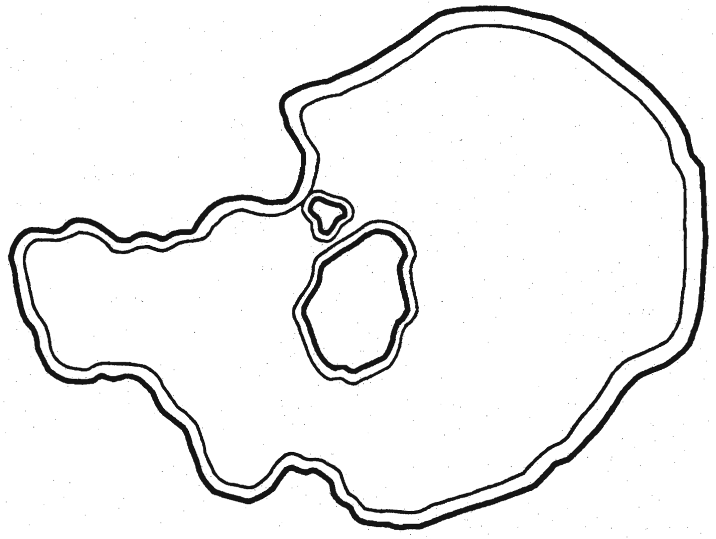
An Auxiliary Report
Prepared for the

MONO BASIN WATER RIGHTS EIR

Water Quality Data Report



Prepared under the Direction of:

California State Water
Resources Control Board
Division of Water Rights
P.O. Box 2000
Sacramento, CA 95810

Prepared With Funding from:

Los Angeles Department of
Water and Power
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Mono Basin EIR Auxiliary Report No. 17

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MONO BASIN WATER RIGHTS EIR

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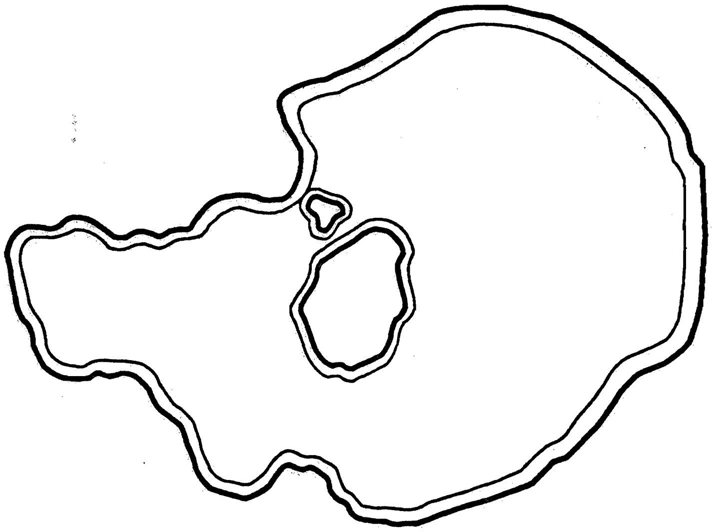

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Mono Basin EIR Auxiliary Report No. 17

Mono Lake Basin and Owens River Valley Water Quality Data Report

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January 1993

An Auxiliary Report
Prepared for the
Mono Basin Water Rights EIR Project

This auxiliary report was prepared to support the environmental impact report (EIR) on the amendment of appropriative water rights for water diversions by the City of Los Angeles Department of Water and Power (LADWP) in the Mono Lake Basin. Jones & Stokes Associates is preparing the EIR under the technical direction of the California State Water Resources Control Board (SWRCB). EIR preparation is funded by LADWP.

SWRCB is considering revisions to LADWP's appropriative water rights on four streams tributary to Mono Lake, Lee Vining Creek, Rush Creek, Parker Creek, and Walker Creek. LADWP has diverted water from these creeks since 1941 for power generation and municipal water supply. Since the diversions began, the water level in Mono Lake has fallen by 40 feet.

The Mono Basin water rights EIR examines the environmental effects of maintaining Mono Lake at various elevations and the effects of possible reduced diversions of water from Mono Basin to Owens Valley and the City of Los Angeles. Flows in the four tributary creeks to Mono Lake and water levels in Mono Lake are interrelated. SWRCB's decision on amendments to LADWP's water rights will consider both minimum streamflows to maintain fish populations in good condition and minimum lake levels to protect public trust values.

This report is one of a series of auxiliary reports for the EIR prepared by subcontractors to Jones & Stokes Associates, the EIR consultant, and contractors to LADWP. Information and data presented in these auxiliary reports are used by Jones & Stokes Associates and SWRCB, the EIR lead agency, in describing environmental conditions and conducting the impact analyses for the EIR. Information from these reports used in the EIR is subject to interpretation and integration with other information by Jones & Stokes Associates and SWRCB in preparing the EIR.

The information and conclusions presented in this auxiliary report are solely the responsibility of the author.

Copies of this auxiliary report may be obtained at the cost of reproduction by writing to Jim Canaday, Environmental Specialist, State Water Resources Control Board, Division of Water Rights, P.O. Box 2000, Sacramento, CA 95810.

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Chapter 1. Introduction

PURPOSE OF REPORT

The California State Water Resources Control Board (SWRCB) is preparing an environmental impact report (EIR) on proposed amendments to appropriative water rights held by the City of Los Angeles Department of Water and Power (LADWP) in Mono Basin for diversions on four streams tributary to Mono Lake: Lee Vining, Walker, Parker, and Rush Creeks. This auxiliary report presents background water quality data and analyses to provide sufficient information for quantifying potential water quality impacts in Mono Basin, the Owens River basin, and the LADWP Aqueduct system from alternative water rights decisions.

Accurate, relevant, and up-to-date water quality data readily accessible for computerized analysis are essential for effective water resources management and decision making. This water quality data report presents and interprets water quality data collected from surface water and groundwater monitoring stations operated by numerous agencies in Mono Basin and Owens River Valley from 1933 through 1991. In addition, Jones & Stokes Associates conducted a field sampling program in 1991 in Mono Basin and Owens River basin to augment existing water quality data.

Data obtained from agencies and the Jones & Stokes Associates' sampling program were organized into Lotus 1-2-3 data files to allow for graphical, statistical, comparative, and regression analyses. The computerized database was used for data evaluations and model development and calibration to assess water quality impacts of alternative water rights amendments. Modeling techniques and results are described in detail in appendices to the Mono Basin EIR. Potential changes in historical water quality patterns are described in the Mono Basin EIR.

Data summaries and analyses presented in this report can facilitate the EIR decision-making process by:

- providing an overview of background water quality conditions in affected areas,
- identifying seasonal and long-term trends in water quality,
- distinguishing geographical sources of important water quality parameters,
- facilitating calibration of water quality impact assessment models,
- furnishing a water quality basis for water resources management, and
- identifying key locations for future water quality monitoring efforts.

STUDY AREA AND LOS ANGELES AQUEDUCT SYSTEM

The study area and Los Angeles (LA) Aqueduct system are diagrammed in Figure 1. (Please refer to the "Figures" section of this report, following Chapter 4, "Citations".) Water from Mono Lake tributaries is diverted to Grant Lake reservoir. From Grant Lake reservoir, the water is exported from Mono Basin through the Mono Craters Tunnel to the Upper Owens River basin, where it enters the Owens River at East Portal below Big Springs. Water from the Upper Owens River basin is stored at Lake Crowley reservoir, then diverted south to Pleasant Valley Reservoir through the Owens River gorge power plants and aqueduct. From Pleasant Valley Reservoir, the water is released to the Middle Owens River, where it flows south to Tinemaha Reservoir. Several miles south of Tinemaha, the LA Aqueduct diverts the Owens River flow to Haiwee Reservoir. Several streams between Tinemaha and Haiwee Reservoirs are diverted into the LA Aqueduct before reaching the Owens River. Releases from Haiwee Reservoir pass through several power plants and enter the City of Los Angeles at the newly constructed LA Aqueduct filtration plant, the terminus of the LA Aqueduct system.

Water quality in the LA Aqueduct system reflects the water quality of the various contributing sources. Surface water quality of each stream is determined by factors such as basin size and soils, runoff versus groundwater ratio, geology (weathering), biological activity, water diversion practices, land use, lakes and reservoirs present in the basin, and geothermal influences.

Chapter 2. Methods

HISTORICAL DATA SOURCES

Historical water quality data were obtained from a variety of sources. Historical data from 1933 to 1991 were obtained from the LADWP, the U.S. Geological Survey (USGS), the California Department of Fish and Game (DFG), the Metropolitan Water District of Southern California (MWD), and the Lahontan Regional Water Quality Control Board (Lahontan RWQCB). Water quality data on prediversion conditions (pre-1940) were limited; postdiversion records were more complete.

HISTORICAL DATA MONITORING LOCATIONS

Water quality in Mono Basin has been monitored at selected Mono Lake tributaries: Lee Vining, Walker, and Parker Creeks; Rush Creek above Grant Lake reservoir; and Grant Lake reservoir outlet. Limnological data have been collected in Mono Lake and Grant Lake reservoir. Specific locations of these monitoring stations have varied somewhat over time. LADWP has conducted special surveys of other Mono Basin springs and groundwater wells not included in this database (Los Angeles Department of Water and Power 1986).

Sampling sites in the Upper Owens River basin include Owens River above East Portal (Big Springs), East Portal (export from Mono Basin), Owens River below East Portal, Mammoth Creek (Hot Creek above Hot Springs), Hot Creek below Hot Springs, and Owens River at Benton Crossing. Sampling also has occurred at several Lake Crowley reservoir tributaries: Convict, McGee, Hilton, Crooked, and Rock Creeks (diversions to Lake Crowley reservoir). Limnological studies have been performed at Lake Crowley reservoir. Lake Crowley reservoir outlet also has been sampled.

In the Middle Owens River basin, routine sampling has been conducted at the Tinemaha Reservoir outlet and at groundwater wells. Historical water quality data also are available for the LA Aqueduct filtration plant for the two other City of Los Angeles water sources delivered by MWD: the Colorado River and the State Water Project.

KEY HISTORICAL WATER QUALITY PARAMETERS

Not all parameters sampled historically were analyzed in this report. Parameters were selected for analysis based on EIR water quality analysis needs and include:

- transient parameters (temperature, pH, and dissolved oxygen);
- minerals;
- nutrients and organics;
- particulates and metals; and
- sediments.

Transient parameters change rapidly and must be measured in situ. Minerals include the major anions and cations (calcium, magnesium, sodium, potassium, chloride, sulfate, and bicarbonate), trace elements (boron, fluoride, and bromide), silica, alkalinity, hardness, total dissolved solids (TDS), and specific conductivity (EC). Nutrients and organics include nitrate, ammonia, total Kjeldahl nitrogen, total and dissolved phosphorus, total organic carbon, chlorophyll, and color. Particulates and metals include total suspended solids (SS), turbidity, arsenic, barium, selenium, aluminum, cadmium, chromium, copper, iron, mercury, manganese, lead, and zinc.

This report also establishes the characteristic water quality "fingerprint" for individual streams and groundwater wellfields, which is expected to remain constant over time with seasonal variations and hydrological fluctuations. Water quality of each contributing surface water and groundwater source is summarized in Table 1 (refer to the "Tables" section of this report, following Chapter 4, "Citations") by the ratios of ion concentrations to conductivity based on 1991 monitoring. Parameters selected for analysis and data file format are presented in Table 2. Table 3 presents the period of record and total number of samples available for each monitoring location.

JONES & STOKES ASSOCIATES 1991 SAMPLING PROGRAM

The 1991 sampling program was conducted from May to October 1991 to assess current water quality and limnological conditions, supplement existing historical data, and provide new data for water quality parameters with no historical records. Data were collected at 14 surface water locations in streams in Mono Basin and Upper Owens River basin (Long Valley). Limnological surveys were conducted at two locations in Grant Lake reservoir and four locations in Lake Crowley reservoir. Water quality parameters sampled included transients, minerals, nutrients and organics, and particulates and metals as described previously. Each lake monitoring location was profiled for pH, temperature, dissolved oxygen, and conductivity using a MARTEK XVII water quality data recorder. Water samples were collected at the surface of each lake location and at one bottom location for each lake. Several bottom sediment samples from Grant Lake and Lake Crowley reservoirs were collected in July 1991.

Data acquisition by Jones & Stokes Associates involved sample collection and laboratory analysis using standard methods. Sample collection included measuring transient parameters, collecting water or bottom sediment samples, and preserving samples for transportation to the laboratory. Laboratory analysis performed by Anlab Analytical Laboratories (Anlab), Sacramento, consisted of measuring specified water quality parameters using standardized and analytical procedures approved by the U.S. Environmental Protection Agency (EPA). Chlorophyll analyses were conducted by Sierra Nevada Aquatic Research Laboratory (SNARL) personnel following filtration and preservation by Jones & Stokes Associates. LADWP collected samples for the same parameters at Lake Crowley reservoir outlet, Tinemaha Reservoir outlet, and the LA Aqueduct filtration plant. LADWP water quality laboratory analyzed the samples. The 1991 LADWP data are included in the historical files for these stations.

DATA ORGANIZATION AND ANALYSIS

The objective of data organization and analysis is to convert data into meaningful information that can assist in decision making. The first task in converting raw data into useful information is to acquire and organize available water quality data. Historical data were entered into spreadsheet files (Lotus 1-2-3) and evaluated for internal consistency. Because no specific information on laboratory quality control procedures was available, internal data consistency was the basic evaluation method for judging the accuracy of historical data. Internal data consistency was evaluated by comparing time series plots of similar variables, checking anion to cation ratios, and reviewing correlation plots of related variables. Outliers have not been removed but are generally ignored during the data analysis. Table 2 presents the general organization and column format of the Lotus 1-2-3 spreadsheets.

Once data are in computerized format, many analysis techniques can be used. Analysis techniques used in this report include basic statistics, time-series plots, ion ratio analysis, parameter correlations, and flow regressions. More advanced data analyses techniques used in the Mono Basin EIR assessments include limnological and mass balance modeling. Chosen data analyses techniques match data reliability and the needs of the Mono Basin EIR. Time-series plots were useful for revealing seasonal or long-term trends, while scatter plots and flow regressions indicated correlation between parameters and general hydrologic relationships. Conductivity was used as the basic "indicator" variable by which water quality changes with streamflow were analyzed. Other parameters such as chloride, arsenic, boron, and fluoride were analyzed to determine trends and relationships with flow and conductivity at each sampling station. Water quality data were statistically analyzed by calculating the minimum, maximum, mean, and interquartile range (IQR) for each parameter. The interquartile range represents the 0% (minimum), 25%, 50% (median), 75%, and 100% (maximum) cumulative distribution values. The percent of each variable above the detection limit was determined, when the detection limit was known, to indicate parameters that were infrequently detected and had calculated mean values that were biased high.

Chapter 3. Water Quality Data Summaries

This chapter presents water quality data summaries and analyses for each monitoring location within the study area. The statistical and graphical results are presented in consistent formats to allow comparison between sampling locations. Data collected by Jones & Stokes Associates during its 1991 sampling are presented in Tables 4-14.

MONO BASIN

Figure 2 shows monitoring locations within Mono Basin.

Mono Lake

Available Water Quality Data

Mono Lake water quality was first sampled by I. C. Russell during his geological survey of Mono Basin in 1883. LADWP has kept records of lake elevations since 1912 and has measured total dissolved solids (TDS) at various locations in Mono Lake since 1937. Water samples were collected in the early 1930s by the Pacific Alkali Company while it was exploring possible commercial recovery of salts from Mono Lake.

D. T. Mason (1967) collected samples in July 1964 and analyzed previous data as part of a limnological survey of Mono Lake. He attempted to characterize the chemical composition of the water using ratios of individual ions to chloride and described the correlation between lake volume and ion concentrations. Metals and other previously unmeasured trace elements also were analyzed in this survey. A limnological study conducted in 1974 by students and faculty from UC Davis did not specifically collect water quality samples, but nutrient determinations were part of their primary productivity experiments (Winkler 1977).

LADWP collected samples at several depths and locations in different seasons during 1974 and in subsequent years to provide the first comprehensive sampling of Mono Lake mineral water quality. Nearly 250 samples have been collected from Mono Lake. Water quality samples also were analyzed by LADWP from two ponds used for evaporation suppression experiments between 1980 and 1983. Taken together, these data provide a good characterization of the mineral water quality of Mono Lake. Metals and trace elements have never been routinely measured and are less accurately known.

Graduate students and staff from UC Santa Barbara have conducted limnological surveys of Mono Lake since 1979. Beginning in 1982, these routine surveys of salinity, temperature, light absorption, nutrients, chlorophyll, and brine shrimp life stages have been funded by LADWP. Nutrients (ammonia and phosphorus) have been regularly sampled. Minerals and metals have not been analyzed routinely. These limnological data have been organized in a database (Dana et al. 1991) and are not included in this report.

Correlation between Lake Volume and Ion Concentrations

Mono Lake is a closed hydrologic system with no outlet. Inflow from tributaries, groundwater, and mineral springs contain dissolved salts, which through time have accumulated in the lake. Geothermal processes have contributed an unknown portion of the minerals. Continual surface evaporation has concentrated the salts and produced the saline conditions found in Mono Lake today.

Although salts continue to accumulate and concentrate in Mono Lake, these processes proceed so slowly that the total mass of dissolved salts in Mono Lake can be considered a constant. It is estimated that 285 million tons of minerals are dissolved in Mono Lake (Los Angeles Department of Water and Power 1987). The concentration of TDS in Mono Lake can then be related to lake volume by the following equation:

$$\text{TDS (g/l)} = (285{,}000{,}000 \text{ tons} \times 2{,}000 \text{ lb/ton} \times 453.6 \text{ g/lb}) \,/\, (\text{Volume [af]} \times 43{,}560 \text{ cu ft/af} \times 28.32 \text{ l/cu ft})$$

$$\text{TDS (g/l)} = 209{,}588{,}145 \text{ (af * g/l)} \,/\, \text{Volume (af)}$$

Lake volume can be calculated from measurements of lake elevation because the bathymetry is well known. The bathymetry of Mono Lake was surveyed by the Pelagos Corporation in 1986, and the bathymetric survey data were used to estimate surface area and cumulative volume at each foot of elevation. Jones & Stokes Associates confirmed the lake area in 1991 for several elevations between 6,372 and 6,440 feet. The salinity corresponding to each foot of elevation, as estimated from Pelagos bathymetry and the above equation, is shown in Table 15.

