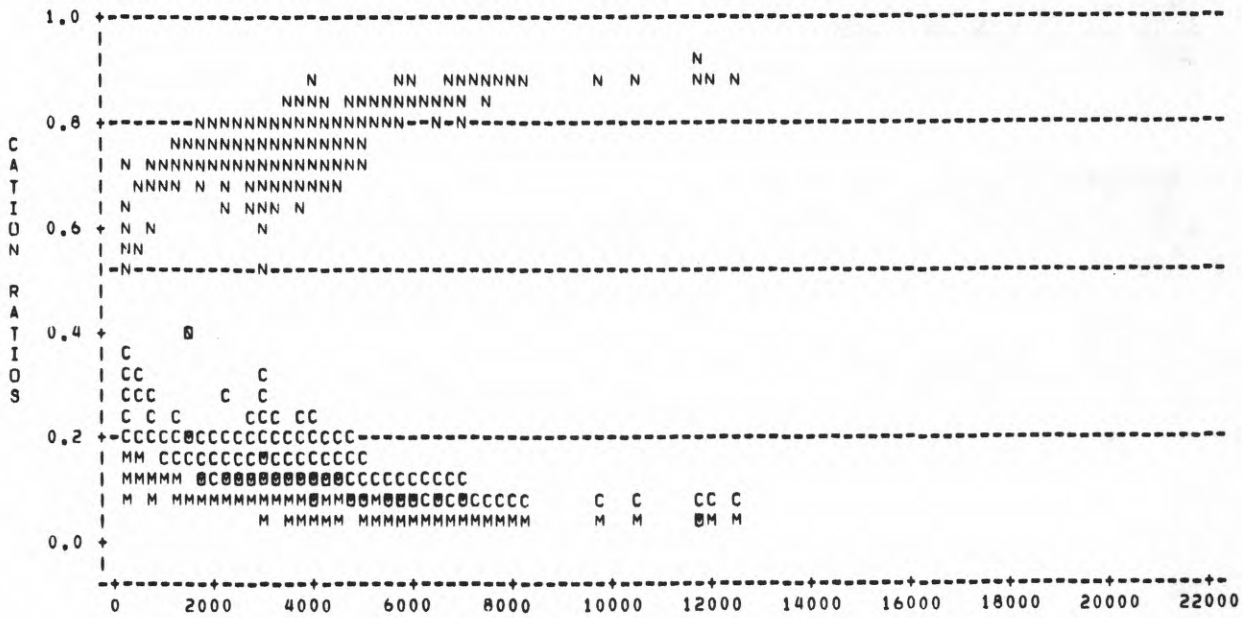
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	903	5124	208	17900	2775	0.87	0.97
Dissolved solids	731	2797	148	7800	1469	.84	.84
pH	784	8.1	6.4	9.3	.4	-.83	.92
Total hardness	767	426	36	1030	155	-.01	.60
Chloride	857	1467	29	5960	935	1.10	1.38
Sulfate	764	283	8.6	3500	163	10.11	199.97
Iron	0						
Fluoride	40	0.3	0.1	0.5	0.1	-.82	2.06
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	675	18	1.4	51	9.2	.91	.71
Boron	38	298	120	820	143	1.57	3.47

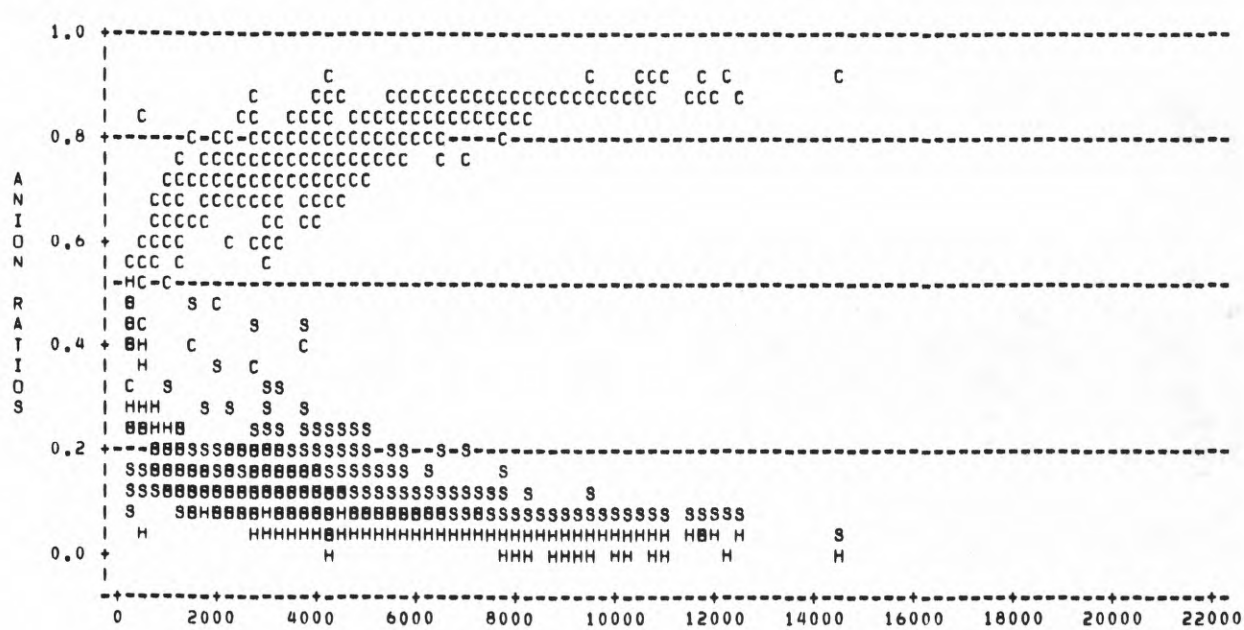
FREQUENCY DISTRIBUTION

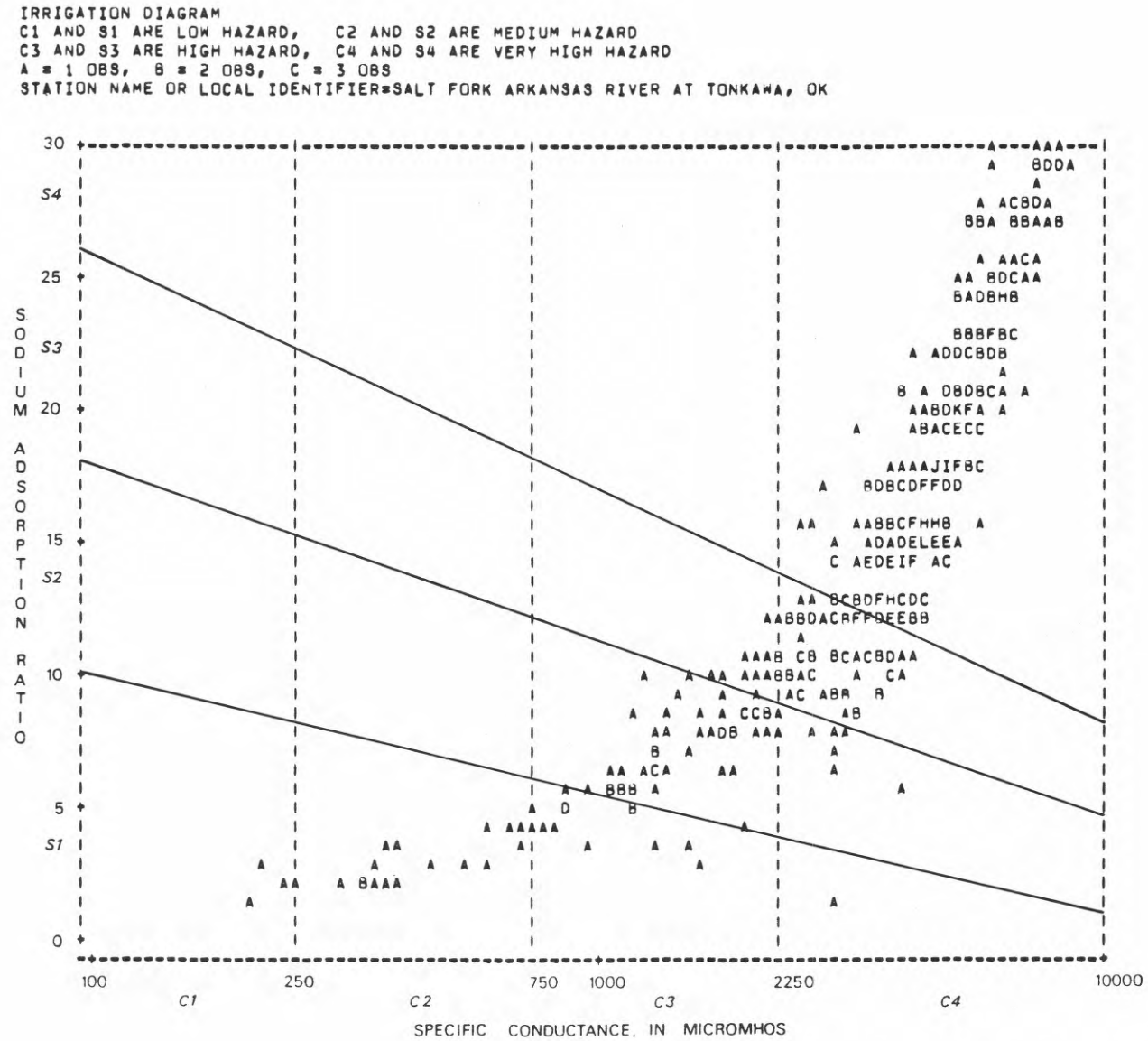
CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	1833	3468	4650	6480	9140
Dissolved solids	1021	1930	2628	3356	4789
pH	7.5	7.8	8.1	8.3	8.4
Total hardness	209	335	440	515	590
Chloride	424	850	1260	1900	2858
Sulfate	120	205	300	353	407
Iron					
Fluoride	0.1	0.2	0.3	0.3	0.3
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	7.9	12	16	22	31
Boron	150	190	260	350	472

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=SALT FORK ARKANSAS RIVER AT TONKAWA, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=SALT FORK ARKANSAS RIVER AT TONKAWA, OK




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=SALT FORK ARKANSAS RIVER AT TONKAWA, OK
SODIUM ADSORPTION RATIO
30
25
20
15
10
5
0
S4
S3
S2
S1
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

SALT FORK ARKANSAS RIVER BASIN

07152200 - Salt Fork Arkansas River near Marland, Okla.

LOCATION.--Lat 36°36'27", long 97°36'35", in NE¼NE¼ sec. 36, T.25 N., R.1 E., Kay County, at bridge on State Highway 156, 3 mi north of Marland.

DRAINAGE AREA.--Not determined.

PERIOD OF RECORD.--1951, 1960 to 1963.

WATER TYPE.--The water was sodium chloride type throughout the range of measured specific conductance.

TREND.--No current data were available.

PUBLIC WATER SUPPLY.--Ninety-five percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 402 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum sulfate concentration of 250 mg/L was exceeded by 46 percent of the sulfate values and the recommended maximum chloride concentration of 250 mg/L was exceeded by 92 percent of the chloride values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum chloride concentration was exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from high to very high with 84 percent of the samples having a very high salinity hazard. The sodium hazard ranged from low to very high with approximately 27 percent of the SAR values equivalent to a high or very high sodium hazard. None of the boron concentrations exceeded the recommended limit for boron sensitive plants.

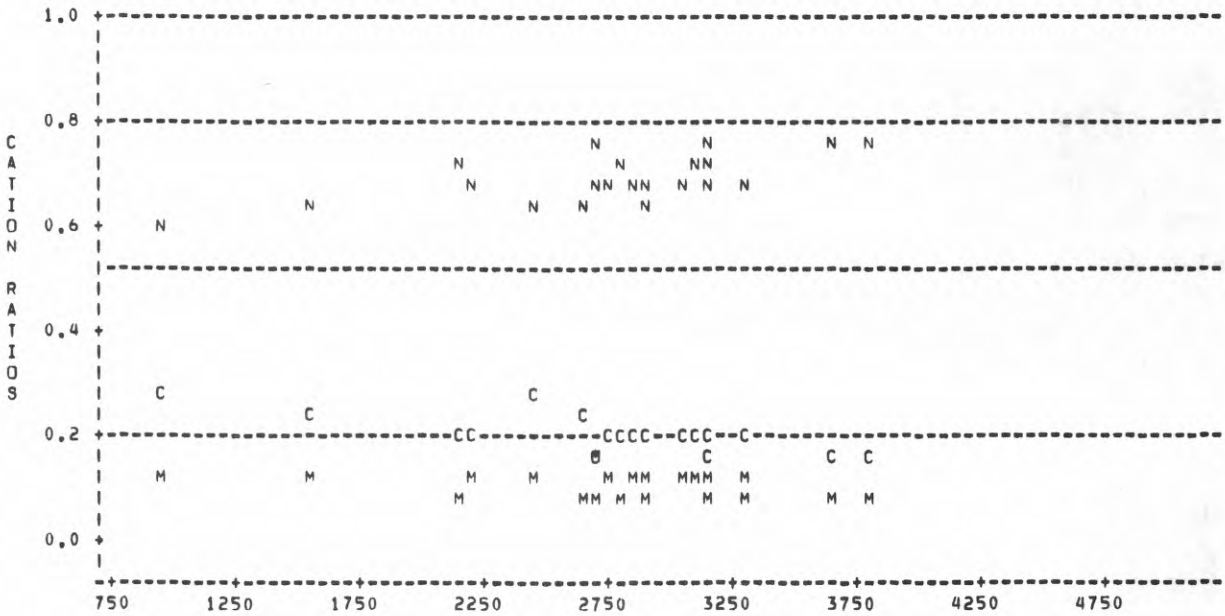
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	37	2932	943	5180	877	-0.14	1.38
Dissolved solids	37	1748	529	3070	531	-.22	1.27
pH	37	8.0	7.3	8.5	.3	-.21	-.63
Total hardness	37	402	162	535	93	-1.19	.90
Chloride	37	719	195	1450	259	.45	1.75
Sulfate	37	226	61	338	71	-.68	-.10
Iron	0						
Fluoride	10	0.4	0.1	0.6	0.2	-.13	-1.26
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	37	10	4.1	19	3.3	1.05	1.94
Boron	2	30	20	40			

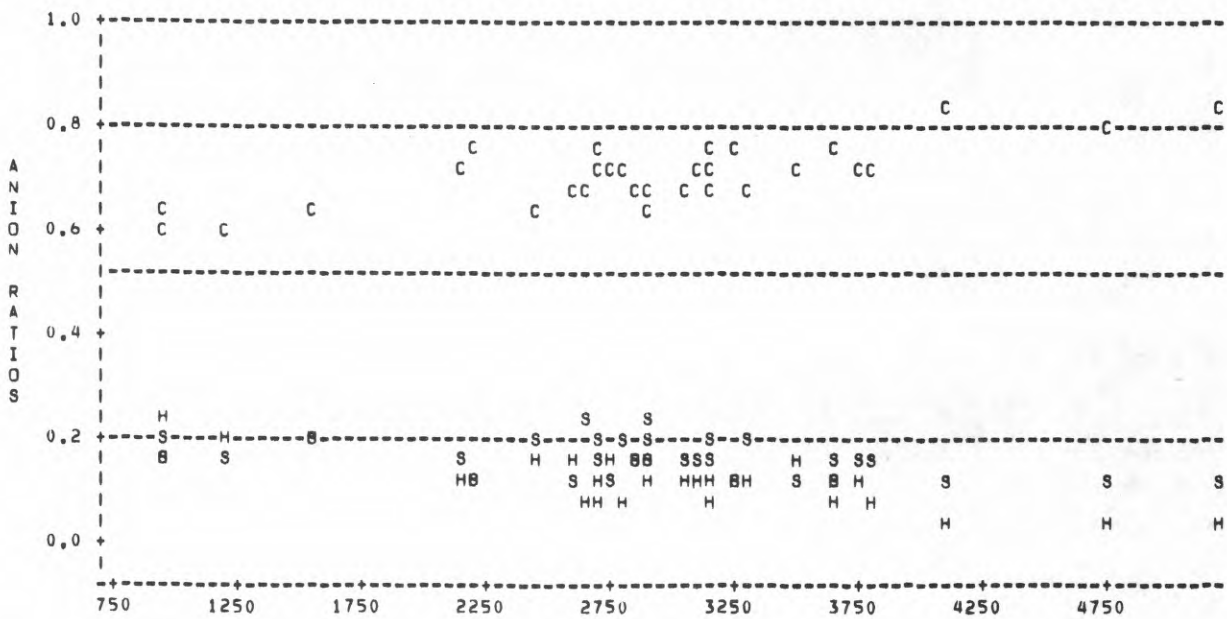
FREQUENCY DISTRIBUTION

CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	1452	2645	2890	3295	3779
Dissolved solids	842	1562	1735	1990	2296
pH	7.6	7.8	8.0	8.3	8.4
Total hardness	242	352	431	458	492
Chloride	301	616	688	788	955
Sulfate	104	178	246	267	308
Iron					
Fluoride	0.1	0.2	0.3	0.4	0.5
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	5.7	8.4	9.6	10	13
Boron					

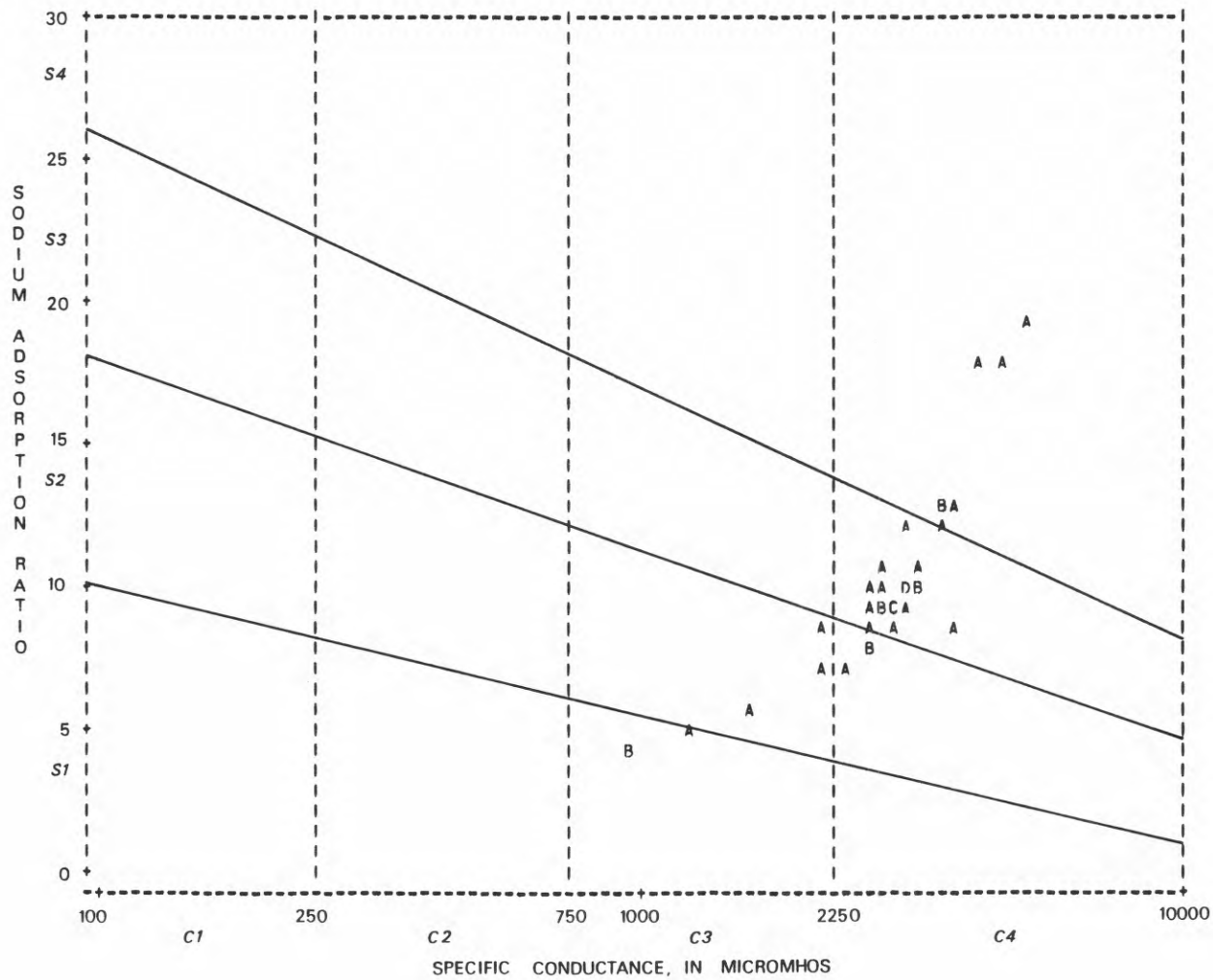
CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=SALT FORK ARKANSAS RIVER NR MARLAND, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=SALT FORK ARKANSAS RIVER NR MARLAND, OK



IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=SALT FORK ARKANSAS RIVER NR MARLAND, OK



07157940 - Bluff Creek near Buttermilk, Kans.

LOCATION.--Lat 37°01'55", long 99°28'45", in NW¼ sec. 3, T.35 S., R.20 W., Comanche County, at county road bridge, 2.2 mi north of Kansas-Oklahoma State line, 11.3 mi southwest of Buttermilk, and at mile 0.3.

DRAINAGE AREA.--657 mi^2, of which 76 mi^2 is probably noncontributing.

PERIOD OF RECORD.--1973 to 1978.

REMARKS.--Water-quality samples were collected through the 1976 water year by the Oklahoma District, and after the 1976 water year by the Kansas District, U.S. Geological Survey.

WATER TYPE.--When the specific conductance was less than 800 umho, which accounted for 32 percent of the samples, the water was calcium carbonate/bicarbonate type. For specific conductance greater than 800 umho and less than 2,100 umho, which accounted for 59 percent of the samples, the water was calcium sulfate type. For specific conductance greater than 2,100 umho there was no predominant ion; however, the ion ratios for sodium and chloride increased.

TREND.--Plots of dissolved solids, hardness, chloride, and sulfate concentrations versus time did not indicate any trend. The Spearman's rhos at the 95-percent probability level for dissolved solids, hardness, and sulfate confirmed the condition of no trend; however, the Spearman's rho for chloride indicated the presence of a positive trend.

PUBLIC WATER SUPPLY.--Ninety percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 418 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum chloride concentration of 250 mg/L was exceeded by 14 percent of the chloride values and the recommended maximum sulfate concentration of 250 mg/L was exceeded by 26 percent of the sulfate values. No toxic metal data were available. Although the chloride and sulfate concentrations exceeded the recommended maximums fairly frequently, the water at this location might be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from low to very high with 75 percent of the samples having a high or very high salinity hazard. The sodium hazard ranged from low to medium with 99 percent of the SAR values equivalent to a low sodium hazard. No boron data were available.

07157940 - Bluff Creek near Buttermilk, Kans.--Continued

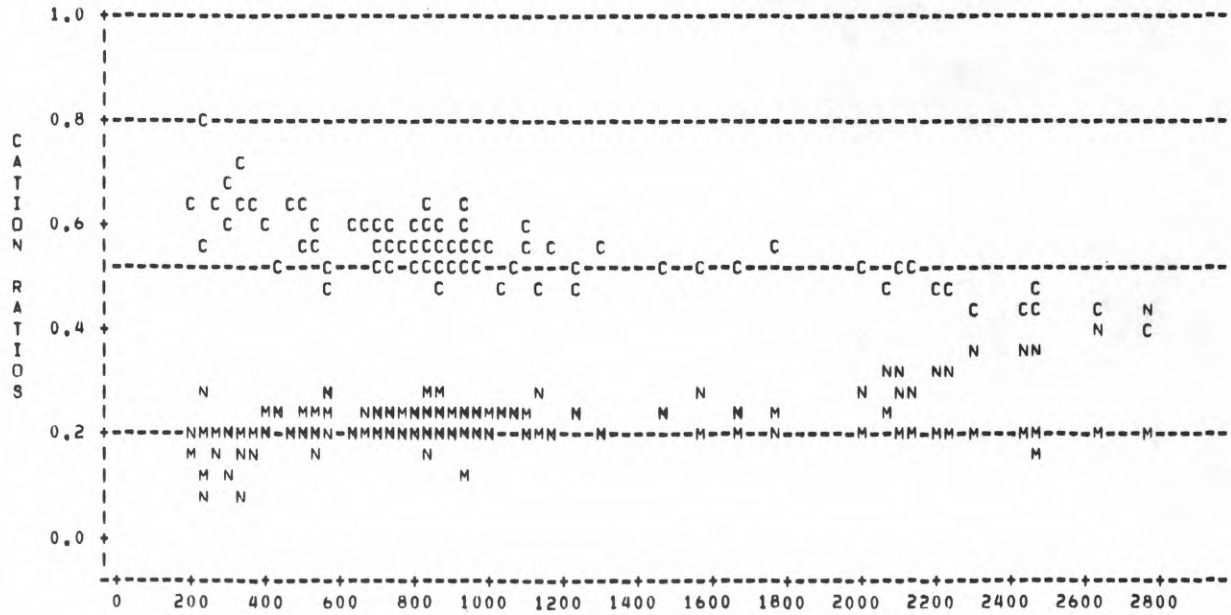
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	130	1027	210	2760	566	1.42	1.42
Dissolved solids	128	696	125	1830	412	1.41	1.07
pH	131	8.1	7.2	8.8	.3	-.41	.31
Total hardness	133	418	93	960	201	1.02	.37
Chloride	259	96	3.0	460	110	1.64	1.45
Sulfate	130	248	11	770	175	1.25	.56
Iron	0						
Fluoride	27	0.6	0.2	0.7	0.1	-1.89	3.49
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	132	1.2	0.1	4.2	0.8	1.90	3.47
Boron	0						

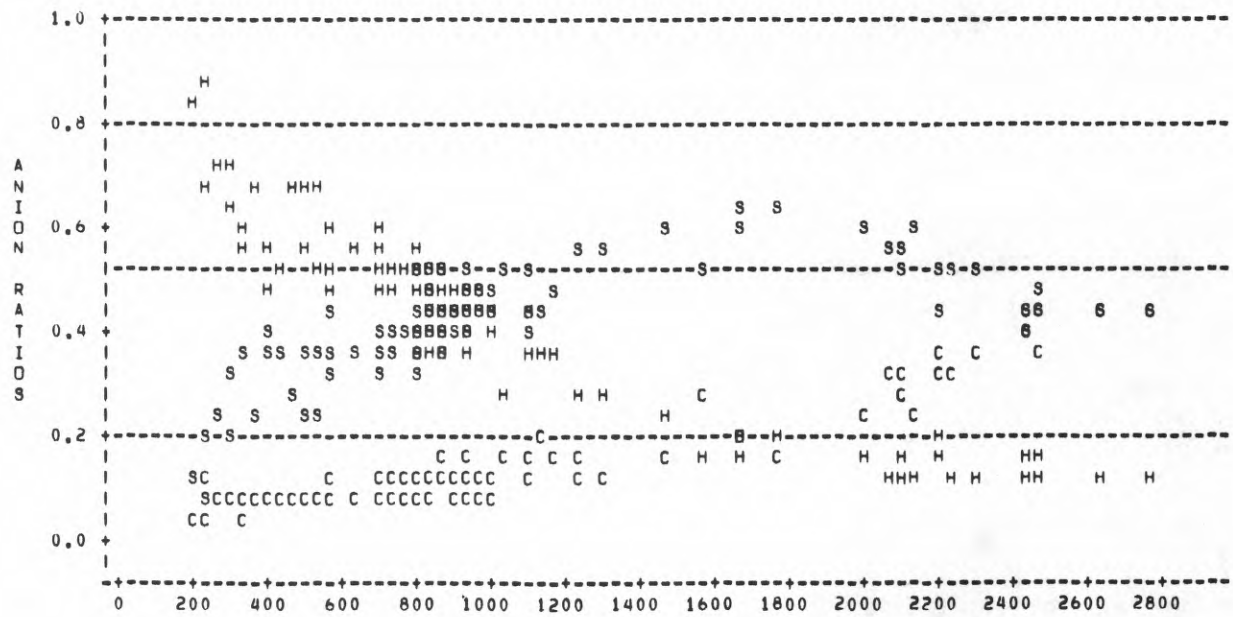
FREQUENCY DISTRIBUTION

CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	455	746	880	1030	2088
Dissolved solids	281	491	580	688	1524
pH	7.7	7.9	8.1	8.2	8.4
Total hardness	200	312	372	438	797
Chloride	19	32	43	106	296
Sulfate	67	150	190	257	580
Iron					
Fluoride	0.3	0.5	0.6	0.6	0.7
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	0.6	0.9	1.0	1.2	2.3
Boron					

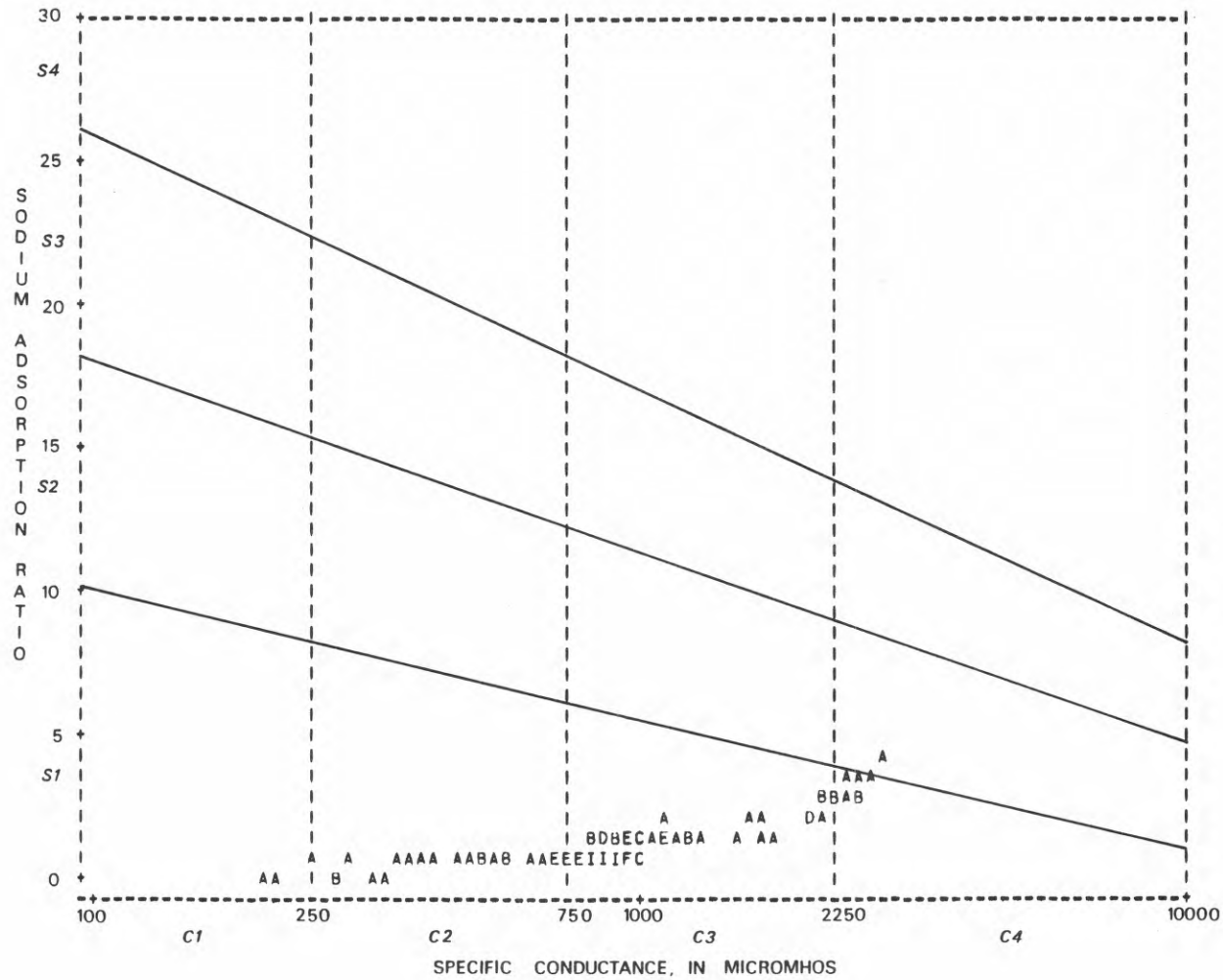
CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=BLUFF CREEK NR BUTTERMILK, KS



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=BLUFF CREEK NR BUTTERMILK, KS



IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=BLUFF CREEK NR BUTTERMILK, KS



07160300 - Boggy Creek at 30th Street, at Enid, Okla.