Mono Lake elevation has naturally fluctuated because of variable runoff patterns. Mono Lake elevation reached the historic high lake elevation of 6,428 feet in 1919. LADWP diversions caused a steady decline in lake elevation to a historic low lake elevation of 6,372 feet in 1982. Figures 3-5 show Mono Lake elevations and corresponding fluctuations in lake volume and salinity from 1913 to 1991. Lake volume ranged from almost 5 million acre-feet (af) in 1919 to just over 2 million af in 1982, with corresponding salinities of 42 grams per liter (g/l) and 97 g/l.

The calculated TDS concentration (Table 15) of Mono Lake water at elevation 6,376.3 feet in August 1989 (the point-of-reference scenario for the Mono Basin EIR) was approximately 90 g/l, which is about 2.5 times the salinity of ocean water. The mineral composition of Mono Lake water (based on LADWP data), however, is quite different from ocean water. Table 16 lists the average concentrations of major constituents in ocean and Mono Lake waters and the percentage of the total TDS contributed by each constituent. Sodium, potassium, sulfate, and silica are the only constituents that occur in similar ratios in both ocean water and Mono Lake water. Mono Lake has much higher alkalinity (carbonate and bicarbonate), phosphorus, boron, fluoride, and arsenic content than ocean water. The high alkalinity creates a high pH of about 9.6 in Mono Lake. The high carbonate and bicarbonate concentrations cause calcium and magnesium to precipitate as tufa and other mineral formations on the bottom of the lake. Calcium and magnesium concentrations of Mono Lake water are consequently much lower than in ocean water. Chloride, bromide, and nitrate concentrations also are much lower.

Evaporation pond experiments conducted by LADWP indicate that the chemical composition of Mono Lake water remains constant even at TDS values above 150 g/l. Mineral precipitation is apparently not a significant factor at these concentrations. Because the composition of dissolved salts in Mono Lake can be considered constant, it is possible to directly estimate individual ion concentrations from measurements or calculations of the total salt concentration.

Minerals

Mono Lake TDS was characterized at a TDS value of 100 g/l for convenience in estimating constituent concentrations at other TDS values. Table 17 shows the summary statistics for the LADWP mineral water quality data from Mono Lake, including the evaporation pond measurements after the data have been adjusted to 100 g/l from the average calculated TDS at the time of measurement. The summary of minerals in Mono Lake water presented in Table 17 at a standardized TDS of 100 g/l indicates that sodium and bicarbonate are the dominant minerals. Sodium is 39% of TDS and bicarbonate is 24% of TDS. Chloride is the next most abundant mineral, making up 23% of the TDS. Sulfate is 13% and potassium is just under 2% of TDS. Table 17 indicates that calcium and magnesium concentrations are quite low, with median values of 4.3 and 44 milligrams per liter (mg/l), respectively. Selected mineral concentrations measured at a range of TDS concentrations are presented in Figures 6-8.

Figures 6-8 show the major ion concentrations measured in Mono Lake and the evaporation ponds. The TDS concentrations, estimated from Mono Lake volume on the date of measurement and measured directly in the evaporation ponds, ranged from 80 g/l to 190 g/l. According to Table 15, this range of TDS would include lake elevations between 6,340 and 6,383.5 feet. The major ion concentrations appear to increase linearly with TDS concentration. Sodium and bicarbonate (alkalinity) are the most abundant ions, with concentrations of 39 g/l and 24 g/l at a TDS of 100 g/l. Chloride and sulfide are the next most abundant ions with concentrations of 23 g/l and 13 g/l at a TDS of 100 g/l. Potassium has a concentration of 1,750 mg/l at a TDS of 100 g/l.

Boron, fluoride, and arsenic concentrations are extremely high in Mono Lake, reflecting the influence of geothermal springs and other volcanic inputs. At a TDS of 100 g/l, the boron concentration is 475 mg/l, one of the highest concentrations in any saline lake (NAS 1987). The fluoride concentration is 65 mg/l, and the arsenic concentration is 17 mg/l. Arsenic concentrations have ranged from 4 to 28 mg/l (Los Angeles Department of Water and Power 1987). Although these are extremely high concentrations, direct toxicity of the brine shrimp, Artemia, apparently does not occur. Mason (1967) reported toxicity to Artemia adults at fluoride concentrations above 250 mg/l and at arsenic concentrations above 50 mg/l. Figure 6 shows that fluoride and arsenic also increase linearly with TDS. However, calcium and magnesium concentrations appear to remain constant with increasing TDS. Figure 8 shows silica, boron, and phosphate concentrations. Silica and phosphate average concentrations can be estimated, but these ions were not measured in the evaporation ponds so their increase at higher TDS cannot be identified.

Transient Parameters

Mono Lake is thermally stratified seasonally. Density of water increases with salinity but decreases with temperature. Because of the high salt content of Mono Lake, density continues to increase with cooling to 0°C. Ice formation is rare on the surface of Mono Lake because cooling surface water becomes more dense than underlying water and sinks. This high salinity permits complete mixing of the water column, in contrast to fresh water, which decreases in density once it cools below 4°C and rises to the surface. Temperature and salinity profiles from Mono Lake measured between 1983 and 1991 are available in the UC Santa Barbara database (University of California at Santa Barbara 1990).

Nutrients and Organics

Mono Lake becomes salinity stratified in years with large freshwater inflows (1983 and 1986). The chemocline, or lake depth at which a given chemical concentration change occurs, was measured at a depth between 16-18 meters in 1985, with TDS increasing from approximately 82 g/l to 94 g/l over an incremental depth change of 2 meters. Vertical mixing across the chemocline is an important mechanism for supplying nutrients into the euphotic zone for phytoplankton growth and erosion of chemical stratification (NAS 1987).

The nutrients nitrogen and phosphorus often limit algal productivity in lakes. In Mono Lake, phosphate is present in substantial concentrations (88 mg/l or 925 micromolar) at a TDS of 100 g/l, but nitrogen (ammonia) concentrations are usually low. Nitrogen is the limiting nutrient for algae growth, and ammonia is the only inorganic nitrogen form present in Mono Lake (University of California, Santa Barbara 1991). Nitrate concentrations are low because nitrifying bacteria that usually oxidize ammonia in aquatic systems are absent in Mono Lake.

Particulates and Metals

Metals have not been routinely measured in Mono Lake, with the only published values presented by Mason (1967). These data were listed tentatively in the comparison with ocean water in Table 16 (adjusted by 1.3 from the measured TDS of 77 g/l to the reference TDS of 100 g/l).

Mono Lake Tributaries

Water quality in the major tributaries (Lee Vining, Walker, Parker, and Rush Creeks) is typical of eastern Sierra Nevada snowmelt runoff streams. This area is largely undeveloped and undisturbed above the LADWP diversion structures. Natural weathering and erosion processes are the main factors affecting water quality in these streams. A seasonal difference between groundwater springs and direct snowmelt runoff occurs.

Transient Parameters

Water temperatures in Lee Vining, Rush, Parker, and Walker Creeks are dependent on snowpack conditions, timing of spring runoff events, and the combination of Southern California Edison (SCE) hydropower and LADWP water storage and diversion practices. Water temperature regimes in these creeks have been substantially altered by historic water diversions for irrigation and aqueduct export. Reduced streamflows from diversions have created drier downstream conditions, which directly affect the growth, maintenance, and vigor of riparian vegetation. Streambank shading from riparian vegetation is an important consideration when evaluating thermal dynamics. Streams with dense stands of riparian vegetation are protected from solar radiation and daily air temperature extremes.

Historical water temperature data for the four Mono Basin tributaries are sparse. Data have been collected recently for the Rush Creek Instream Flow Incremental Methodology (IFIM) study in 1987 (California Department of Fish and Game 1991). Water temperature monitors were placed at four locations in lower Rush Creek: 1) Grant Lake reservoir outlet, 2) old U.S. Highway 395 bridge, 3) downstream of Walker Creek, and 4) a culvert upstream of County Road (mouth). Data were collected from July 1987 to July 1988. Water temperatures at all four stations exhibited similar patterns, although the magnitude of temperature fluctuation increased downstream. The dry, clear atmosphere of the 7,000-foot elevation, combined with the general absence of shading, causes solar radiation and the diurnal temperature variations to dominate stream thermal dynamics. The warmest water temperatures occurred in July and August (maximum 27.4°C), and the coldest temperatures occurred in December and January (near 0°C). Water temperatures exhibited the least variation at Grant Lake reservoir outlet, with a maximum daily difference of about 3.3°C. Diurnal variations of up to 15°C were observed at the downstream stations.

Continuous and instantaneous temperature, turbidity, and dissolved oxygen data were collected from July through October for the 1991 water quality monitoring study of Rush and Lee Vining Creeks (Cullen 1992). Figures 9-11 depict minimum, average, and maximum continuous temperature measurements at these four Mono Lake tributaries. Rush Creek was sampled in 1991 at the same four locations as for the 1987 study, although only temperature data from below Grant Lake reservoir outlet and at the mouth are shown in Figure 11. The 1991 data generally agree with the 1987 study.

Temperatures in Lee Vining Creek were measured below the LADWP diversion, below U.S. 395, and at the mouth in the 1991 water quality monitoring study (Trihey & Associates 1992). Figure 9 shows temperatures below the diversion and at the mouth. Downstream temperatures are generally warmer and show greater diurnal fluctuation (up to 10°C) than upstream water temperatures (up to 7°C). Lee Vining Creek is apparently colder than Rush Creek, with a temperature difference of about 5°C (Figure 9).

Walker and Parker Creeks were measured at the confluence of Rush Creek and exhibited temperatures similar to Lee Vining Creek (Figure 10). Table 18 gives the monthly average temperatures observed in Walker, Parker, Rush, and Lee Vining Creeks during the IFIM studies and grab measurements during the 1991 Jones & Stokes Associates sampling surveys. Temperatures measured during the 1991 sampling period were quite similar in the four tributaries.

Minerals

The only available historical Mono Lake tributary data were collected above the Lee Vining Creek diversion point by LADWP. Water quality data for Parker, Walker, and Rush Creeks were collected by Jones & Stokes Associates in 1991. Water quality data for these streams are presented in Tables 19-22. Conductivity in the four streams was similar, averaging between 40 to 60 microsiemens per cubic meter (μS/cm). A graph of conductivity versus flow for Lee Vining Creek is presented in Figure 12. The figure depicts an inverse relationship of conductivity and flow, with higher conductivities measured during low-flow periods. Historical conductivity data for Lee Vining Creek ranged from 25 μS/cm to about 75 μS/cm.

The mineral content of the Mono Lake tributaries is very low, similar to other high-quality Sierra Nevada streams. These streams have a low alkalinity and hardness and low concentrations of calcium, magnesium, sodium, potassium, and other ions. Concentrations of these and other constituents given in Tables 19-22 are indicative of high-quality surface waters. Average 1991 alkalinity values for the four streams averaged from 11 to 20 mg/l, with the highest values found in Rush Creek, and were similar to the measured hardness values. Calcium concentrations were generally less than 10 mg/l, and magnesium concentrations were about 1 mg/l or less (Figures 13-14). Figure 13 shows calcium and magnesium in Lee Vining Creek. The concentration of these major cations increases linearly with conductivity. The 1991 Jones & Stokes Associates measurements generally confirm the historical LADWP data (Figures 13, 15, and 17). Sodium and potassium concentrations were generally less than 4 mg/l and 1 mg/l for the Mono Lake tributaries, respectively (Figures 15-16). 1991 sulfate concentrations (Figures 17-18) were a little higher for Parker and Walker Creeks than for Rush and Lee Vining Creeks.

Grant Lake Reservoir

Grant Lake is a small LADWP storage reservoir for flows from Rush Creek and other diverted Mono Basin tributaries. Grant Lake reservoir water quality is considered excellent, reflecting the high quality of its sources. It is a cold, high-altitude reservoir with a short residence time and relatively low productivity.

Available Water Quality Data

During the 1991 Jones & Stokes Associates sampling program, depth profiles of temperature, dissolved oxygen (DO), pH, and EC were taken near the inlet and outlet areas of the lake. Water samples were collected at the surface near the outlet and at Grant Lake reservoir outlet (drawn from the lake bottom) and analyzed for minerals, nutrients, organics, particulates, and metals.

LADWP has monitored Grant Lake reservoir outlet for selected parameters since 1934. The quality of water from Grant Lake reservoir outlet comprises a mixture of the four tributary streams that constitute Mono Basin's export (Table 24).

Transient Parameters

During the 1991 Jones & Stokes Associates sampling program, limited temperature stratification was observed at the inlet area of Grant Lake reservoir (Figures 19 and 20A-B). Maximum temperature differences between surface and bottom samples were generally about 2°C. Oxygen profiles indicate that the temperature profile at the inlet could be caused by cold water flowing into Grant Lake reservoir from Rush Creek because oxygen levels at the inlet area increased with depth (Figure 21A-B). Temperature stratification was much weaker at the outlet of Grant Lake reservoir (Figures 22A-B). Surface temperatures were similar at the inlet and outlet location. Oxygen levels are fairly constant with depth at the outlet, which is indicative of effective vertical mixing (Figures 23A-B).

Temperatures at both the inlet and outlet increased about 10°C between May 15 and July 10, rising from 10-20°C. The temperature increase pattern appears similar at both locations (Figure 24). Outlet temperatures were slightly higher than the inlet because of absorption of solar heat in the reservoir. Increased water temperatures during storage in Grant Lake reservoir may increase temperatures in releases to lower Rush Creek, relative to baseline temperatures in upper Rush Creek or Lee Vining Creek. In general, oxygen concentrations remained relatively constant at both locations from May to July. There was no evidence of anoxia near the bottom at either the inlet or outlet; all Grant Lake reservoir oxygen concentrations were above 6 mg/l.

Minerals

Table 24 indicates that the mineral content of Grant Lake reservoir outlet is low, signifying the snowmelt runoff that dominates eastside Sierra Nevada streams. Concentrations of the selected parameters of calcium, magnesium, sodium, potassium, sulfate, and chloride are all in the range of excellent drinking water quality. Figure 25 shows the historical LADWP conductivity data from Grant Lake reservoir outlet. Conductivity values have generally ranged from 40 μS/cm to 100 μS/cm, with an average of about 60 μS/cm. The 1991 Jones & Stokes Associates data generally conformed to these historical data, which suggests that runoff quality has remained unchanged (Figure 25). A few outliers should probably be ignored. Because the outflow is generally independent of the runoff due to reservoir storage effects, no relationship exists between outflow and conductivity values (Figure 26).

Historical and 1991 data for calcium and magnesium, sodium and potassium, and sulfate and chloride in relation to conductivity are presented in Figures 27-29. Data collected in 1991 show good agreement with historic average concentrations for these parameters. Table 24 indicates that the 1991 measurements were similar to the historical means for most parameters. The figures indicate that the major ions increase with conductivity. The ratio of an ion concentration to conductivity at 100 μS/cm provides a convenient value to characterize the chemical compositions of Mono Lake tributary water quality. The sulfate concentration would be 8 mg/l at a conductivity of 100 μS/cm and the chloride concentration would be about 3 mg/l (Figure 29). Calcium would be 11 mg/l and magnesium would be 1.5 mg/l (Figure 27). Sodium would be 4.5 mg/l and potassium would be 1.25 mg/l (Figure 28).

Historical arsenic data were frequently reported at the detection limit of 10 μg/l and are therefore probably less than 10 mg/l. Arsenic was not detected with a detection limit of 4 μg/l in 1991 samples. Boron and fluoride concentrations were also very low; fluoride was not detected in any 1991 samples with a detection limit of 0.1 mg/l and averaged only 0.05 mg/l (0.02 mg/l median) in historic samples. Boron was detected in only 40% of 1991 samples, averaging 0.02 mg/l. Historical boron concentrations averaged 0.04 mg/l (0.02 mg/l median) and were frequently not detected.

Nutrients and Organics

Grant Lake reservoir is very low in nitrogen and phosphorus. Nitrate and dissolved phosphate were not detected in surface samples (Table 23). Total phosphate was detected at or below 0.05 mg/l in only 50% of the samples collected. Data collected from the outlet of Grant Lake reservoir show similar results (Table 24). Nutrient concentrations are quite low at the outlet; nitrate was 0.10 mg/l at a conductivity of 100 μS/cm, and phosphate was 0.03 mg/l (Figure 30).

Chlorophyll *a* data were obtained from 1991 surface water samples collected at the outlet location and are presented in Table 23. Chlorophyll *a* values ranged from 0.9 to 13.3 μg/l, with an average of 5.8 μg/l. The highest value of 13.3 μg/l was on August 13 (Figure 31). Chlorophyll *a* was not correlated with temperature, oxygen, or other parameters. Overall, values were low despite substantial surface warming, which is indicative of an oligotrophic, high-altitude reservoir. Total organic carbon measurements in 1991 ranged from 3 to 4 mg/l. Color measurements averaged 6 units. Turbidity values are extremely low, indicating almost no particulates in Grant Lake reservoir outflow.

Particulates and Metals

Trace element concentrations are frequently not detectable or very low in Grant Lake reservoir outlet (Table 24).

Sediments

Jones & Stokes Associates sampled sediment at four locations in Grant Lake during July 23-25, 1991. Laboratory results are presented in Table 25 and compared to the typical range of concentrations found in sediment, soil, and rocks of the western United States. The first sediment sample (Sed1) was taken at the outlet and consisted of dark, slightly greenish, viscous mud. No sulfur odor was observed, indicating that DO was present at the lake bottom. DO profiles taken at the site confirmed this observation, with DO measured at 6.5 mg/l approximately 2 feet above the lake floor. Mineral and metal sediment concentrations were generally higher at the outlet than at the other sampling locations, but well within normal background ranges. Lead, zinc, and boron concentrations were slightly higher than average. Nutrient concentrations were lower than at Lake Crowley reservoir, except for phosphate, which was measured in concentrations of about 900 mg/kg. The other Grant Lake reservoir sediment samples were collected at the lake middle (Sed2), the inlet (Sed3), and the delta where Rush Creek enters Grant Lake reservoir (Sed4). Samples from the lake middle and inlet were similar in appearance and measured values to the outlet. The sediment from the creek delta consisted mostly of sand, and all constituent concentrations were much lower, except for silica, which is consistent with this location. Sediment from the delta is probably regularly flushed into the lake at high flows.