LOCATION.--Lat 36°23'24", long 97°50'10", in NW¼NW¼ sec. 15, T.22 N., R.6 W., Garfield County, at 30th Street in Enid.

DRAINAGE AREA.--Not determined.

PERIOD OF RECORD.--1975.

WATER TYPE.--The water was generally mixed type throughout the range of measured specific conductance.

TREND.--The current period of record is insufficient, less than 5 years, to perform trend analyses.

PUBLIC WATER SUPPLY.--Seventy-five percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 277 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum chloride concentration of 250 mg/L was exceeded by 5 percent of the chloride values and the recommended maximum pH value of 9.0 was exceeded by 5 percent of the pH values. The data for the toxic metals cadmium, chromium, and lead did not exceed maximum contaminant levels. No data were available for arsenic and mercury. Based on the data, this water would probably be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from medium to high with 75 percent of the samples having a high salinity hazard. All SAR values were equivalent to a low sodium hazard. No boron data were available.

07160300 - Boggy Creek at 30th Street, at Enid, Okla.--Continued

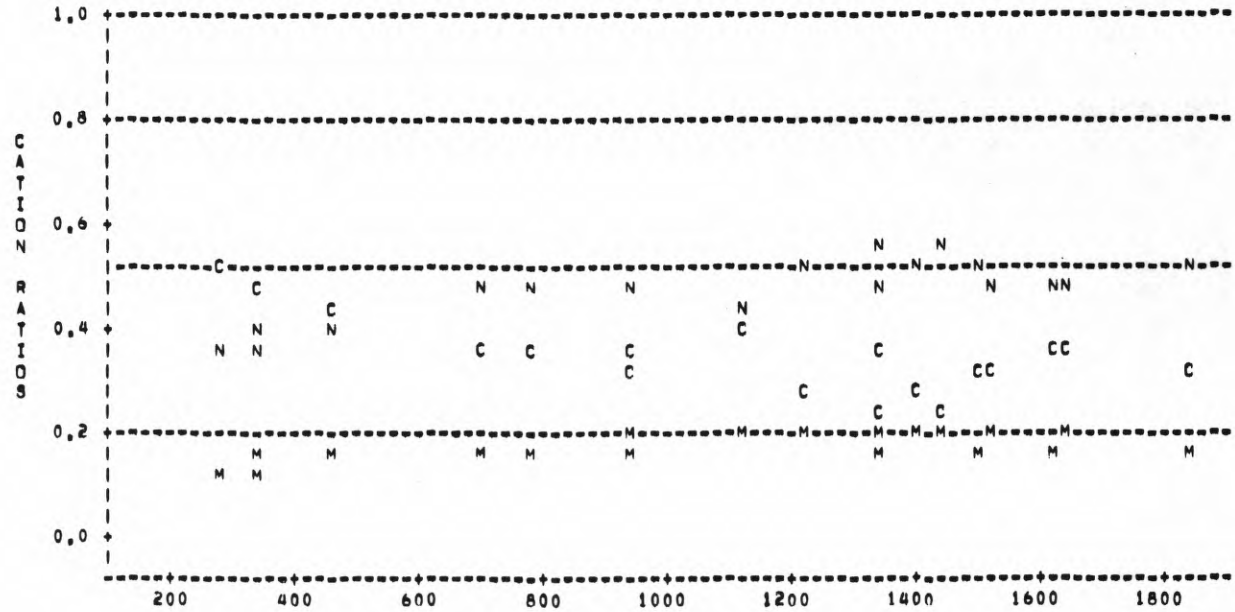
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	20	1109	274	1850	485	-0.48	-0.99
Dissolved solids	20	666	152	1250	316	-.15	-.77
pH	19	8.1	7.3	9.2	.5	.27	.30
Total hardness	20	277	98	440	112	-.22	-1.08
Chloride	20	160	19	320	86	-.20	-.83
Sulfate	20	99	21	160	47	-.60	-1.23
Iron	2	20	10	30			
Fluoride	0						
Arsenic	0						
Cadmium	2	0	0	1			
Chromium	2	0	0	0			
Lead	2	4	2	7			
Mercury	0						
SAR	20	3.0	1.0	4.4	1.1	-.72	-.71
Boron	0						

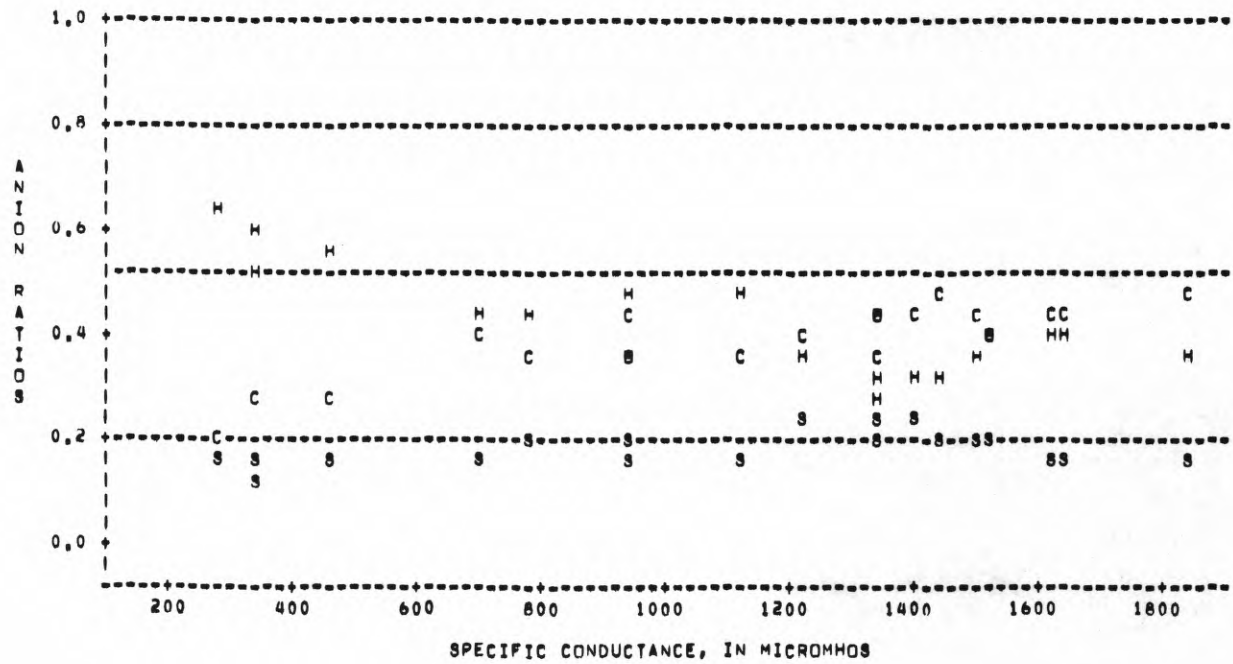
FREQUENCY DISTRIBUTION

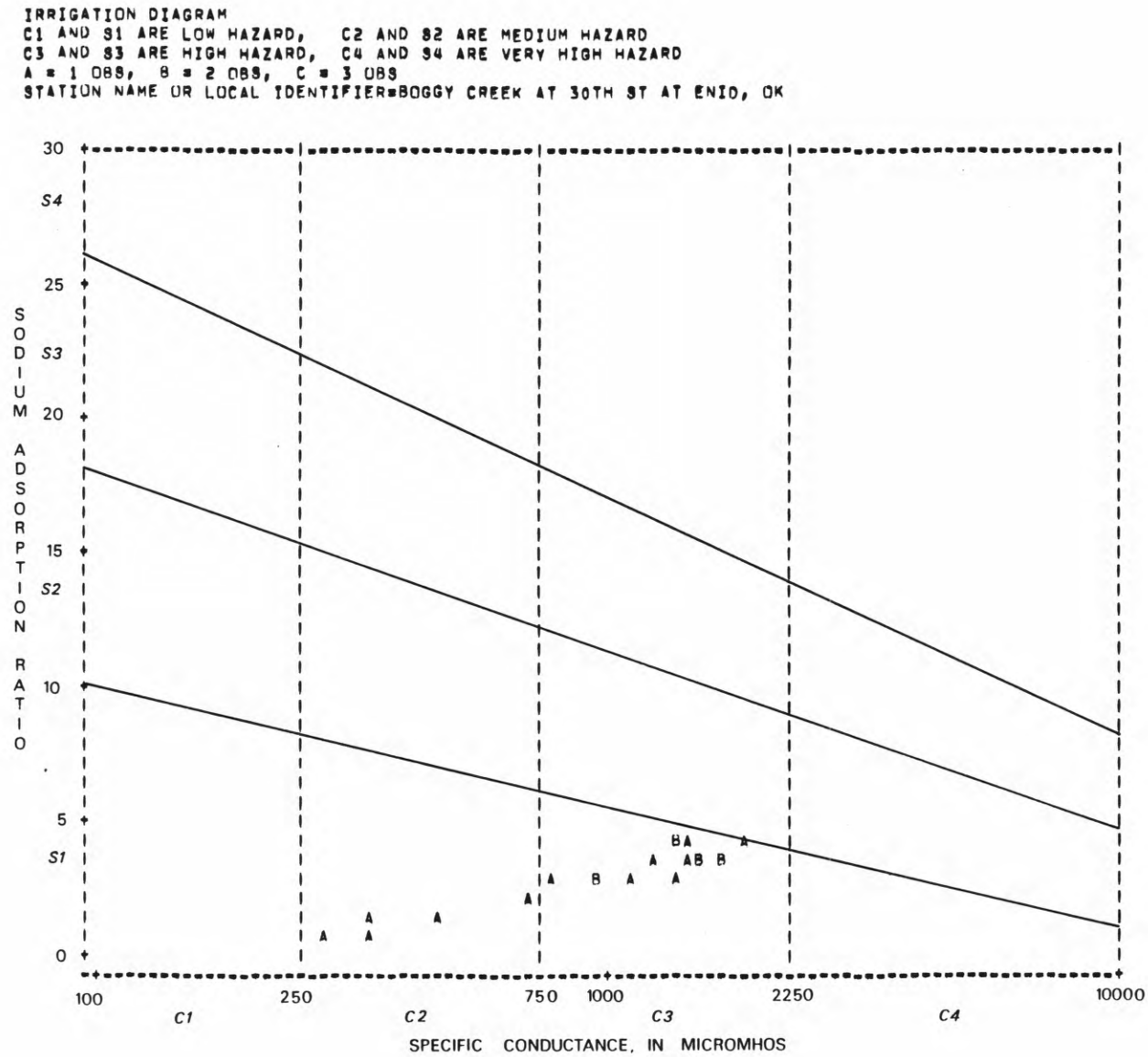
CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	306	695	1220	1450	1630
Dissolved solids	174	405	715	868	973
pH	7.3	7.8	8.1	8.3	8.6
Total hardness	104	170	275	370	420
Chloride	32	95	160	220	245
Sulfate	21	45	120	132	138
Iron					
Fluoride					
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	1.0	2.3	3.2	3.8	4.2
Boron					

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=BOGGY CREEK AT 30TH ST AT ENID, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=BOGGY CREEK AT 30TH ST AT ENID, OK




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=BOGGY CREEK AT 30TH ST AT ENID, OK
SODIUM ADSORPTION RATIO
30
S4
25
S3
20
15
S2
10
5
S1
0
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

CIMARRON RIVER BASIN

07157960 - Buffalo Creek near Lovedale, Okla.

LOCATION.--Lat 36°46'08", long 99°21'58", in NW¼NW¼ sec. 4, T.26 N., R.20 W., Harper County, at bridge on State Highway 34, 1.2 mi east of Lovedale, 1.3 mi upstream from Sleeping Bear Creek, and at mile 7.6.

DRAINAGE AREA.--408 mi^2.

PERIOD OF RECORD.--1974 to 1978.

WATER TYPE.--When the specific conductance was less than 5,000 umho, which accounted for 98 percent of the samples, the water was calcium sulfate type. No ion data were available for specific conductance greater than 5,000 umho.

TREND.--Plots of dissolved solids, hardness, chloride, and sulfate versus time indicated trends of increasing concentration for dissolved solids and sulfate. The Spearman's rhos at the 95-percent probability level for sulfate and dissolved solids confirmed the existence of positive trends. The Spearman's rhos for chloride and hardness showed no trend.

PUBLIC WATER SUPPLY.--All of the hardness values were greater than 180 mg/L and the average hardness concentration was 1,537 mg/L. The hardness class for this water was very hard. The recommended maximum chloride concentration of 250 mg/L was exceeded by 17 percent of the chloride values and the recommended maximum sulfate concentration of 250 mg/L was exceeded by 96 percent of the sulfate values. The recommended maximum pH value of 9.0 was exceeded by 1 percent of the pH values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum chloride and sulfate concentrations were exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from medium to very high with 80 percent of the samples having a very high salinity hazard. The sodium hazard ranged from low to medium with approximately 95 percent of the SAR values equivalent to a low sodium hazard. No boron data were available.

07157960 - Buffalo Creek near Lovedale, Okla.--Continued

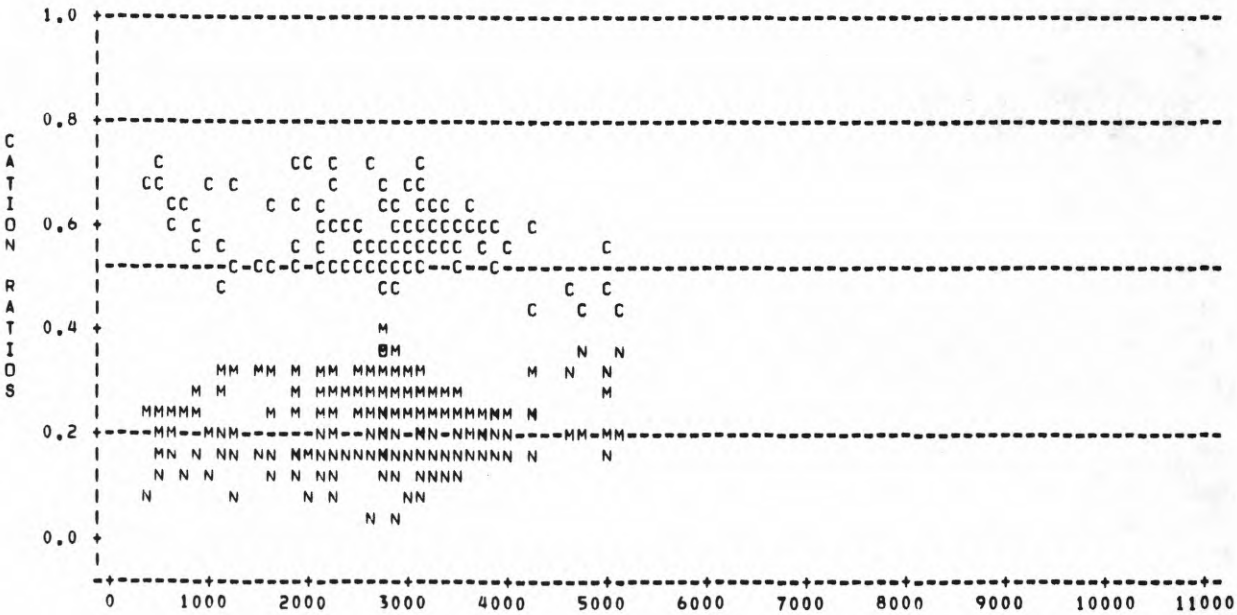
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	196	2953	427	9000	1073	0.81	5.73
Dissolved solids	164	2580	295	4270	903	-.76	.28
pH	187	7.9	5.0	9.1	.4	-2.76	24.39
Total hardness	159	1537	200	2300	518	-1.01	.31
Chloride	160	193	9.3	850	118	2.28	9.61
Sulfate	153	1407	100	2300	475	-.93	.42
Iron	0						
Fluoride	0						
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	158	1.5	0.2	4.7	0.8	1.81	5.65
Boron	0						

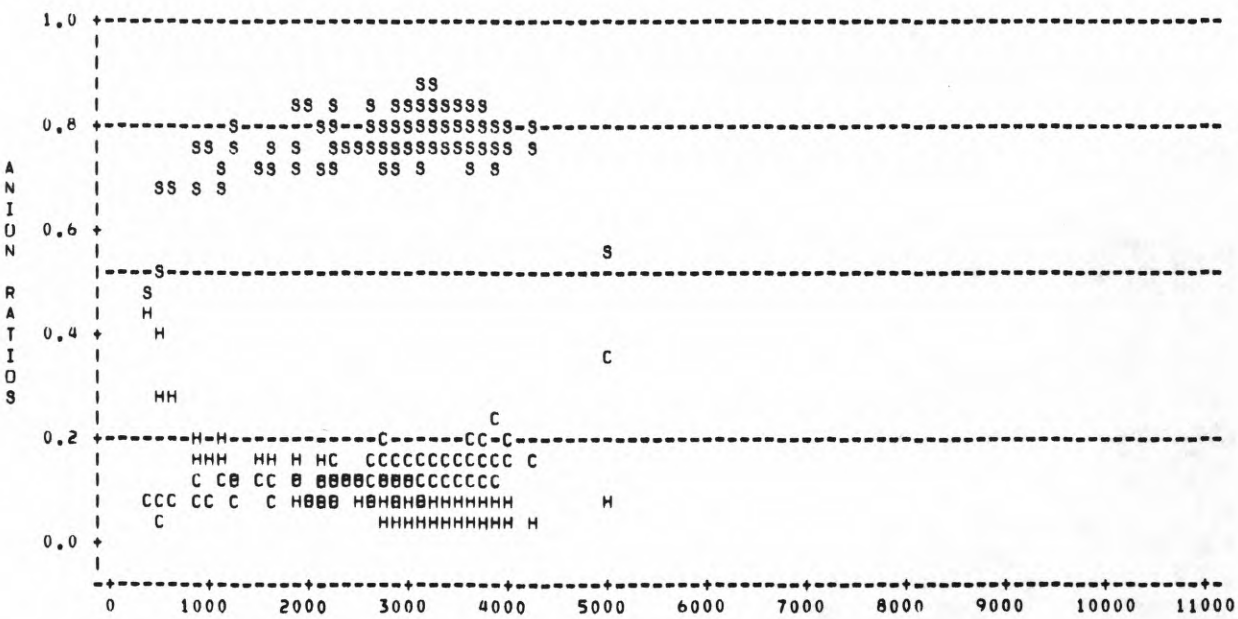
FREQUENCY DISTRIBUTION

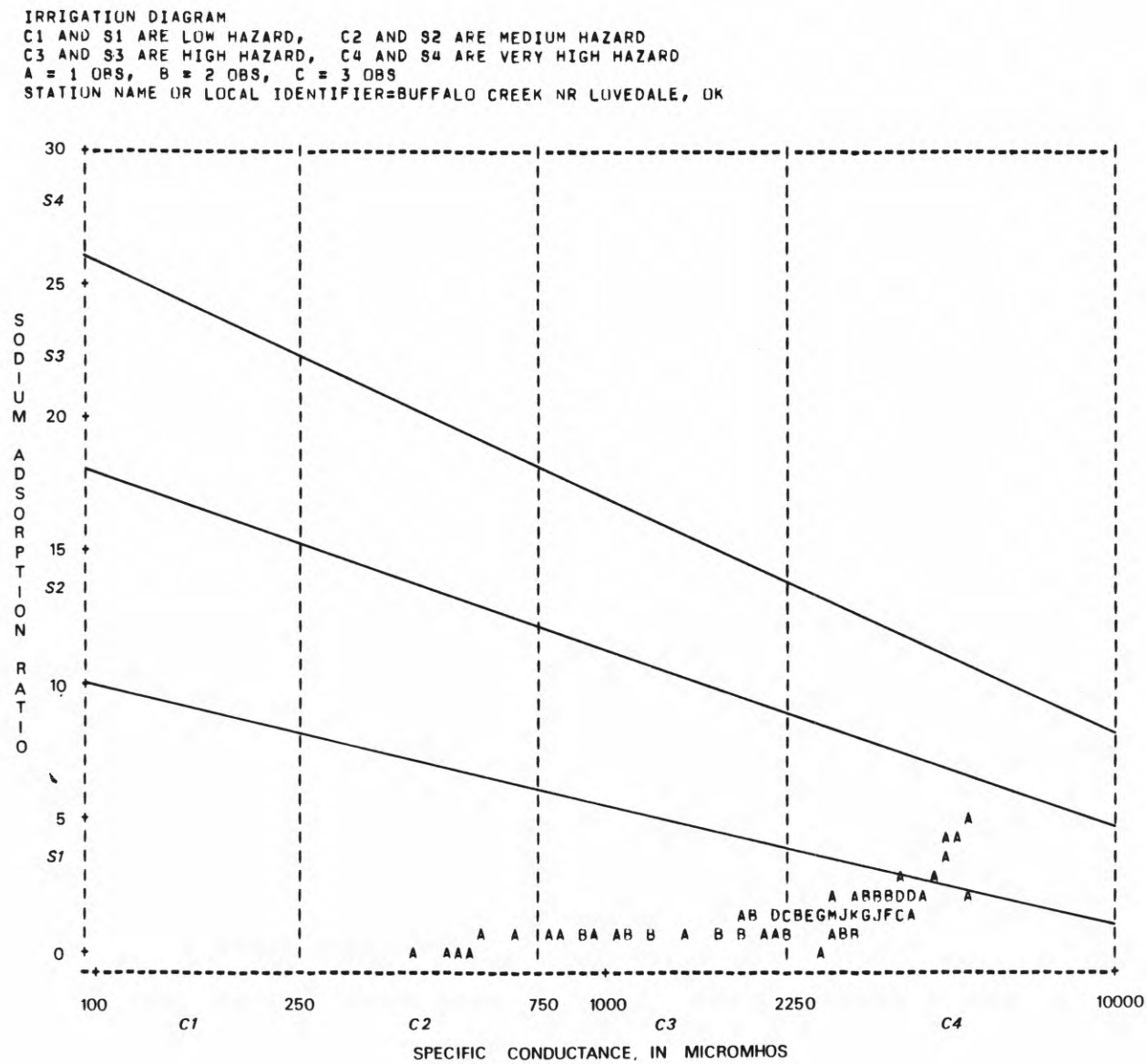
CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	1590	2495	2990	3480	3944
Dissolved solids	1049	2200	2680	3220	3572
pH	7.5	7.7	7.9	8.0	8.1
Total hardness	608	1262	1604	1925	2018
Chloride	58	140	180	224	310
Sulfate	691	1139	1446	1713	1900
Iron					
Fluoride					
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	0.6	1.1	1.4	1.6	2.1
Boron					

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=BUFFALO CREEK NR LOVEDALE, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=BUFFALO CREEK NR LOVEDALE, OK




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=BUFFALO CREEK NR LOVEDALE, OK
SODIUM ADSORPTION RATIO
30
S4
25
S3
20
15
S2
10
5
S1
0
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

CIMARRON RIVER BASIN

07154500 - Cimarron River near Kenton, Okla.

LOCATION.--Lat 36°55'36", long 102°57'31", in SE¼ sec. 4, T.5 N., R.1 E., Cimarron County, at county road bridge, 1.5 mi upstream from North Carrizo Creek, 1.7 mi northeast of Kenton, 2.2 mi downstream from Carrizozo Creek, and at mile 594.0.

DRAINAGE AREA.--1,106 mi^2, of which 68 mi^2 is probably noncontributing.

PERIOD OF RECORD.--1952 to 1963, 1977 to 1978.

WATER TYPE.--When the specific conductance was greater than 1,200 umho, which accounted for 74 percent of the samples, the water was generally sodium sulfate type. For specific conductance less than 1,200 umho, the water was calcium carbonate/bicarbonate type.

TREND.--The current period of record is insufficient, less than 5 years, to perform trend analyses.

PUBLIC WATER SUPPLY.--Ninety-eight percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 515 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum sulfate concentration of 250 mg/L was exceeded by 73 percent of the sulfate values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum sulfate concentration was exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from medium to very high with 93 percent of the samples having a high or very high salinity hazard. The sodium hazard ranged from low to medium with 53 percent of the SAR values equivalent to a low sodium hazard. One boron analysis was available and the concentration did not exceed the limits, 750 ug/L, for boron sensitive plants.

07154500 - Cimarron River near Kenton, Okla.--Continued

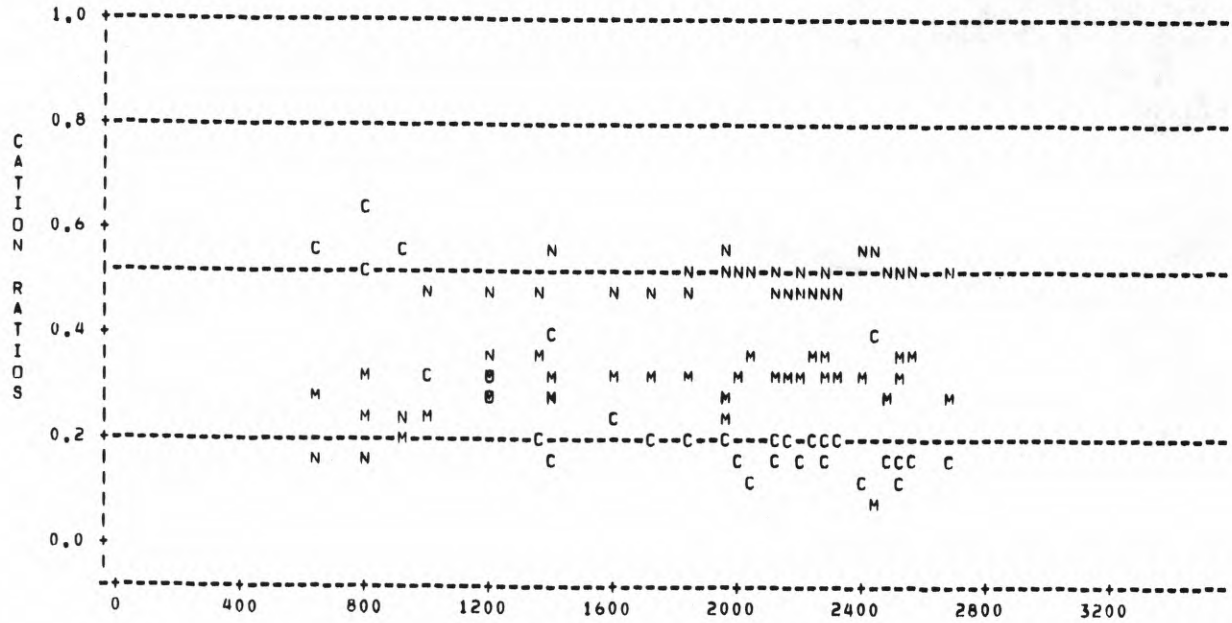
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	70	1788	350	3300	681	-0.34	-0.85
Dissolved solids	23	1319	372	2660	647	.04	-.68
pH	61	8.1	6.9	8.4	.4	-1.16	.67
Total hardness	61	515	102	865	163	-.46	-.49
Chloride	70	52	6.4	110	26	-.26	-.82
Sulfate	30	583	70	1480	377	.41	-.58
Iron	0						
Fluoride	0						
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	57	4.3	0.6	8.0	1.8	-.74	-.31
Boron	1	350					

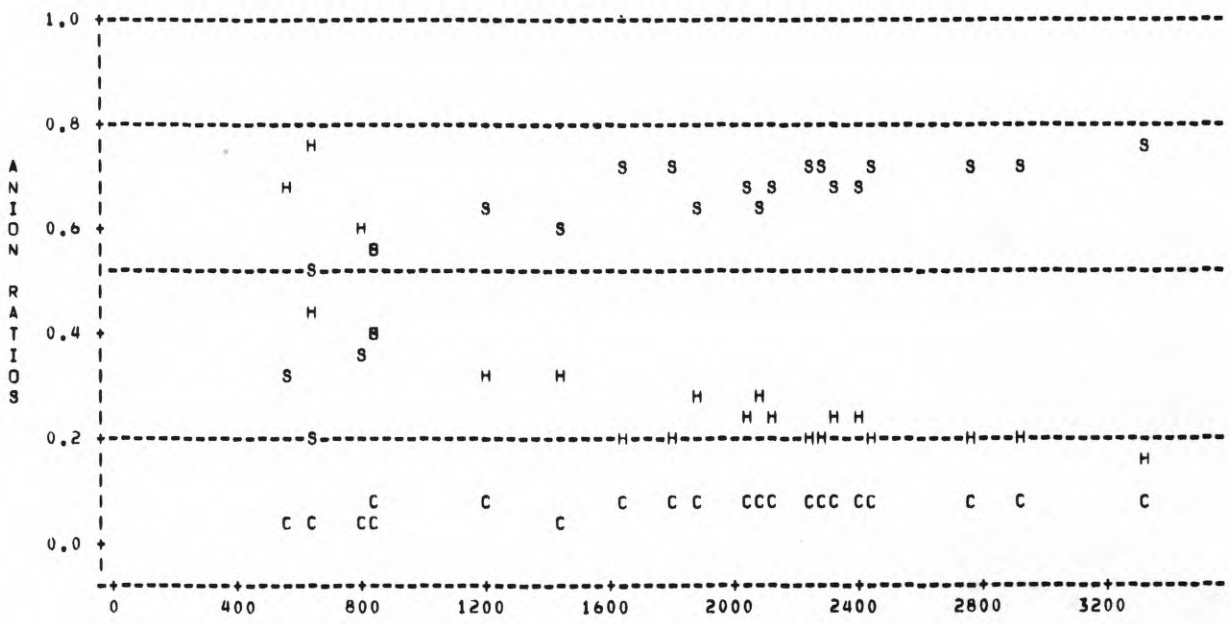
FREQUENCY DISTRIBUTION

CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	780	1195	2000	2280	2500
Dissolved solids	394	545	1440	1708	2020
pH	7.2	7.7	8.1	8.1	8.2
Total hardness	280	380	562	648	673
Chloride	10	25	59	68	78
Sulfate	91	207	561	805	990
Iron					
Fluoride					
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	1.1	3.0	4.8	5.5	6.0
Boron					

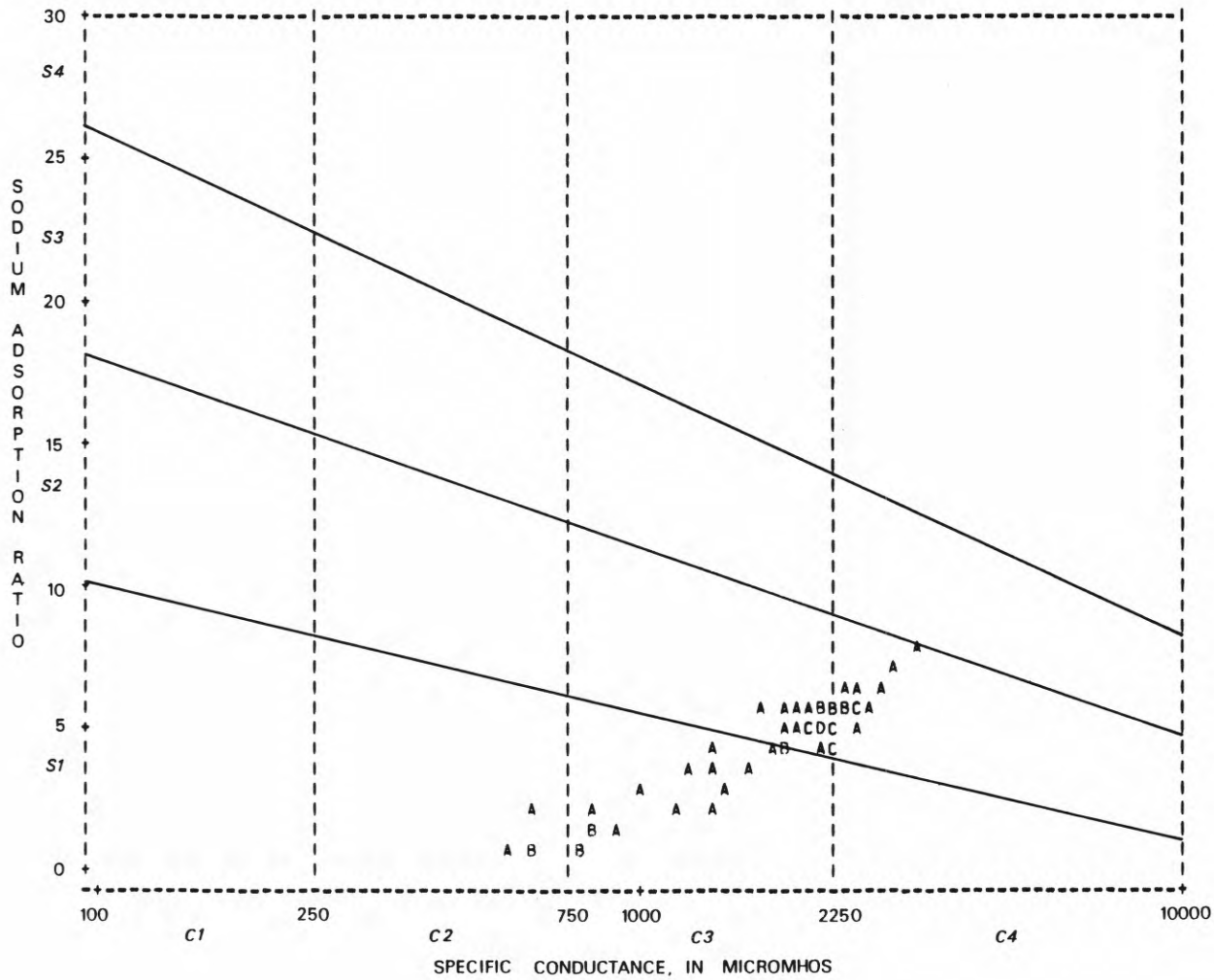
CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR KENTON, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR KENTON, OK



IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR KENTON, OK



CIMARRON RIVER BASIN

07157000 - Cimarron River near Mocane, Okla.