UPPER OWENS RIVER BASIN

Geothermal activity strongly influences water quality in the Upper Owens River basin upstream of Lake Crowley reservoir. Visible geothermal activity consists of hot springs, fumaroles, and thermally altered rock centered primarily around Hot Creek, Little Hot

Creek, Casa Diablo Hot Springs, Whitmore Hot Springs, and the Alkali Lakes (California Department of Water Resources 1967). In general, geothermal waters in Long Valley are a sodium bicarbonate or sodium chloride-bicarbonate type, with typically high concentrations of dissolved solids and trace elements (primarily boron, fluoride, arsenic, and phosphorus). Figure 32 shows monitoring locations and corresponding available data in the Owens River basin.

East Portal

Exports from the Mono Lake tributaries emerge from the Mono Crater Tunnel at East Portal and flow into the Upper Owens River. Water quality in the East Portal is influenced by a nearly constant flow of poor-quality groundwater, called "tunnel make" by LADWP, that dominates the quality of East Portal when exports from Mono Basin are low.

Minerals

Historical conductivity data from East Portal ranged from 75 to 450 μS/cm (Table 26). Data collected in 1991, when no exports occurred, were relatively constant, ranging from 408 to 433 μS/cm. East Portal conductivity is strongly correlated with flow (Figure 33). The general features of the dilution observed at East Portal of tunnel make with Mono Basin export flows can be approximated with a flow regression between East Portal conductivity and East Portal flow as:

$$\text{East Portal EC} = 450 \text{ x Flow Volume}^{-6}$$

Similar flow regressions are observed at other locations where a runoff source is diluting a geothermal or groundwater baseflow. The general characteristics of the dilution effects can be adequately described with a two-parameter flow regression, rather than by estimating the two conductivity values and the two flow components. Because of the strong flow, chloride values were similar to Big Springs, with historical and 1991 values ranging from 6 to 7.3 mg/l (Figure 35). Calcium and magnesium concentrations at East Portal were higher than at Big Springs, and averaged 24-40 mg/l and 10-18 mg/l, respectively (Figure 34). East Portal and Big Springs had similar concentrations of sodium, potassium, and sulfate (Figures 35-36).

A graph of arsenic and conductivity values is presented in Figure 37. Arsenic concentrations in East Portal ranged from 2 to 20 μg/l, with historic and 1991 averages of 8 μg/l and 13 μg/l, respectively. Arsenic in tunnel make is assumed to be nearly constant. Boron and fluoride concentrations in East Portal were lower than in Big Springs and generally ranged from below detection limits to 0.4 mg/l. As discussed above for other parameters at East Portal, boron and fluoride values were grouped around conductivities of 100 μS/cm and 400 μS/cm; boron and fluoride values were lower at 100 μS/cm (Figure 38).

Nutrients and Organics

Historical and 1991 nitrate concentrations were low in the East Portal, comparable to Big Springs values. Historic nitrate and phosphate values were quite variable (Figure 39). Nitrate values for 1991 ranged from below detection limits to 1 mg/l and averaged 0.61 mg/l. Phosphate concentrations ranged from not detected to 0.08 mg/l and averaged 0.04 mg/l.

Owens River above East Portal (Big Springs)

Big Springs is the historic headwater of the Owens River. Big Springs is a relatively constant groundwater spring that provides baseflow for the Upper Owens River. Deadman Creek, Glass Creek, and other tributaries provide additional runoff from snowmelt. The average annual flow for Big Springs is approximately 50 cubic feet per second (cfs), based on review of historical data.

Minerals

Conductivity measured in Big Springs during the Jones & Stokes Associates 1991 sampling program ranged from 166 to 223 μS/cm, averaging 206 μS/cm. Historical conductivities were lower than 1991 data and averaged 178 μS/cm. Flow conditions in 1991 were low, so the 1991 conductivities were higher than historical data. Conductivity decreased somewhat as flows increased, but the decrease during runoff was moderated by stable groundwater sources (Figure 40). Historical and 1991 Jones & Stokes Associates ranges for minerals are presented in Table 27 and shown plotted as a function of EC in Figures 41-45. Calcium and magnesium were both about 7 mg/l at the highest conductivities of 225 μS/cm. Sodium was about 25 mg/l, and potassium about 4 mg/l. Chloride was about 10 mg/l, and sulfate was about 7 mg/l.

The trace elements arsenic, boron, and fluoride were selected for analysis because they are good indicators of geothermal sources. Arsenic concentrations in Big Springs ranged from 12 to 20 μg/l, and averaged 17 μg/l. Arsenic increased directly with EC (Figure 44). The ratio of arsenic to EC is approximately 20/1000 or 0.02. Boron and fluoride concentrations in Big Springs were approximately equal with mean values 0.4 mg/l for boron and 0.5 mg/l for fluoride (Figure 45). These concentrations are much higher than measured at Grant Lake reservoir and indicate some geothermal influence at Big Springs.

Nutrients and Organics

Historical and 1991 nitrate concentrations in Big Springs were very low, while phosphate concentrations in Big Springs were relatively high with a mean value of 0.35 mg/l (Figure 46). Phosphorus increased linearly with conductivity.

Mammoth Creek

Mammoth Creek water quality is similar to other Sierra streams, containing low concentrations of minerals and nutrients. Mammoth Creek is known as Hot Creek below the Hot Creek Fish Hatchery, and water quality changes drastically below Hot Springs due to the influence of hot geothermal springs.

Minerals

Mammoth Creek conductivity ranged from about 50 µS/cm to 200 µS/cm, based on historical and 1991 data (Table 28). The historical average conductivity was 124 µS/cm, while the 1991 average value was 97 µS/cm. The relationship of flow to conductivity is presented in Figure 47. Mammoth Creek mineral concentrations increased with conductivity, corresponding to low-flow periods (Table 28) (Figures 48-52). The 1991 data provide better estimates than the historical data for several low concentration minerals.

Arsenic is discharged from geothermal springs at several locations along Mammoth Creek. Mammoth Creek arsenic concentrations range from below detection limits to 50 µg/l (Figure 51). Most arsenic values were between 5 to 10 µg/l (Table 28), indicating that Mammoth Creek is a small but consistent source of arsenic. Boron and fluoride data are shown in Figure 52.

Nutrients and Organics

Samples of Mammoth Creek taken above the fish hatchery had average historic nitrate concentrations of 0.2 mg/l; data collected in 1991 had no values above the 0.2 mg/l detection limit. Historic dissolved phosphate concentrations averaged about 0.1 mg/l. Total phosphate concentrations for 1991 ranged from 0.04 to 0.3 mg/l and averaged about 0.1 mg/l. Mammoth Creek nitrate and phosphate as a function of conductivity are shown in Figure 53.

Hot Creek

Mammoth Creek flows into Hot Creek below the Hot Creek Fish Hatchery. Hot Springs, which is the major geothermal spring in the Upper Owens River Valley (Long Valley), discharges into Hot Creek a couple of miles below Hot Springs Fish Hatchery.

Transient Parameters

Daily temperature records were collected by USGS at the Hot Creek stream gage below Hot Springs in 1988. The daily average Hot Creek water temperature in 1988 was about 29.4°C. The seasonal variation is dominated by the hot water emerging from Hot Springs. Winter temperatures remained above 24°C, while summer temperatures reached 35°C. During snowmelt runoff, the streamflow was sufficient to dilute the hot springs water, yet temperatures remained about 24°C. EBASCO Environmental and Jones & Stokes Associates measured instantaneous temperatures in 1991 at the same location as USGS (Figure 54). Temperatures decreased to 21°C during 1991 spring runoff and reached a summer high of 38°C.

Minerals

High conductivity values in Hot Creek are indicative of the strong geothermal influence from Hot Springs. Conductivities generally range from about 500 to 700 μS/cm, except when spring runoff flows dilute geothermal sources (U.S. Geological Survey 1984). Historic conductivity values in Hot Creek ranged from about 200 to 650 μS/cm and averaged 454 μS/cm and 506 μS/cm for historic and 1991 data, respectively (Table 29). Flows are well correlated with conductivity (Figure 55), reflecting the relatively constant source of dissolved salts from Hot Springs. Flows from Hot Springs are estimated to be approximately 15 cfs (1,000 af/month). Spring flows at Hot Creek Fish Hatchery are about equal to Hot Springs, so the average Hot Springs conductivity can be estimated as 1,300 μS/cm.

All minerals increase with conductivity and can best be characterized with ratios between the mineral and conductivity. Calcium and magnesium concentrations were low, with values of 12 and 5.5 mg/l at a conductivity value of 500 μS/cm. (The calcium to conductivity ratio is about 0.024, and the magnesium to conductivity ratio is about 0.011 [Figure 56]). Potassium concentrations were 8 mg/l, while sodium concentrations were 80 mg/l, at a conductivity of 500 μS/cm. The potassium to conductivity ratio was 0.016 and the sodium to conductivity ratio was 0.160 (Figure 57). Chloride concentrations were 45 mg/l, and sulfate concentrations were 25 mg/l at a conductivity of 500 μS/cm (Figure 58). There is a general increase in sulfate, sodium, and chloride in Hot Creek and a decrease in calcium progressing downstream from its origin to its confluence with the Owens River (U.S. Geological Survey 1984).

Hot Creek contains moderate to high concentrations of geothermal trace elements, including boron, fluoride, arsenic, and antimony (antimony is usually found with arsenic) (California Department of Water Resources 1967, U.S. Geological Survey 1984).

Historical data for arsenic concentrations range from 10 μg/l to 370 μg/l; 1991 data range from 120 μg/l to 330 μg/l. Historical and 1991 mean arsenic concentrations were 172 and 224 μg/l, respectively (Table 29). Arsenic was well correlated with Hot Creek conductivities (Figure 59). Although the relationship is curvilinear, some arsenic is present in Mammoth Creek water. The largest contribution of arsenic comes from the Hot Creek gorge. Approximately 85% of the arsenic in Hot Creek comes from the gorge. A single spring complex in the gorge is the largest arsenic source in Long Valley and produces over 50% of the arsenic in Hot Creek (U.S. Geological Survey 1976). Arsenic concentration can be as high as 1,100 μg/l in some Hot Creek springs. A much larger flow with lower arsenic concentrations dilutes the Hot Creek arsenic concentration during runoff periods.

Boron and fluoride originate from hot springs in relatively constant quantities (California Department of Water Resources 1967). Historic concentrations of boron range from 0.4 to 2.9 mg/l and averaged 1.6 mg/l; fluoride concentrations range from 0.4 to 3.8 mg/l and averaged 1.7 mg/l (Table 29). The California Department of Water Resources (1967) reported average boron and fluoride concentrations of 1.82 mg/l and 1.76 mg/l, respectively. Data from 1991 indicate a range of 1.2 to 2.6 mg/l for both boron and fluoride, with both parameters averaging 2.0 mg/l (Figures 60-61). Boron and fluoride increased directly with conductivity, with a boron-to-conductivity and a fluoride-to-conductivity ratio of 0.04.

Nutrients and Organics

Historical and 1991 data indicate that Hot Creek has high concentrations of phosphate (Table 29). Both Hot Springs and the Hot Creek Hatchery are significant sources of phosphorus. Total phosphate concentrations ranged from 0.19 mg/l to 0.31 mg/l, with an average of 0.2 mg/l at a conductivity value of 500 μS/cm (Figure 62). High phosphorus concentrations have resulted in abundant growth of algae and macrophytes in Hot Creek (U.S. Geological Survey 1984). Nitrate concentrations were low.

Particulates and Metals

Iron, barium, aluminum, and manganese concentrations are higher in the geothermal waters from Hot Springs than in most of the streams sampled during 1991. Mercury also was detected in 1991 in three of eight samples at concentrations ranging from 0.17 μg/l to 0.30 μg/l. Other metals remained below detection limits.

Owens River at Benton Crossing

Benton Crossing is located just upstream of the inflow to Lake Crowley reservoir. Water quality of the Owens River at Benton Crossing reflects the flow-weighted mixed quality of Big Springs, East Portal, and Hot Creek plus inflows from smaller creeks and springs.

Minerals

Table 30 contains the summary of historical and 1991 samples from Benton Crossing. Benton Crossing conductivity historically ranged from 295 to 560 μS/cm; data collected during 1991 ranged from 375 to 531 μS/cm. The relationship between conductivity and flow at Benton Crossing is similar to that of East Portal, Big Springs, and Hot Creek (Figure 63). Benton Crossing mineral concentrations increased directly with conductivity (Figures 64-66). Concentrations depend on the flow contribution from East Portal, Big Springs, and Hot Creek.

Historical arsenic concentrations at Benton Crossing ranged from 10 to 170 μg/l and averaged 60 μg/l (arsenic was not measured in 1991) (Figure 67). High arsenic concentrations at Benton Crossing reflect the contribution from Hot Creek. Boron and fluoride concentrations in Benton Crossing also were much higher than Big Springs or East Portal. Boron and fluoride values were strongly correlated with conductivity; concentrations increased from about 0.5 to 1.5 mg/l with a conductivity increase from 200 μS/cm to 500 μS/cm (Figure 68).

Nutrients and Organics

Nitrate concentrations were low or below detection limits at Benton Crossing. Phosphate concentrations were high, ranging from 0.1 mg/l at a conductivity of about 200 μS/cm to about 0.25 mg/l at 500 μS/cm; historical and 1991 average concentrations were 0.2 mg/l and 0.22 mg/l, respectively (Figure 69).

Other Lake Crowley Reservoir Tributaries

The following five tributaries to Lake Crowley reservoir were monitored for water quality, and the results are included in this data report: Convict, McGee, Hilton, Rock (diversions), and Crooked Creeks (Figure 32). Water quality in these streams is similar to that of Mammoth Creek.

Convict Creek

Table 31 provides the statistics for historical and 1991 samples from Convict Creek. Historical conductivities ranged from about 125 to 175 μS/cm, and averaged 145 mg/l and 160 mg/l for historical and 1991 values, respectively. Conductivity did not correlate well with flow due to the seasonal storage effects of Convict Lake (Figure 70). Historical and 1991 mineral data are shown in Figures 71-73. Convict Creek calcium values ranged from 20 to 30 mg/l; historical values averaged 25 mg/l and 1991 values averaged 28 mg/l. Convict Creek sulfate values ranged from 7 to 26 mg/l, and averaged 12 and 14 mg/l for historical and 1991 data, respectively. The 1991 samples had slightly higher concentrations because of low flows during the previous several years.

McGee Creek

Table 32 summarizes the historical and 1991 data for McGee Creek. McGee Creek conductivity ranged from 56 to 175 μS/cm; historical values averaged 122 μS/cm, and 1991 values averaged 90 μS/cm (Figure 74). Mineral concentrations as a function of conductivity are shown in Figures 75-77. McGee Creek sulfate values ranged from 5 to 32 mg/l and averaged 13 and 9.4 mg/l for historical and 1991 data, respectively.

Hilton Creek

Table 33 summarizes the historical and 1991 data for Hilton Creek. Hilton Creek had the lowest conductivities of the Lake Crowley reservoir tributaries, which ranged from 24 to 62 μS/cm; historical values averaged 43 μS/cm, and 1991 values averaged 29 μS/cm (Figure 78). Figures 79-81 show selected mineral concentrations as a function of conductivity. Calcium and sulfate concentrations found in Hilton Creek were among the lowest of the streams, with less than 5 mg/l for calcium and less than 2 mg/l for sulfate (Figures 79 and 81).

Crooked Creek

Table 34 summarizes the 1991 data from Crooked Creek. No historical data were available. Crooked Creek conductivities ranged from 43 to 128 μS/cm and averaged 74 μS/cm (Figure 82). Selected minerals were graphed and are shown in Figures 83-84. Iron content of Crooked Creek was very high compared to other Lake Crowley reservoir tributaries, ranging from 100 to 700 mg/l (Figure 84).

Rock Creek

Table 35 summarizes the historical and 1991 data from Rock Creek. Rock Creek diversions at Tom's Place can occur only during excess runoff periods because minimum flows must be maintained below the diversion. Historical data for most water quality parameters are substantially higher than the 1991 data, suggesting that a different location was sampled historically. Conductivities ranged from 25 to 125 μS/cm (Figure 85). Figures 86-88 show mineral concentrations as a function of conductivity.

Lake Crowley Reservoir

Available Water Quality Data

EPA conducted a water quality study of Lake Crowley reservoir in 1975 during the National Eutrophication Survey, a sampling program initiated in 1972 to investigate the threat of accelerated eutrophication in freshwater lakes. Three stations were sampled during June and November 1975 at the surface and various depths for chemical and physical parameters indicative of eutrophication, including dissolved oxygen, nutrients, and chlorophyll *a*.

Melack and Lesack (1983) conducted a research program in 1982 to evaluate algal growth dynamics and potential algal growth controls.

Jones & Stokes Associates conducted bimonthly limnological and water quality studies of Lake Crowley reservoir from May to September 1991. Data were collected from four sampling locations: Dam Arm, Chalk Cliffs, Green Banks, and McGee Bay. Temperature, pH, conductivity, and DO data were collected at 1-meter increments from the surface to the lake bottom. Total and dissolved phosphorus, general minerals, and chlorophyll *a* samples also were collected at the surface.

LADWP has monitored Lake Crowley reservoir outlet for minerals since 1940.

Transient Parameters

Lake Crowley reservoir is thermally stratified in spring and summer. Hourly 1991 temperature data from LADWP datapods located at the surface and bottom at Dam Arm show thermal stratification beginning in late May, strengthening through the summer with a maximum temperature difference of about 9°C in July, then weakening substantially in September until the lake mixed in October (Figure 89). Surface temperatures reached a peak of 24°C in the beginning of July, while bottom temperatures seemingly peaked at 17°C in September before mixing occurred.

Temperature profiles collected during the 1991 Jones & Stokes Associates sampling program corroborate the above LADWP data and show the depth of the upper mixed layer. Figures 90A-B indicate that the lake remained vertically mixed through May. An initial stratification of 3.5°C was measured on June 6, with a bottom temperature of 11°C. The mixed layer was just 2 meters (m) deep. On June 20, the surface mixed layer had warmed to 17°C, with a depth of about 5 m. On July 11, surface temperatures were 21°C and bottom temperatures were 13°C at Dam Arm, a difference of about 8°C. The mixed layer depth was reduced to 3 m. By the end of July, the mixed layer depth was approximately 6 m deep but with a slightly reduced average temperature of 20°C. During August and September, the mixed layer deepened as surface temperatures cooled slightly. Both August surveys measured a mixed depth of 10 m at 19°C. The lake had not fully mixed on September 25, with a surface temperature of 17.5°C and a bottom temperature of 16.5°C.

Lake Crowley reservoir is eutrophic, and the epilimnion is replenished with DO by primary production and atmospheric aeration. The hypolimnion, in contrast, becomes gradually depleted of DO from the lake sediment as decomposition processes consume DO. DO is not replenished in the hypolimnion due to a lack of primary production because of insufficient light and the absence of mixing with the epilimnion.