LOCATION.--Lat 36°58'31", long 100°18'49", on west line of NW¼ sec. 24, T.6 N., R.25 E., Beaver County, at county road bridge 6.5 mi northeast of Mocane, 13 mi upstream from Crooked Creek, and at mile 364.1

DRAINAGE AREA.--8,670 mi^2, of which 4,365 mi^2 is probably noncontributing.

PERIOD OF RECORD.--1947 to 1949, 1952 to 1964, 1976 to 1977.

WATER TYPE.--When the specific conductance was greater than 750 umho, which accounted for 85 percent of the samples, the water was sodium chloride type. For specific conductance less than 750 umho there was no predominant ion.

TREND.--The current period of record is insufficient, less than 5 years, to perform trend analyses.

PUBLIC WATER SUPPLY.--Ninety-eight percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 350 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum sulfate concentration of 250 mg/L was exceeded by 1 percent of the sulfate values and the recommended maximum chloride concentration of 250 mg/L was exceeded by 90 percent of the chloride values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum chloride concentration was exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from low to very high with 45 percent of the samples having a very high salinity hazard. The sodium hazard ranged from low to very high with 92 percent of the SAR values equivalent to a low or medium sodium hazard. The data indicated that phytotoxic effects from boron should not occur. However, due to the small number of samples, 9, and a maximum recorded value of 600 ug/L, it is possible that boron could reach phytotoxic concentrations.

07157000 - Cimarron River near Mocane, Okla.--Continued

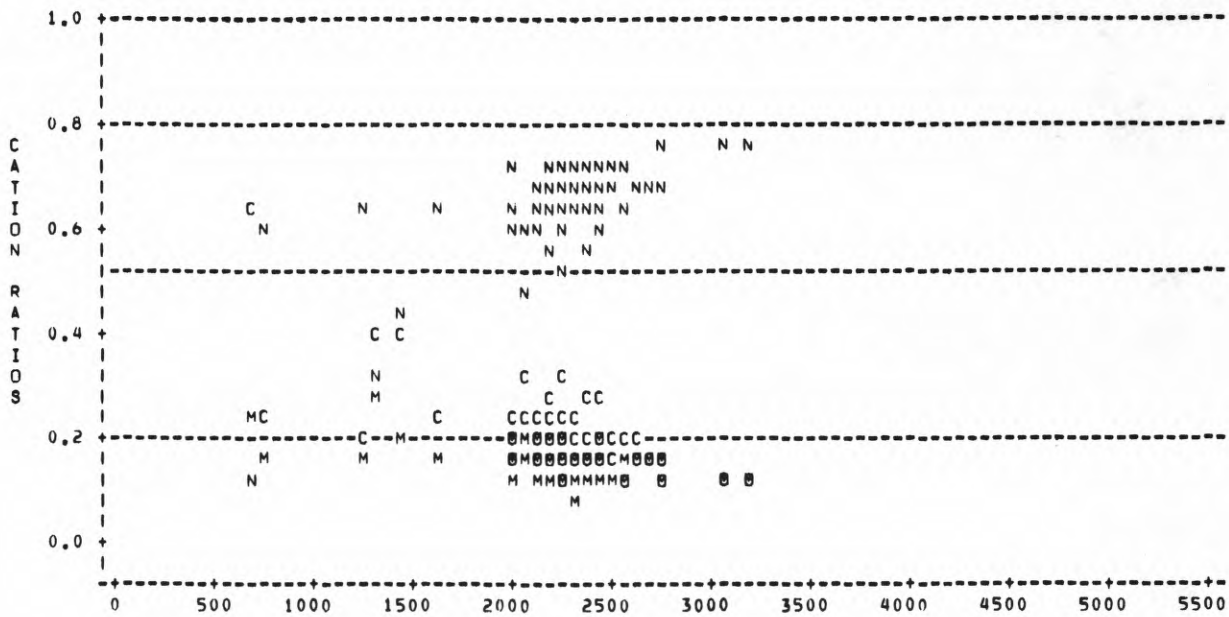
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	303	1927	64	4800	867	-0.69	0.29
Dissolved solids	193	1248	383	2670	358	-.43	1.27
pH	120	7.9	6.9	8.5	.4	-.70	-.24
Total hardness	259	350	138	580	63	-.39	2.67
Chloride	303	501	8.5	1150	174	-.47	1.04
Sulfate	220	164	39	305	41	-1.10	1.98
Iron	0						
Fluoride	9	0.9	0.9	1.0			
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	109	7.8	0.5	14	1.9	-.46	2.91
Boron	9	298	140	600			

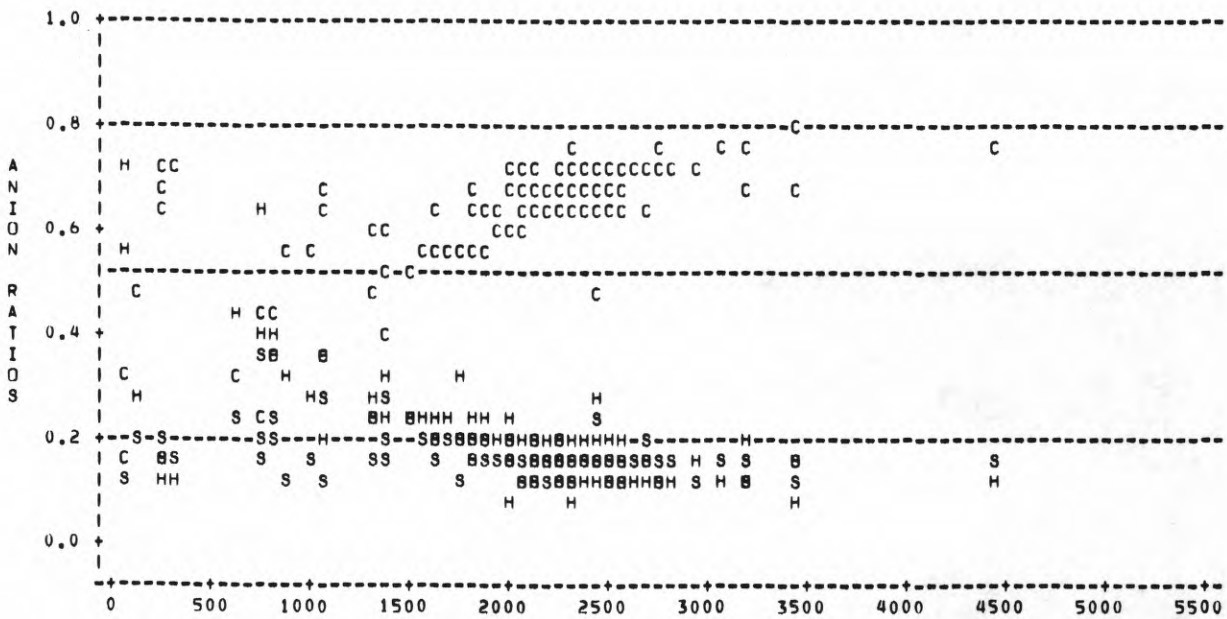
FREQUENCY DISTRIBUTION

CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	266	1550	2220	2420	2650
Dissolved solids	717	1078	1342	1429	1557
pH	7.2	7.6	7.9	8.1	8.3
Total hardness	270	324	359	378	406
Chloride	255	447	529	590	687
Sulfate	96	152	174	187	199
Iron					
Fluoride					
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	5.7	6.9	7.9	8.6	9.6
Boron					

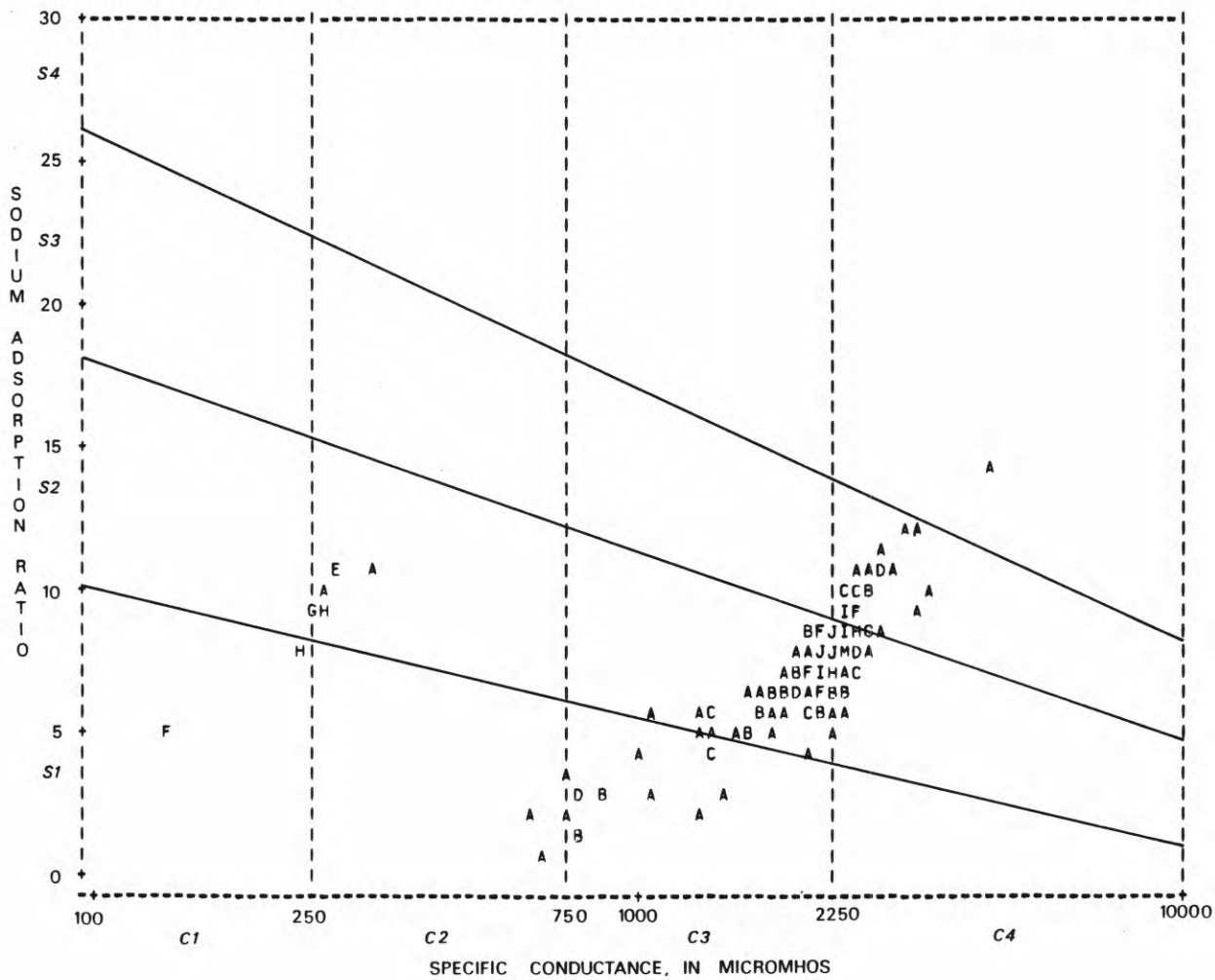
CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR MOCANE, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR MOCANE, OK



IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR MOCANE, OK



CIMARRON RIVER BASIN

07157740 - Cimarron River near Buttermilk, Kans.

LOCATION.--Lat 37°01'36", long 99°28'45", in NW¼ sec. 3, T.35 S., R.20 W., Comanche County, at county road bridge, 0.5 mi upstream from Bluff Creek, 2 mi north of Kansas-Oklahoma State line, 11.5 mi southwest of Buttermilk, and at mile 304.8.

DRAINAGE AREA.--11,120 mi^2, of which 4,737 mi^2 is probably noncontributing.

PERIOD OF RECORD.--1973 to 1978.

REMARKS.--Water-quality samples were collected through the 1976 water year by the Oklahoma District and after the 1976 water year by the Kansas District, U.S. Geological Survey.

WATER TYPE.--When the specific conductance was greater than 800 umho, which accounted for 95 percent of the samples, the water was sodium chloride type. For specific conductance less than 800 umho the water was generally calcium carbonate/bicarbonate type.

TREND.--Plots of dissolved solids, hardness, chloride, and sulfate concentrations versus time did not indicate any trend. The Spearman's rhos at the 95-percent probability level also did not indicate any trend.

PUBLIC WATER SUPPLY.--Ninety-five percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 480 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum sulfate concentration of 250 mg/L was exceeded by 59 percent of the sulfate values and the recommended maximum chloride concentration of 250 mg/L was exceeded by 90 percent of the chloride values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum chloride concentration was exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from medium to very high with 82 percent of the samples having a very high salinity hazard. The sodium hazard ranged from low to high with approximately 20 percent of the SAR values equivalent to a high sodium hazard. No boron data were available.

07157740 - Cimarron River near Buttermilk, Kans.--Continued

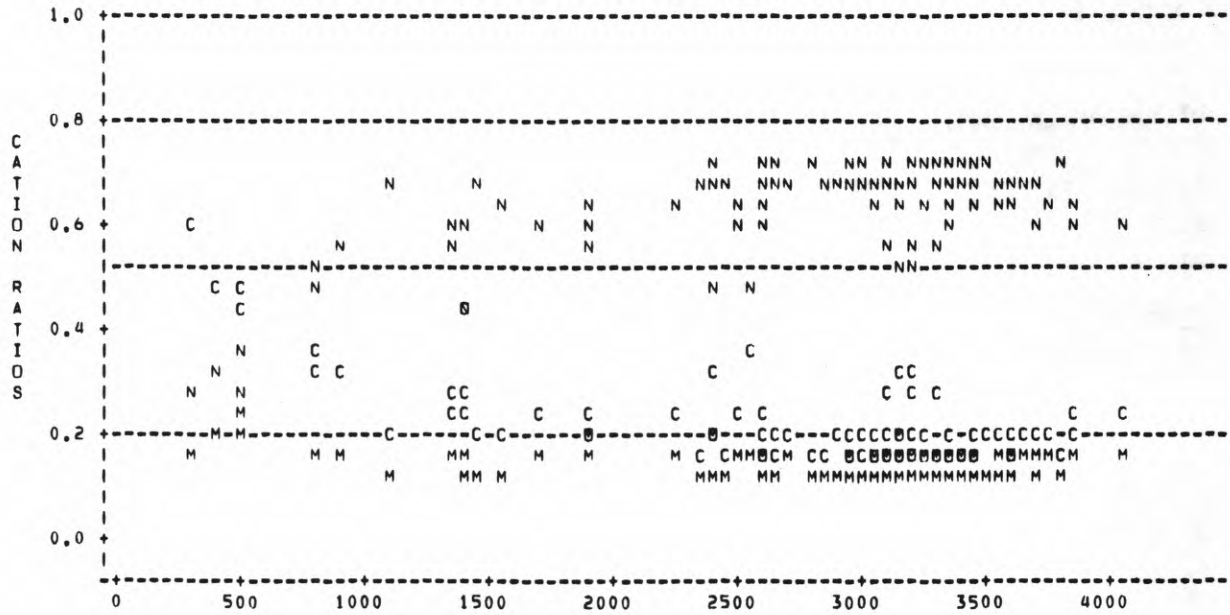
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	120	2828	292	4050	849	-1.31	1.09
Dissolved solids	115	1705	176	2440	532	-1.19	.80
pH	119	8.1	7.4	8.7	.2	-.51	.17
Total hardness	119	480	100	800	150	-.14	.12
Chloride	224	673	24	1700	254	-.11	2.66
Sulfate	119	296	17	620	134	.57	.04
Iron	0						
Fluoride	24	0.8	0.3	1.2	0.2	-.55	.63
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	113	8.2	0.7	12	2.4	-1.23	1.18
Boron	0						

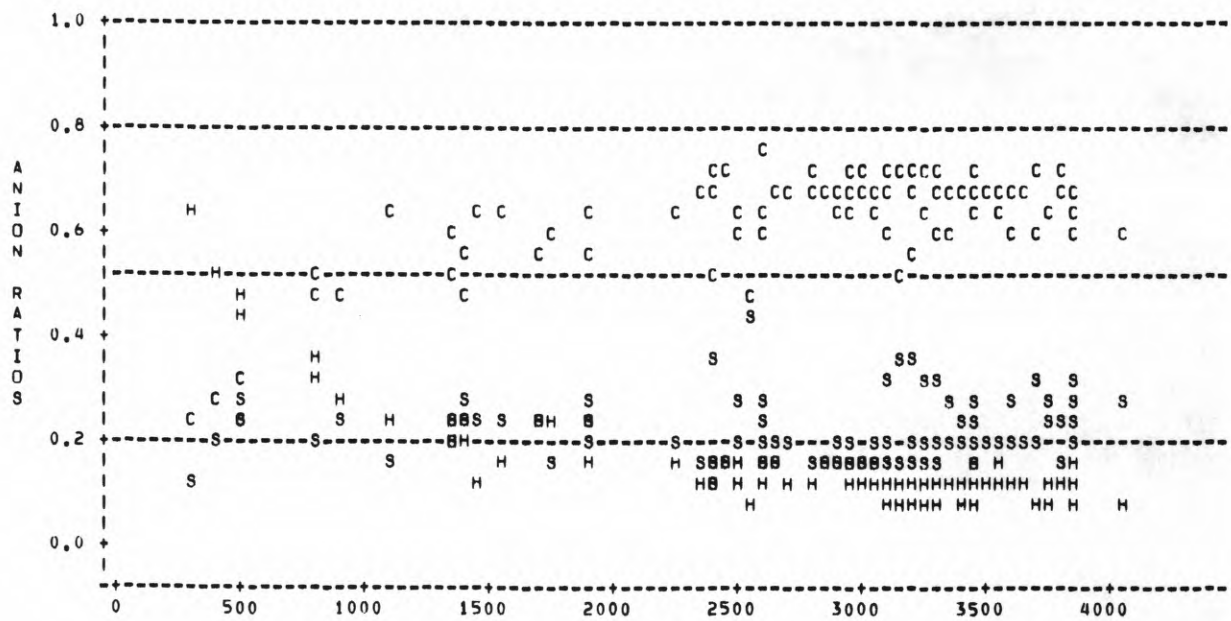
FREQUENCY DISTRIBUTION

CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	1390	2510	3095	3350	3625
Dissolved solids	815	1518	1850	2038	2240
pH	7.7	7.9	8.1	8.2	8.3
Total hardness	270	406	478	554	672
Chloride	257	555	723	820	888
Sulfate	140	210	268	352	506
Iron					
Fluoride	0.4	0.6	0.8	0.9	1.1
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	4.7	6.6	8.9	9.8	10
Boron					

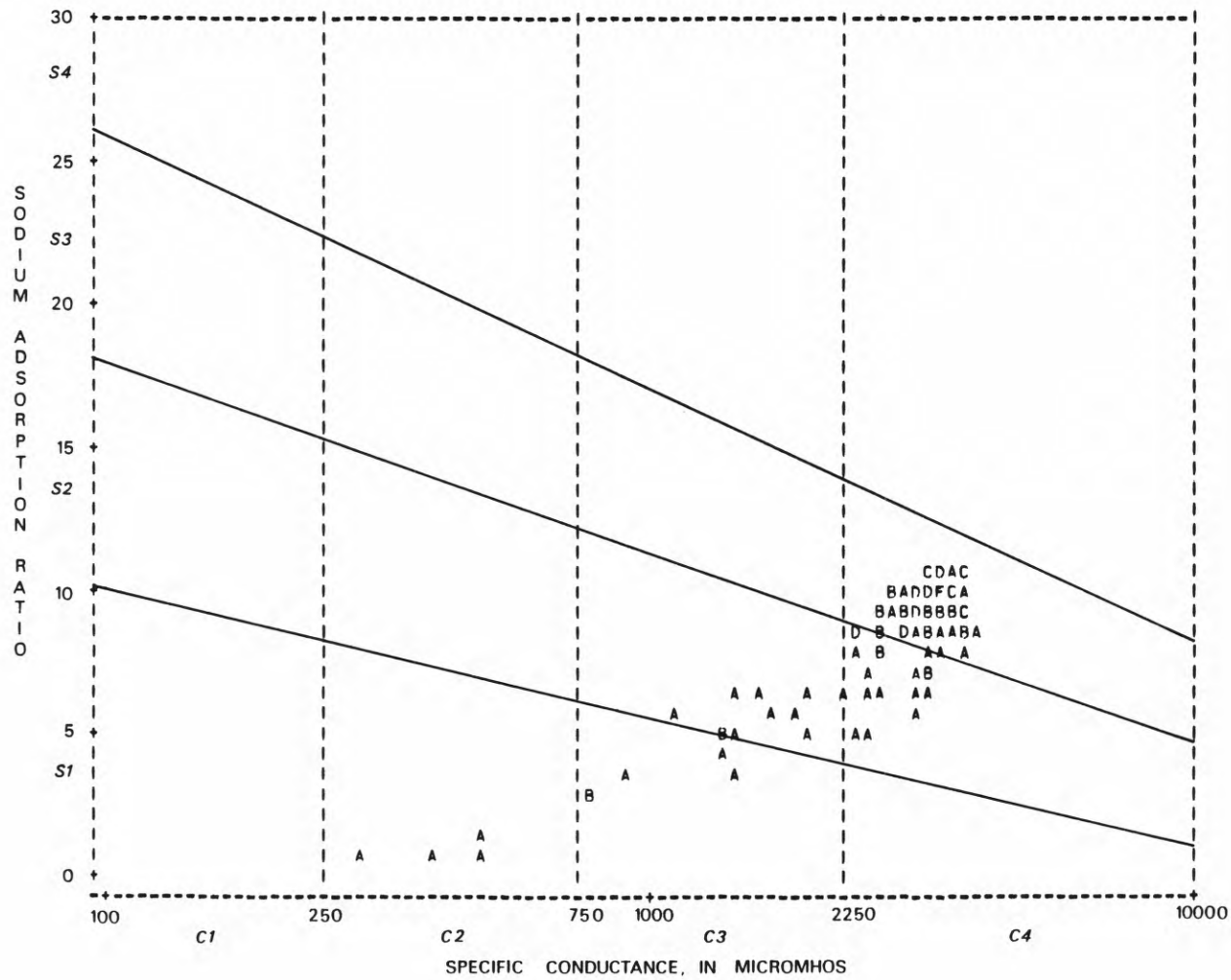
CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR BUTTERMILK, KS



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR BUTTERMILK, KS



IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR BUTTERMILK, KS



CIMARRON RIVER BASIN

07157950 - Cimarron River near Buffalo, Okla.

LOCATION.--Lat 36°55'28", long 99°23'56", in NW¼SW¼ sec. 7, T.28 N., R.20 W., Harper County, on left bank 800 ft downstream from unnamed tributary, 6 mi upstream from Keno Creek, 7 mi upstream from bridge on U.S. Highway 64, 14 mi northeast of Buffalo, and at mile 296.0.

DRAINAGE AREA.--11,930 mi^2, of which 4,813 mi^2 is probably noncontributing.

PERIOD OF RECORD.--1953, 1960 to 1963, 1968 to 1978.

WATER TYPE.--The water was sodium chloride type throughout the range of measured specific conductance.

TREND.--Plots of dissolved solids, hardness, sulfate, and chloride concentration versus time indicate trends of increasing concentration. The Spearman's rhos for the four constituents at the 95-percent probability level confirmed the presence of positive trends.

PUBLIC WATER SUPPLY.--Ninety-nine percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 585 mg/L. The hardness class for this water was very hard. The recommended maximum sulfate concentration of 250 mg/L was exceeded by 71 percent of the sulfate values, the recommended maximum chloride concentration of 250 mg/L was exceeded by 99 percent of the chloride values, and the recommended maximum iron concentration of 300 ug/L was exceeded by 6 percent of the iron values. Cadmium exceeded the maximum contaminant level of 10 ug/L in 12 percent of the cadmium values and lead exceeded the maximum contaminant level of 50 ug/L in 6 percent of the lead values. Arsenic, chromium, and mercury did not exceed maximum contaminant levels. Because of the frequency and magnitude by which the recommended maximum sulfate and chloride concentrations were exceeded and because the maximum cadmium and lead contaminant levels were exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from high to very high with 96 percent of the samples having a very high salinity hazard. The sodium hazard ranged from low to very high with 88 percent of the SAR values equivalent to a very high sodium hazard. The data indicate that phytotoxic effects from boron should not occur.

07157950 - Cimarron River near Buffalo, Okla.--Continued

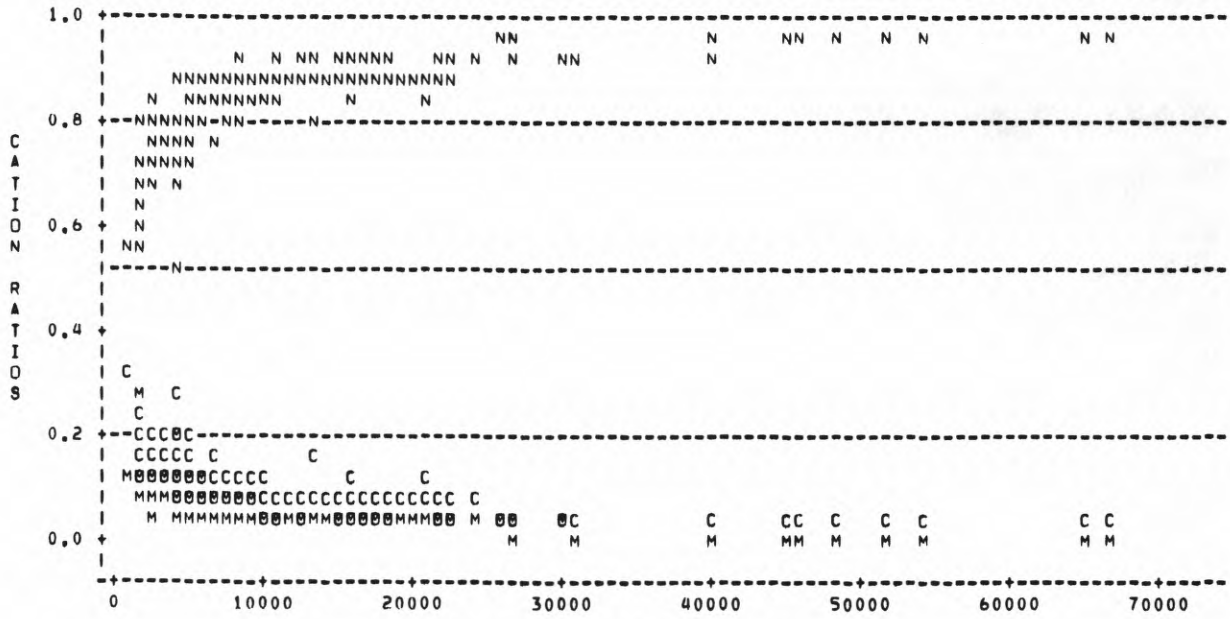
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	531	10475	860	67000	10458	2.63	7.93
Dissolved solids	469	6617	512	49200	7278	2.85	9.40
pH	461	8.1	6.9	8.9	.3	-.73	1.10
Total hardness	443	585	140	1600	272	1.42	1.85
Chloride	505	3427	140	29000	4123	3.09	11.69
Sulfate	473	380	16	2400	248	2.71	12.07
Iron	17	107	10	670	158	3.19	11.29
Fluoride	57	.7	.3	1.1	.2	-.54	.62
Arsenic	17	3	1	4	.9	-.65	.23
Cadmium	17	3	0	24	6.1	3.01	9.13
Chromium	17	5	0	30	7.9	2.28	6.14
Lead	17	8	0	58	14	3.00	9.93
Mercury	17	.1	0.0	.9	.2	3.72	14.43
SAR	418	37	1.4	218	35	2.70	8.87
Boron	10	201	40	430	123	.45	-.17

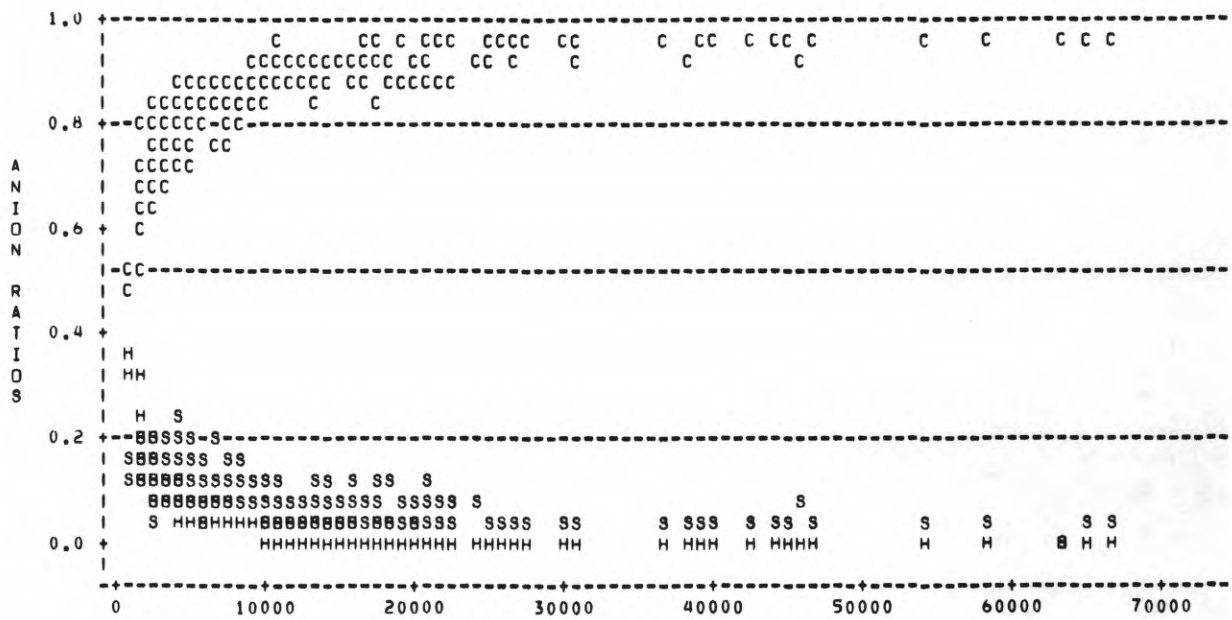
FREQUENCY DISTRIBUTION

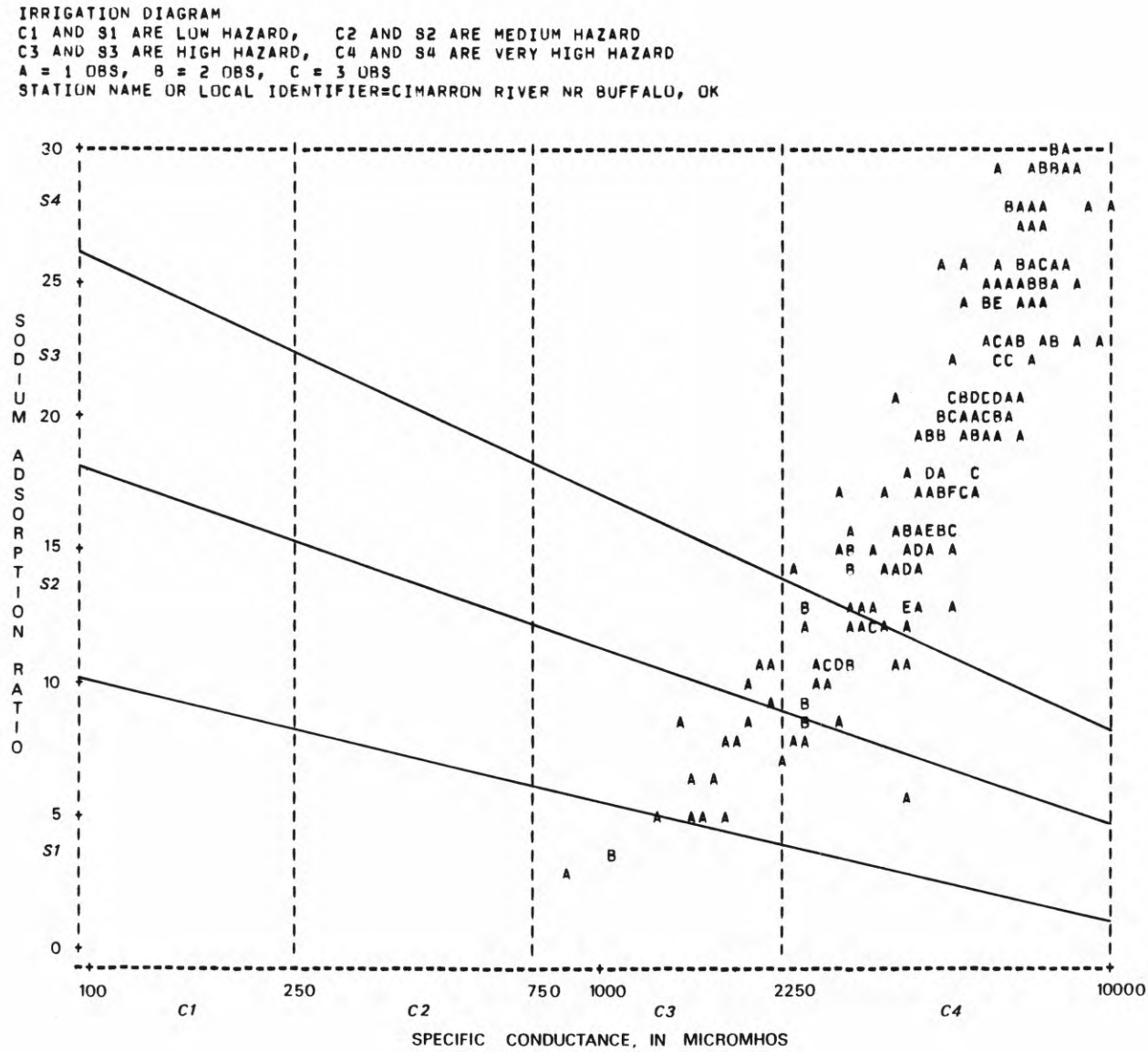
CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	2980	4510	6870	11825	22180
Dissolved solids	1749	2660	4010	7320	14010
pH	7.6	7.9	8.1	8.3	8.4
Total hardness	330	410	510	661	989
Chloride	718	1200	2000	3822	7450
Sulfate	179	240	310	420	669
Iron	12	21	45	110	184
Fluoride	.5	.6	.7	.8	.8
Arsenic	1	2	3	3	3
Cadmium	0	0	1	2	6
Chromium	0	0	0	9	10
Lead	0	1	2	7	18
Mercury	0.0	0.0	0.0	0.0	.1
SAR	11	17	24	43	74
Boron	40	95	160	275	310

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR BUFFALO, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR BUFFALO, OK




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR BUFFALO, OK
SODIUM ADSORPTION RATIO
30
25
20
15
10
5
0
S4
S3
S2
S1
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

CIMARRON RIVER BASIN

07157980 - Cimarron River at Freedom, Okla.

LOCATION.--Lat 36°45'18", long 99°06'58", in SE¼SE¼ sec. 3, T.26 N., R.18 W., Woodward County, at old bridge on State Highway 50, 1.0 mi south of Freedom, and at mile 272.4.

DRAINAGE AREA.--12,706 mi^2, of which 4,813 mi^2 is probably noncontributing.

PERIOD OF RECORD.--1953, 1974 to 1978.

WATER TYPE.--The water was sodium chloride type throughout the range of measured specific conductance.

TREND.--Plots of dissolved solids, hardness, chloride, and sulfate concentrations versus time indicate trends of increasing concentration. The Spearman's rhos at the 95-percent probability level for the four constituents confirm the presence of positive trends.

PUBLIC WATER SUPPLY.--More than 99 percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 1,277 mg/L. The hardness class for this water was very hard. The recommended maximum sulfate concentration of 250 mg/L was exceeded by 92 percent of the sulfate values and the recommended maximum chloride concentration of 250 mg/L was exceeded by more than 99 percent of the chloride values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum sulfate and chloride concentrations were exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard was very high for all samples. All SAR values were equivalent to a very high sodium hazard. No boron data were available.

07157980 - Cimarron River at Freedom, Okla.--Continued

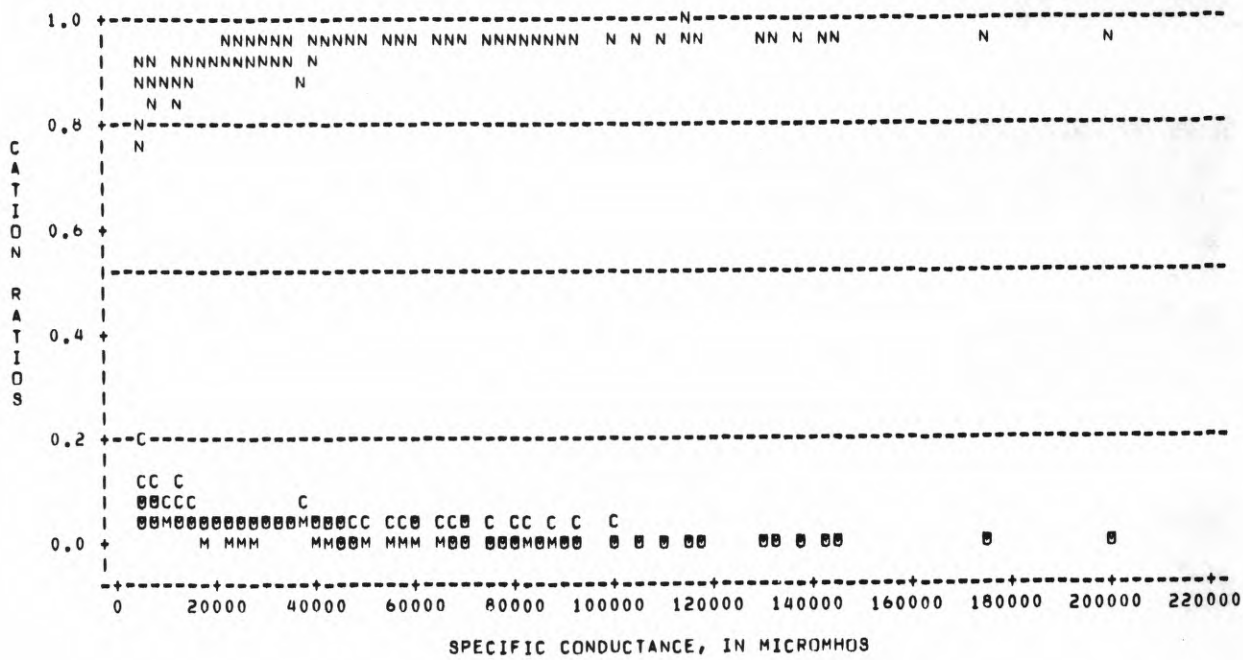
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	210	45224	4560	199000	37581	1.48	2.08
Dissolved solids	186	35648	2680	189000	35883	1.86	3.45
pH	209	7.9	6.1	8.6	.4	-.83	2.14
Total hardness	192	1277	180	4600	795	1.59	2.87
Chloride	190	20671	1300	110000	2150	1.94	3.88
Sulfate	188	782	22	2600	509	1.51	2.71
Iron	0						
Fluoride	0						
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	177	143	14	490	108	1.20	.80
Boron	0						

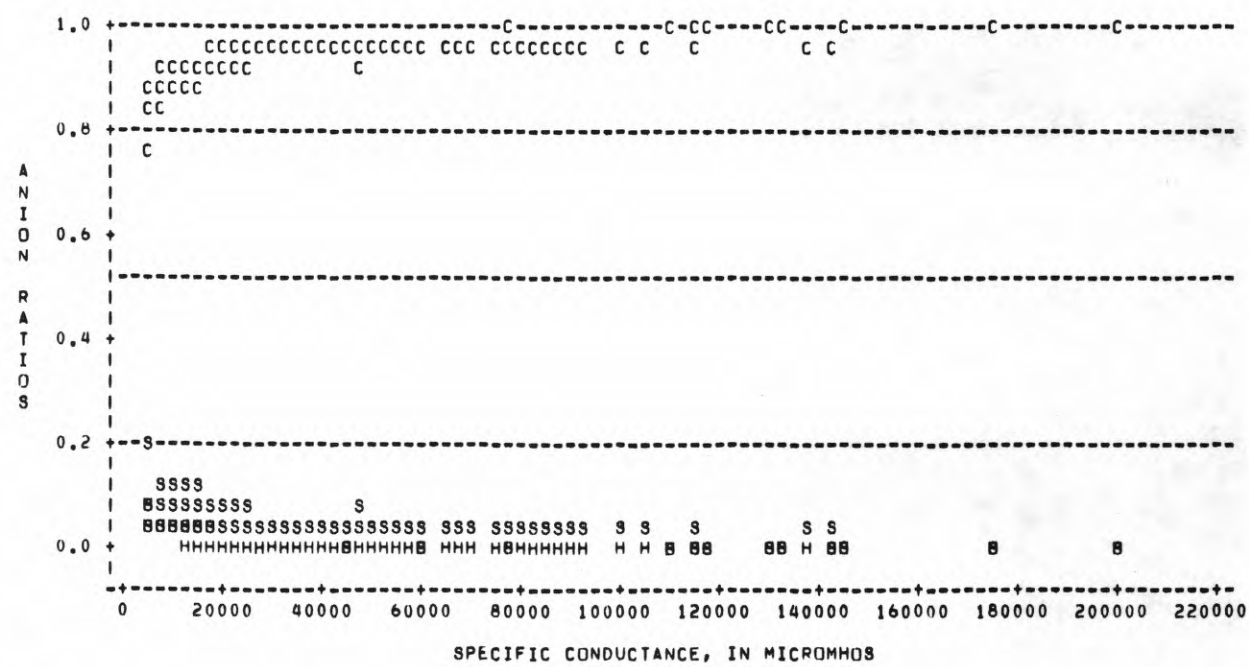
FREQUENCY DISTRIBUTION

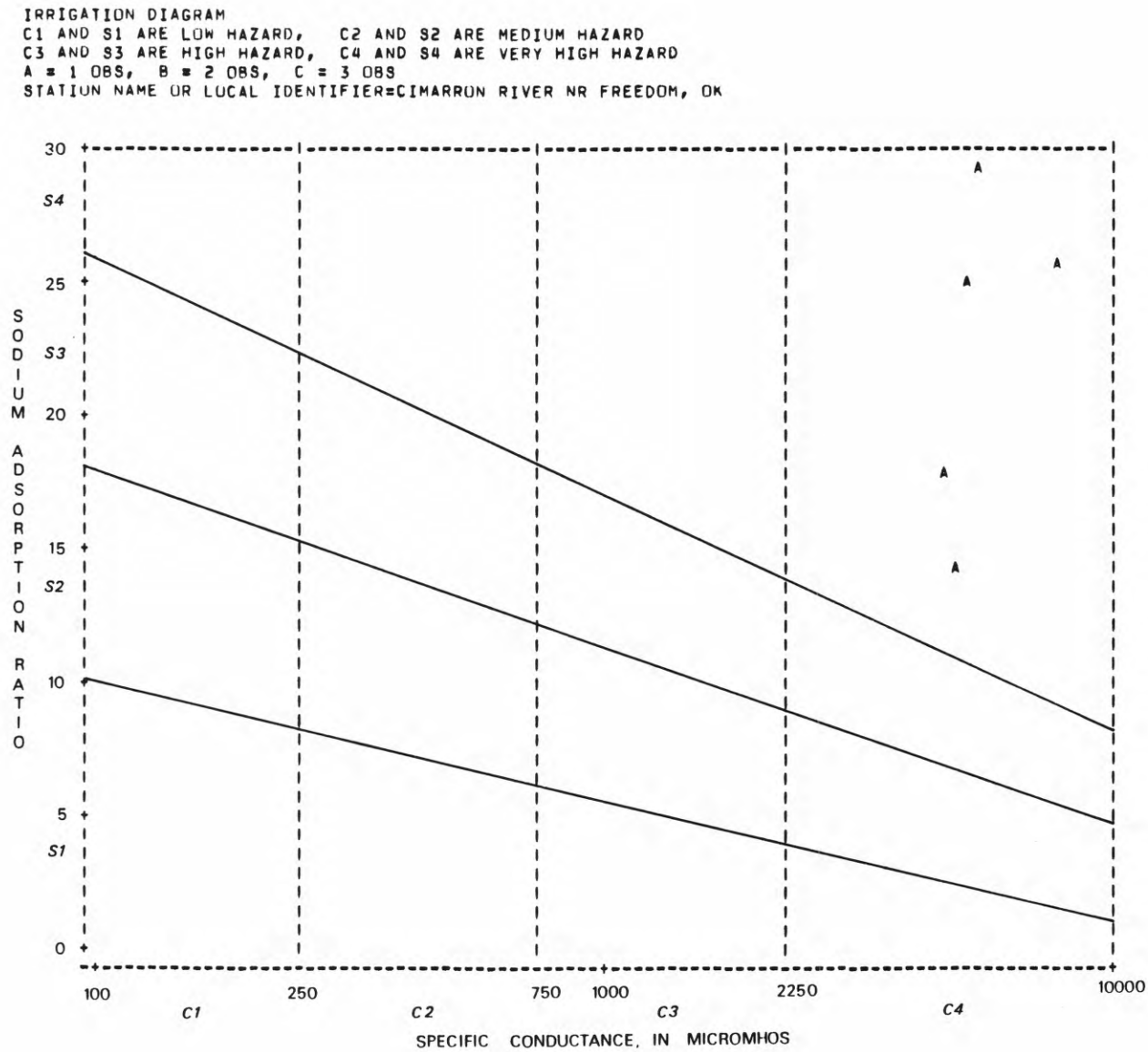
CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	9957	17850	32100	61300	96500
Dissolved solids	6016	10680	21800	47750	81040
pH	7.4	7.6	7.9	8.1	8.3
Total hardness	542	720	1060	1500	2290
Chloride	3300	6175	12000	26830	47000
Sulfate	280	450	655	970	1400
Iron					
Fluoride					
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	37	56	104	196	314
Boron					

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR FREEDOM, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR FREEDOM, OK




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR FREEDOM, OK
SODIUM ADSORPTION RATIO
30
S4
25
S3
20
15
S2
10
5
S1
0
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

07158000 - Cimarron River near Waynoka, Okla.

LOCATION.--Lat 36°31'02", long 98°52'45", near center of sec. 35, T.24 N., R.16 W., Woods County, at bridge on U.S. Highway 281, 0.8 mi downstream from Main Creek, 5 mi south of Waynoka, and at mile 247.0.

DRAINAGE AREA.--13,334 mi^2, of which 4,830 mi^2 is probably noncontributing.

PERIOD OF RECORD.--1951 to 1963, 1968 to 1978.

WATER TYPE.--When the specific conductance was greater than 4,000 umho, which accounted for more than 99 percent of the samples, the water was sodium chloride type. For specific conductance less than 4,000 umho the water was calcium type with no predominant anion.

TREND.--Plots of the dissolved solids, hardness, chloride, and sulfate concentrations versus time indicate trends of increasing concentration. The Spearman's rhos at the 95-percent probability level confirm the presence of positive trends for the four constituents.

PUBLIC WATER SUPPLY.--More than 99 percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 1,040 mg/L. The hardness class for this water was very hard. The recommended maximum sulfate concentration of 250 mg/L was exceeded by 95 percent of the sulfate values and the recommended maximum chloride concentration of 250 mg/L was exceeded by more than 99 percent of the chloride values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum sulfate and chloride concentrations were exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from high to very high with more than 99 percent of the samples having a very high salinity hazard. The sodium hazard ranged from low to very high with more than 99 percent of the SAR values equivalent to a very high sodium hazard. One of 6 boron values exceeded the recommended limit, 1,000 ug/L, for boron semitolerant plants.

07158000 - Cimarron River near Waynoka, Okla.--Continued

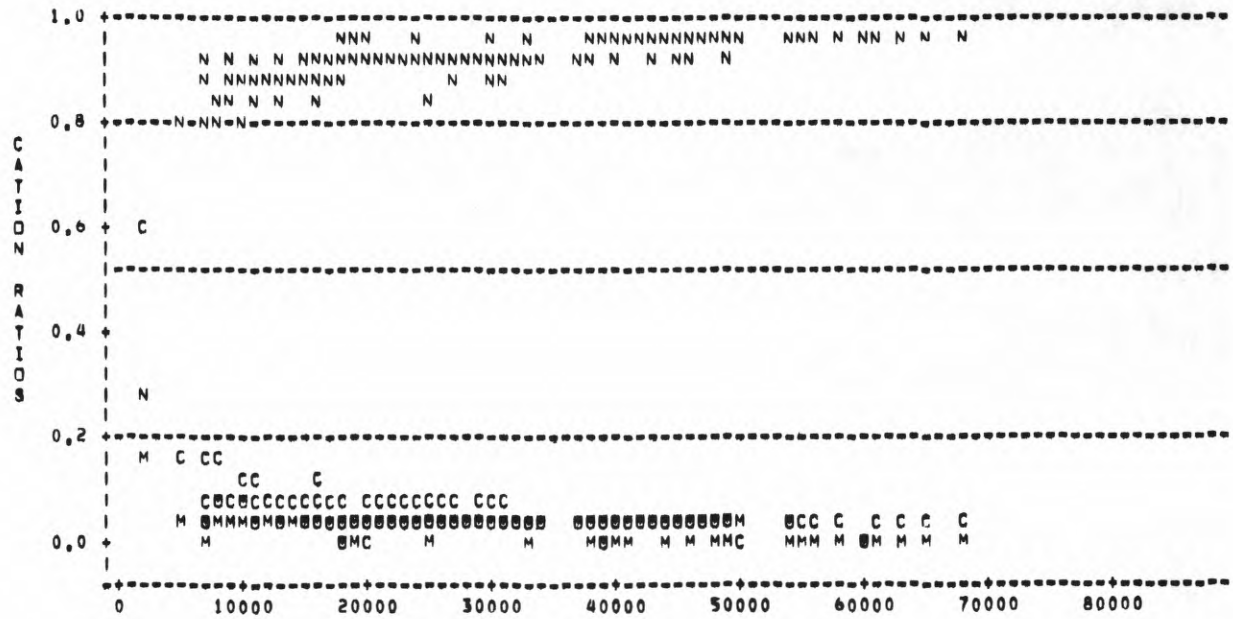
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	532	28435	1840	80000	15213	0.73	-0.06
Dissolved solids	419	19632	377	58600	11475	.83	.18
pH	444	8.0	7.0	8.9	.3	-.55	.02
Total hardness	425	1040	240	2300	366	.28	-.33
Chloride	510	10654	240	36000	6715	.97	.46
Sulfate	414	670	4.2	2120	283	.67	1.33
Iron	0						
Fluoride	97	0.7	0.3	1.2	0.2	-.03	-.32
Arsenic	1	8					
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	351	97	1.1	267	47	.67	.20
Boron	6	553	260	1300			

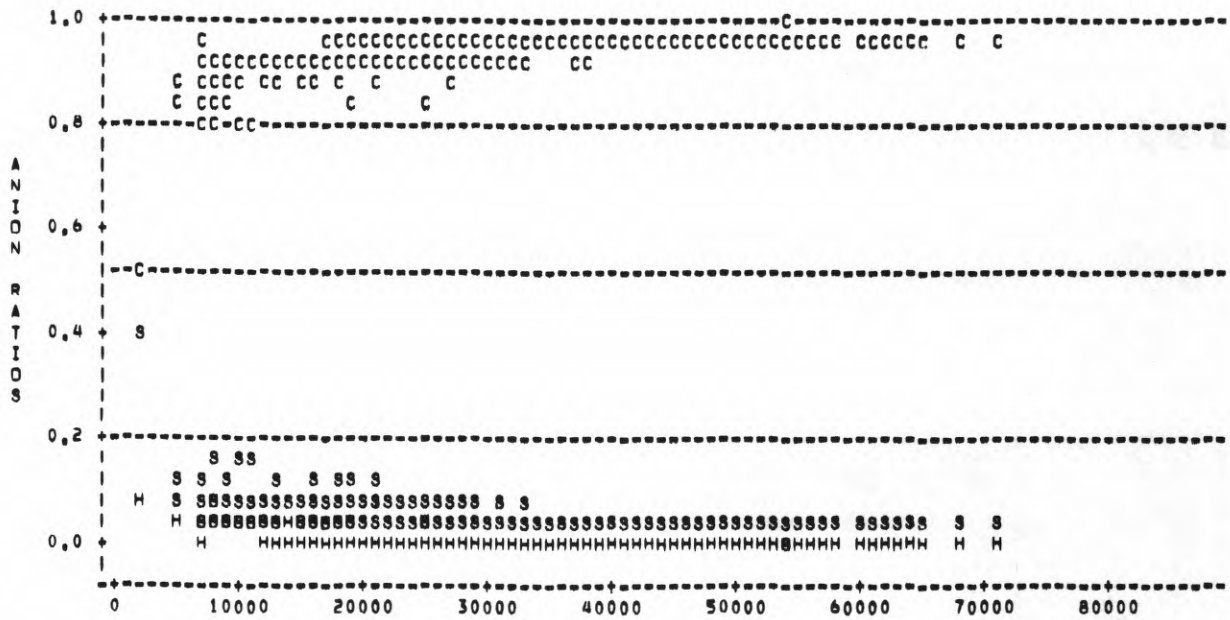
FREQUENCY DISTRIBUTION

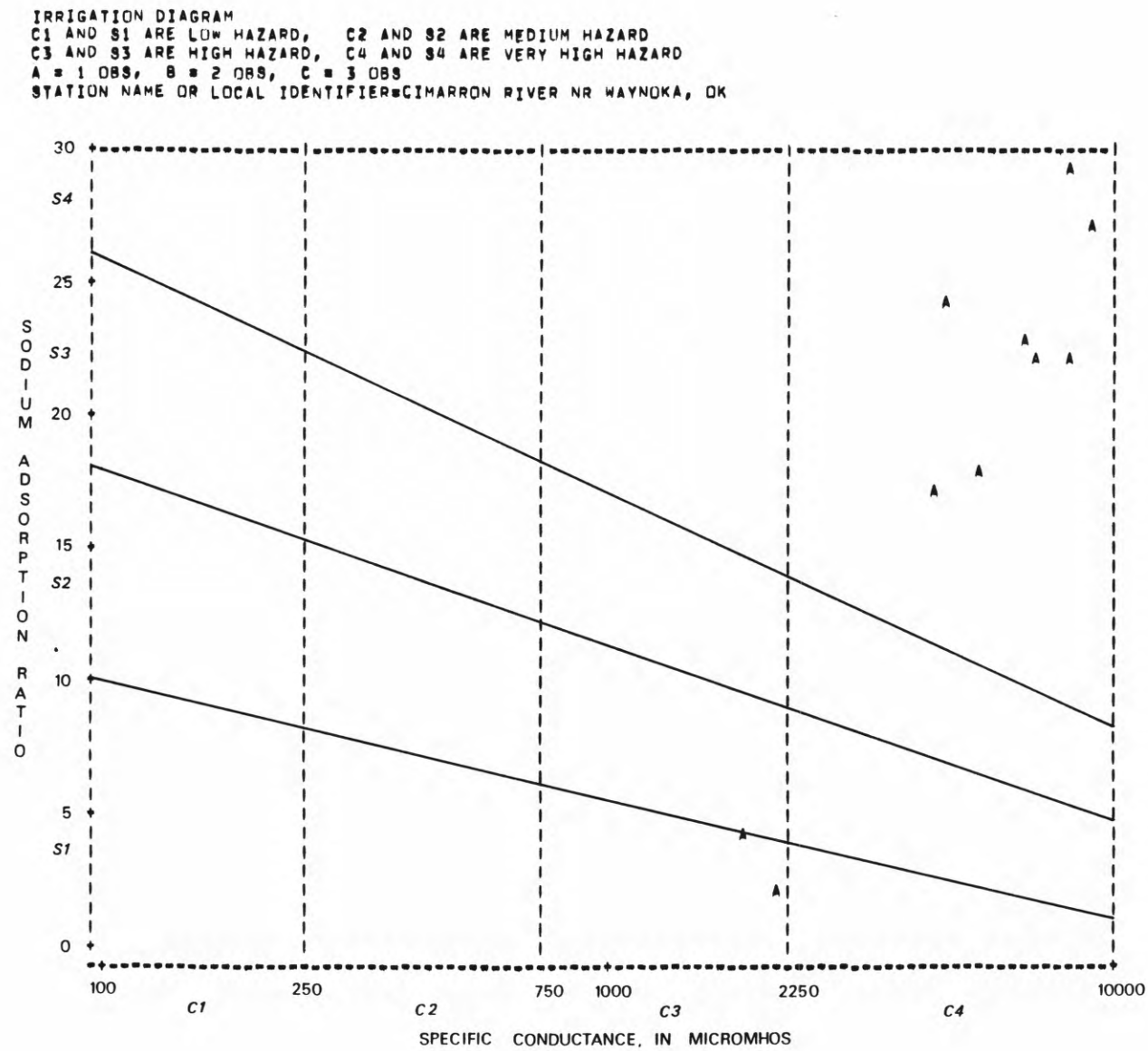
CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	10740	17200	24500	38300	50780
Dissolved solids	6679	11170	16500	27010	35800
pH	7.5	7.8	8.0	8.2	8.3
Total hardness	602	770	999	1300	1500
Chloride	3310	5700	8800	14900	20000
Sulfate	321	480	633	845	1000
Iron					
Fluoride	0.4	0.5	0.6	0.8	0.9
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	43	63	86	130	163
Boron					

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR WAYNOKA, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR WAYNOKA, OK




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR WAYNOKA, OK
SODIUM ADSORPTION RATIO
30
S4
25
S3
20
15
S2
10
5
S1
0
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

CIMARRON RIVER BASIN

07159100 - Cimarron River near Dover, Okla.

LOCATION.--Lat 35°57'06", long 97°54'51", in SW¼NE¼ sec. 14, T.17 N., R.7 W., Kingfisher County, at bridge on U.S. Highway 81, 1.0 mi downstream from Turkey Creek, 2.0 mi south of Dover, 2.5 mi upstream from Kingfisher Creek, and at mile 160.6.