DO levels on May 16 indicated a slight decrease with depth; concentrations ranged between about 9 mg/l at the surface to about 7 mg/l at the bottom (Figures 91A-B). DO levels on June 20 had increased at the surface to about 11 mg/l but had sharply declined to 3 mg/l near the bottom. Hypolimnetic DO concentrations were anoxic below 15 m depth on July 11 and remained anoxic below 10 m depth through August. Deepening of the surface mixed layer in September allowed the re-aeration of a portion of the reservoir. Anoxic conditions were observed below 15 m depth on September 10, and DO concentrations were only 1 mg/l at 15 m depth on September 25, indicating that lake mixing had not yet occurred. The influence of the anoxic hypolimnion is shown in Figure 92.

Minerals

The mineral quality of Lake Crowley reservoir is indicated by the historical conductivity data that have been collected since 1940, which are summarized in Table 40 and shown in Figure 93. Outlet conductivity values have historically ranged from 188 to 592 μS/cm and averaged 325 μS/cm. Outlet data collected in 1991 ranged from 508 to 546 μS/cm and averaged 521 μS/cm. In contrast, 1991 surface conductivities ranged from 466 to 510 μS/cm and averaged 483 μS/cm (Tables 36-39). Higher 1991 conductivity values and higher hypolimnetic conductivity values are indicative of drought conditions and a lack of seasonal runoff dilution in Lake Crowley reservoir in recent years. Other historic periods of elevated conductivity values can be seen during the early 1940s, 1977, and the 1987-1991 dry periods.

The mineral quality of Lake Crowley reservoir is governed by the variable mixture of Mono Basin exports, Upper Owens River tributaries, geothermal springs, and Rock Creek diversions. The geothermal springs supply a relatively constant source of minerals, while tributary runoff, Mono Basin exports, and Rock Creek diversions provide a seasonal dilution of these geothermal minerals. The resulting chemical composition is remarkably constant.

Calcium and magnesium concentrations are plotted against conductivity in Figure 94. Because the calcium content of geothermal sources is much lower than from tributary runoff, the calcium composition is highest at low conductivity and fluctuates between 15 and 25 mg/l at higher conductivities. Magnesium content is more uniform with a magnesium to conductivity ratio of approximately 1.25% (5 mg/l at a conductivity of 400 μS/cm). Sodium and potassium concentrations increase directly with conductivity, suggesting that the composition of geothermal and runoff water is similar (Figure 95). Actually, the sodium to conductivity ratio of geothermal sources is about 15%, while runoff sources average about 5%. This causes the sodium to conductivity curve to bend upwards at higher conductivity values. The potassium content of all sources is approximately 1.5%.

Figure 96 shows sulfate and potassium concentration as a function of conductivity. Sulfate content of the tributaries is variable between 2.5% and 10%, while the geothermal sources are 5%, giving a slightly downward bend to the sulfate and conductivity plot. The 1991 sulfate concentrations were about 20 mg/l with a sulfate to conductivity ratio of 3.5%. Chloride concentrations for 1991 indicate a chloride to conductivity ratio of approximately 7%, although the Mono Basin export ratio is 3% and the tributary ratios also are quite low. The chloride to conductivity ratio for geothermal sources is approximately 9%, causing the upward bend in the chloride curve.

Historical arsenic concentrations measured at Lake Crowley reservoir outlet ranged from about 10 to 100 μg/l and averaged 44 μg/l (Table 40). Arsenic concentrations ranged from 70 to 110 μg/l and averaged 94 μg/l during 1991. Historical arsenic concentrations were quite variable at low conductivities (250 to 400 μS/cm), indicating a variable mixture of geothermal and tributary runoff water (Figure 97). The arsenic content of Hot Creek water was approximately 250 μg/l at a conductivity of 500 μS/cm (0.05%). Variable dilution with Mono Basin exports and tributary runoff produced the variations in historical arsenic values. The 1991 data indicate an arsenic content of 0.02%, approximately 40% of the Hot Creek content. The 1991 arsenic concentrations and content are the highest observed. The historical data indicate that dilution in Lake Crowley reservoir has usually been much greater than during 1991, because the arsenic content has varied from 0.005% to 0.02%.

Hot Creek was determined to be the main contributing source of arsenic to Lake Crowley reservoir, contributing approximately 65% of the annual arsenic load, 85% of which originates from the Hot Creek gorge (Table 41) (U.S. Geological Survey 1976).

Boron and fluoride concentrations are nearly equal (Table 40). The 1991 data indicate a ratio of 0.25%. Historic boron concentrations ranged from about 0.4 to 1.5 mg/l and averaged 0.73 mg/l. Boron concentrations for 1991 data ranged from 1.3 to 1.5 mg/l and averaged 1.4 mg/l (Figure 98). Fluoride values for 1991 were nearly identical to boron concentrations (Figure 99). Both are excellent indicators for geothermal sources; fluoride and boron are generally in low concentrations in Mono Basin export and tributary runoff sources.

Nutrients and Organics

Melack and Lesack sampled Lake Crowley reservoir in 1982 to evaluate algal growth dynamics and potential algal growth limits. During that study, concentrations of inorganic nitrogen were low in surface waters while concentrations of inorganic (dissolved) phosphorus were relatively high. Ratios of nitrogen to phosphorus, important in determining algal growth conditions, were generally low (less than 15 μg/l) and indicated favorable conditions for the growth of blue-green nitrogen-fixing algae. However, algal identification was not part of their study. (Melack and Lesack 1982.)

Temporal changes in nutrients were monitored and indicated that regeneration of inorganic phosphorus and nitrogen may be important in the anoxic hypolimnion (Melack and Lesack 1982). Loading rates were not determined, however. Algal blooms were observed in July and August, with nutrient concentrations dropping during the blooms, although inorganic nitrogen remained low throughout the study. Tributary sampling indicated that the two major sources of phosphorus were Big Springs and Hot Creek. The phosphorus content of geothermal sources are slightly higher than Mono Basin exports and tributary runoff. Big Springs phosphorus content is extremely high relative to the other locations.

Historical LADWP data and 1991 Jones & Stokes Associates data indicate that Lake Crowley reservoir had low nitrogen levels in surface water samples at Dam Arm (Table 36). Total phosphate concentrations ranged from 0.09 to 0.12 mg/l and averaged 0.1 mg/l. Dissolved phosphate concentrations ranged from 0.03 to 0.08 mg/l and averaged 0.05 mg/l. Dissolved phosphate concentrations were generally about one-half of total phosphate concentrations (Table 36).

Nitrogen and phosphorus concentrations were higher in the outlet of Lake Crowley reservoir (Figures 100-101). Nitrate was not detected in 1991 samples. Ammonia and total Kjeldahl method-derived nitrogen concentrations were high in the outlet. Ammonia concentrations ranged from about 0.1 mg/l to 2.6 mg/l and averaged 0.94 mg/l. Total phosphate concentrations ranged from 0.1 to 0.65 mg/l and averaged 0.25 mg/l. Historical dissolved phosphate ranged from 0.003 to 0.6 mg/l and averaged 0.125 mg/l.

Higher nitrogen and phosphate concentrations in the outlet of Lake Crowley reservoir may be the result of sediment release during anoxic periods, as reported by Melack and Lesack (1983). Ammonia and phosphate concentrations increased with time during the anoxic period. DO increased slightly and ammonia and phosphate decreased substantially on September 25, which indicates that mixing had reached the lower depths and fall turnover had begun (Figure 91B). Complete turnover had probably occurred by October 8, indicated by the presence of dissolved oxygen and absence of sulfide in outlet samples analyzed by LADWP (Ball pers. comm.).

Chlorophyll *a* data from the 1991 Jones & Stokes Associates sampling program from all four locations are presented in Figure 102A. Concentrations of chlorophyll *a* near the dam, Chalk Cliffs, and McGee Bay were similar, except for one high value of 80 μg/l at Chalk Cliffs. The lowest values were found at Green Banks, which is in the upstream portion of Lake Crowley reservoir. Chlorophyll *a* measurements were not collected for the initial surveys.

The Secchi depth measurements can be interpreted to determine the light conditions and algal patterns (chlorophyll *a* concentrations) in Lake Crowley reservoir. Light penetration in the lake can be assumed to be exponential and represented by the following equation:

$$I = Io * e^{-kt * z}$$

where: Io is the incident light at the surface,
I is the light at depth z (m), and
kt is the light extinction coefficient (m^{-1}).

Light extinction is caused by background water adsorption of inorganic particulates and algal pigments (chlorophyll). Because Lake Crowley reservoir has very low suspended solids concentrations, the light extinction coefficient (kt) can be approximated as:

$$kt = kw + c \times \text{chlorophyll } a \ (\mu g/l)$$

where: kw is the light extinction coefficient of water and
C is the chlorophyll *a* coefficient.

The deepest Secchi depth measured was approximately 5 m. The light level visually detected as the Secchi depth must be assumed. If the Secchi depth is assumed to correspond to a light level that is 13.5% of the incident light, then kt is related to the Secchi depth (m) as follows:

$$kt = -\ln(Io/I)/\text{Secchi depth} = 2/\text{Secchi depth}$$

For the deepest observed Secchi depth of 5 m, kt is 0.4 m^{-1}. Chlorophyll will increase kt, and pairs of chlorophyll *a* and Secchi depth measurements indicate that the chlorophyll *a* coefficient (c) is approximately 0.02. A chlorophyll concentration of 10 μg/l will increase kt by 0.2 m^{-1} and reduce the Secchi depth to 3.3 m. A chlorophyll concentration of 80 μg/l will increase kt by 1.6 m^{-1} and reduce the Secchi depth to 1 m. Figure 102B shows the estimated chlorophyll concentrations based on the Secchi depth measurements at the four Lake Crowley reservoir stations during 1991. The patterns generally match the measured chlorophyll concentrations.

The euphotic zone, as estimated by the 1% light level, is 2.3 times the Secchi depth, if the Secchi depth is assumed to correspond to the 13.5% light level. The euphotic zone in relation to the surface mixed depth can be interpreted as governing lake productivity. Only the portion of the lakebed within the euphotic zone can support aquatic macrophytes. The euphotic zone depths are shown in Figure 102C and compared to the surface mixed depths.

Particulates and Metals

Metals and particulate analyses of the Lake Crowley reservoir outlet are summarized in Table 40. Barium, manganese, and mercury were frequently detected in outlet samples at Dam Arm (Figure 103). Mercury concentrations ranged from not detected to 0.3 μg/l and averaged 0.19 μg/l; mercury was detected in 60% of the samples. Manganese concentrations ranged from 12 to 210 μg/l and averaged 121 μg/l.

Lake level fluctuations and potential liberation of heavy metals into the water column via exposed lake bottom sediments are of concern in Lake Crowley reservoir. Results of 1991 Jones & Stokes Associates sampling of Lake Crowley reservoir sediments are listed in Table 42. Mercury has been detected in the lake at concentrations nearing EPA water quality criteria, and outflow concentrations have exceeded inflow concentrations at times (Milliron pers. comm.).

The study of Lake Crowley reservoir by Melack and Lesack stated that copper sulfate treatment had not occurred that summer (Melack and Lesack 1982). Copper sulfate was used to suppress growth of blue-green algae on June 18 and July 30, 1981. The rates of application were low, less than 1 lb/af, or 0.35 mg/l, and these rates were the only applications of copper sulfate reported by LADWP (Wilson pers. comm.).

Sediments

Table 42 lists the results of the Jones & Stokes Associates sediment sampling on July 23, 1991. Eight Lake Crowley reservoir locations were sampled, as shown in Figure 32. Sediment samples gathered at Dam Arm, Chalk Cliffs, and McGee Bay consisted of fine, black-grey, viscous to gelatinous mud with a distinct sulfurous odor, indicating an anoxic lake bottom. DO profiles taken at these sites confirmed that oxygen was present at less than 0.1 mg/l at the bottom water layer due to the development of a summer thermocline. All constituent concentrations were within the ranges typically found in sediment, except for arsenic and mercury.

Arsenic measurements ranged from below detection to 81 mg/kg at the outlet, with an average of 33 mg/kg. This is approximately twice as high as the upper limit of typical western sediment concentrations and is probably caused by high arsenic contributions from Hot Creek. However, arsenic concentrations in Lake Crowley reservoir are below the total threshold limit concentration (TTLC) of 500 mg/kg set by the California Department of Health Services to protect human health. Mercury concentrations at Lake Crowley reservoir ranged from below detection limits to 0.62 mg/kg at Chalk Cliffs, with an average of 0.43 mg/kg. Sediments in the western United States typically have mercury concentrations ranging from below detection to 0.22 mg/kg, indicating that mercury concentrations in Lake Crowley reservoir sediments appear to be elevated relative to background levels. The TTLC for mercury is 20 mg/kg, which is well above Lake Crowley reservoir concentrations.

Sediment samples from Green Banks, where the Owens River enters Lake Crowley reservoir, contained more sand and had no odor. The lake bottom at Green Banks was well oxygenated due to shallow depth. Silica concentrations were higher at this location, as indicated by the high sand content. Concentrations of minerals and metals were lower because these parameters generally attach to fine organic material (mud and silt), which is transported toward the lake outlet before settling.

MIDDLE AND LOWER OWENS RIVER BASIN

Figure 104 shows monitoring locations within the Middle and Lower Owens River basin. Mono Basin exports and water from the Upper Owens River basin is stored at Lake Crowley reservoir, then diverted south to Pleasant Valley reservoir through the Owens River gorge power plants and aqueduct. Pleasant Valley reservoir was constructed as a tailbay for the three hydroelectric plants in the Owens River gorge, and water quality in the reservoir reflects that of the outflow from Lake Crowley reservoir and inflows from Round Valley and Birchim Canyon Springs. From Pleasant Valley reservoir, the water is released to the Middle Owens River, flowing south to Tinemaha reservoir. Major tributaries to the Middle Owens River between Pleasant Valley and Tinemaha reservoirs include Fish Springs; Bishop Canal; and Horton, Baker, Big Pine, and Tinemaha Creeks (U.S. Geological Survey 1987). Several miles south of Tinemaha reservoir, the LA Aqueduct diverts the Owens River flow to Haiwee reservoir. Several streams flow directly into the aqueduct between Tinemaha and Haiwee reservoirs. Groundwater is pumped from several wellfields in the Owens Valley. Releases from Haiwee pass through several power plants and enter the City of Los Angeles at the newly constructed LA Aqueduct filtration plant.

Only data from Tinemaha reservoir and groundwater are presented for the Middle Owens River basin.

Tinemaha Reservoir

Tinemaha reservoir regulates the Owens River flow before it is diverted into the LA Aqueduct and functions as a limited storage location when the aqueduct is shut down or during periods of heavy runoff (Los Angeles Department of Water and Power 1989). LADWP has routinely monitored water quality at Tinemaha reservoir outlet since 1933. USGS sampled the outlet monthly for general parameters from 1974 to 1986 and collected daily continuous measurements of conductivity in the 7-year period from 1975 to 1981. Historical LADWP and USGS water quality data for Tinemaha reservoir outlet are presented in Table 43.

Minerals

Water quality in Tinemaha reservoir is a variable mixture of releases from Lake Crowley reservoir, tributary runoff, and groundwater pumping. Outlet conductivities, reflecting the mixed sources, are nonetheless relatively constant (Figure 105). Historical LADWP data form the Tinemaha reservoir outlet averaged 316 μS/cm, and USGS data averaged 287 μS/cm, with median values of 310 and 288 μS/cm, respectively, indicating an even data distribution. Outlet conductivities ranged from 153 to 450 μS/cm, although most values were between 280 and 350 μS/cm (Figure 105).

Lake Crowley reservoir is the principal water source for Tinemaha reservoir and largely determines water quality at Tinemaha reservoir. The Tinemaha reservoir conductivity time series from 1940 to 1991 (Figure 105) closely matches a similar time series of Lake Crowley reservoir outlet conductivity (Figure 93). Lake Crowley reservoir outlet conductivity values have historically averaged 325 μS/cm with a median of 310 μS/cm and a range of 188 to 592 μS/cm. Tinemaha reservoir outlet conductivities are slightly lower and less variable than Lake Crowley reservoir outlet measurements, probably due to mixing with runoff and groundwater, and regulation of releases from Lake Crowley reservoir.

USGS daily conductivity data show the seasonal decrease in conductivity that typically occurs in June to July due to dilution from low conductivity snowmelt runoff (Figures 106A and 106D-106G). The effects of the 1976-1977 drought conditions also can be seen in these daily records, indicated by a lack of seasonal runoff dilution and a steady increase in conductivity from 275 μS/cm to 400 μS/cm (Figures 106B-C). The effects of the more recent 1987-1991 drought are demonstrated in Figure 105.

Monthly grab measurements collected by USGS and LADWP also are shown in Figures 106A-G, plotted on the date of the USGS sample (the LADWP sample was collected sometime in the same month). Generally, the conductivity data from the two agencies match closely. For most purposes, the monthly grab samples provide a good representation of the monthly water quality.

Groundwater pumped from the wellfields between Pleasant Valley reservoir and Tinemaha reservoir is discharged into the Middle Owens River and affects water quality at the Tinemaha reservoir outlet. Groundwater conductivities from these wellfields range from about 200 μS/cm to 800 μS/cm and average approximately 350 μS/cm. Conductivity in Tinemaha reservoir therefore tends to increase as a result of extended groundwater pumpage.

Chloride concentrations ranged from 3.2 to 46 mg/l for USGS and LADWP data, respectively. Chloride values were well correlated with conductivity (Figure 108). Calcium concentrations generally ranged from 10 to 30 mg/l and averaged 22 and 23 mg/l for USGS and LADWP data, respectively. The calcium to conductivity ratio is approximately 7.5% but is higher at low conductivity and lower at high conductivity (Figure 107). Magnesium concentrations ranged from 0.9 to 24 mg/l and averaged 4 and 4.6 mg/l for USGS and LADWP data, respectively, with a magnesium to conductivity ratio of about 1.5% (Figure 107). Sodium concentrations generally ranged from 6 to 92 mg/l and averaged 32 and 36 mg/l, respectively, with a sodium to conductivity ratio of about 11% (Figure 108). Sulfate concentrations ranged from 5 to 84 mg/l and averaged 23 and 24 mg/l, respectively, with a sulfate to conductivity ratio of 7% (Figure 109). Potassium concentrations were the lowest of the mineral group. Potassium concentrations averaged about 4 mg/l, with a potassium to conductivity ratio of about 1.2% (Figure 109). Good agreement was noted between LADWP and USGS data for all minerals.

Arsenic values generally ranged from 10 to 50 μg/l and averaged 23 and 24 μg/l for USGS and LADWP data, with an arsenic to conductivity ratio of 0.08% (Figure 110). The large decrease in arsenic concentration from Lake Crowley reservoir outlet, which averaged 44 μg/l, is due to dilution with Owens River tributaries and groundwater. Arsenic concentrations had large variations (10-30 μg/l) between conductivities of 200 and 400 μS/cm (Figure 110). The observed variation is due to dilution of Long Valley waters flowing down the Owens River with high conductivity, low arsenic groundwater from the Owens Valley, and with low conductivity and low arsenic runoff from Owens Valley tributaries.

Boron and fluoride concentrations were both 1 mg/l or less and averaged about 0.5 to 0.6 mg/l. Boron and fluoride showed poor correlation with conductivity for the same reasons discussed above for arsenic (Figures 111-112). Only geothermal sources have significant arsenic, boron, and fluoride, while several sources have high conductivity.

Nutrients and Organics

Nitrate and phosphate concentrations were generally low and averaged about 0.12 mg/l for nitrate and 0.08 mg/l for phosphate (0.025 mg/l-P). Nitrate and phosphate were poorly correlated with conductivity (Figures 113-114).

Groundwater

Background

In 1908, LADWP drilled its first test wells in the Middle and Lower Owens River basin to investigate the feasibility of exporting groundwater to supplement surface water diversions during the peak irrigation season. The first wells were artesian wells located east of Independence. Groundwater export began in earnest in 1917, when production wells were drilled, half of which were installed with air compressors to augment artesian flows. Since 1917, more than 500 wells have been drilled; about 90 of these are pump-equipped with yields of 1,000-5,000 gallons per minute (2-10 cfs). Pumpage increased steadily from 1917 with increasing demand to a peak of about 140,000 af/yr in 1931, supplying approximately 30% of total aqueduct flow that year. Between 1932 and 1960, almost no pumping occurred because LADWP water needs were met by exports from the Upper Owens River, Mono Basin, the Colorado River, and other surface water sources. The water table rose as a result of pumping cessation, and groundwater discharge from artesian wells during this period increased from less than 5,000 af/yr to about 10,000 af/yr. In 1960, groundwater pumping resumed, and pumpage between 1971 to 1983 averaged about 100,000 af/yr, with an occasional peak of 160,000 af/yr. The water table has fallen in response, and with it artesian discharge has decreased. Several springs have dried up as a result of pumping. In particular, Fish Springs Hatchery is now supplied by wells from the Big Pine wellfield.

The majority of the about 500 wells currently in existence are drilled at depths ranging from 100 to 600 feet and are located on the west side of the Owens River Valley along lines perpendicular to groundwater flow patterns. Although about 80% of the wells are artesian, these free-flowing wells in recent years generally have contributed less than 10% of the total groundwater export. Wells in the Owens River Valley have for the purposes of this report been grouped into four major wellfields: Laws (LW), Bishop-Warm Springs (BW), Big Pine-Crater Mountain (BP), and below Tinemaha (BT). The BT wellfield group encompasses all wellfields located between Tinemaha and Haiwee reservoirs: Taboose-Aberdeen, Thibault-Sawmill Creek, Independence-Oak Creek, Symmes-Shepherd Creek, Bairs-George Creek, and Lone Pine. Groundwater pumped from the LW, BW and BP wellfields between Pleasant Valley and Tinemaha reservoirs are discharged into the Middle Owens River and affect water quality at the Tinemaha reservoir outlet. Groundwater withdrawals from the numerous wellfields between Tinemaha and Haiwee reservoirs are discharged into the LA Aqueduct at several points along this reach and affect water quality at the LA Aqueduct filtration plant.

From 1971 to 1983, average pumpage was 13,758 af/yr from LW, 4,344 af/yr from BW, 27,512 af/yr from BP, and 52,128 af/yr from BT. The BP and the Taboose-Aberdeen wellfields account for approximately 50% of the total groundwater pumpage (97,742 af/yr) from the Owens River Valley. Pumpage is generally one-third of well capacity. Figure 115 depicts individual well capacities within the four major wellfields. Combined capacity is 59 cfs for the 14 wells in LW wellfield, 26 cfs for the 11 wells in the BW wellfield, 97 cfs for the 19 wells in the BP wellfield, and 161 cfs for the 47 wells in the BT wellfields (Tables 44-47). Overall pumping capacity is 343 cfs. The groundwater pumping is greatest during periods when runoff is insufficient to supply Los Angeles water demands. The groundwater has the highest impact on water quality when pumping is high relative to runoff and releases from Lake Crowley reservoir.

Transient Parameters

Groundwater temperatures generally fluctuate much less seasonally than do surface water temperatures, and they average 17°C (Table 48). Significant variations exist between individual wells, however, and temperatures have been found to range from 4 to 28°C (Figure 116). Local geothermal activity may produce some warm groundwater temperatures, but these temperatures may be seasonal average temperatures. Pumping has been used to control ice damage to the aqueduct during winter. Groundwater pH ranges from 6.5 to 9.2 and averages 7.5 (Figure 117).

Minerals

Groundwater is generally of lower quality than surface water because of its higher mineral content. Owens Valley groundwater conductivities range from 100 to 1,600 μS/cm (Figure 118) and average 288 μS/cm (Table 48). The LW wellfield has the highest median conductivity of 528 μS/cm, followed by BP (318 μS/cm) and BW (206 μS/cm). BT has the lowest median conductivity of 186 μS/cm, but some very productive wells within the BT wellfield (in the Taboose-Aberdeen and Thibault-Sawmill Creek wellfields) have conductivities above 1,000 μS/cm, thus significantly lowering the overall water quality of the BT wellfield. Groundwater from these high conductivity wells generally have high boron concentrations and a few also have elevated arsenic levels, indicating a geothermal influence. Some wells have much higher concentrations of minerals than others.

The ratios of ion concentration to conductivity are relatively constant for each individual well but variable within and between wellfields. Tables 44-48 lists the IQR of ion concentrations from the major wellfields.

LW wells have the highest average calcium concentrations of 50 mg/l, and BW the lowest of 17 mg/l (Figure 119). Overall average calcium concentration is 23 mg/l. LW wells also have the highest average magnesium concentration of 10.5 mg/l, followed by BP (7.8 mg/l), BT (6.7 mg/l), and BW (2.5 mg/l) (Figure 120). Average sodium concentrations for the four wellfields are 49 mg/l (LW), 28mg/l (BP), 27 mg/l (BT), and 21 mg (BW) (Figure 121). Average potassium concentrations range from 5.9 mg/l to 2.4 mg/l, with LW again exhibiting the highest concentrations and BW the lowest concentrations (Figure 122). Sulfate and chloride concentrations follow the same trend, ranging from 85 mg/l (LW) to 11 mg/l (BW) and 13 mg/l (LW) to 4.1 mg/l (BW) (Figures 123-124).

Arsenic was measured above the LADWP detection limit of 10 μg/l in a few wells (Figure 125). Median boron concentrations were 0.11 mg/l, but some wells in the Taboose-Aberdeen and the Thibault-Sawmill Creek consistently had concentrations above 1.00 mg/l and some as high as 3.30 mg/l (Figure 126). Fluoride concentrations were variable between wellfields, with the highest values (4.0 mg/l) found within the BW and the LW wellfield and the lowest within the IO and SS wellfields (Figure 127).

Particulates and Metals

Iron is the only metal that has been routinely measured. The majority of the measurements were below detection limits, although some individual wells recorded iron concentrations as high as 1.2 mg/l (Figure 128).

Nutrients and Organics

Nitrate and phosphate values are generally quite variable. Some wells in the Taboose-Aberdeen and the Thibault-Sawmill Creek apparently have elevated levels of nitrate and phosphate (Figures 129-130).

The influence of groundwater pumping on overall water quality at the LA Aqueduct filtration plant is determined by the ratio of groundwater to surface water exports. An overall ion ratio for constituents of interest from Owens Valley groundwater can be calculated by flow-weighting the contribution from individual wells according to capacity. Actual pumping may be quite variable from month to month, but the potential contribution from groundwater can be generally determined in this way. Figures 131-138 shows the relationship between selected mineral concentrations and conductivity for each major wellfield.

LOS ANGELES DEPARTMENT OF WATER AND POWER WATER SUPPLY QUALITY

Water supplies for the City of Los Angeles are obtained from a combination of local groundwater wells, the LA Aqueduct, and MWD. The City of Los Angeles relies primarily on LA Aqueduct and local groundwater supplies to meet its water demands because water from these sources is generally of better quality and less costly. However, the LA Aqueduct and local groundwater supplies cannot meet the total demand, and the City of Los Angeles relies on water purchases from MWD to supplement its water supplies. During low runoff years such as 1976 and 1977, the proportion of MWD supplies increases. In high runoff years, the MWD supplies decrease. Recently, as LA Aqueduct deliveries have fallen due to drought and court injunctions, MWD purchases have grown correspondingly to more than 50% of the total water supply. Local groundwater extraction has remained relatively constant at 100,000 af/yr, although it increases slightly in drought years. The amounts of water supplied by each source are presented in Table 49.

Local Groundwater Supplies

Local groundwater is extracted from four basins: the Upper Los Angeles River Basin (also known as the San Fernando Groundwater Basin) and Sylmar, Central, and West Coast Basins. The Upper Los Angeles River Basin supplies the majority of groundwater delivered. Groundwater supply peaked in 1989 due to drought demands at 136,300 af/yr. In 1977, which was the previous high year, the supply was 132,300 af/yr. (Tiegen pers. comm.)

Los Angeles Aqueduct Filtration Plant

The final raw water supply at the LA Aqueduct terminus consists of a combination of Mono Basin exports, surface water from the Owens River, and pumped groundwater from the Owens River Valley.

The average volume of water supplied by the LA Aqueduct is approximately 360,000 af/yr, with a maximum volume of 520,000 af/yr in 1984. The contribution of Mono Basin exports to the LA Aqueduct averages approximately 54,000 af/yr (Los Angeles Department of Water and Power 1991). In 1990, LA Aqueduct supplies decreased to 206,000 af/yr, which is close to the 1941 minimum volume, and MWD supplies increased to the maximum volume of 395,000 af/yr. The LA Aqueduct filtration plant is designed to treat a peak flow of 600 million gallons per day (1,841 af per day or 928 cfs). The plant utilizes conventional treatment processes, including screening, flocculation, sedimentation, and chlorination to purify and disinfect these raw water supplies. A combination of ozonation and deep-bed filtration provides the most effective level of additional purification.

Minerals

Historical LADWP water quality data for the LA Aqueduct filtration plant are presented in Table 50. Conductivity at the LA Aqueduct filtration plant was higher than Tinemaha reservoir outlet values, indicating that aqueduct sources between Tinemaha and Haiwee reservoirs had conductivities higher than were present at the Tinemaha reservoir outlet. Conductivity ranged from 173 to 618 μS/cm and averaged 340 μS/cm. Conductivity versus time (presented in Figure 139) indicates a pattern similar to Tinemaha reservoir. Conductivity values were usually 300-400 μS/cm, with a few periods with lower conductivity values, presumably during peak runoff months.

Chloride concentrations ranged from 6 to 47 mg/l and averaged 18 mg/l, a slight increase over Tinemaha reservoir chloride values. Selected mineral ion concentrations at the LA Aqueduct filtration plant were very similar to Tinemaha reservoir; the relationship of each ion to conductivity as presented in Figures 140-145 shows about the same linear pattern. Calcium and sulfate concentrations increased slightly. Calcium concentrations ranged from 15 to 36 mg/l and averaged 25 mg/l (Figure 140). Sulfate concentrations ranged from 11 to 220 mg/l and averaged 28 mg/l (Figure 142).

Arsenic concentrations ranged from undetectable to 66 μg/l and averaged 22 μg/l, which is about the same as the Tinemaha reservoir outlet concentration. Arsenic showed a similar relationship with conductivity as it did at the Tinemaha reservoir outlet, although over twice as many samples were collected at the LA Aqueduct filtration plant (Figure 143). Boron and fluoride concentrations were almost identical to those at the Tinemaha reservoir outlet. Concentrations of both constituents averaged 0.5 mg/l. The relationship between boron and fluoride and conductivity also is similar to that at the Tinemaha reservoir outlet (Figures 144-145).

Nutrients and Organics

LA Aqueduct filtration plant nitrate and phosphate concentrations as functions of conductivity are presented in Figures 146 and 147, respectively. Nitrate and phosphate concentrations were poorly correlated with conductivity and were generally low.

Metropolitan Water District Supplies

LADWP's sources of water, besides local groundwater and the LA Aqueduct, are MWD supplies from the Colorado River (CR) and the State Water Project (SWP). MWD's total deliveries of water to LADWP have averaged about 200,000 af/yr for the last 5 years. In fiscal year 1989-1990, MWD delivered more water, approximately 395,000 af, primarily due to drought conditions and reduced LA Aqueduct supplies.

MWD completed the 242-mile-long CR aqueduct in 1941 and contracted with SWP to obtain water from the 444-mile-long California Aqueduct in 1960 (Los Angeles Department of Water and Power 1991). SWP deliveries to MWD began in 1973. MWD blends water from both sources and distributes this water to LADWP. The composition of blended water is highly variable and is affected by complex water availability and delivery agreements.

In the last 6 years, the proportion of CR water comprising MWD supplies ranged from approximately 75% in 1985 and 1986 to approximately 48% in 1990. The resulting 52% of MWD supply obtained from SWP in 1990 was the highest since 1971, reflecting MWD's increasing reliance on SWP supplies (Los Angeles Department of Water and Power 1991).

Water quality data are summarized in Table 51 based on 1985-1990 MWD data from each water source. Two locations were selected to represent each of these sources: Lake Mathews (CR) and Castaic Lake (SWP). These locations were selected because they utilize 100% of their respective sources.

Colorado River

Conductivity and TDS values from 1985 to 1990 are presented in Figure 148. Although both MWD water sources have high conductivies and salinities, the conductivities in the CR were consistently higher than in the SWP and showed less variability, ranging from 834 to 958 μS/cm and averaging 887 μS/cm. TDS values for the CR ranged from 520 to 609 mg/l and averaged 556 mg/l. Chloride values for the CR ranged from 55 to 77 mg/l and averaged 63.5 mg/l (Figure 149). The mineral content, alkalinity, and hardness are all generally higher in the CR than in the SWP. Arsenic, boron, and fluoride concentrations are presented in Figures 150-152, respectively.

Calcium and magnesium were fairly stable in the CR, ranging from 64 to 78 mg/l and 24 to 29 mg/l, respectively (Figure 153). Sodium values in the CR ranging from 71 to 91 mg/l were higher and fluctuated less than in the SWP. Figure 154 presents sodium and chloride values versus conductivity. Potassium values in the CR were low, ranging from 3 to 5 mg/l, and were therefore not presented graphically.

The average arsenic concentration of the CR was 3 μg/l, similar to the SWP. No apparent correlation with conductivity was noted (Figure 155). The CR had lower boron concentrations but higher fluoride concentrations than the SWP. Concentrations of both constituents were below 0.5 mg/l. Boron and fluoride concentrations are presented in Figures 156 and 157, respectively. A slight inverse correlation between conductivity and CR boron concentrations exists.

State Water Project

SWP water is in itself a mixture of water from the Sacramento River and the San Joaquin River that is occasionally influenced by seawater intrusion. SWP conductivities ranged from 376 to 722 μS/cm and averaged 536 μS/cm. TDS values for the SWP ranged from 235 to 410 mg/l and averaged 301 mg/l. Chloride values are presented in Figure 155. The SWP chloride values historically have been less than the CR, ranging from 18 to 60 mg/l until late 1987. SWP chloride values increased by a large margin over CR values at this time up to a maximum of 128 mg/l in mid-1989. Since SWP chloride concentrations have equaled or exceeded CR values from about 1986, other major ions are contributing to the higher conductivity and TDS of the CR.

Calcium and magnesium concentrations in the SWP were more variable than those of the CR, ranging from 23 to 42 mg/l and 6.5 to 19 mg/l, respectively. Calcium and magnesium versus conductivity is presented in Figure 153. Sodium values were lower and more variable than the SWP; values ranged from 33 to 88 mg/l. Figure 154 presents sodium and chloride values versus conductivity. Potassium values were low, ranging from 3 to 5 mg/l.

Both the CR and the SWP had similar arsenic concentrations. Arsenic concentrations in the SWP averaged 2.2 μg/l. No apparent correlation with conductivity was noted (Figure 155).

The SWP had higher boron concentrations but lower fluoride concentrations than the CR. Concentrations of both constituents were below 0.5 mg/l. The high variability of SWP boron and fluoride concentrations is evident in Figure 156. A slight inverse correlation between conductivity and SWP boron and fluoride exists (Figures 156-157).

Chapter 4. Citations

PRINTED REFERENCES

California. Department of Fish and Game. 1991. Instream flow requirements for brown trout, Rush Creek, Volume I. (Stream Evaluation Report 91-2.) Sacramento, CA.

_________. Department of Water Resources. 1967. Investigations of geothermal waters in the Long Valley area: Mono County. July. Resources Agency. Los Angeles, CA.

Cullen, R. T. 1992. 1991 water quality monitoring of Rush and Lee Vining Creeks. Trihey & Associates. Walnut Creek, CA.

Dana, G. L., R. Jellison, and J. M. Melack. 1991. 1991 annual report to the Los Angeles Department of Water and Power: Mono database. Marine Science Institute, University of California. Santa Barbara, CA.

Goldberg, E. D., W. S. Broecker, M. G. Gross, and K. K. Turekian. 1971. Marine chemistry, in Radioactivity in the Marine Environment. National Academy of Sciences. Washington, DC.

Los Angeles Department of Water and Power. 1986. Report on springs in the Mono Basin. November. Los Angeles, CA.

_________. 1987. Mono Basin geology and hydrology. March. Aqueduct Division, Hydrology Section. Los Angeles, CA.

_________. 1989. The Los Angeles aqueduct filtration plant. March. Los Angeles, CA.

Mason, D. T. 1967. Limnology of Mono Lake, California. (Volume 83.) University of California Press. Berkeley, CA.

Melack, J. M., and L. Lesack. 1982. Long Valley Reservoir research program. (Progress report.) University of California. Santa Barbara, CA.

NAS. See National Academy of Sciences.

National Academy of Sciences. 1987. The Mono Basin ecosystem: effects of changing lake level. National Academy Press. Washington, DC.