DRAINAGE AREA.--15,713 mi^2, of which 4,926 mi^2 is probably noncontributing.

PERIOD OF RECORD.--1951 to 1953, 1974 to 1978.

WATER TYPE.--The water was sodium chloride type throughout the range of measured specific conductance.

TREND.--Plots of the dissolved solids, hardness, sulfate, and chloride concentrations versus time indicate trends of increasing concentration. The Spearman's rhos at the 95-percent probability level confirm the presence of positive trends for the four constituents.

PUBLIC WATER SUPPLY.--Ninety-seven percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 736 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum pH of 9.0 was exceeded by less than 0.5 percent of the pH values, the recommended maximum sulfate concentration of 250 mg/L was exceeded by 86 percent of the sulfate values, and the recommended maximum chloride concentration of 250 mg/L was exceeded by more than 99 percent of the chloride values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum sulfate and chloride concentrations were exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from high to very high with 95 percent of the samples having a very high salinity hazard. The sodium hazard ranged from low to very high with approximately 90 percent of the SAR values equivalent to a very high sodium hazard. No boron data were available.

07159100 - Cimarron River near Dover, Okla.--Continued

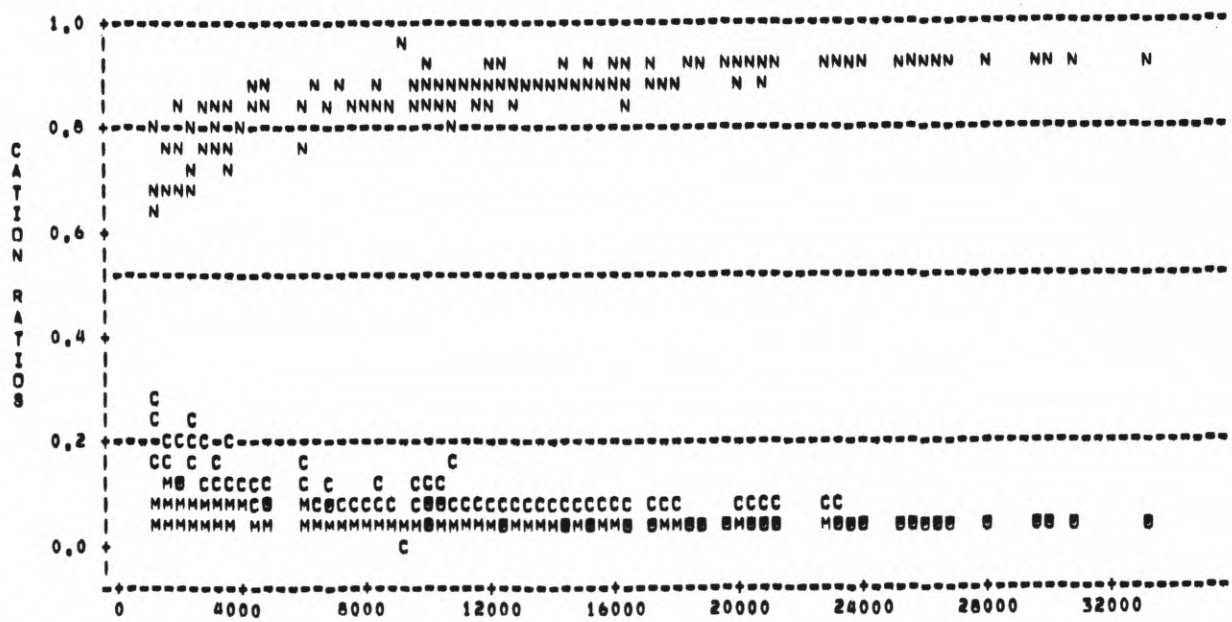
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	220	13821	1130	33100	7020	0.30	-0.27
Dissolved solids	182	8093	651	21300	4700	.41	-.28
pH	220	7.9	7.0	9.2	.3	.12	.18
Total hardness	182	736	140	1300	279	-.47	-.67
Chloride	184	4340	220	13000	2715	.56	.01
Sulfate	181	508	43	870	199	-.59	-.54
Iron	0						
Fluoride	0						
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	167	43	4.7	103	21	.24	-.25
Boron	0						

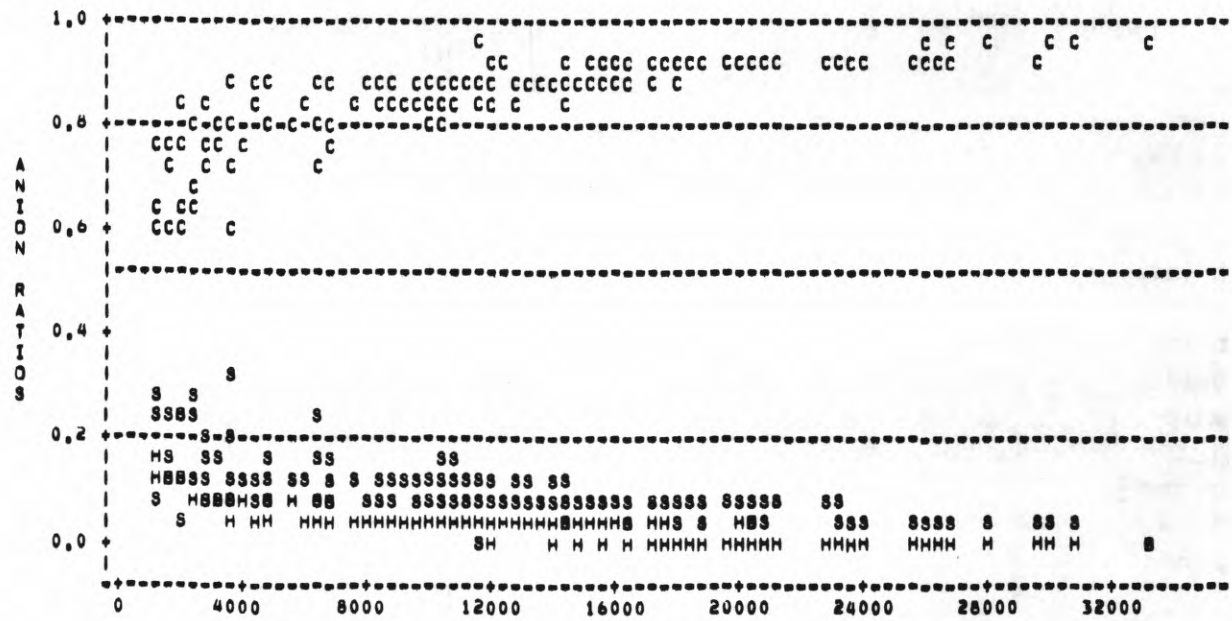
FREQUENCY DISTRIBUTION

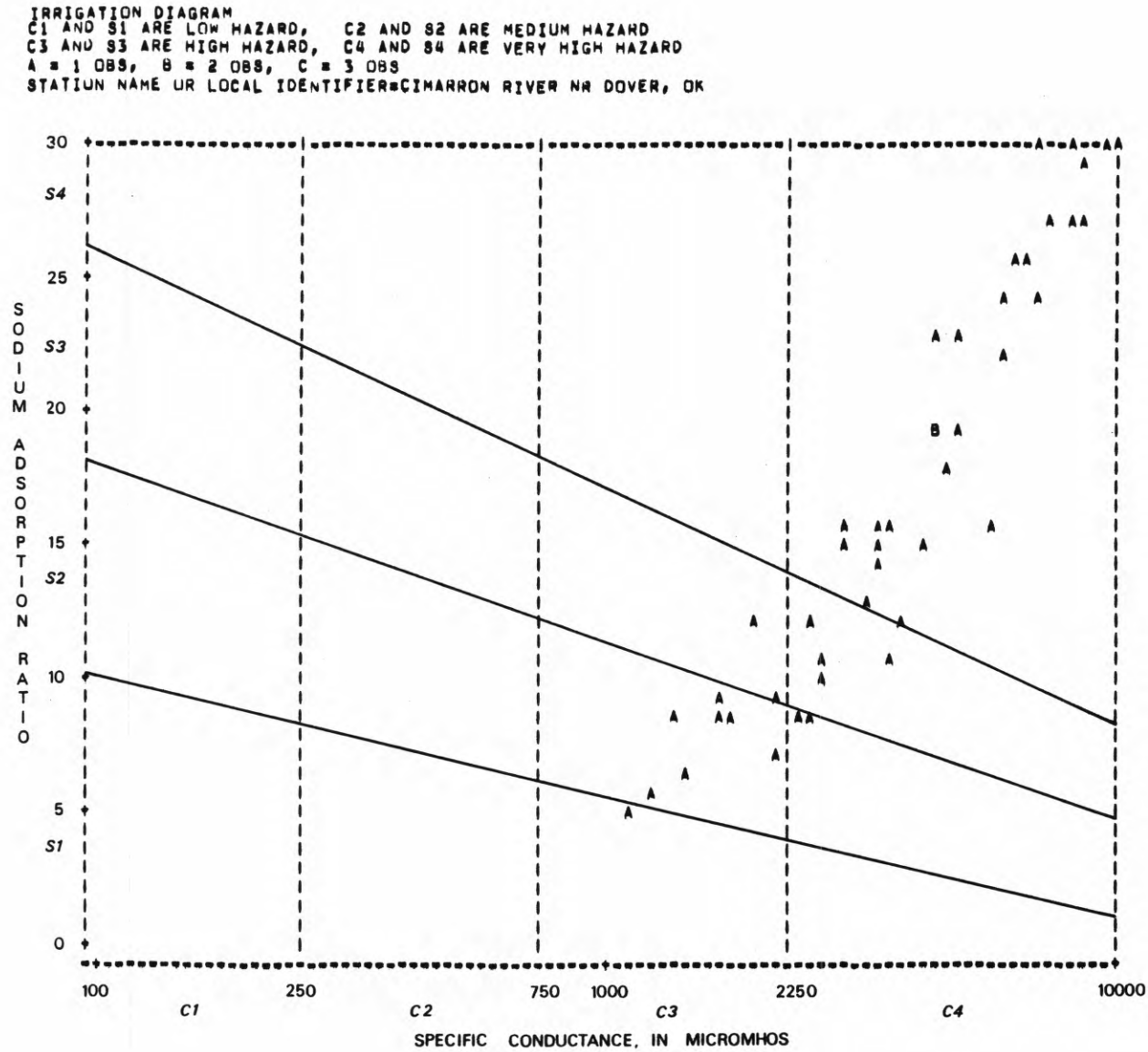
CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	3350	8380	13000	17600	22600
Dissolved solids	1672	4530	7860	10770	14630
pH	7.4	7.6	7.9	8.1	8.3
Total hardness	282	540	800	929	1010
Chloride	782	2200	4100	5900	7960
Sulfate	182	365	552	659	731
Iron					
Fluoride					
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	12	29	42	56	70
Boron					

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR DOVER, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR DOVER, OK




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR DOVER, OK
SODIUM ADSORPTION RATIO
30
S4
25
S3
20
15
S2
10
5
S1
0
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

CIMARRON RIVER BASIN

07160000 - Cimarron River near Guthrie, Okla.

LOCATION.--Lat 35°55'10", long 97°25'35", in NE¼SE¼ sec. 29, T.17 N., R.2 W., Logan County, 125 ft upstream from the Atchison, Topeka, and Santa Fe Railway Co. bridge, 1.2 mi downstream from Cottonwood Creek, 2.5 mi north of Guthrie, 6.5 mi upstream from Skeleton Creek, and at mile 121.8.

DRAINAGE AREA.--16,892 mi^2, of which 4,926 mi^2 is probably noncontributing.

PERIOD OF RECORD.--1949, 1953 to 1963, 1976 to 1978.

WATER TYPE.--The water was sodium chloride type throughout the range of measured specific conductance.

TREND.--The current period of record is insufficient, less than 5 years, to perform trend analyses.

PUBLIC WATER SUPPLY.--Ninety-eight percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 710 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum sulfate concentration of 250 mg/L was exceeded by 86 percent of the sulfate values and the recommended maximum chloride concentration of 250 mg/L was exceeded by 98 percent of the chloride values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum sulfate and chloride concentrations were exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from high to very high with 94 percent of the samples having a very high salinity hazard. The sodium hazard ranged from low to very high with approximately 90 percent of the SAR values equivalent to a very high sodium hazard. One of 6 boron values exceeded the recommended limit, 1,000 ug/L, for boron semitolerant plants.

07160000 - Cimarron River near Guthrie, Okla.--Continued

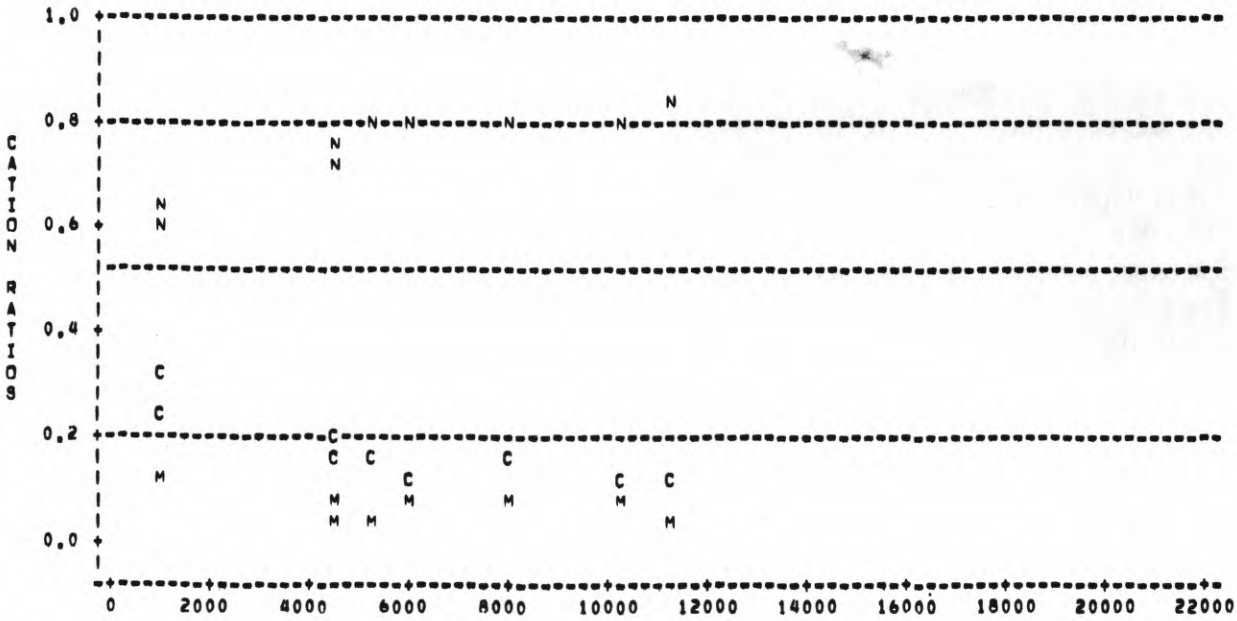
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	102	9655	1080	18800	4452	0.12	-0.61
Dissolved solids	24	4881	611	11300	2792	.56	.13
pH	94	8.1	6.8	8.7	.3	-1.07	3.65
Total hardness	87	710	86	1238	235	-.36	.08
Chloride	101	3064	190	7179	1558	.28	-.46
Sulfate	43	505	70	1020	214	.14	.22
Iron	0						
Fluoride	7	0.4	0.3	0.6			
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	23	27	4.8	63	14	0.90	1.01
Boron	6	510	150	1300			

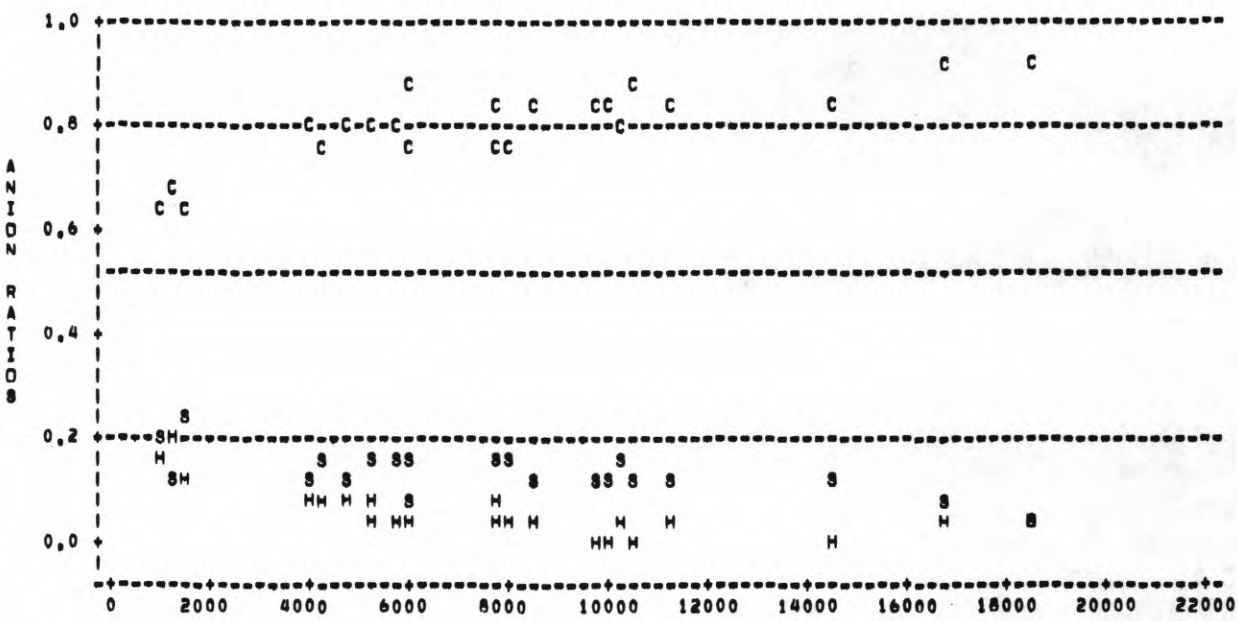
FREQUENCY DISTRIBUTION

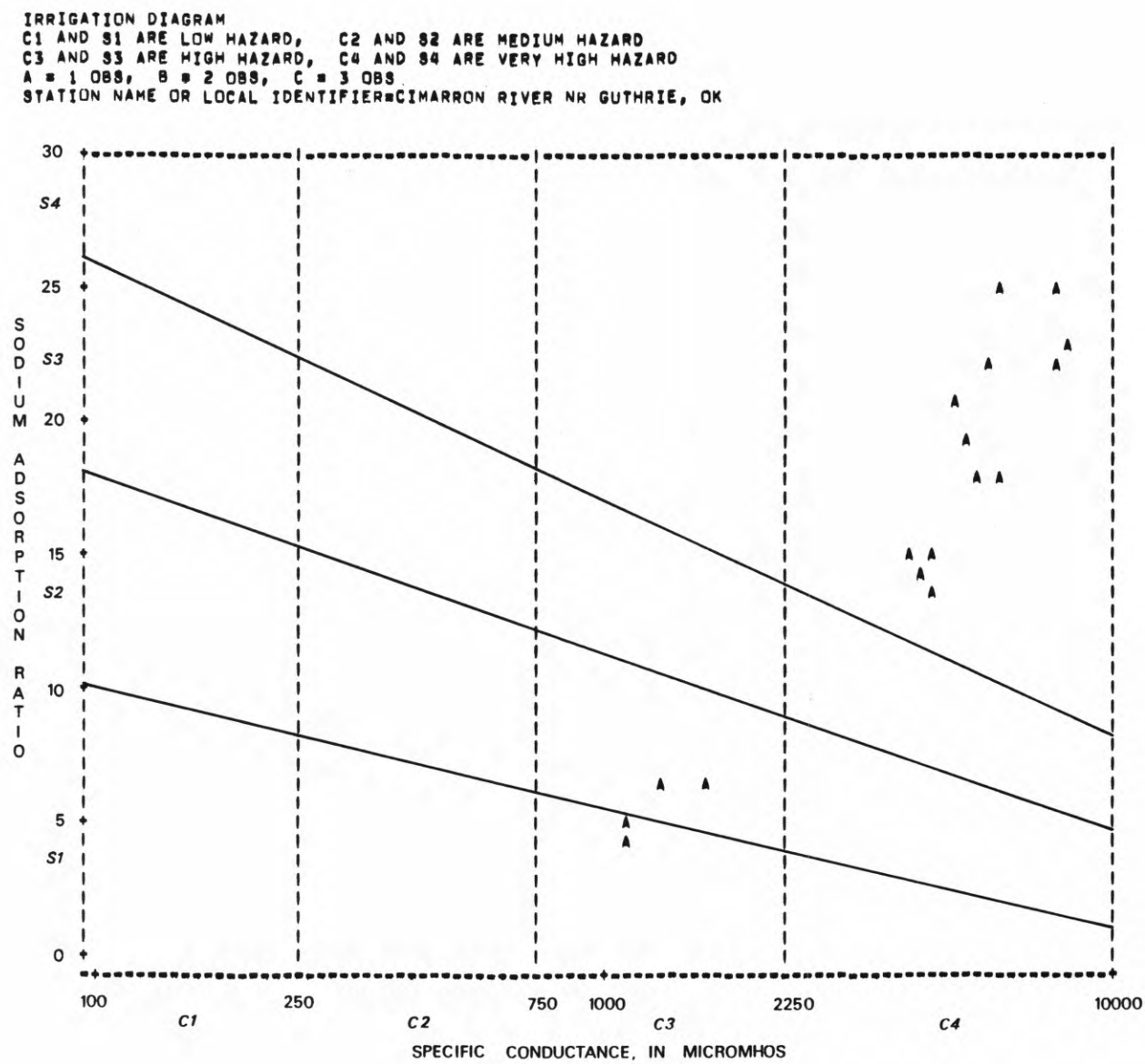
CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	3774	5983	9770	12250	15920
Dissolved solids	821	2980	4790	6360	8240
pH	7.8	7.9	8.1	8.3	8.4
Total hardness	398	579	714	856	997
Chloride	1110	1793	3055	4041	5345
Sulfate	198	343	536	581	753
Iron					
Fluoride					
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	8.8	18	24	32	46
Boron					

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR GUTHRIE, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR GUTHRIE, OK




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER NR GUTHRIE, OK
SODIUM ADSORPTION RATIO
30
S4
25
S3
20
15
S2
10
5
S1
0
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

CIMARRON RIVER BASIN

07161000 - Cimarron River at Perkins, Okla.

LOCATION.--Lat 35°57'32", long 97°01'49", in SW¼SW¼ sec. 7, T.17 N., R.3 E., Payne County, at bridge on U.S. Highway 177, 1.0 mi south of Perkins, 1.5 mi upstream from Dugout Creek, 4.0 mi downstream from Wildhorse Creek, and at mile 87.3.

DRAINAGE AREA.--17,852 mi^2, of which 4,926 mi^2 is probably noncontributing.

PERIOD OF RECORD.--1950, 1953 to 1963, 1965 to 1978.

WATER TYPE.--The water was sodium chloride type throughout the range of measured specific conductance.

TREND.--Plots of the dissolved solids, hardness, sulfate, and chloride concentrations versus time indicate trends of increasing concentration. The Spearman's rhos at the 95-percent probability level confirm the presence of positive trends for the four constituents.

PUBLIC WATER SUPPLY.--Ninety-three percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 542 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum pH of 9.0 was exceeded by 1 percent of the pH values, the recommended maximum sulfate concentration of 250 mg/L was exceeded by 65 percent of the sulfate values, and the recommended maximum chloride concentration of 250 mg/L was exceeded by 95 percent of the chloride values. The maximum contaminant level for fluoride was exceeded by less than 0.5 percent of the fluoride values. The toxic metals arsenic, cadmium, chromium, lead, and mercury did not exceed maximum contaminant levels. Because of the frequency and magnitude by which the recommended maximum sulfate and chloride concentrations were exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from low to very high with 88 percent of the samples having a very high salinity hazard. The sodium hazard ranged from low to very high with approximately 85 percent of the SAR values equivalent to a very high sodium hazard. The data indicate that phytotoxic effects could occur in boron sensitive and semitolerant plants.

07161000 - Cimarron River at Perkins, Okla.--Continued

UNIVARIATE STATISTICS

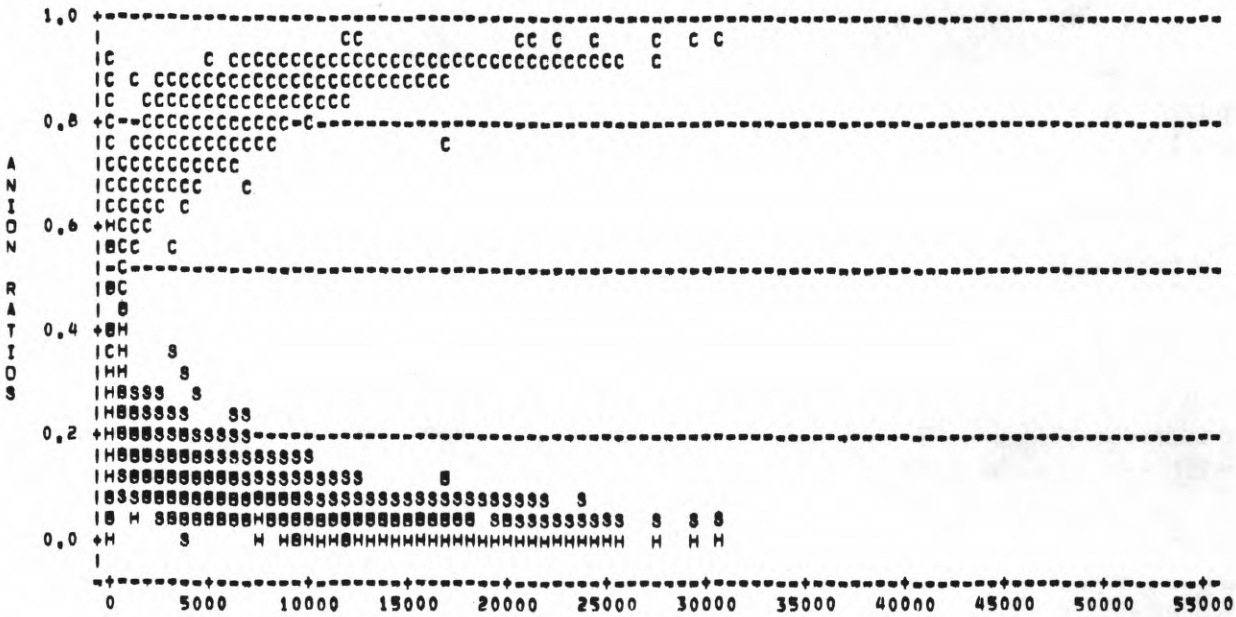
CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	2122	7865	353	48000	4910	0.95	2.48
Dissolved solids	2043	4741	277	19600	3555	1.37	4.64
pH	1998	8.2	6.6	9.8	.3	-.19	1.90
Total hardness	1986	542	88	1880	237	-.04	-.25
Chloride	2035	2404	31	10900	1669	.99	1.28
Sulfate	2039	321	12	851	153	-.02	-.60
Iron	14	27	0	60	19	.57	-.53
Fluoride	397	.5	0.0	1.9	.2	1.01	2.87
Arsenic	14	4	2	9	2.4	.98	.09
Cadmium	14	2	0	8	2.2	1.86	4.11
Chromium	14	7	0	30	8.0	1.64	4.16
Lead	14	10	2	45	15	1.85	2.06
Mercury	12	.1	0.0	.3	.1	1.95	4.37
SAR	1971	27	1.5	93	15	.70	.45
Boron	123	298	0	1200	241	1.49	2.68

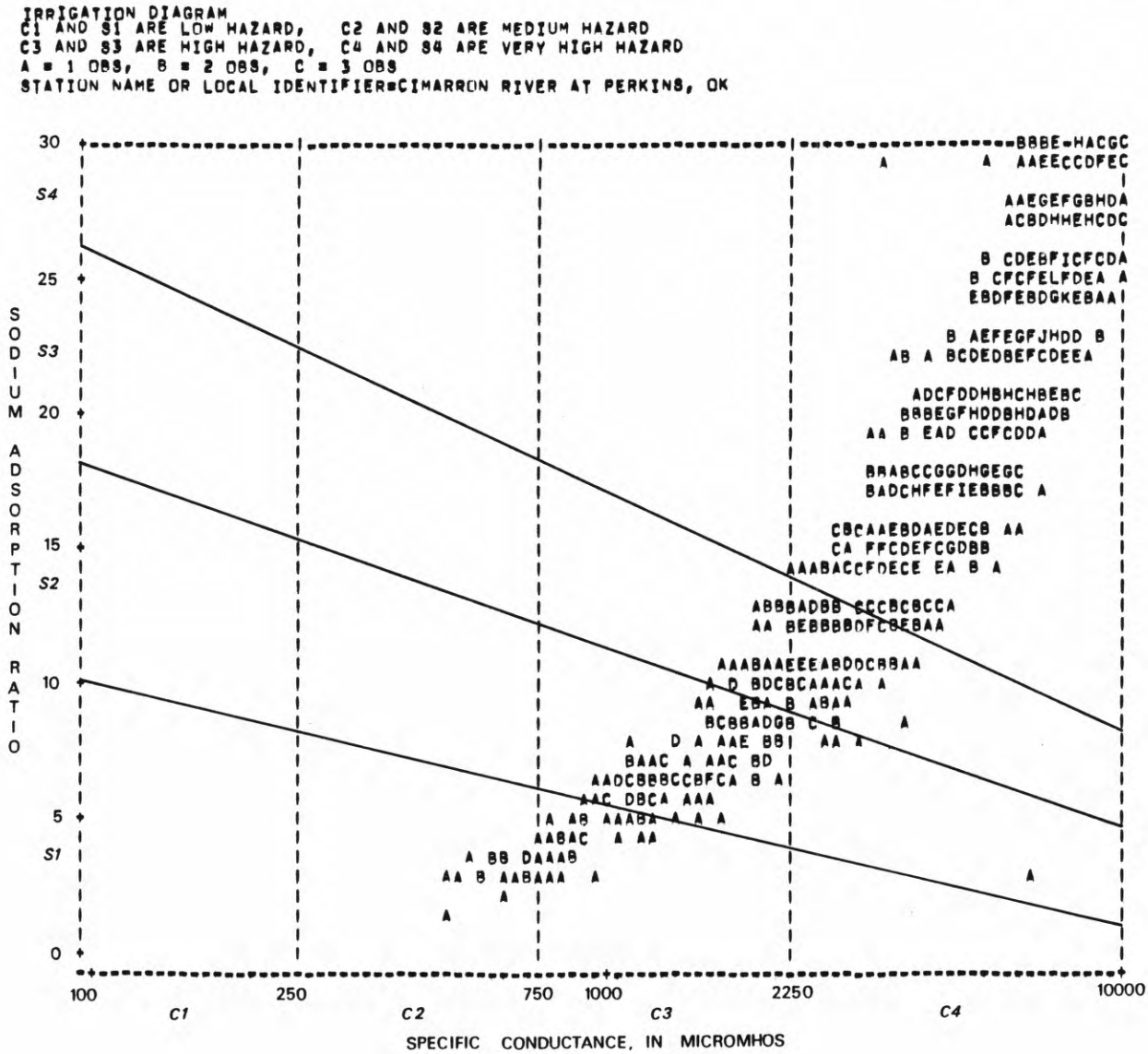
FREQUENCY DISTRIBUTION

CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	2002	4125	7237	11000	14410
Dissolved solids	1137	2404	4305	6546	9000
pH	7.7	8.0	8.2	8.4	8.5
Total hardness	212	360	560	720	837
Chloride	478	1136	2100	3400	4695
Sulfate	110	210	330	440	507
Iron	1	8	18	35	46
Fluoride	.3	.4	.5	.6	.8
Arsenic	1	2	3	5	6
Cadmium	0	0	1	2	4
Chromium	0	0	5	8	10
Lead	1	1	3	4	33
Mercury	0.0	0.0	0.0	0.0	.1
SAR	9.7	17	25	36	48
Boron	36	129	234	402	537

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER AT PERKINS, OK

ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER AT PERKINS, OK




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER AT PERKINS, OK
SODIUM ADSORPTION RATIO
30
25
20
15
10
5
0
S4
S3
S2
S1
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

CIMARRON RIVER BASIN

07164000 - Cimarron River at Mannford, Okla.