Shacklette, H. T., J. C. Hamilton, J. G. Boerngen, and J. M. Bowles. 1971. Elemental composition of surficial materials in the conterminous United States. (Professional Paper 574-D.) U.S. Government Printing Office. Washington, DC.

Shacklette, H. T., and J. G. Boerngen. 1984. Element concentrations in soils and other surficial materials on the conterminous United States. (Professional Paper 1270.) U.S. Geological Survey. Washington, DC.

U.S. Geological Survey. Water Resources Division. 1976. Sources of arsenic tributary to Lake Crowley, California. (Water Resources Investigations 76-36.) Menlo Park, California. Prepared for Los Angeles Department of Water and Power, Los Angeles, CA.

_________. Water Resources Division. 1984. Water quality appraisal Mammoth Creek and Hot Creek, Mono County, California. (Water Resources Investigation Report 84-4060.) Sacramento, CA. Prepared for California State Water Resources Control Board, Sacramento, CA.

_________. Water Resources Division. 1985. Study and interpretation of the chemical characteristics of natural water. (Water Supply Paper 2254.) U.S. Government Printing Office. Washington, DC.

_________. Water Resources Division. 1987. Hydrologic and geochemical monitoring in Long Valley Caldera, Mono County, California, 1985. (Water Resources Investigation Report 87-4090.) Sacramento, CA.

University of California, Santa Barbara. 1990. Mono Lake monthly report for December 1990. Field sampling data for December survey. Santa Barbara, CA.

Winkler, D. W. (ed.) 1977. An ecological study of Mono Lake, California. (Institute of Ecology Publication No. 12.) Institute of Ecology. University of California, Davis, CA.

PERSONAL COMMUNICATIONS

Ball, Doug. Water biologist. Los Angeles Department of Water and Power, Los Angeles, CA. October 15, 1991 - telephone conversation.

Miliron, Curtis. Biologist. California Department of Fish and Game, Sacramento, CA. February 1991 - telephone conversation with Doug Brewer regarding water temperatures.

Teigen, Paul. Engineer. Bookman-Edmonston Engineering, Inc., Sacramento, CA. July 26, 1991 - memorandom to Thomas Wegge, Jones & Stokes Associates.

Wilson, R. G. Northern district engineer. Los Angeles Department of Water and Power, Los Angeles, CA. November 7, 1991 - letter regarding treatment practices at Lake Crowley reservoir.

Tables

Table 1. Comparison of Median 1991 Mineral to Conductivity Ratios

Location:	EC μS/cm	Ca/EC %	Mg/EC %	SO4/EC %	Cl/EC %	Na/EC %	K/EC %	As/EC %	F/EC %	B/EC %	PO4/EC %
Lee Vining Creek (1)	44	12.50	1.14	10.91	1.75	4.09	1.59	ND	ND	0.04	0.04
Walker Creek (1)	40	10.75	1.40	14.50	1.64	5.50	1.83	ND	ND	ND	0.18
Parker Creek (1)	52	14.62	1.06	15.38	1.92	3.08	1.33	ND	ND	ND	0.15
Rush Creek (1)	51	14.12	1.16	7.65	1.96	3.53	1.24	7.84	ND	0.04	0.10
Grant Lake Outlet (1)	61	13.11	1.64	6.56	3.28	4.92	1.64	ND	ND	0.05	0.05
Tunnel Make (1)	423	9.46	4.26	1.65	1.82	5.20	0.73	3.78	0.09	0.06	0.01
Big Springs (1)	217	3.09	3.32	3.23	4.33	11.98	1.94	7.83	0.23	0.19	0.17
Mammoth Creek (1)	89	9.44	3.03	4.16	ND	5.84	1.24	6.74	0.11	ND	0.06
Hot Creek (1)	557	2.15	1.06	5.03	8.98	16.88	1.53	44.88	0.39	0.39	0.05
Benton Crossing (1,2)	476	3.99	2.52	3.36	6.93	13.03	1.47	12.61	0.27	0.27	0.05
Convict Creek (1)	159	17.61	0.28	8.81	ND	0.94	0.47	3.14	ND	ND	ND
McGee Creek (1)	95	14.74	0.52	10.53	ND	1.89	0.95	ND	ND	ND	0.04
Hilton Creek (1)	27	13.70	0.78	ND	ND	5.93	1.78	ND	ND	ND	0.22
Crooked Creek (1)	62	10.81	1.35	2.58	1.61	7.42	2.58	ND	0.32	ND	0.03
Rock Creek (1)	34	8.82	0.65	6.18	ND	9.12	1.74	ND	0.29	ND	0.03
Crowley Lake Outlet (1)	519	4.24	1.27	3.66	7.13	14.64	1.58	18.11	0.27	0.27	0.04
Tinemaha Lake Outlet (2)	310	7.42	1.45	7.10	4.84	10.97	1.23	6.45	0.19	0.15	0.02
Groundwater (2)	229	8.90	2.00	7.90	3.10	8.30	1.10	4.70	0.14	0.06	0.02
LAA Filter Plant (2)	337	7.42	1.75	7.72	5.04	10.68	1.19	5.93	0.18	0.15	0.02
State Water Project (3)	518	5.41	2.70		11.97	9.46	0.62	0.39	0.03	0.04	
Colorado River (3)	880	7.84	2.90		7.05	8.86	0.45	0.34	0.03	0.01	

Sources of Data:
1: Jones & Stokes Associates 1991 Sampling Program
2: Los Angeles Department of Water and Power
3: Metropolitan Water District

Notes: Median 1991 JSA values were used where available; otherwise maximum values or LADWP data were used to calculate the ion to conductivity ratios.

ND indicates that all measurements were below detection limits.

Table 2. Content and Column Formats for Lotus 1–2–3 Data Files.

Columns	Contents	Units
A	Sampling Date	mmm–yy
B	Flow	cfs
C	Flow	AF/month
D	Field Conductivity	µS/cm
E	Field pH	–log(H+)
F	Field Temperature	°C
G	Field Dissolved Oxygen	mg/l
H	Field Alkalinity (as CaCO3)	mg/l
I	Analyses Date	mm–dd–yy
J	Laboratory Conductivity	µS/cm
K	Laboratory pH	–log(H+)
L	Total Organic Carbon	mg/l
M	Color	units
N	Turbidity	NTU
O	Total Suspended Solids	mg/l
P	Total Dissolved Solids	mg/l
Q	Laboratory Alkalinity	mg/l
R	Hardness	mg/l
S	Calcium	mg/l
T	Magnesium	mg/l
U	Sodium	mg/l
V	Potassium	mg/l
W	Sulfate	mg/l
X	Chloride	mg/l
Y	Silica	mg/l
Z	Boron	mg/l
AA	Fluoride	mg/l
AB	Bromide	mg/l
AC	Ammonia (as N)	mg/l
AD	Total Kjeldahl Nitrogen	mg/l
AE	Nitrate (as N)	mg/l
AF	Total Phosphate (as P)	mg/l
AG	Dissolved Phosphate (as P)	mg/l
AH	Silver	µg/l
AI	Aluminium	µg/l
AJ	Arsenic	µg/l
AK	Barium	µg/l
AL	Cadmium	µg/l
AM	Chromium	µg/l
AN	Copper	µg/l
AO	Iron	µg/l
AP	Mercury	µg/l
AQ	Manganese	µg/l
AR	Lead	µg/l
AS	Selenium	µg/l
AT	Zinc	µg/l

Notes:
If the worksheet contains data from more than one source, the second set of data with identical headers will be located under columns AV to CO. Statistics are located below the data which begin at row 16.

Table 3. Water Quality Data Available in Lotus 1–2–3 Format

File Name	Sample Location	Record Period	# Samples	Data Source	Data Location
MONOLAKE.WK1	Mono Lake	1974–1990	255	LADWP	a11..x276
LEEVININ.WK1	Lee Vining Creek	1934–1939	53	LADWP	a16..at68
	Lee Vining Creek	1940–1947	54	LADWP	a69..at122
	Lee Vining Creek	1991	8	JSA	av123..co130
WALKER.WK1	Walker Creek	1991	8	JSA	a16..at23
PARKER.WK1	Parker Creek	1991	8	JSA	a16..at23
RUSH.WK1	Rush Creek	1991	8	JSA	a16..at23
GRANTSUR.WK1	Grant Lake Surface	1991	10	JSA	a16..at25
GRANTBOT.WK1	Grant Lake Bottom/Outlet	1934–1939	50	LADWP	a16..at65
	Grant Lake Bottom/Outlet	1940–1989	354	LADWP	a68..at662
	Grant Lake Bottom/Outlet	1991	10	JSA	av672..co681
BIGSPRIN.WK1	Big Springs	1933–1939	68	LADWP	a16..at83
	Big Springs	1940	10	LADWP	a84..at94
	Big Springs	1991	8	JSA	av693..co700
EASTPORT.WK1	East Portal	1936–1939	38	LADWP	a16..at56
	East Portal	1940–1982	299	LADWP	a57..at571
	East Portal	1991	8	JSA	av666.co673
BELOW–EP	Below East Portal	1940–1988	303	LADWP	a16..at586
MAMMOTH.WK1	Mammoth Creek	1933–1939	48	LADWP	a16..at63
	Mammoth Creek	1940–1980	240	LADWP	a64..at303
	Mammoth Creek	1991	8	JSA	av304..co311
HOT.WK1	Hot Creek	1965–1990	233	LADWP	a20..at322
	Hot Creek	1982–1991	97	USGS	av230..co329
	Hot Creek	1991	8	JSA	cq330..ej337
BENTON.WK1	Benton Crossing	1973–1980	84	LADWP	a16..at108
	Benton Crossing	1991	8	JSA	av109..co116
CONVICT.WK1	Convict Creek	1933	1	LADWP	a16..at16
	Convict Creek	1941–1983	64	LADWP	a17..at80
	Convict Creek	1991	8	JSA	av81..co88
MCGEE.WK1	McGee Creek	1941–1983	66	LADWP	a16..at81
	McGee Creek	1991	8	JSA	av82..co89
HILTON.WK1	Hilton Creek	1947–1980	57	LADWP	a16..at72
	Hilton Creek	1991	8	JSA	av73..co90
CROOKED.WK1	Crooked Creek	1991	8	JSA	a16..at23
ROCK.WK1	Rock Creek	1941–1980	54	LADWP	a16..at69
	Rock Creek	1991	8	JSA	av70..co77
CROWSUR1.WK1	Crowley Lake Surface #1	1991	10	JSA	a16..at25
CROWSUR2.WK1	Crowley Lake Surface #2	1991	9	JSA	a16..at25
CROWSUR3.WK1	Crowley Lake Surface #3	1991	9	JSA	a16..at25
CROWSUR4.WK1	Crowley Lake Surface #4	1991	9	JSA	a16..at25
CROWBOT1.WK1	Crowley Lake Bottom/Outlet	1940–1991	558	LADWP	a22..at639
	Crowley Lake Bottom/Outlet	1991	10	JSA	av640..co649
TINEMAHA.WK1	Tinemaha Outlet	1933–1939	32	LADWP	a16..at47
	Tinemaha Outlet	1947–1991	531	LADWP	a136..at673
	Tinemaha Outlet	1974–1990	103	USGS	av467..co607
VNNORMAN.WK1	LAA Filter Plant	1934–1939	137	LADWP	a16..at152
	LAA Filter Plant	1940–1991	706	LADWP	a153..at858
MWD.WK1	Metropolitan Water District	1985–1990	66	MWD	a8..ay73

Notes:
LADWP: Los Angeles Department of Water and Power
JSA: Jones & Stokes Associates, Inc.
USGS: U.S. Geological Survey
MWD: Metropolitan Water District

Table 4. JSA 1991 Sampling Program: Results from May 1 – 3 Water Quality Sampling.

Variable:	Units:	Detection limit:	East Portal:	Big Springs:	Hot Creek:	Mammoth Creek:	Convict Creek:	McGee Creek:	Hilton Creek:	Crooked Creek:	Rock Creek:	Benton Xing:	Crowley Surf 1:	Crowley Bot 1:	Crowley Surf 2:	Crowley Surf 3:	Crowley Surf 4:	Rush Creek:	Parker Creek:	Walker Creek:	Lee Vining Creek:	Grant Lk Surface:	Grant Lk Bottom:
Laboratory Conductivity	µS/cm	1	430	217	616	178	173	122	43	121	61	503	509	508				92	66	51	57	63	62
Field Conductivity	µS/cm	10	308	155	700	60	72	70	20	71	37	300	312	305				60	40	33	35	40	40
Field Temperature	°C	0.1	12.1	8.0	30.0	0.0	4.0	3.5	2.5	5.5	3.9	5.8	8.9	8.3				8.8	7.5	7.7	6.3	8.9	7.9
Field Dissolved Oxygen	mg/l	0.1																					
Laboratory pH	−log(H+)	0.1	7.5	8.3	7.4	7.5	7.5	7.1	6.9	7.0	6.8	8.0	8.4	8.4				6.8	6.7	6.8	6.7	6.8	6.6
Field pH	−log(H+)	0.1											8.8	8.7									
Total Dissolved Solids	mg/l	15	280	160	400	110	110	78	35	100	51	330	310	320				60	46	42	37	40	38
Alkalinity (as CaCO3)	mg/l	2	220	89	190	85	70	40	19	58	25	190	180	180				34	18	13	16	20	20
Chloride	mg/l	1	8	9	59	ND	ND	ND	ND	1	ND	34	38	38				3	ND	1	1	2	2
Sulfate	mg/l	2	6	7	33	7	15	14	ND	2	4	17	21	21				5	8	6	7	3	3
Hardness (as CaCO3)	mg/l	1	180	46	58	58	80	50	15	30	13	98	77	77				34	23	15	19	22	22
Calcium	mg/l	0.1	39	6.7	13	12	29	19	5.4	9.9	4.7	19	20	19				11	7.8	4.7	6.6	7.5	7.4
Magnesium	mg/l	0.1	18	6.9	6.0	6.9	0.50	0.62	0.45	1.2	0.58	12	6.5	6.2				1.2	0.74	0.81	0.68	0.95	0.92
Sodium	mg/l	0.5	22	26	100	13	1.6	2.6	2.2	14	6.3	62	66	67				3.6	2.6	3.0	2.2	2.5	2.5
Potassium	mg/l	0.01	3.1	4.3	9.5	2.6	0.79	1.1	0.9	2.7	1.2	7.0	8.2	7.7				1.0	0.93	1.0	0.79	0.85	0.86
Silica	mg/l	0.1	54	55	64	30	9.5	11	9.2	32	15	55	26	26				11	13	12	8.4	7.1	6.8
Boron	mg/l	0.02	0.28	0.45	2.60	ND	ND	ND	ND	ND	ND	1.30	1.5	1.5				0.04	ND	ND	0.02	0.04	0.03
Fluoride	mg/l	0.1	0.3	0.5	2.6	0.1	ND	ND	ND	0.2	0.1	1.3	0.1	1.3				ND	ND	ND	ND	ND	ND
Bromide	mg/l	0.01											ND	ND				ND	ND	ND	ND	ND	ND
Bromine	mg/l	0.01	0.026	0.040	0.17	0.016	ND	ND	ND	0.027	ND	0.098	0.100	0.100				ND	ND	ND	ND	ND	ND
Anion/Cation Ratio			1.07	1.05	1.11	1.00	1.06	1.00	0.90	0.92	0.97	1.08	1.09	1.09				1.04	0.90	0.89	1.00	0.86	0.88
Alk/Hardness Ratio			1.22	1.93	3.28	1.47	0.88	0.80	1.27	1.93	1.92	1.94	2.34	2.34				1.00	0.78	0.87	0.84	0.91	0.91
EC/TDS Ratio			1.54	1.36	1.54	1.62	1.57	1.56	1.23	1.21	1.20	1.52	1.64	1.59				1.53	1.43	1.21	1.54	1.58	1.63
CA/Mg Ratio			2.17	0.97	2.17	1.74	58.00	30.65	12.00	8.25	8.10	1.58	3.08	3.06				9.17	10.54	5.80	9.71	7.89	8.04
Ammonia (as N)	mg/l	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND				ND	ND	ND	ND	ND	ND
Total Kjeldahl Nitrogen	mg/l	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.5	ND				ND	ND	ND	ND	ND	ND
Nitrate (as N)	mg/l	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND				ND	ND	ND	ND	ND	ND
Total Phosphate	mg/l	0.02	0.08	0.36	0.28	0.08	ND	ND	ND	ND	ND	0.24	0.10	0.10				ND	ND	0.02	ND	0.05	0.03
Dissolved Phosphate	mg/l	0.02											0.07									ND	
Chlorophyll A	µg/l																						
Total Organic Carbon	mg/l	3	ND	3.4	3.5	4.1	ND	3.3	3	7.5	5.8	7.3	11	10				3.5	ND	3.1	ND	3.5	ND
Color	units	3	ND	10	3	10	ND	3	10	45	20	30	15	10				ND	3	10	ND	ND	ND
Total Suspended Solids	mg/l	3	ND	ND	8	ND	ND	ND	ND	3	ND	4	4	3				ND	ND	ND	ND	11	6
Turbidity	NTU	0.1	1.5	0.4	1.4	0.4	0.2	0.3	0.3	1.0	0.6	1.0	1.4	0.9				0.4	1.4	0.5	0.3	3.2	3.4
Aluminium	µg/l	50	76	ND	110	ND	ND	ND	ND	ND	ND			ND				ND	130	120	ND		200
Iron	µg/l	30	390	40	89	74	ND	50	71	590	120	140	62	38				96	130	78	110	330	230
Manganese	µg/l	10	230	ND	51	ND	ND	ND	ND	48	ND	95	13	14				29	ND	ND	ND	39	32
Arsenic	µg/l	4	17	19	330	6	7	ND	ND	ND	ND			110				ND	ND	ND	ND		ND
Barium	µg/l	10	120	23	36	ND	ND	ND	ND	ND	ND			25				ND	15	ND	ND		ND
Cadmium	µg/l	0.1	0.3	ND	ND	ND	ND	ND	0.1	ND	ND			ND				ND	ND	ND	ND		ND
Chromium	µg/l	1	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				2	1	ND	ND		ND
Copper	µg/l	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND				ND	ND	ND	ND	ND	ND
Lead	µg/l	1	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Mercury	µg/l	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND			0.3				ND	ND	ND	ND		ND
Selenium	µg/l	1	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Silver	µg/l	1	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Zinc	µg/l	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	34	10				12	ND	ND	ND	30	ND

Notes: The data were sampled by Doug Brewer, Russ Brown, Mike Zanoli, and Joanna Field of Jones & Stokes Associates and analyzed by ANLAB Analytical Laboratories (Report No. 134452).

Table 5. JSA 1991 Sampling Program: Results from May 15–17 Water Quality Sampling.

Variable:	Units:	Detection limit:	East Portal:	Big Springs:	Hot Creek:	Mammoth Creek:	Convict Creek:	McGee Creek:	Hilton Creek:	Crooked Creek:	Rock Creek:	Benton Xing:	Crowley Surf 1:	Crowley Bot 1:	Crowley Surf 2:	Crowley Surf 3:	Crowley Surf 4:	Rush Creek:	Parker Creek:	Walker Creek:	Lee Vining Creek:	Grant Lk Surface:	Grant Lk Bottom:
Laboratory Conductivity	µS/cm	1	433	208	618	136	171	95	35	128	47	531	510	519	517	533	520	81	64	51	53	64	63
Field Conductivity	µS/cm	10	340	155	690	84	110	70	25	118	34	370	385	375	395	420	405	59	47	37	38	45	45
Field Temperature	°C	0.1	11.6	10.4	26.3	3.9	4.9	11.2	8.3	18.5	10.0	5.8	10.0	9.3	10.5	12.1	11.3	10.9	10.5	9.2	9.6	10.9	9.9
Field Dissolved Oxygen	mg/l	0.1											8.8	7.2	8.8	8.8	8.8					7.8	
Laboratory pH	−log(H+)	0.1	7.8	8.4	7.6	8.1	8.2	7.9	7.3	7.8	7.5	8.4	8.7	8.6	8.7	8.7	8.7	7.6	7.5	7.4	7.5	7.7	7.7
Field pH	−log(H+)	0.1	7.7	8.3	7.4	8.1	7.6	8.1	7.9	7.9	8.6	8.1	8.7	8.6	8.7	8.7	8.7	8.0	8.0	8.0	8.1	7.9	8.1
Total Dissolved Solids	mg/l	15	270	150	400	82	100	59	23	100	32	330	310	320	320	310	310	56	40	39	34	39	35
Alkalinity (as CaCO3)	mg/l	2	210	85	180	61	68	33	15	59	22	200	190	190	190	200	190	30	18	15	14	20	26
Chloride	mg/l	1	7	9	57	ND	ND	ND	ND	ND	ND	35	38	38	38	39	38	3	ND	1	ND	2	2
Sulfate	mg/l	2	7	7	31	5	14	10	ND	2	3	18	21	20	20	20	19	4	8	6	7	4	4
Hardness (as CaCO3)	mg/l	1	180	45	59	47	81	39	12	30	12	110	80	80	80	83	80	31	22	15	18	23	23
Calcium	mg/l	0.1	40	6.6	13	10	30	14	4.4	11	3.8	20	20	20	21	20	20	10.0	7.7	4.8	6.6	7.7	7.7
Magnesium	mg/l	0.1	18	6.9	6.0	5.1	0.50	0.49	0.42	1.2	0.47	13	6.3	6.4	6.5	7.3	6.5	1.0	0.69	0.81	0.61	0.88	0.86
Sodium	mg/l	0.5	21	24	100	8.7	1.5	1.9	1.9	15	4.7	72	72	75	74	79	75	3.5	2.2	3.2	1.8	2.8	2.6
Potassium	mg/l	0.01	3.6	4.7	11	2.3	0.84	0.94	0.86	3.1	1.0	8.9	9.2	9.2	9.2	9.5	9.1	0.90	0.87	1.1	0.79	0.96	0.89
Silica	mg/l	0.1	57	52	52	25	38	9.8	9.2	38	12	55	26	28	27	32	29	11	11	13	7.7	7.4	6.8
Boron	mg/l	0.02	0.29	0.40	2.5	ND	ND	ND	ND	ND	ND	1.4	1.5	1.5	1.5	1.6	1.5	0.04	ND	ND	ND	0.02	0.02
Fluoride	mg/l	0.1	0.4	0.4	2.5	0.1	ND	ND	ND	0.2	ND	1.3	1.6	1.5	1.4	1.4	1.4	ND	ND	ND	ND	ND	ND
Bromide	mg/l	0.01	0.02	ND	0.12	ND	ND	ND	ND	ND	ND	0.05	0.08	0.08	0.09	0.09	0.09	ND	ND	ND	ND	ND	ND
Bromine	mg/l	0.01																					
Anion/Cation Ratio			0.98	0.95	1.02	0.93	1.06	1.01	0.86	0.86	1.09	0.98	1.04	0.98	1.02	1.00	1.02	0.80	0.91	0.96	0.88	0.92	1.10
Alk/Hardness Ratio			1.17	1.89	3.05	1.30	0.84	0.85	1.25	1.97	1.83	1.82	2.38	2.38	2.38	2.41	2.38	0.97	0.82	1.00	0.78	0.87	1.13
EC/TDS Ratio			1.60	1.39	1.55	1.66	1.71	1.61	1.52	1.28	1.47	1.61	1.65	1.62	1.62	1.72	1.68	1.45	1.60	1.31	1.56	1.64	1.80
CA/Mg Ratio			2.22	0.96	2.17	1.96	60.00	28.57	10.48	9.17	8.09	1.54	3.17	3.13	3.23	2.74	3.08	10.00	11.16	5.93	10.82	8.75	8.95
Ammonia (as N)	mg/l	0.05	ND	ND	0.08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Kjeldahl Nitrogen	mg/l	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.5	ND	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrate (as N)	mg/l	0.2	0.21	ND	0.31	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Phosphate	mg/l	0.02	0.04	0.34	0.23	0.08	ND	ND	0.02	0.02	ND	0.24	0.09	0.12	0.10	0.13	0.11	ND	ND	ND	ND	0.03	0.03
Dissolved Phosphate	mg/l	0.02											0.06		0.08	0.11	0.08					ND	
Chlorophyll A	µg/l																						
Total Organic Carbon	mg/l	3	ND	ND	3.1	3.2	ND	ND	4.3	8.3	4.8	12	7.8	7.9	5.7	7.1	6.9	3.5	ND	3.3	3	4.4	4.3
Color	units	3	ND	5	5	10	4	5	20	45	15	40	15	10	15	15	15	5	5	10	5	5	5
Total Suspended Solids	mg/l	3	ND	5	7	ND	ND	4	4	ND	ND	5	ND	5	4	ND	ND	ND	4	7	ND	ND	ND
Turbidity	NTU	0.1	1.4	0.5	1.2	0.7	0.3	0.6	0.6	1.3	0.6	1.2	1.3	1.5	2.0	1.3	1.0	0.3	1.2	0.8	0.2	1.0	0.6
Aluminium	µg/l	50	ND	ND	ND									ND									
Iron	µg/l	30	380	57	83	130	ND	84	200	670	140	120	36	36	37	39	ND	110	160	150	86	69	64
Manganese	µg/l	10	220	ND	73	39	ND	ND	ND	36	ND	82	15	34	17	21	17	41	ND	ND	ND	15	16
Arsenic	µg/l	4	20	20	320									110									
Barium	µg/l	10	110	24	33									27									
Cadmium	µg/l	0.1	0.3	ND	ND									ND									
Chromium	µg/l	10	ND	ND	ND									ND									
Copper	µg/l	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead	µg/l	1	ND	ND	ND									ND									
Mercury	µg/l	0.1	ND	ND	ND									ND									
Selenium	µg/l	1	ND	ND	ND									ND									
Silver	µg/l	1	ND	ND	ND									ND									
Zinc	µg/l	10	13	ND	ND	ND	ND	ND	ND	ND	ND	ND	28	16	13	ND	ND	ND	ND	ND	ND	20	ND

Notes: The data were sampled by Joanna Field and Mike Zanoli of Jones & Stokes Associates and analyzed by ANLAB Analytical Laboratories (Report No. 134775).

Table 6. JSA 1991 Sampling Program: Results from June 4–6 Water Quality Sampling.

Variable:	Units:	Detection limit:	East Portal:	Big Springs:	Hot Creek:	Mammoth Creek:	Convict Creek:	McGee Creek:	Hilton Creek:	Crooked Creek:	Rock Creek:	Benton Xing:	Crowley Surf 1:	Crowley Bot 1:	Crowley Surf 2:	Crowley Surf 3:	Crowley Surf 4:	Rush Creek:	Parker Creek:	Walker Creek:	Lee Vining Creek:	Grant Lk Surface:	Grant Lk Bottom:
Laboratory Conductivity	µS/cm	1	429	166	345	83	170	56	25	43	26	375	501	518	519	524	518	61	46	61	30	63	63
Field Conductivity	µS/cm	10	355	139	412	58	130	28	8	29	2	372	450	420	450	460	460	28	37	22	5	40	35
Field Temperature	°C	0.1	11.9	16.4	28.2	15.5	12.1	9.2	9.7	22.1	11.3	20.0	14.6	11.2	14.6	14.9	15.7	12.2	14.3	15.4	7.4	13.3	12.9
Field Dissolved Oxygen	mg/l	0.1	8.1	9.3	4.3	7.8	8.9	9.6	9.2	6.1	9.0	10.1	8.5	5.5	8.6	8.9	8.3	9.0	8.4	8.3	10.7	8.9	8.6
Laboratory pH	−log(H+)	0.1	7.4	8.4	7.2	7.1	7.9	7.1	6.8	6.8	6.8	8.7	8.5	8.4	8.5	8.6	8.6	7.1	6.8	6.8	6.8	7.3	7.1
Field pH	−log(H+)	0.1	8.1	8.9	7.6	8.1	8.5	8.1	7.7	7.5	7.7	9.0	8.9	8.6	9.3	9.3	9.0	7.9	7.7	7.6	7.2	8.2	8.7
Total Dissolved Solids	mg/l	15	280	120	210	51	100	43	22	40	23	250	300	310	310	320	310	42	38	44	20	49	47
Alkalinity (as CaCO3)	mg/l	2	210	65	100	38	66	20	10	16	10	140	180	180	180	190	190	22	11	16	6	23	22
Chloride	mg/l	1	7	7	28	ND	ND	ND	ND	ND	ND	24	38	40	40	40	41	2	1	ND	ND	2	2
Sulfate	mg/l	2	7	6	19	4	14	5	ND	ND	ND	14	20	20	21	20	21	4	6	10	4	4	4
Hardness (as CaCO3)	mg/l	1	180	38	43	32	80	24	8	12	7	74	77	82	80	84	82	23	14	22	11	23	23
Calcium	mg/l	0.1	41	5.8	9.5	7.3	29	8.2	3.0	3.8	2.5	15	21	20	21	20	20	7.9	3.9	7.8	3.6	7.9	7.5
Magnesium	mg/l	0.1	18	5.4	4.2	2.5	0.45	0.24	0.19	0.52	0.20	8.7	6.4	6.6	6.6	7.2	6.6	0.69	0.58	0.58	0.30	0.82	0.80
Sodium	mg/l	0.5	22	18	52	4.3	1.3	0.79	1.6	3.5	1.8	48	75	78	80	79	79	2.0	2.9	1.6	0.82	2.3	2.2
Potassium	mg/l	0.01	3.4	3.7	6.2	2.3	0.99	0.63	0.54	1.6	0.58	6.2	8.0	8.2	8.1	8.4	8.3	0.84	1.5	0.81	0.50	0.81	0.85
Silica	mg/l	0.1	50	44	41	13	8.9	6.4	5.1	11	6.2	49	25	26	26	29	25	7.8	10	7.9	4.7	6.9	6.8
Boron	mg/l	0.02	0.26	0.28	1.2	ND	ND	ND	ND	ND	ND	0.99	1.4	1.4	1.4	1.5	1.4	ND	ND	ND	ND	0.02	0.02
Fluoride	mg/l	0.1	0.3	0.4	1.2	0.1	ND	ND	ND	0.1	ND	1.0	1.4	1.4	1.4	1.4	1.4	ND	ND	ND	ND	ND	ND
Bromide	mg/l	0.01	0.02	ND	0.07	ND	0.05	ND	ND	ND	ND	0.04	0.08	0.08	0.08	0.08	0.08	ND	ND	ND	ND	ND	ND
Bromine	mg/l	0.01																					
Anion/Cation Ratio			1.00	1.00	1.03	1.04	1.00	1.04	0.83	0.72	0.87	1.03	1.02	1.04	0.98	1.02	1.04	1.02	0.90	1.08	0.84	1.03	1.04
Alk/Hardness Ratio			1.17	1.71	2.33	1.19	0.83	0.83	1.25	1.33	1.43	1.89	2.34	2.20	2.25	2.26	2.32	0.96	0.79	0.73	0.55	1.00	0.96
EC/TDS Ratio			1.53	1.38	1.64	1.63	1.70	1.30	1.14	1.08	1.13	1.50	1.67	1.67	1.67	1.64	1.67	1.45	1.21	1.39	1.50	1.29	1.34
CA/Mg Ratio			2.28	1.07	2.26	2.92	64.44	34.17	15.79	7.31	12.50	1.72	3.28	3.03	3.18	2.78	3.03	11.45	6.72	13.45	12.00	9.63	9.38
Ammonia (as N)	mg/l	0.05	ND	ND	0.17	ND	ND	ND	ND	ND	ND	ND	ND	0.19	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Kjeldahl Nitrogen	mg/l	0.5	ND	0.9	1.3	ND	1.8	0.5	ND	0.6	ND	ND	1.0	0.7	0.8	0.9	0.8	ND	1.3	ND	ND	ND	ND
Nitrate (as N)	mg/l	0.2	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Phosphate	mg/l	0.02	0.06	0.30	0.31	0.30	ND	0.05	0.06	0.06	0.02	0.24	0.12	0.16	0.11	0.13	0.10	0.16	0.08	0.07	0.02	ND	0.02
Dissolved Phosphate	mg/l	0.02											0.08		0.10	0.12	0.09					ND	
Chlorophyll A	µg/l																						
Total Organic Carbon	mg/l	3	ND	3.5	6.1	7.1	ND	3.3	4.3	8.9	3.2	8.4	6.8	5.9	6.3	6.9	5.9	ND	4.8	ND	ND	ND	3.5
Color	units	3	3	15	25	15	3	15	15	45	30	35	10	15	15	15	15	5	10	5	3	4	5
Total Suspended Solids	mg/l	3	ND	11	50	75	5	26	13	9	6	22	6	4	4	4	4	7	40	26	6	4	4
Turbidity	NTU	0.1	2.0	2.1	9.2	15	1.2	4.5	2.0	1.6	1.9	6.5	1.4	1.0	1.1	1.2	1.0	1.4	7.3	5.8	1.6	1.6	2.0
Aluminium	µg/l	50	60	54	180	300	ND	360	80	89	85			57				120	430	210	140		120
Iron	µg/l	30	ND	ND	36	ND	ND	ND	ND	94	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	µg/l	10	230	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	µg/l	4	16	13	130	6	5	ND	ND	ND	ND			77				ND	ND	ND	ND		ND
Barium	µg/l	10	110	20	35	29	ND	ND	ND	ND	ND			25				ND	ND	26	ND		ND
Cadmium	µg/l	0.1	0.4	ND	ND	0.8	0.7	ND	1.1	ND	ND			ND				1.6	1.8	ND	ND		0.4
Chromium	µg/l	10	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Copper	µg/l	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead	µg/l	1	ND	ND	ND	2	ND	ND	ND	ND	ND			ND				1	4	ND	ND		ND
Mercury	µg/l	0.1	ND	0.4	ND	0.8	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Selenium	µg/l	1	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Silver	µg/l	10	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Zinc	µg/l	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes: The data were sampled by Doug Brewer and Joanna Field of Jones & Stokes Associates and analyzed by ANLAB Analytical Laboratories (Report No. 135189).

Table 7. JSA 1991 Sampling Program: Results from June 19–21 Water Quality Sampling.