LOCATION.--Lat 36°09'32", long 96°23'54", in SW¼NW¼ sec. 6, T.19 N., R.8 E., Creek County, at county road bridge, 0.5 mi north of Mannford, and at mile 17.7.

DRAINAGE AREA.--18,849 mi^2, of which 13,923 mi^2 is probably noncontributing.

PERIOD OF RECORD.--1950 to 1952, 1960 to 1963.

WATER TYPE.--The water was sodium chloride type throughout the range of measured specific conductance.

TREND.--No current data were available.

PUBLIC WATER SUPPLY.--Ninety-eight percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 764 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum sulfate concentration of 250 mg/L was exceeded by 49 percent of the sulfate values, and the recommended maximum chloride concentration of 250 mg/L was exceeded by 99 percent of the chloride values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum chloride concentration was exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from medium to very high with 90 percent of the samples having a very high salinity hazard. The sodium hazard ranged from low to very high with approximately 85 percent of the SAR values equivalent to a very high sodium hazard. The data indicate that phytotoxic effects could occur in boron sensitive and semitolerant plants.

07164000 - Cimarron River at Mannford, Okla.--Continued

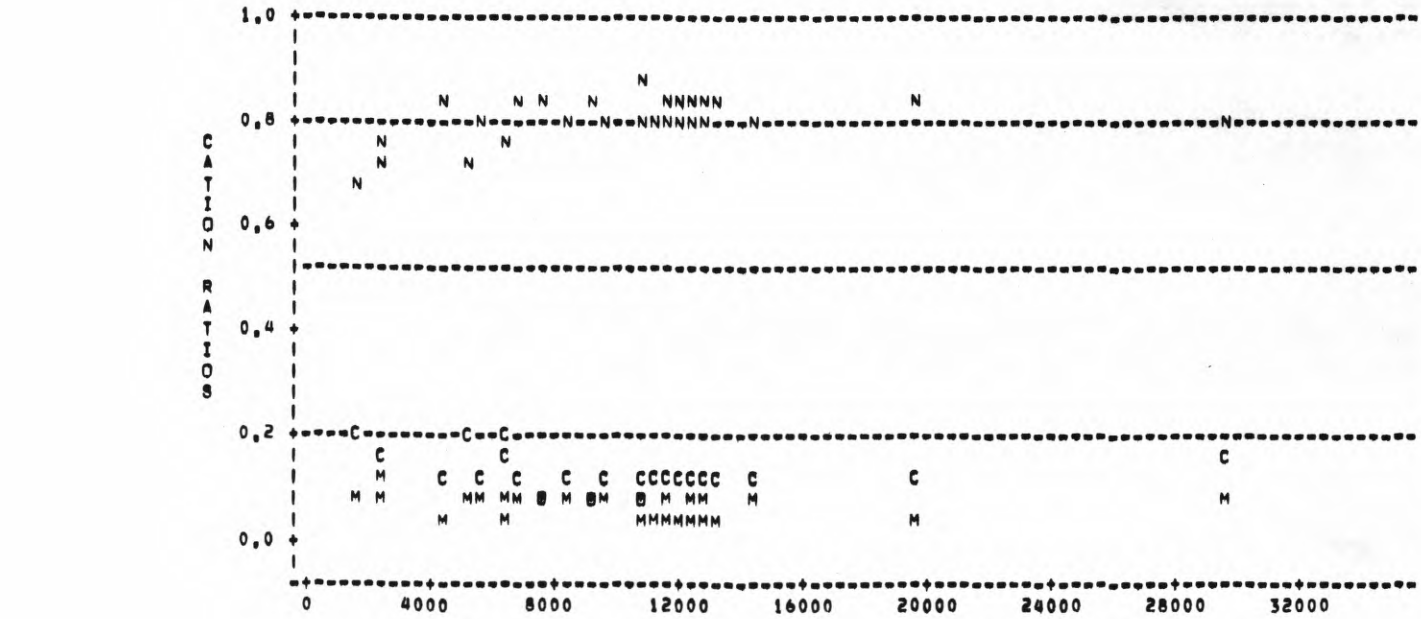
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	383	7582	641	34200	5097	1.46	3.52
Dissolved solids	373	4729	369	22400	3442	1.62	4.01
pH	251	7.9	7.2	8.5	.3	-.30	-.20
Total hardness	373	764	108	4030	534	2.42	9.21
Chloride	383	2430	130	12600	1888	1.74	4.95
Sulfate	366	255	20	630	124	.20	-.78
Iron	0						
Fluoride	31	0.2	0.0	0.7	0.2	0.91	0.32
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	54	24	3.6	42	9.4	-.31	-.59
Boron	18	489	110	1400	375	1.40	1.57

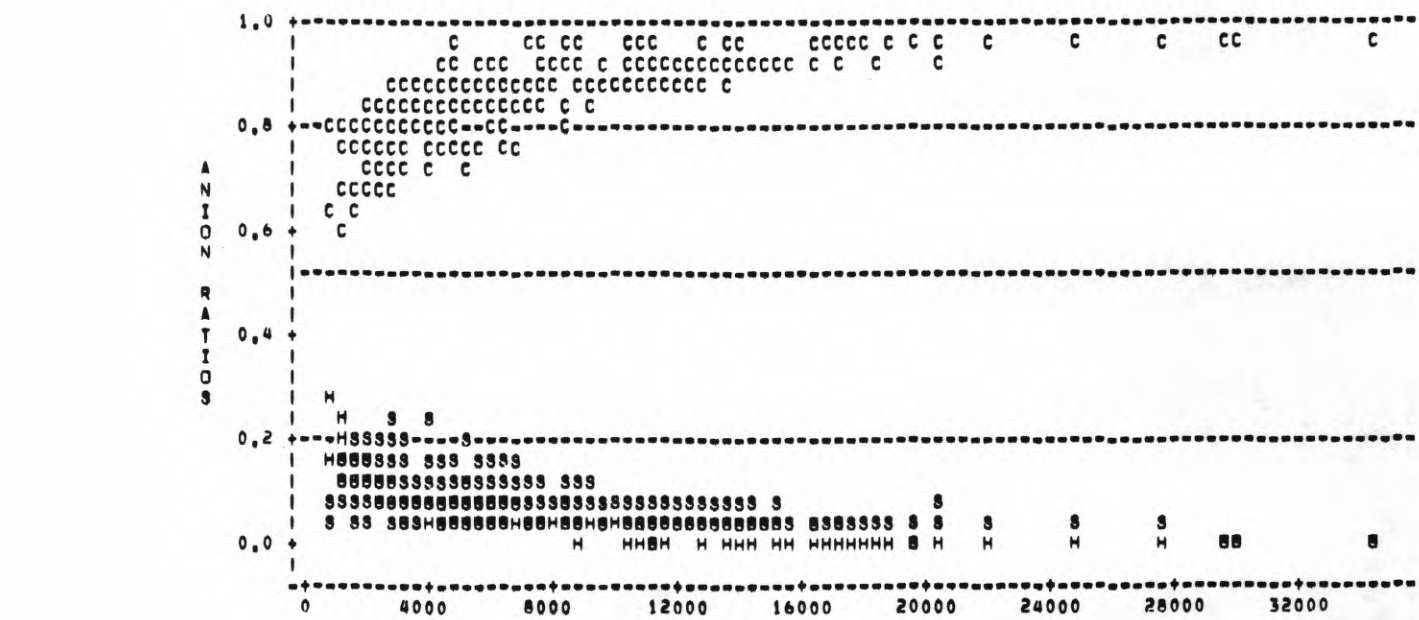
FREQUENCY DISTRIBUTION

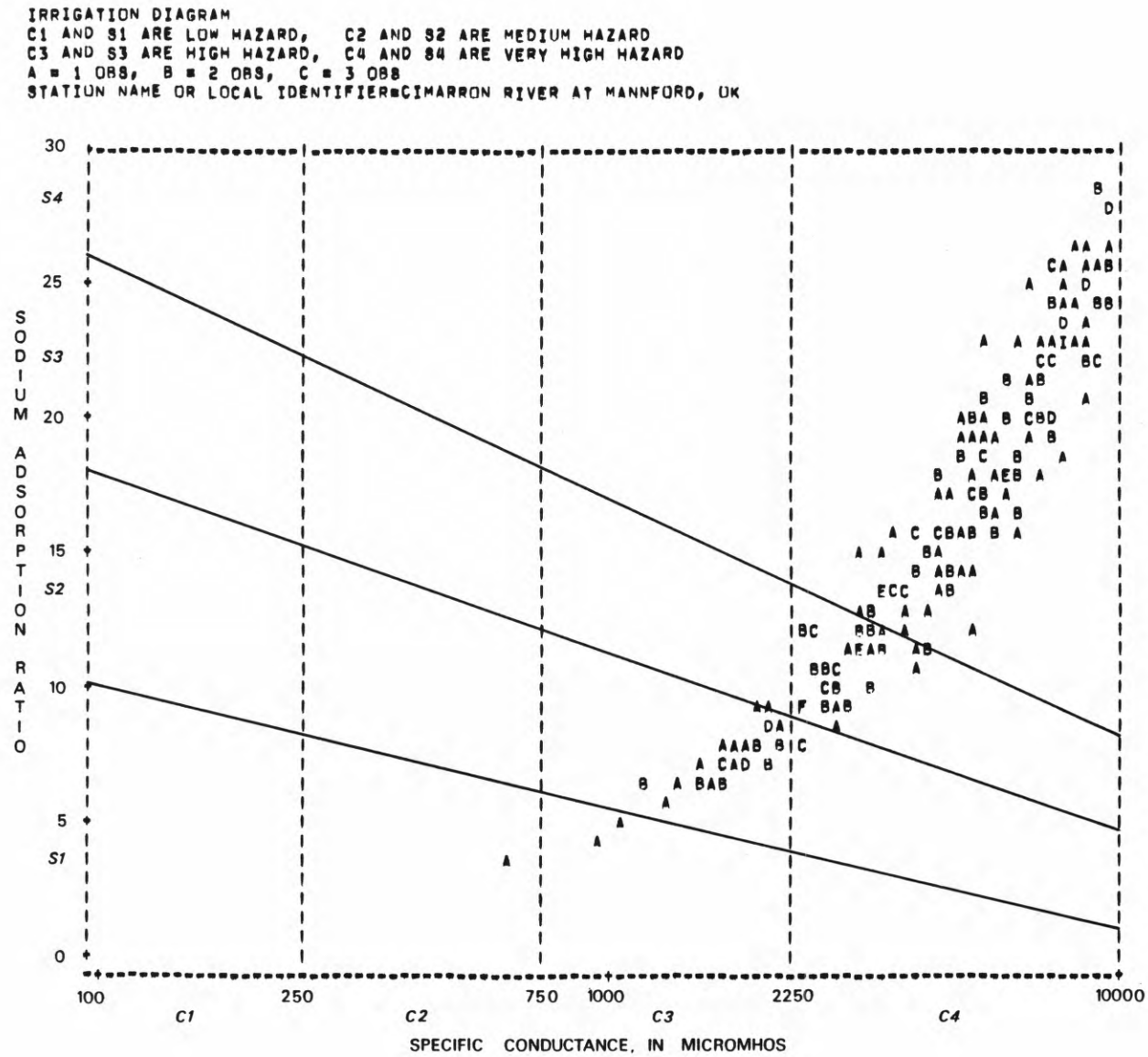
CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	2371	3494	6555	10690	13400
Dissolved solids	1310	1990	3868	6576	8555
pH	7.6	7.8	7.9	8.1	8.3
Total hardness	270	377	636	998	1269
Chloride	549	1002	1975	3601	4527
Sulfate	100	150	246	354	413
Iron					
Fluoride	0.0	0.0	0.2	0.3	0.4
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	8.9	16	26	30	32
Boron	110	190	420	525	948

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER AT MANNFORD, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER AT MANNFORD, OK




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=CIMARRON RIVER AT MANNFORD, OK
SODIUM ADSORPTION RATIO
30
S4
25
S3
20
15
S2
10
5
S1
0
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

CIMARRON RIVER BASIN

07159750 - Cottonwood Creek at Seward, Okla.

LOCATION.--Lat 35°47'43", long 97°29'32", in SW¼ sec. 2, T.15 N., R.3 W., Logan County, at county road bridge, 0.3 mi west of Seward, 7.7 mi southwest of Guthrie, and at mile 19.2.

DRAINAGE AREA.--316 mi^2.

PERIOD OF RECORD.--1973 to 1978.

WATER TYPE.--When the specific conductance was less than 500 umho, which accounted for 8 percent of the samples, the water was calcium carbonate/bicarbonate type. For specific conductance between 500 and 1,200 umho, which occurred for 51 percent of the samples, the water was generally sodium carbonate/bicarbonate type. For specific conductance greater than 1,200 umho the water was mixed type.

TREND.--Plots of the dissolved solids, hardness, chloride, and sulfate concentrations versus time indicate a trend of decreasing hardness concentration and a trend of increasing chloride concentration. The Spearman's rho for chloride at the 95-percent probability level confirms the presence of a positive trend; however, the Spearman's rho for hardness did not indicate any trend. The Spearman's rhos for dissolved solids and sulfate did not indicate any trend.

PUBLIC WATER SUPPLY.--Eighty-seven percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 315 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum pH of 9.0 was exceeded by less than 0.5 percent of the pH values, the recommended maximum sulfate concentration of 250 mg/L was exceeded by less than 1 percent of the sulfate values, and the recommended maximum iron concentration of 300 ug/L was exceeded by less than 1 percent of the iron values. The toxic metals arsenic, cadmium, chromium, and lead did not exceed maximum contaminant levels. No mercury data were available. Based on the data, this water would probably be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from low to high with 81 percent of the samples having a high salinity hazard. All of the SAR values were equivalent to a low sodium hazard. No boron data were available.

07159750 - Cottonwood Creek at Seward, Okla.--Continued

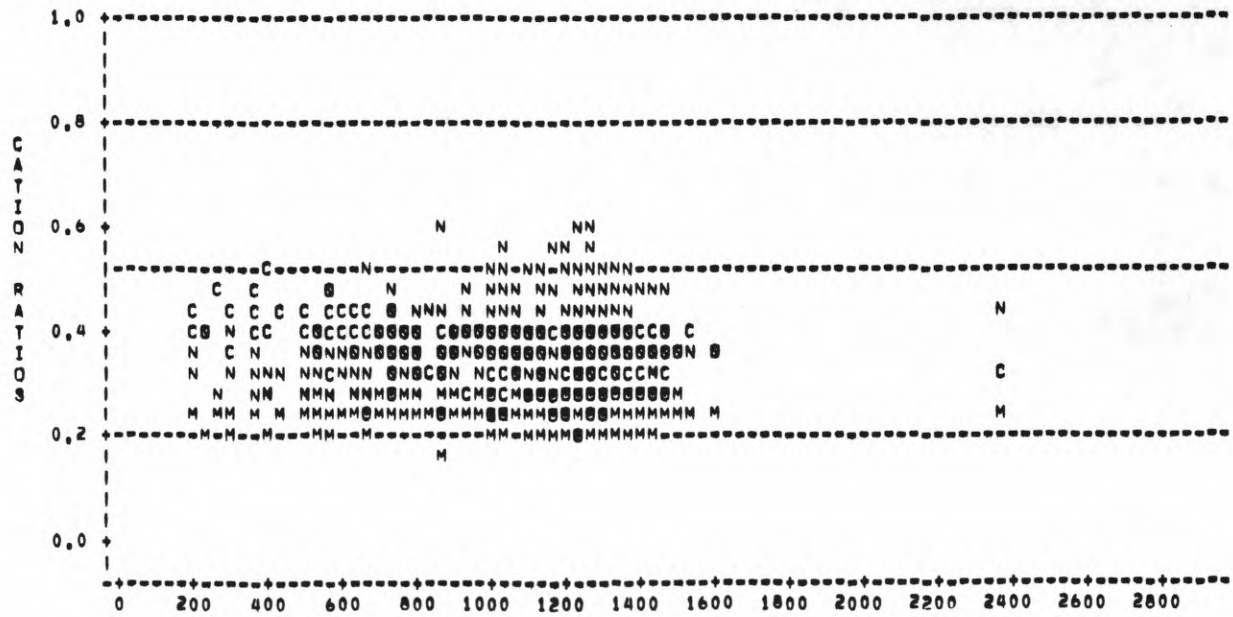
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	360	1073	127	9000	535	8.93	134.18
Dissolved solids	257	634	49	1030	223	-.58	-.61
pH	331	7.7	6.7	9.3	.4	.00	.07
Total hardness	256	315	59	550	110	-.10	-.51
Chloride	259	106	16	180	44	-.27	-1.07
Sulfate	255	157	9.1	290	60	-.46	-.64
Iron	24	83	10	380	90	2.32	5.53
Fluoride	4	.5	.4	.6			
Arsenic	1	2					
Cadmium	24	2	0	8	2.0	1.37	2.24
Chromium	23	0	0	10	2.1	4.80	23.00
Lead	23	5	0	16	4.0	1.21	1.45
Mercury	0						
SAR	248	2.3	0.7	4.3	0.8	.04	-.55
Boron	0						

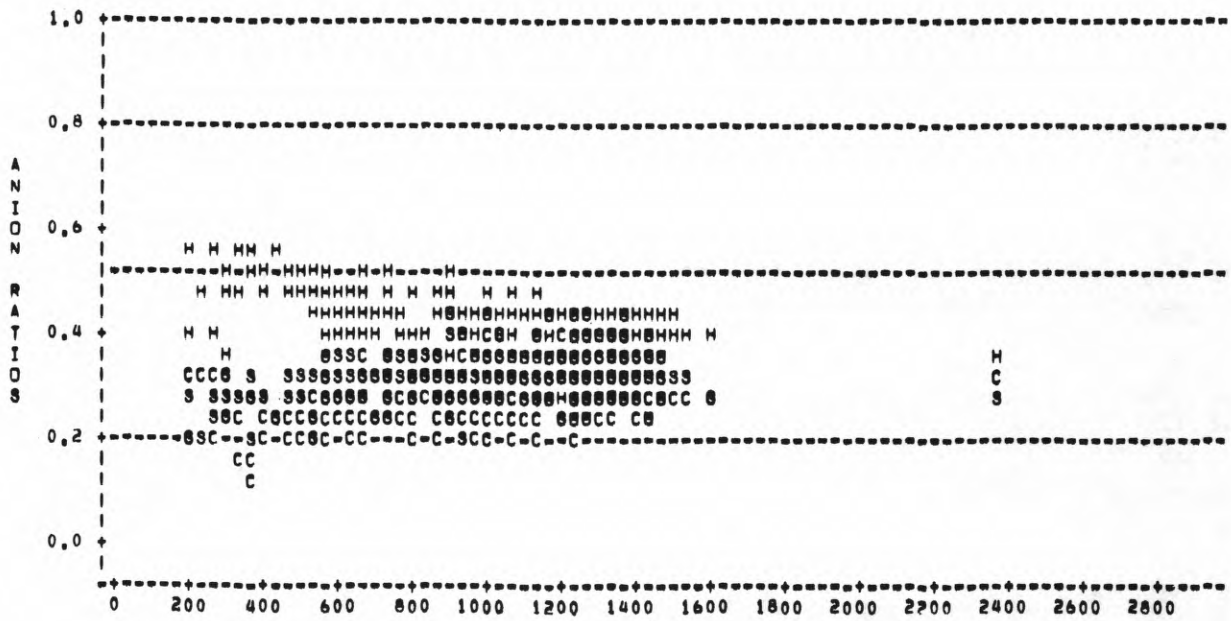
FREQUENCY DISTRIBUTION

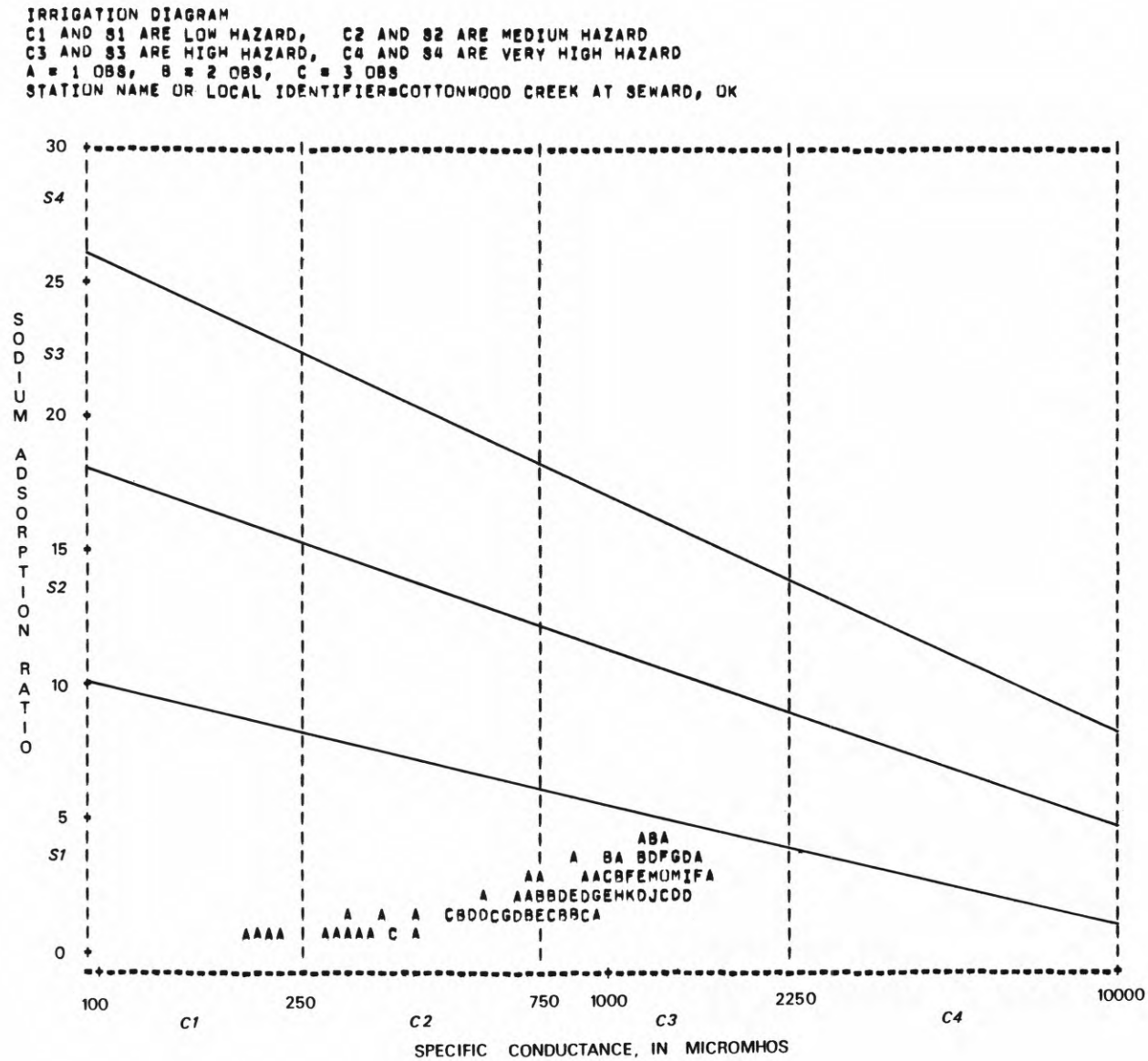
CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	554	843	1140	1292	1398
Dissolved solids	305	469	686	811	888
pH	7.1	7.4	7.7	8.0	8.2
Total hardness	164	228	320	390	455
Chloride	41	71	110	140	160
Sulfate	68	110	170	200	230
Iron	8	30	50	80	136
Fluoride					
Arsenic					
Cadmium	0	0	1	3	4
Chromium	0	0	0	0	0
Lead	0	1	3	6	9
Mercury					
SAR	1.3	1.8	2.3	2.8	3.3
Boron					

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=COTTONWOOD CREEK AT SEWARD, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=COTTONWOOD CREEK AT SEWARD, OK




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=COTTONWOOD CREEK AT SEWARD, OK
SODIUM ADSORPTION RATIO
30
S4
25
S3
20
15
S2
10
5
S1
0
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

07159800 - Cottonwood Creek near Guthrie, Okla.

LOCATION.--Lat 35°52'45", long 97°26'30", in SE¼NE¼ sec. 8, T.16 N., R.2 W., Logan County, at bridge on State Highway 33 at Guthrie.

DRAINAGE AREA.--Not determined.

PERIOD OF RECORD.--1952 to 1961.

WATER TYPE.--The water was mixed type throughout the range of measured specific conductance.

TREND.--No current data were available.

PUBLIC WATER SUPPLY.--Ninety-seven percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 370 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum sulfate concentration of 250 mg/L was exceeded by 1 of 6 sulfate values. No toxic metal data were available. Based on the data, the water at this location would be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from medium to high with 94 percent of the samples having a high salinity hazard. All SAR values were equivalent to a low sodium hazard. No boron data were available.

07159800 - Cottonwood Creek near Guthrie, Okla.--Continued

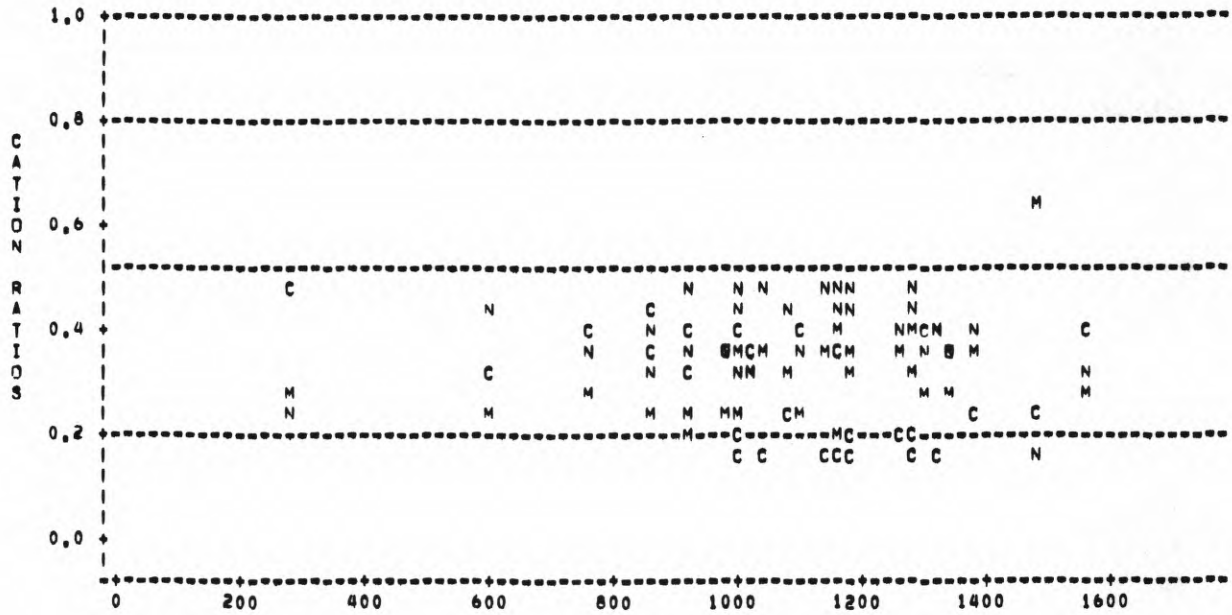
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	29	1079	284	1550	264	-0.89	1.86
Dissolved solids	6	686	641	750			
pH	29	8.2	7.4	8.7	0.3	-.62	.52
Total hardness	29	370	105	1240	187	3.75	17.75
Chloride	29	96	11	132	29	-1.09	1.25
Sulfate	6	201	122	258			
Iron	0						
Fluoride	0						
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	29	2.5	0.6	3.4	0.7	-1.02	-.81
Boron	0						

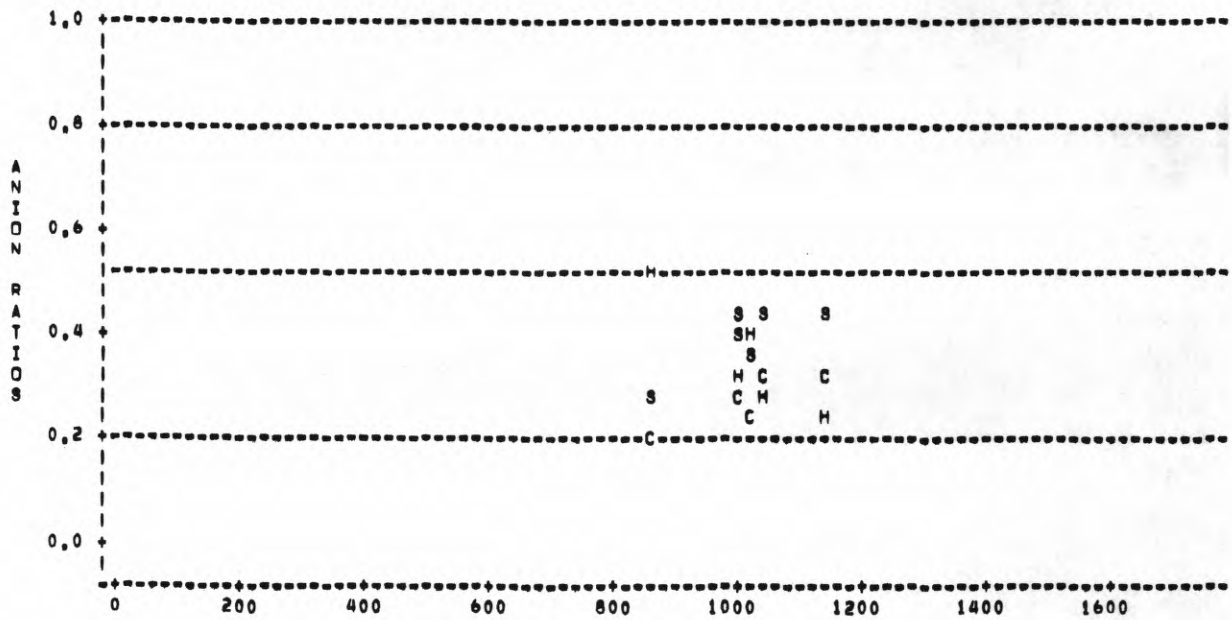
FREQUENCY DISTRIBUTION

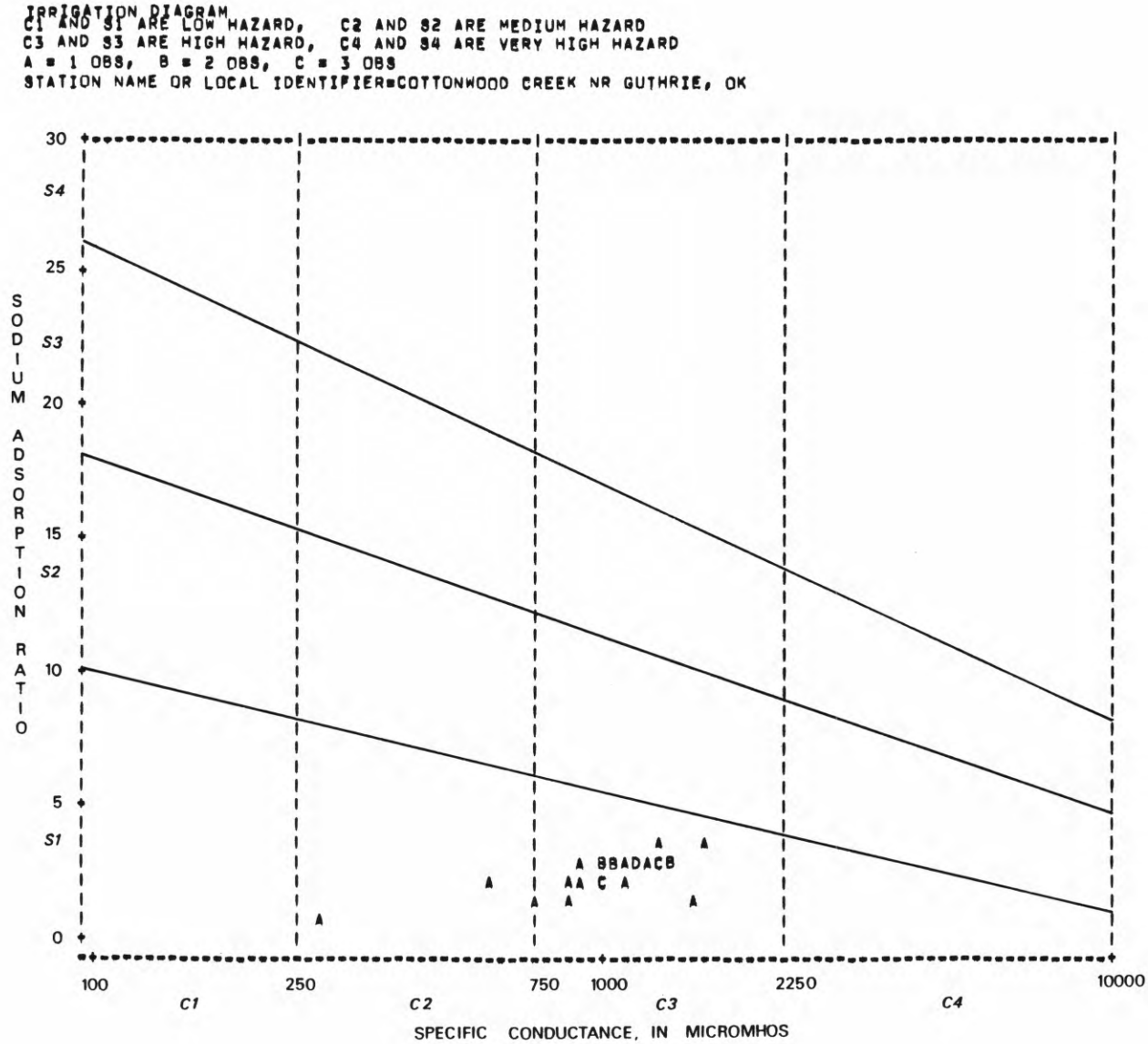
CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	737	933	1110	1265	1335
Dissolved solids					
pH	7.7	8.0	8.2	8.4	8.5
Total hardness	251	290	330	390	491
Chloride	58	72	102	117	125
Sulfate					
Iron					
Fluoride					
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	1.6	2.0	2.7	3.1	3.2
Boron					

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=COTTONWOOD CREEK NR GUTHRIE, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=COTTONWOOD CREEK NR GUTHRIE, OK




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=COTTONWOOD CREEK NR GUTHRIE, OK
SODIUM ADSORPTION RATIO
30
S4
25
S3
20
15
S2
10
5
S1
0
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

CIMARRON RIVER BASIN

07157500 - Crooked Creek near Nye, Kans.

LOCATION.--Lat 37°02'02", long 100°11'55", in SE¼NW¼ sec. 1, T.35 S., R.27 W., Meade County, at county road bridge, 6.5 mi east of Nye, and at mile 14.0.

DRAINAGE AREA.--1,157 mi^2, of which 344 mi^2 is probably noncontributing.

PERIOD OF RECORD.--1947, 1958 to 1963.

WATER TYPE.--When the specific conductance was greater than 1,200 umho, which accounted for 85 percent of the samples, the water was sodium chloride type. For specific conductance less than 800 umho, which accounted for 11 percent of the samples, the water was carbonate/bicarbonate type with no predominant cation. For specific conductance greater than 800 umho and less than 1,200 umho the water was mixed type.

TREND.--No current data were available.

PUBLIC WATER SUPPLY.--Eighty-nine percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 319 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum pH of 9.0 was exceeded by 2 percent of the pH values, the recommended maximum sulfate concentration of 250 mg/L was exceeded by 2 percent of the sulfate values, and the recommended maximum chloride concentration of 250 mg/L was exceeded by 83 percent of the chloride values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum chloride concentration was exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from medium to very high with 70 percent of the samples having a very high salinity hazard. The sodium hazard ranged from low to very high with approximately 35 percent of the SAR values equivalent to a very high sodium hazard. None of the boron values exceeded the recommended limit, 750 ug/L, for boron sensitive plants.

07157500 - Crooked Creek near Nye, Kans.--Continued

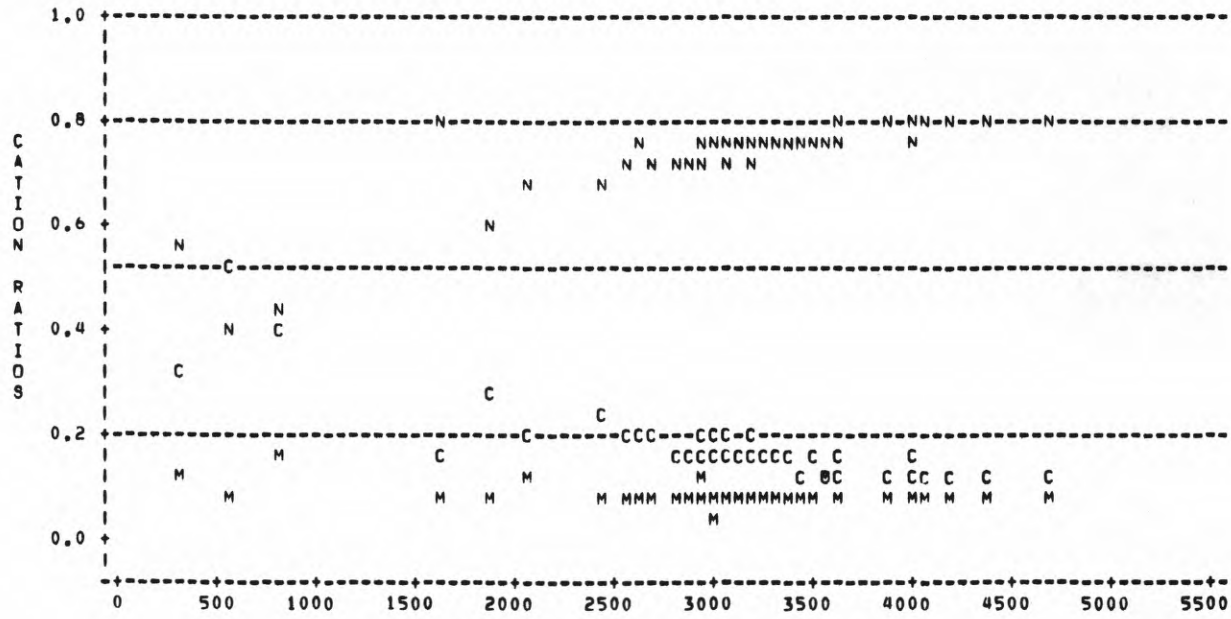
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	150	2666	320	4700	1103	-0.58	-0.58
Dissolved solids	88	1459	173	2710	668	-.39	-1.00
pH	61	8.0	7.4	9.3	.4	.59	1.23
Total hardness	107	319	66	440	91	-1.03	.15
Chloride	137	670	38	1400	328	-.45	-.63
Sulfate	90	125	15	358	62	.35	1.20
Iron	0						
Fluoride	21	1.0	0.3	1.2	0.3	-1.43	1.70
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	58	11	1.5	18	4.0	-.88	.46
Boron	6	168	130	230			

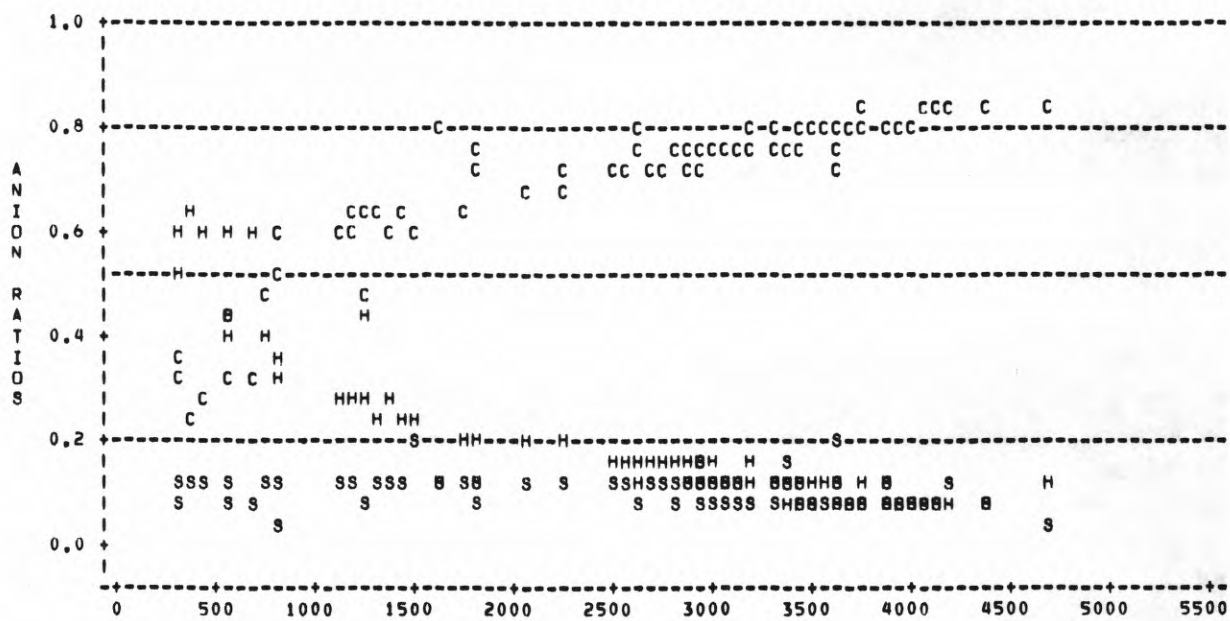
FREQUENCY DISTRIBUTION

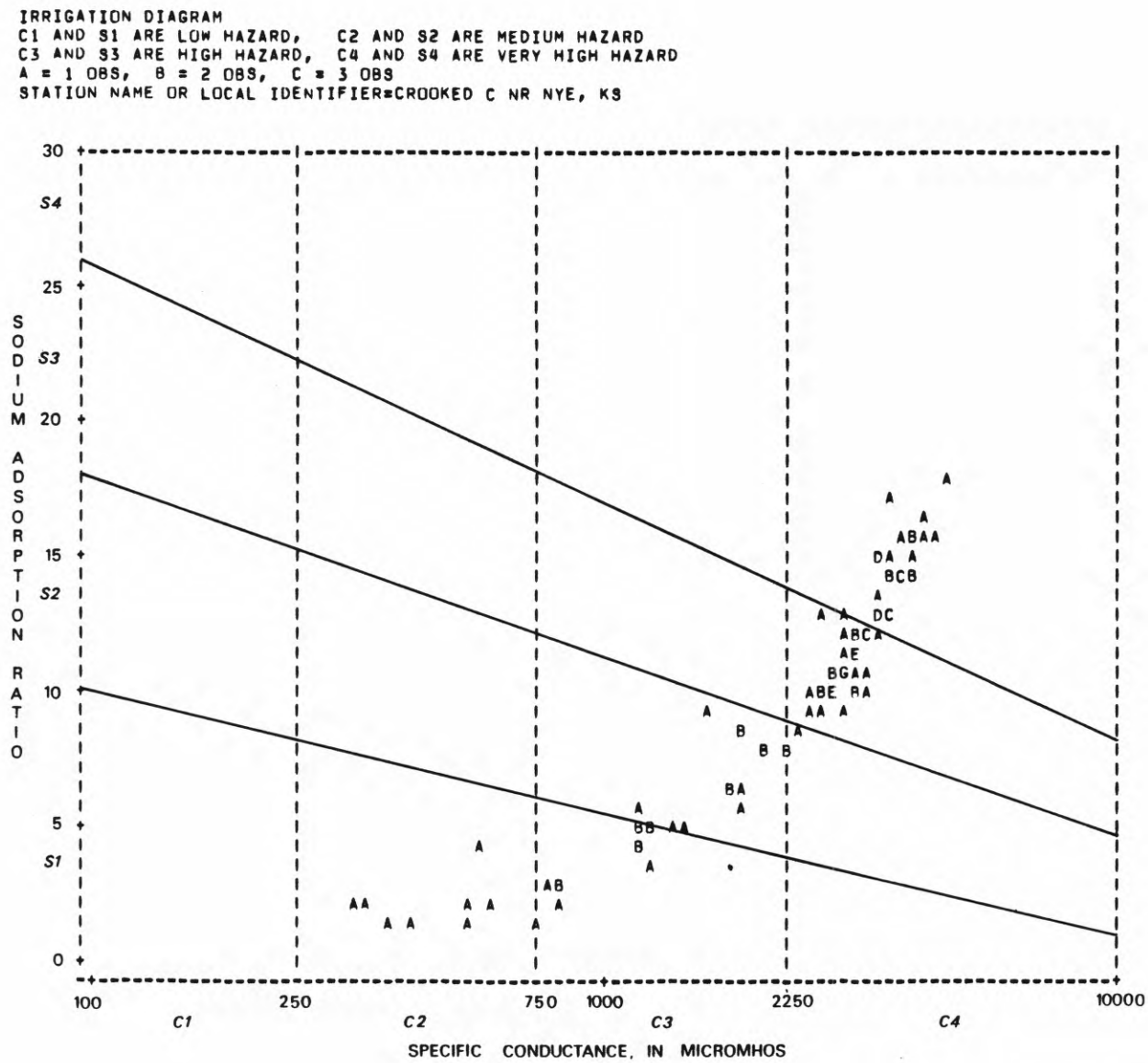
CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	777	1818	2970	3412	3900
Dissolved solids	410	826	1635	1980	2254
pH	7.6	7.9	8.0	8.3	8.5
Total hardness	180	247	352	386	410
Chloride	134	431	750	898	1014
Sulfate	31	72	137	160	186
Iron					
Fluoride	0.4	0.8	1.0	1.1	1.2
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	3.3	9.6	11	13	15
Boron					

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CROOKED C NR NYE, KS



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=CROOKED C NR NYE, KS




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=CROOKED C NR NYE, KS
SODIUM ADSORPTION RATIO
30
S4
25
S3
20
15
S2
10
5
S1
0
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

07158150 - Salt Creek near Hitchcock, Okla.

LOCATION.--Lat 36°00'56", long 98°22'12", in NW¼NE¼ sec. 28, T.18 N., R.11 W., Blaine County, at bridge on county road, 0.4 mi downstream from Bitter Creek, 3.2 mi northwest of Hitchcock, and at mile 18.2.

DRAINAGE AREA.--44.4 mi^2.

PERIOD OF RECORD.--1960, 1968 to 1970.

WATER TYPE.--When the specific conductance was greater than 5,000 umho, which accounted for 89 percent of the samples, the water was chloride type. For specific conductance less than 5,000 umho the water was sulfate type. No cation data are available.

TREND.--No current data are available.

PUBLIC WATER SUPPLY.--More than 99 percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 3,547 mg/L. The hardness class for this water was very hard. The recommended maximum sulfate concentration of 250 mg/L was exceeded by 100 percent of the sulfate values and the recommended maximum chloride concentration of 250 mg/L was exceeded by 99 percent of the chloride values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum sulfate and chloride concentrations were exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard was very high for all samples. The sodium hazard ranged from medium to very high with approximately 96 percent of the SAR values equivalent to a very high sodium hazard. No boron data were available.

07158150 - Salt Creek near Hitchcock, Okla.--Continued

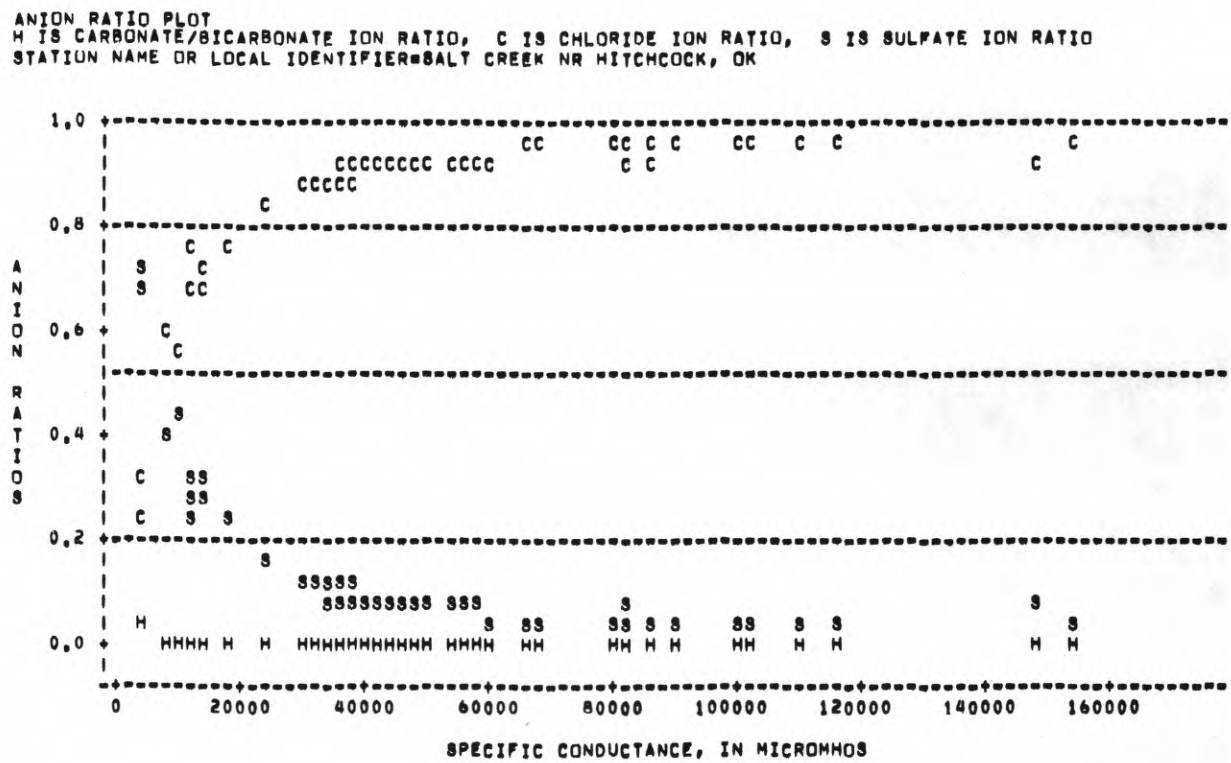
UNIVARIATE STATISTICS

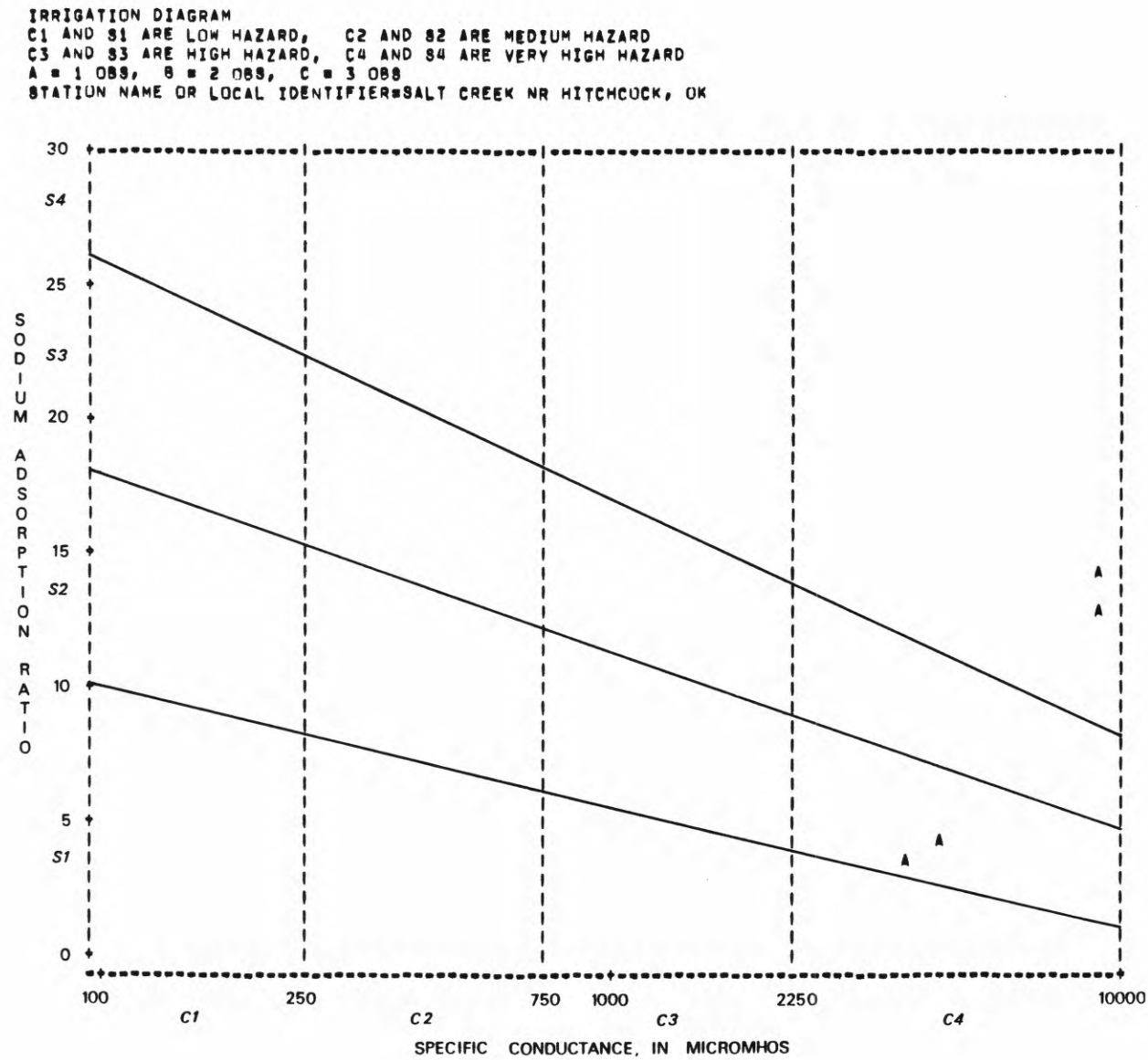
CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	109	38984	2540	155000	35239	1.54	2.32
Dissolved solids	109	31447	1650	164000	34247	2.21	5.36
pH	46	7.8	7.5	8.5	.2	.40	2.01
Total hardness	46	3547	1780	8400	1689	1.56	1.97
Chloride	109	16470	210	93000	19413	2.20	5.31
Sulfate	109	2086	625	7500	770	3.65	22.30
Iron	0						
Fluoride	0						
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	46	108	3.3	285	78	.77	-.18
Boron	0						

FREQUENCY DISTRIBUTION

CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	4704	13050	28900	50450	85270
Dissolved solids	3778	9147	20300	37080	70550
pH	7.6	7.7	7.8	7.9	8.0
Total hardness	2056	2325	2900	4165	5170
Chloride	666	3650	10250	19950	38530
Sulfate	1447	1695	1980	2228	2715
Iron					
Fluoride					
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	17	51	88	156	222
Boron					

No cation distribution data are available




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=SALT CREEK NR HITCHCOCK, OK
SODIUM ADSORPTION RATIO
30
S4
25
S3
20
15
S2
10
5
S1
0
A
A
A
A
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

CIMARRON RIVER BASIN

07158400 - Salt Creek near Okeene, Okla.

LOCATION.--Lat 36°06'11", long 98°11'36", in SW¼ sec. 20, T.19 N., R.9 W., Kingfisher County, at county road bridge, 2.2 mi downstream from Spring Creek, 7.0 mi east of Okeene, and at mile 2.2.

DRAINAGE AREA.--196 mi^2.

PERIOD OF RECORD.--1973 to 1978.

WATER TYPE.--The water was sodium chloride type throughout the range of measured specific conductance.

TREND.--Plots of the dissolved solids, hardness, chloride, and sulfate concentrations versus time indicate trends of increasing concentration. The Spearman's rhos at the 95-percent probability level confirm the presence of positive trends for the four constituents.

PUBLIC WATER SUPPLY. Ninety-six percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 1,150 mg/L. Generally, the hardness class for this water was very hard. The recommended maximum sulfate concentration of 250 mg/L was exceeded by 92 percent of the sulfate values and the recommended maximum chloride concentration of 250 mg/L was exceeded by 95 percent of the chloride values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum chloride and sulfate concentrations were exceeded, this water would not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from medium to very high with 91 percent of the samples having a very high salinity hazard. The sodium hazard ranged from low to very high with approximately 85 percent of the SAR values equivalent to a very high sodium hazard. No boron data were available.

07158400 - Salt Creek near Okeene, Okla.--Continued

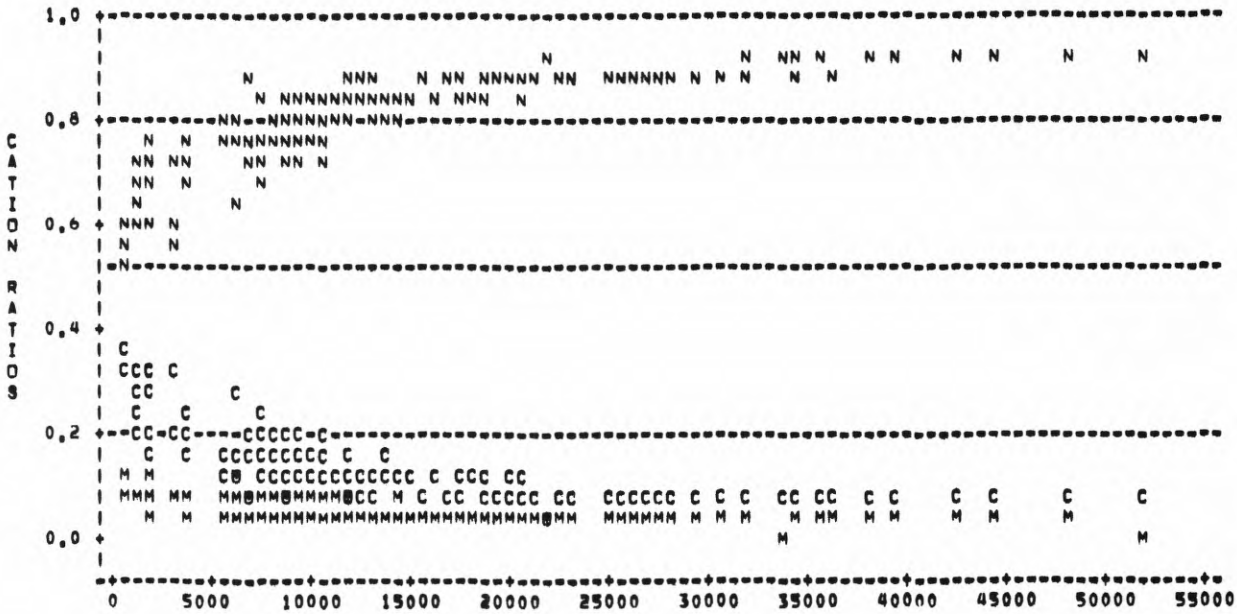
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	214	14496	373	51600	9667	1.07	1.34
Dissolved solids	172	9480	226	35600	6854	1.33	2.07
pH	211	7.9	6.8	8.4	.3	-.60	.44
Total hardness	174	1150	82	2700	498	-.01	.44
Chloride	174	4788	120	21000	3950	1.47	2.57
Sulfate	176	929	41	1700	357	-.97	.25
Iron	0						
Fluoride	0						
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	160	36	2.4	109	23	.85	.41
Boron	0						

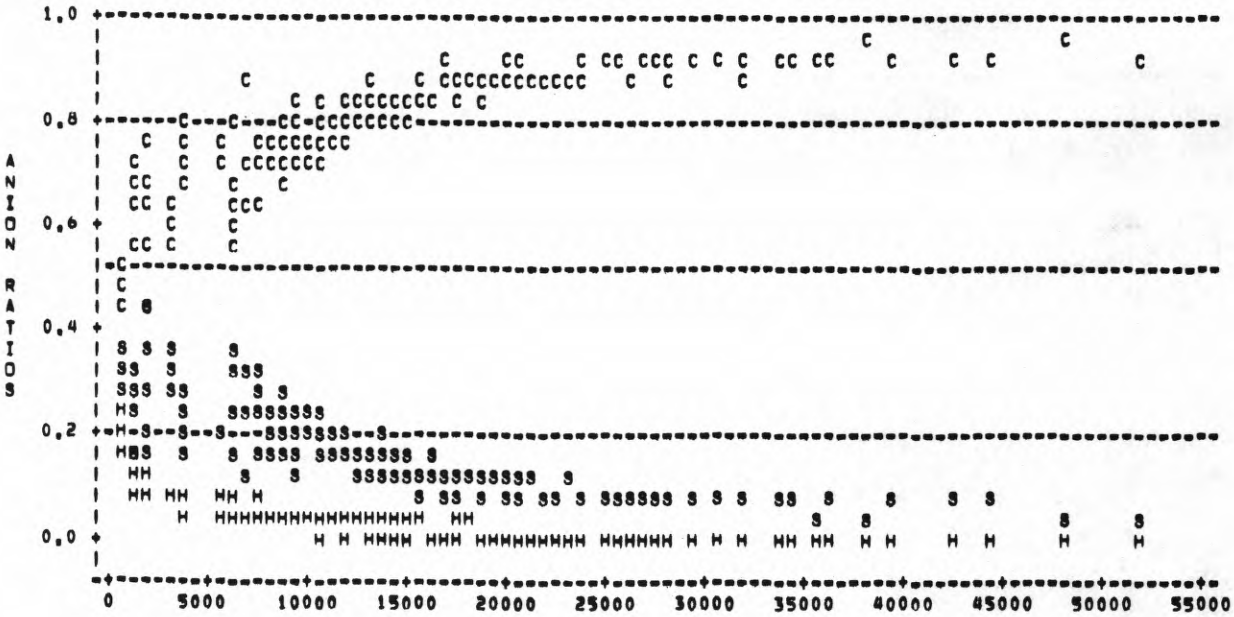
FREQUENCY DISTRIBUTION

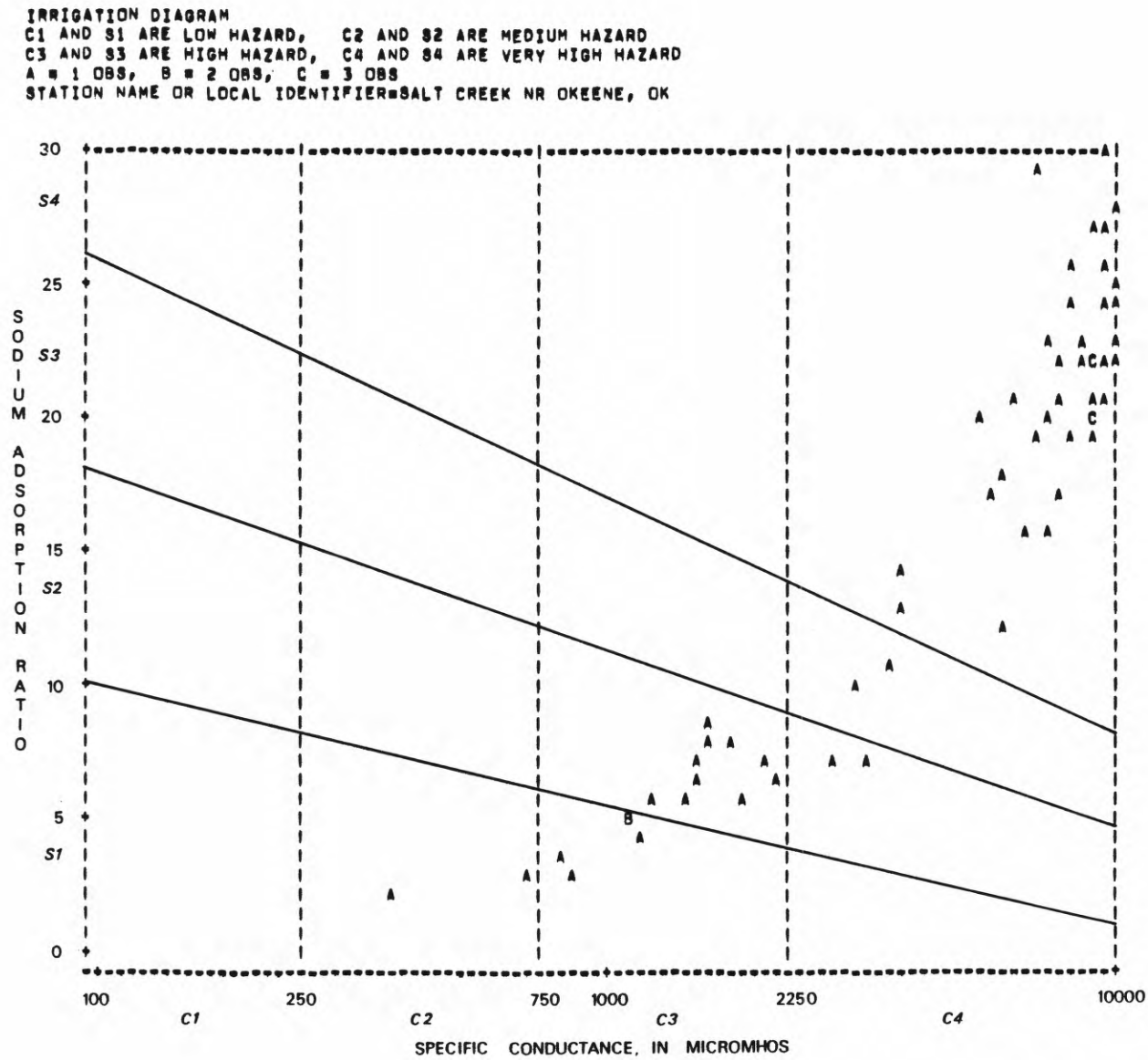
CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	2948	8385	12300	20000	27480
Dissolved solids	1792	5460	7410	12600	18740
pH	7.4	7.6	7.9	8.0	8.2
Total hardness	402	885	1200	1400	1596
Chloride	538	2083	3475	6530	9986
Sulfate	296	777	1000	1200	1220
Iron					
Fluoride					
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	7.4	21	30	49	68
Boron					

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=SALT CREEK NR OKEENE, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=SALT CREEK NR OKEENE, OK




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=SALT CREEK NR OKEENE, OK
SODIUM ADSORPTION RATIO
30
S4
25
S3
20
15
S2
10
5
S1
0
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

07160500 - Skeleton Creek near Lovell, Okla.

LOCATION.--Lat 36°03'36", long 97°35'05", in NW¼SW¼ sec. 1, T.18 N., R.4 W., Logan County, at bridge on State Highway 74, 2 mi upstream from Otter Creek, 2.8 mi east of Lovell, and at mile 14.6.

DRAINAGE AREA.--410 mi^2.

PERIOD OF RECORD.--1951 to 1955, 1975 to 1978.

WATER TYPE.--When the specific conductance was greater than 500 umho, which accounted for 87 percent of the samples, the water was sodium chloride type. For specific conductance less than 500 umho the water was carbonate/bicarbonate type with no predominant cation.

TREND.--The current period of record is insufficient, less than 5 years, to perform trend analyses.

PUBLIC WATER SUPPLY.--Sixty-nine percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 289 mg/L. For average conditions, the hardness class for this water was very hard. The recommended maximum sulfate concentration of 250 mg/L was exceeded by 3 percent of the sulfate values and the recommended maximum chloride concentration of 250 mg/L was exceeded by 46 percent of the chloride values. The maximum contaminant level for fluoride was exceeded by 1 percent of the fluoride values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended maximum chloride concentration was exceeded and because the maximum fluoride contaminant level was exceeded, this water might not be suitable for use as a public water supply.

IRRIGATION.--The salinity hazard ranged from low to very high with 73 percent of the samples having a high or very high salinity hazard. The sodium hazard ranged from low to high with approximately 60 percent of the SAR values equivalent to a low sodium hazard. The data indicate that phytotoxic effects could occur in boron sensitive plants.

07160500 - Skeleton Creek near Lovell, Okla.--Continued

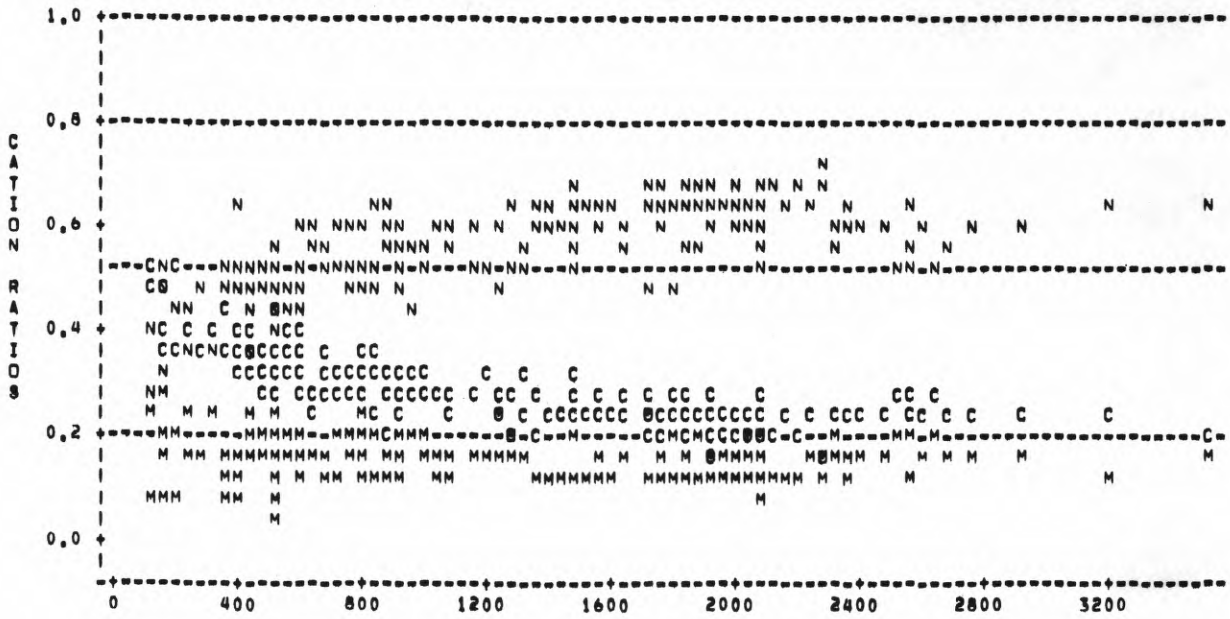
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	438	1426	105	3530	817	0.34	-0.87
Dissolved solids	404	809	67	2100	476	.47	-.72
pH	402	8.1	6.5	8.9	.4	-.55	.67
Total hardness	430	289	38	840	162	.63	-.33
Chloride	435	247	7.5	875	173	.81	.44
Sulfate	423	116	7.0	760	98	3.05	14.58
Iron	0						
Fluoride	114	0.1	0.0	2.1	0.3	121.49	25.05
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	301	4.4	0.5	8.7	2.0	.10	-1.10
Boron	15	408	0	750	205	-.85	.72

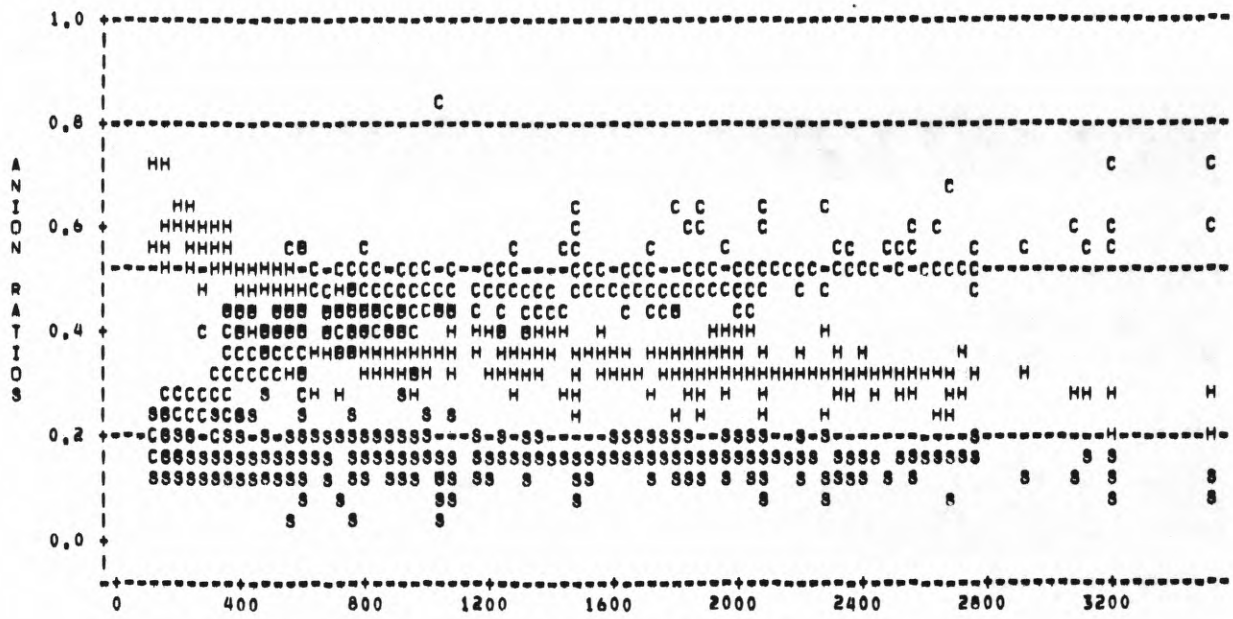
FREQUENCY DISTRIBUTION

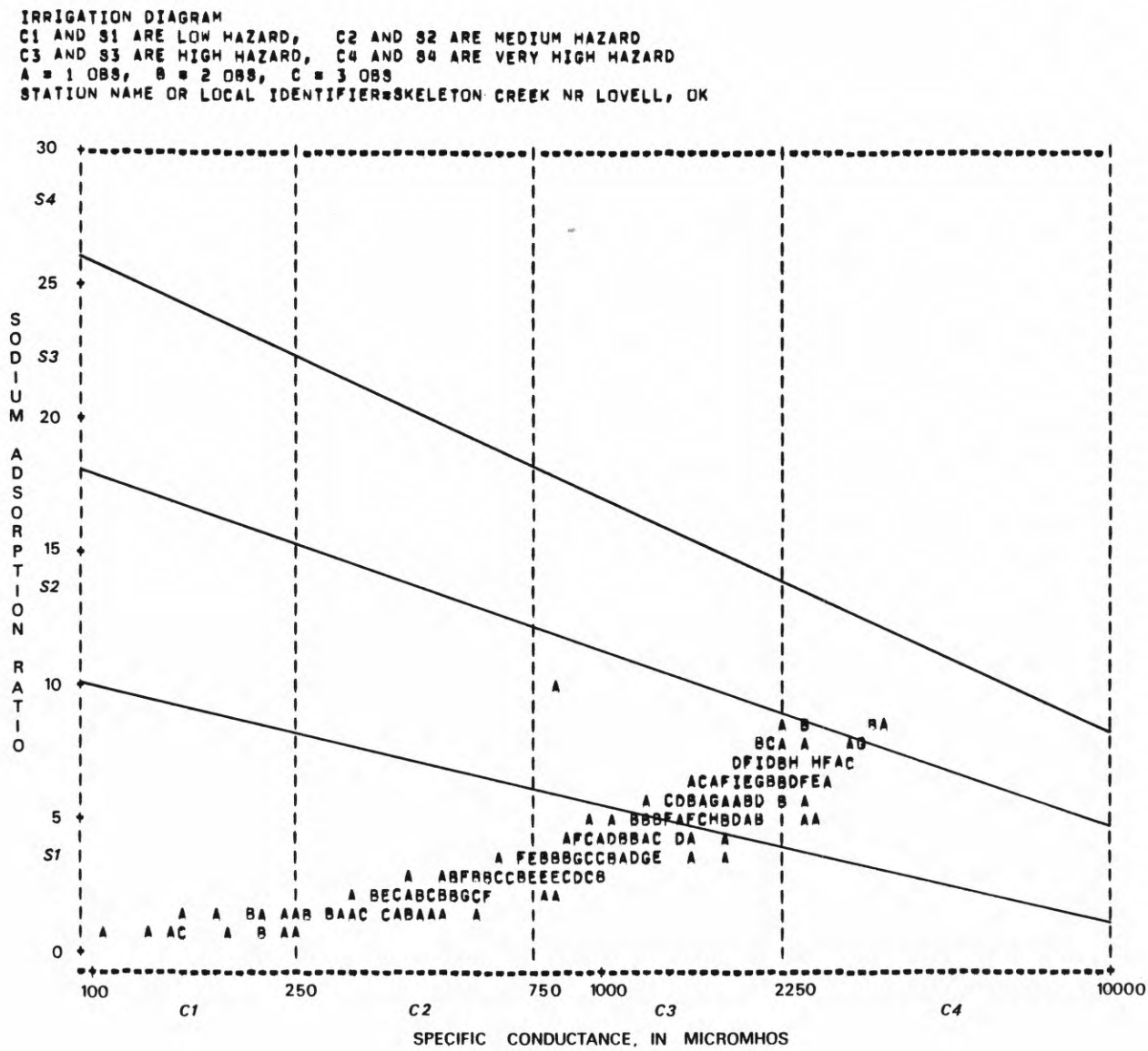
CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	404	722	1330	2054	2582
Dissolved solids	235	406	732	1147	1496
pH	7.6	7.8	8.1	8.3	8.5
Total hardness	100	152	272	373	552
Chloride	48	108	219	358	484
Sulfate	26	52	103	156	200
Iron					
Fluoride	0.0	0.0	0.0	0.0	0.2
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	1.8	2.6	4.2	6.2	7.1
Boron	0	302	440	505	575

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=SKELETON CREEK NR LOVELL, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=SKELETON CREEK NR LOVELL, OK




IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=SKELETON CREEK NR LOVELL, OK
SODIUM ADSORPTION RATIO
30
S4
25
S3
20
15
S2
10
5
S1
0
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

07159000 - Turkey Creek near Drummond, Okla.

LOCATION.--Lat 36°19'05", long 98°00'03", in NE¼NE¼ sec. 12, T.21 N., R.8 W., Garfield County, at county road bridge, 2.2 mi northeast of Drummond.

DRAINAGE AREA.--248 mi^2.

PERIOD OF RECORD.--1948, 1952 to 1959.

WATER TYPE.--When the specific conductance was greater than 250 umho, which accounted for 94 percent of the samples, the water was sodium chloride type. For specific conductance less than 250 umho the water was sodium carbonate/bicarbonate type.

TREND.--No current data were available.

PUBLIC WATER SUPPLY.--Sixty-one percent of the hardness values were greater than 180 mg/L and the average hardness concentration was 314 mg/L. For average conditions, the hardness class for this water was very hard. The recommended maximum sulfate concentration of 250 mg/L was exceeded by 11 percent of the sulfate values and the recommended maximum chloride concentration of 250 mg/L was exceeded by 49 percent of the chloride values. No toxic metal data were available. Because of the frequency and magnitude by which the recommended chloride concentration was exceeded, this water might not be suitable for use as a public supply.

IRRIGATION.--The salinity hazard ranged from low to very high with 32 percent of the samples having a very high salinity hazard. The sodium hazard ranged from low to very high with approximately 50 percent of the SAR values equivalent to a low sodium hazard. No boron data were available.

07159000 - Turkey Creek near Drummond, Okla.--Continued

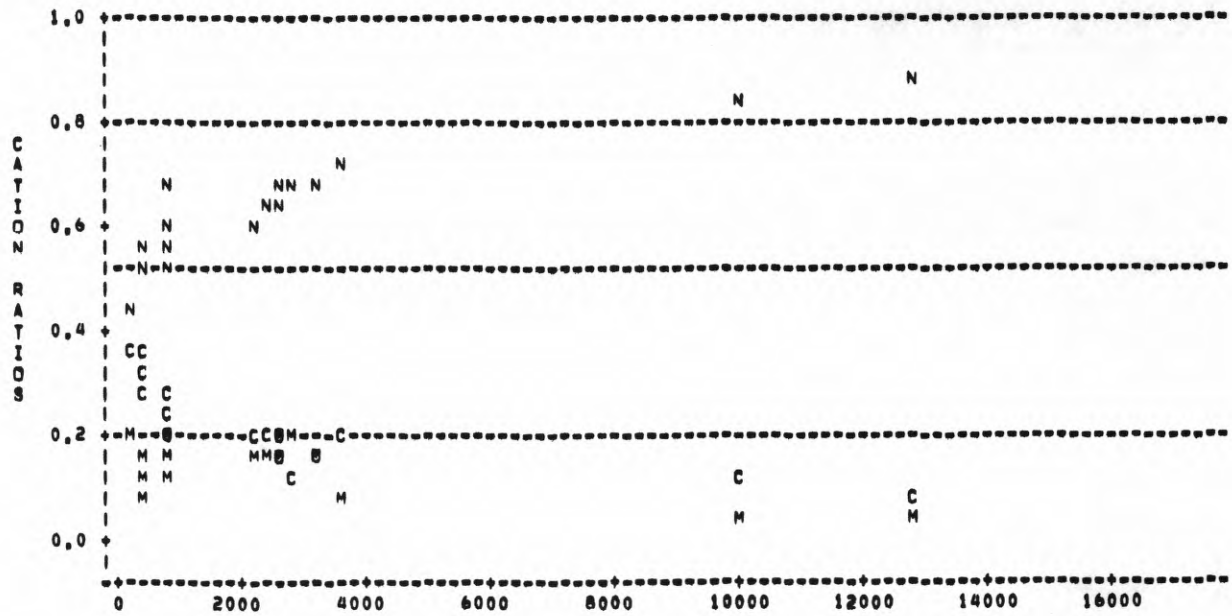
UNIVARIATE STATISTICS

CONSTITUENT	N	MEAN	MIN	MAX	STD	SKEW	KURT
Specific conductance	108	1954	155	12700	2051	2.39	8.08
Dissolved solids	79	989	160	7680	1148	3.70	17.72
pH	28	7.8	6.8	8.5	.4	-.56	-.42
Total hardness	108	314	36	1020	237	.99	.30
Chloride	108	478	10	4100	621	3.07	13.12
Sulfate	85	109	2.1	650	124	2.50	7.04
Iron	0						
Fluoride	2	0.2	0.1	0.3			
Arsenic	0						
Cadmium	0						
Chromium	0						
Lead	0						
Mercury	0						
SAR	18	8.3	1.4	37	9.7	2.34	5.03
Boron	0						

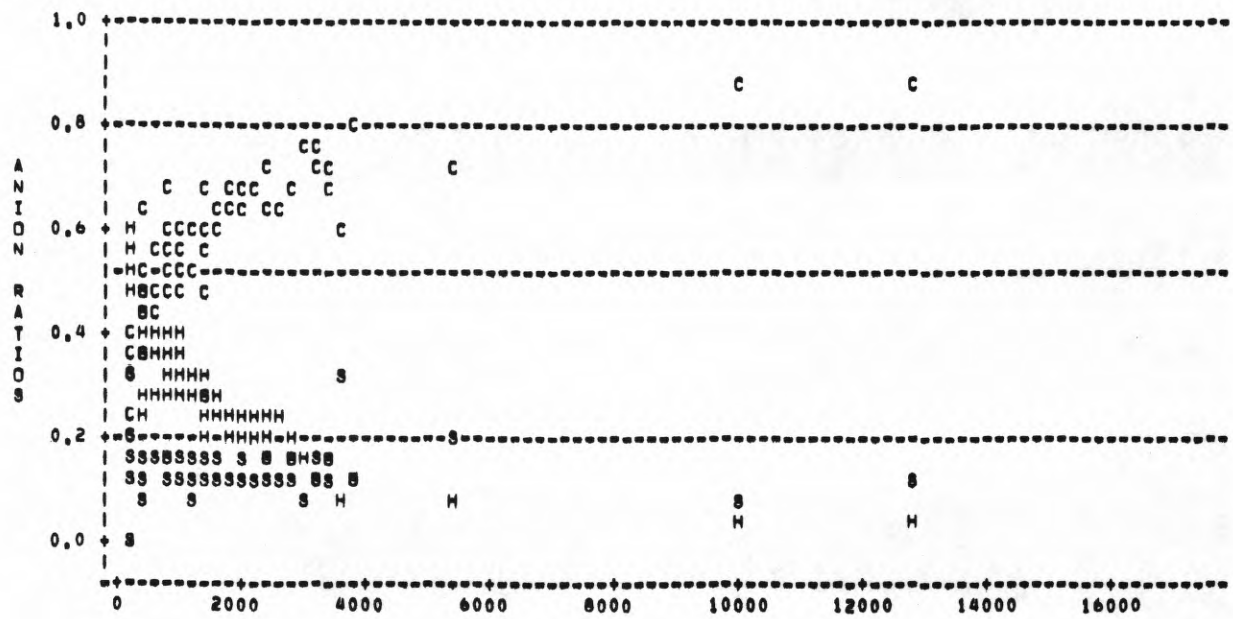
FREQUENCY DISTRIBUTION

CONSTITUENT	PERCENTILE CONCENTRATION				
	10th	25th	50th	75th	90th
Specific conductance	298	486	1230	2865	4192
Dissolved solids	212	300	593	1250	1957
pH	7.2	7.4	7.8	8.1	8.2
Total hardness	72	110	246	490	632
Chloride	34	77	232	690	1086
Sulfate	17	35	62	131	256
Iron					
Fluoride					
Arsenic					
Cadmium					
Chromium					
Lead					
Mercury					
SAR	1.9	2.3	4.5	8.2	15
Boron					

CATION RATIO PLOT
N IS SODIUM ION RATIO, C IS CALCIUM ION RATIO, M IS MAGNESIUM ION RATIO
STATION NAME OR LOCAL IDENTIFIER=TURKEY CREEK NR DRUMMOND, OK



ANION RATIO PLOT
H IS CARBONATE/BICARBONATE ION RATIO, C IS CHLORIDE ION RATIO, S IS SULFATE ION RATIO
STATION NAME OR LOCAL IDENTIFIER=TURKEY CREEK NR DRUMMOND, OK



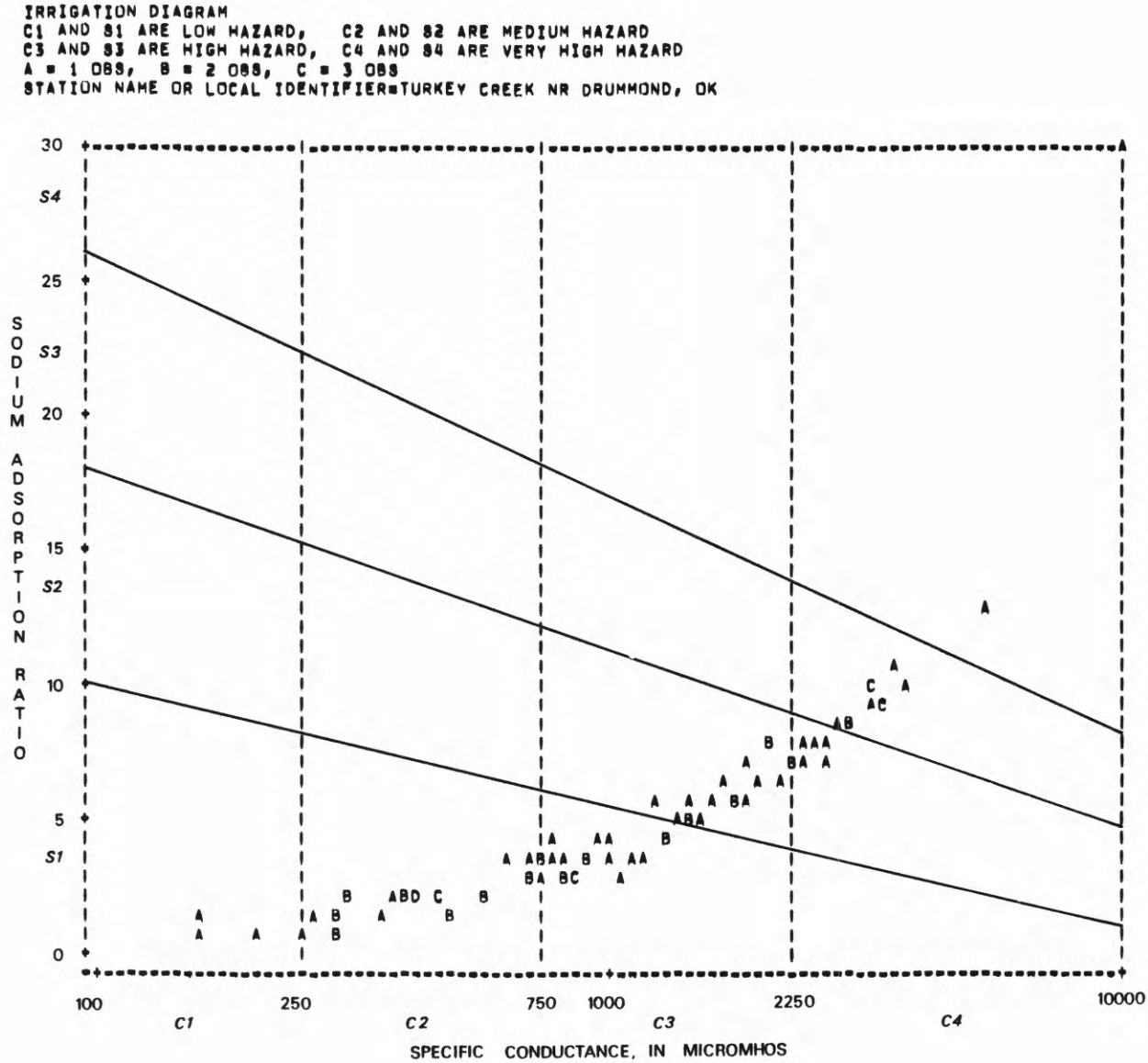

IRRIGATION DIAGRAM
C1 AND S1 ARE LOW HAZARD, C2 AND S2 ARE MEDIUM HAZARD
C3 AND S3 ARE HIGH HAZARD, C4 AND S4 ARE VERY HIGH HAZARD
A = 1 OBS, B = 2 OBS, C = 3 OBS
STATION NAME OR LOCAL IDENTIFIER=TURKEY CREEK NR DRUMMOND, OK
SODIUM ADSORPTION RATIO
30
S4
25
S3
20
15
S2
10
5
S1
0
100
250
750
1000
2250
10000
C1
C2
C3
C4
SPECIFIC CONDUCTANCE, IN MICROMHOS

Table 3.--List of stations in downstream order

NUMBER	STATION NAME	PAGE
07148350	Salt Fork Arkansas River near Winchester, Okla.	46
07148400	Salt Fork Arkansas River near Alva, Okla.	50
07148450	Salt Fork Arkansas River near Ingersoll, Okla.	54
07149000	Medicine Lodge River near Kiowa, Kans.	38
07150500	Salt Fork Arkansas River near Jet, Okla.	58
07150700	Pond Creek near Lamont, Okla.	42
07151000	Salt Fork Arkansas River at Tonkawa, Okla.	62
07151550	Chikaskia River near Drury, Kans.	26
07152000	Chikaskia River near Blackwell, Okla.	30
07152050	Chikaskia River near Tonkawa, Okla.	34
07152200	Salt Fork Arkansas River near Marland, Okla.	66
07152250	Bois d'Arc Creek near Ponca City, Okla.	22
07154500	Cimarron River near Kenton, Okla.	82
07157000	Cimarron River near Mocane, Okla.	86
07157500	Crooked Creek near Nye, Kans.	130
07157740	Cimarron River near Buttermilk, Kans.	90
07157940	Bluff Creek near Buttermilk, Kans.	70
07157950	Cimarron River near Buffalo, Okla.	94
07157960	Buffalo Creek near Lovedale, Okla.	78
07157980	Cimarron River at Freedom, Okla.	98
07158000	Cimarron River near Waynoka, Okla.	102
07158150	Salt Creek near Hitchcock, Okla.	134
07158400	Salt Creek near Okeene, Okla.	138
07159000	Turkey Creek near Drummond, Okla.	146
07159100	Cimarron River near Dover, Okla.	106
07159750	Cottonwood Creek at Seward, Okla.	122
07159800	Cottonwood Creek near Guthrie, Okla.	126
07160000	Cimarron River near Guthrie, Okla.	110
07160300	Boggy Creek at 30th Street, at Enid, Okla.	74
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