Variable:	Units:	Detection limit:	East Portal:	Big Springs:	Hot Creek:	Mammoth Creek:	Convict Creek:	McGee Creek:	Hilton Creek:	Crooked Creek:	Rock Creek:	Benton Xing:	Crowley Surf 1:	Crowley Bot 1:	Crowley Surf 2:	Crowley Surf 3:	Crowley Surf 4:	Rush Creek:	Parker Creek:	Walker Creek:	Lee Vining Creek:	Grant Lk Surface:	Grant Lk Bottom:
Laboratory Conductivity	µS/cm	1	408	184	357	57	157	67	23	59	24	378	483	522	504	498	505	51	52	39	26	62	61
Field Conductivity	µS/cm	10	301	132	332	38	122	47	20	53	19	280	437	425	460	460	450	42	40	31	21	61	51
Field Temperature	°C	0.1	12.1	11.2	21.0	8.1	13.5	8.9	11.1	15.7	10.5	11.7	17.3	11.9	17.4	17.7	18.1	13.2	11.5	13.2	9.9	15.2	14.8
Field Dissolved Oxygen	mg/l	0.1	7.0	9.1	7.5	8.5	7.7	9.2	8.3	8.3	8.3	8.0	8.8	2.6	8.4	7.7	8.0	7.9	8.0	8.2	9.0	8.0	8.2
Laboratory pH	−log(H+)	0.1	6.4	7.8	7.0	7.1	7.9	7.1	6.8	7.1	6.8	7.8	8.5	8.0	8.5	8.5	8.5	6.9	6.8	6.8	6.7	7.2	7.1
Field pH	−log(H+)	0.1	6.7	8.3	7.4	7.4	8.3	7.8	7.6	7.8	8.1	8.2	8.9	8.4	9.0	8.9	9.0	7.9	7.7	7.9	7.7	8.1	7.9
Total Dissolved Solids	mg/l	15	240	140	230	50	110	55	17	50	15	240	310	340	320	330	340	31	42	30	23	53	33
Alkalinity (as CaCO3)	mg/l	2	200	74	110	24	64	24	9	26	9	140	180	190	180	180	180	18	10	9	6	22	22
Chloride	mg/l	1	8.0	7.8	20	ND	ND	ND	ND	ND	ND	19	40	34	46	43	56	1.0	ND	1.0	ND	2.0	2.1
Sulfate	mg/l	2	6.3	6.1	17	2.8	14	6.5	ND	2.1	ND	13	19	20	20	20	21	3.9	9.5	5.8	3.6	7.6	4.2
Hardness (as CaCO3)	mg/l	1	180	41	48	21	75	29	8	18	7	78	76	83	80	81	74	20	20	12	9	23	24
Calcium	mg/l	0.1	38	6.2	10	6.0	28	11.0	2.8	6.3	2.3	17	21	23	21	22	22	7.2	7.2	4.0	3.3	8.2	8.0
Magnesium	mg/l	0.1	17	6.3	4.8	1.3	0.47	0.29	0.14	0.84	0.19	9.1	6.4	6.8	6.7	7.3	6.7	0.59	0.52	0.56	0.30	0.85	0.83
Sodium	mg/l	0.5	20	20	47	2.7	1.6	1.1	1.2	4.4	1.8	49	73	71	66	78	77	1.8	1.4	2.5	1.1	2.4	2.7
Potassium	mg/l	0.01	2.9	3.7	5.9	0.75	0.74	0.56	0.42	1.1	0.48	5.7	7.7	7.5	7.9	7.9	7.9	0.63	0.53	0.73	0.41	0.76	0.76
Silica	mg/l	0.1	41	42	39	8.6	8.4	6.7	4.4	14	5.2	39	21	23	21	25	21	6.7	6.1	7.9	4.4	6.4	6.4
Boron	mg/l	0.02	0.25	0.36	1.3	ND	ND	ND	ND	ND	ND	1.0	1.4	1.5	1.4	1.5	1.5	ND	ND	ND	ND	ND	ND
Fluoride	mg/l	0.1	0.3	0.4	1.2	ND	ND	ND	ND	ND	ND	1.1	1.4	1.4	1.4	1.4	1.4	ND	ND	ND	ND	ND	ND
Bromide	mg/l	0.01	ND	ND	0.06								0.07	0.08									
Bromine	mg/l	0.01																					
Anion/Cation Ratio			1.02	1.00	1.03	0.98	1.07	1.07	0.86	1.16	0.95	0.92	1.02	0.94	1.11	1.00	1.08	0.76	0.85	0.89	0.84	1.08	0.98
Alk/Hardness Ratio			1.11	1.80	2.29	1.14	0.85	0.83	1.13	1.44	1.29	1.79	2.37	2.29	2.25	2.22	2.43	0.90	0.50	0.75	0.67	0.96	0.92
EC/TDS Ratio			1.70	1.31	1.55	1.14	1.43	1.22	1.35	1.18	1.60	1.58	1.56	1.54	1.58	1.51	1.49	1.65	1.24	1.30	1.13	1.17	1.85
CA/Mg Ratio			2.24	0.98	2.08	4.62	59.57	37.93	20.00	7.50	12.11	1.87	3.28	3.38	3.13	3.01	3.28	12.20	13.85	7.14	11.00	9.65	9.64
Ammonia (as N)	mg/l	0.05	ND	ND	0.07	ND	ND	ND	ND	ND	ND	ND	0.06	0.21	0.07	0.06	ND	ND	ND	ND	ND	ND	ND
Total Kjeldahl Nitrogen	mg/l	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.5	0.6	0.5	0.5	0.8	0.7	ND	ND	ND	ND	ND	ND
Nitrate (as N)	mg/l	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Phosphate	mg/l	0.02	0.04	0.30	0.19	0.04	ND	ND	ND	ND	ND	0.18	0.09	0.16	0.09	0.14	0.09	0.02	ND	ND	ND	ND	ND
Dissolved Phosphate	mg/l	0.02											0.07		0.09	0.12	0.07					ND	
Chlorophyll A	µg/l																						
Total Organic Carbon	mg/l	3	ND	ND	3.3	ND	ND	ND	ND	ND	ND	6.1	4.6	4.4	5.2	6.3	4.6	ND	ND	ND	ND	ND	ND
Color	units	3	ND	10	15	10	3	3	10	25	10	40	15	15	15	20	15	10	ND	5	3	15	15
Total Suspended Solids	mg/l	3	ND	8	6	8	ND	4	5	11	4	23	3	ND	4	6	6	4	4	6	ND	8	10
Turbidity	NTU	0.1	0.5	0.5	1.0	0.5	0.3	0.3	0.6	0.7	0.4	1.5	1.0	0.5	1.2	1.4	2.0	0.6	0.5	0.5	0.3	1.6	2.5
Aluminium	µg/l	50	ND	52	95	77	ND	100	54	ND	55			ND				ND	ND	ND	75		230
Iron	µg/l	30	46	ND	42	ND	ND	ND	ND	230	ND	37	ND	ND	ND	31	ND	ND	ND	ND	ND	32	36
Manganese	µg/l	10	260	ND	ND	ND	ND	ND	ND	ND	ND	15	ND	15	ND	14	ND	ND	ND	ND	ND	ND	ND
Arsenic	µg/l	4	9	12	120	ND	ND	ND	ND	ND	ND			94				ND	ND	ND	ND		ND
Barium	µg/l	10	99	22	ND	ND	ND	ND	ND	ND	ND			29				ND	19	ND	ND		ND
Cadmium	µg/l	0.1	0.3	0.2	ND	ND	ND	ND	ND	ND	ND			0.3				ND	ND	ND	ND		0.3
Chromium	µg/l	10	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Copper	µg/l	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead	µg/l	1	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Mercury	µg/l	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND			0.18				ND	ND	ND	ND		ND
Selenium	µg/l	1	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Silver	µg/l	10	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Zinc	µg/l	10	15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12	ND	12	ND	ND	ND	ND	ND	ND

Notes: The data were sampled by Joanna Field and Mike Zanoli of Jones & Stokes Associates and analyzed by ANLAB Analytical Laboratories (Report No. 135571).

Table 8. JSA 1991 Sampling Program: Results from July 10−12 Water Quality Sampling.

Variable:	Units:	Detection limit:	East Portal:	Big Springs:	Hot Creek:	Mammoth Creek:	Convict Creek:	McGee Creek:	Hilton Creek:	Crooked Creek:	Rock Creek:	Benton Xing:	Crowley Surf 1:	Crowley Bot 1:	Crowley Surf 2:	Crowley Surf 3:	Crowley Surf 4:	Rush Creek:	Parker Creek:	Walker Creek:	Lee Vining Creek:	Grant Lk Surface:	Grant Lk Bottom:
Laboratory Conductivity	µS/cm	1	414	215	444	64	152	69	22	55	22	418	482	517	489	499	491	45	46	37	28	69	61
Field Conductivity	µS/cm	10	330	191	507	53	114	47	14	45	16	379	498	415	499	490	489	38	34	30	20	53	51
Field Temperature	°C	0.1	12.1	16.8	29.3	14.4	15.2	13.0	16.0	17.8	15.5	18.2	21.2	12.8	21.3	20.7	20.3	18.0	13.6	17.7	13.5	19.4	18.2
Field Dissolved Oxygen	mg/l	0.1	7.6	8.5	7.1	8.0	7.2	6.8	7.2	7.4	6.7	8.9	10.9	0.1	12.0	10.1	10.9	7.2	7.6	7.3	7.4	7.2	7.3
Laboratory pH	−log(H+)	0.1	7.7	8.4	7.6	7.7	8.0	7.4	7.2	7.6	7.2	8.4	9.0	8.0	9.0	8.8	9.0	7.3	7.2	7.3	7.3	7.6	7.5
Field pH	−log(H+)	0.1	7.6	8.5	7.5	7.9	8.0	7.9	7.8	8.5	8.7	8.4	9.2	7.8	9.3	9.3	9.2	8.2	7.7	7.6	7.8	7.8	7.8
Total Dissolved Solids	mg/l	15	260	160	280	36	88	40	16	37	15	260	280	300	290	300	290	31	26	22	20	35	31
Alkalinity (as CaCO3)	mg/l	2	210	87	140	29	61	25	9	26	8	160	180	190	180	180	180	16	10	10	8	25	22
Chloride	mg/l	1	6	11	42	ND	ND	ND	ND	ND	ND	30	34	38	37	37	36	ND	ND	ND	ND	1.9	1.3
Sulfate	mg/l	2	7	7	22	3.1	13	7.0	ND	ND	ND	12	18	18	17	16	16	3.4	7.2	4.7	2.9	4	3.7
Hardness (as CaCO3)	mg/l	1	170	50	53	23	70	32	8	18	6	87	77	84	79	86	80	18	18	12	10	23	23
Calcium	mg/l	0.1	40	6.7	12	6.2	28	11.0	2.8	5.6	2.2	18	20	22	20	20	20	6.2	6.3	3.8	3.4	8.1	7.9
Magnesium	mg/l	0.1	18	7.2	5.6	1.6	0.43	0.30	0.14	0.81	0.16	10	6.4	6.6	6.5	7.1	6.5	0.51	0.45	0.50	0.32	0.79	0.77
Sodium	mg/l	0.5	23	27	74	4.1	1.9	1.8	1.8	4.6	2.5	56	73	78	75	76	75	1.8	1.2	2.2	1.4	3.3	2.5
Potassium	mg/l	0.01	2.9	4.2	6.8	0.80	0.65	0.56	0.37	1.2	0.41	6.4	7.7	8.2	7.9	8.0	7.8	0.58	0.51	0.65	0.42	1.2	0.73
Silica	mg/l	0.1	43	47	47	9.6	8.1	6.6	4.3	16	4.5	45	21	24	21	26	21	6.4	5.4	7.1	4.7	6.4	6.2
Boron	mg/l	0.02	0.27	0.42	1.6	ND	ND	ND	ND	ND	ND	1.1	1.3	1.4	1.3	1.4	1.3	ND	ND	ND	ND	0.02	ND
Fluoride	mg/l	0.1	0.4	0.5	1.6								1.5	1.5									
Bromide	mg/l	0.01	0.01	0.02	0.08								0.07	0.07									
Bromine	mg/l	0.01																					
Anion/Cation Ratio			1.00	1.05	0.98	1.00	1.00	0.96	0.75	0.88	0.63	0.98	0.98	1.00	0.98	1.00	1.00	0.89	0.86	0.88	0.78	0.98	0.95
Alk/Hardness Ratio			1.24	1.74	2.64	1.26	0.87	0.78	1.13	1.44	1.33	1.84	2.34	2.26	2.28	2.09	2.25	0.89	0.56	0.83	0.80	1.09	0.96
EC/TDS Ratio			1.59	1.34	1.59	1.78	1.73	1.73	1.38	1.49	1.47	1.61	1.72	1.72	1.69	1.66	1.69	1.45	1.77	1.68	1.40	1.97	1.97
CA/Mg Ratio			2.22	0.93	2.14	3.88	65.12	36.67	20.00	6.91	13.75	1.80	3.13	3.33	3.08	2.82	3.08	12.16	14.00	7.60	10.63	10.25	10.26
Ammonia (as N)	mg/l	0.05	0.08	0.05	0.10	ND	ND	0.05	ND	ND	ND	0.07	ND	0.58	ND	0.12	ND	ND	ND	ND	ND	0.12	ND
Total Kjeldahl Nitrogen	mg/l	0.5	ND	ND	ND	ND	ND	ND	4	ND	ND	ND	1.1	1.2	1.2	1.0	0.9	ND	ND	ND	ND	1.0	ND
Nitrate (as N)	mg/l	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Phosphate	mg/l	0.02	0.02	0.36	0.24	0.04	ND	ND	ND	0.02	ND	0.20	0.12	0.23	0.14	0.17	0.10	ND	ND	ND	ND	0.02	0.02
Dissolved Phosphate	mg/l	0.02											0.03		0.03	0.07	0.04					ND	
Chlorophyll A	µg/l												40.9		80.3	20.3	27.2					0.9	
Total Organic Carbon	mg/l	3	ND	ND	4.6	ND	ND	ND	ND	8.5	ND	5.0	5.1	5.7	8.3	7.3	6.7	9.5	4.2	ND	ND	3.8	ND
Color	units	3	ND	ND	15	10	ND	ND	4	20	5	35	10	10	15	15	15	5	ND	5	ND	4	ND
Total Suspended Solids	mg/l	3	ND	4	6	7	ND	3	4	4	ND	5	11	ND	10	9	6	ND	4	4	3	ND	ND
Turbidity	NTU	0.1	0.8	0.5	1.0	0.7	0.2	0.3	0.7	1.1	0.5	1.3	4.0	0.6	4.6	3.1	2.2	0.4	0.6	0.5	0.3	1.2	0.8
Aluminium	µg/l	50	ND	ND	78									ND									
Iron	µg/l	30	58	ND	42	ND	ND	ND	ND	240	ND	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	µg/l	10	230	ND	ND	ND	ND	ND	ND	ND	ND	16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	µg/l	4	11	17	140									92									
Barium	µg/l	10	95	21	26									35									
Cadmium	µg/l	0.1	0.3	ND	ND									ND									
Chromium	µg/l	10	ND	ND	ND									ND									
Copper	µg/l	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead	µg/l	1	ND	ND	1									ND									
Mercury	µg/l	0.1	ND	ND	ND									ND									
Selenium	µg/l	1	ND	ND	ND									ND									
Silver	µg/l	10	ND	ND	ND									ND									
Zinc	µg/l	10	16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	29	ND

Notes: The data were sampled by Joanna Field and Simon Page of Jones & Stokes Associates and analyzed by ANLAB Analytical Laboratories (Report No. 136051).

Table 9. JSA 1991 Sampling Program: Results from July 23–25 Water Quality Sampling.

Variable:	Units:	Detection limit:	East Portal:	Big Springs:	Hot Creek:	Mammoth Creek:	Convict Creek:	McGee Creek:	Hilton Creek:	Crooked Creek:	Rock Creek:	Benton Xing:	Crowley Surf 1:	Crowley Bot 1:	Crowley Surf 2:	Crowley Surf 3:	Crowley Surf 4:	Rush Creek:	Parker Creek:	Walker Creek:	Lee Vining Creek:	Grant Lk Surface:	Grant Lk Bottom:
Laboratory Conductivity	μS/cm	1	423	221	557	95	159	115	30	69	46	444	467	538	477	463	479	39	57	40	47	63	62
Field Conductivity	μS/cm	10	355	192	721	68	132	83	20	60	29	401	462	501	472	429	465	24	36	22	26	50	48
Field Temperature	°C	0.1	12.4	14.9	33.2	15.3	18.0	11.0	10.2	19.0	11.7	15.5	19.4	15.2	20.3	17.8	20.0	17.8	12.4	12.6	11.0	19.0	18.1
Field Dissolved Oxygen	mg/l	0.1				8.3	8.3	8.2	8.4	8.4	8.2		5.6	0.0	7.4	7.4	7.1	8.6	8.5	8.3	8.5	7.6	6.9
Laboratory pH	−log(H+)	0.1	7.8	8.4	7.7	8.0	8.1	8.2	7.7	7.2	7.2	8.4	9.0	7.8	9.1	9.0	9.1	7.3	7.3	7.3	7.4	7.6	7.6
Field pH	−log(H+)	0.1	7.7	8.6	7.8	8.2	8.3	7.9	7.1	7.8	7.7	8.7	9.4	7.0	9.5	9.5	9.4	7.8	7.7	7.8	7.2	8.5	8.0
Total Dissolved Solids	mg/l	15	260	170	360	62	93	75	19	59	38	280	280	320	290	290	260	25	37	27	32	36	41
Alkalinity (as CaCO3)	mg/l	2	210	92	170	44	62	41	12	30	14	160	160	200	170	170	170	12	14	12	14	21	22
Chloride	mg/l	1	6.3	9.4	49	ND	ND	ND	ND	ND	ND	28	34	36	35	32	36	1.0	ND	ND	ND	1.6	1.4
Sulfate	mg/l	2	6.0	6.6	26	3.4	13	12	ND	1.6	2.1	16	18	18	17	16	18	2.8	8.2	5.1	4.9	3.6	3.6
Hardness (as CaCO3)	mg/l	1	180	47	54	32	70	48	10	20	8	82	65	87	66	84	66	13	20	12	16	22	22
Calcium	mg/l	0.1	38	7.0	12	8.4	27	18	3.8	7.0	3.1	17	16	23	16	16	16	4.7	7.6	4.0	5.5	7.4	7.7
Magnesium	mg/l	0.1	18	7.3	5.7	3.1	0.43	0.52	0.21	0.91	0.26	9.8	6.4	6.6	6.4	9.3	6.4	0.42	0.55	0.54	0.54	0.72	0.73
Sodium	mg/l	0.5	21	25	88	5.4	0.27	1.4	1.6	5.9	4.3	57	77	82	76	65	74	1.4	1.6	2.2	2.6	2.5	2.2
Potassium	mg/l	0.01	3.1	4.2	8.5	1.1	0.67	0.92	0.47	1.5	0.59	6.9	8.0	8.4	8.0	7.7	7.8	0.51	0.69	0.68	0.73	0.79	0.72
Silica	mg/l	0.1	49	54	64	12	8.6	10	6.4	21	8.1	49	24	28	24	45	24	6.0	8.4	6.3	8.2	6.7	7.0
Boron	mg/l	0.02	0.26	0.40	2.1	ND	ND	ND	ND	ND	ND	1.2	1.3	1.3	1.3	1.3	1.3	ND	ND	ND	ND	0.02	ND
Fluoride	mg/l	0.1	0.4	0.5	2.2								1.3	1.4									
Bromide	mg/l	0.01	ND	ND	0.11								0.07	0.08									
Bromine	mg/l	0.01																					
Anion/Cation Ratio			1.05	1.05	1.02	1.00	1.07	1.10	0.79	0.89	0.89	1.02	0.94	0.96	0.98	1.00	0.98	0.97	0.88	0.94	0.84	0.98	1.00
Alk/Hardness Ratio			1.17	1.96	3.15	1.38	0.89	0.85	1.20	1.50	1.75	1.95	2.46	2.30	2.58	2.02	2.58	0.92	0.70	1.00	0.88	0.95	1.00
EC/TDS Ratio			1.63	1.30	1.55	1.53	1.71	1.53	1.58	1.17	1.21	1.59	1.67	1.68	1.64	1.60	1.84	1.56	1.54	1.48	1.47	1.75	1.51
CA/Mg Ratio			2.11	0.96	2.11	2.71	62.79	34.62	18.10	7.69	11.92	1.73	2.50	3.48	2.50	1.72	2.50	11.19	13.82	7.41	10.19	10.28	10.55
Ammonia (as N)	mg/l	0.05	0.16	ND	0.16	ND	ND	ND	ND	0.22	ND	0.12	0.18	1.7	0.06	0.14	ND	ND	ND	ND	ND	ND	0.06
Total Kjeldahl Nitrogen	mg/l	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.5	0.8	2.2	0.7	ND	0.5	ND	ND	ND	ND	ND	ND
Nitrate (as N)	mg/l	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Phosphate	mg/l	0.02	0.04	0.35	0.26	0.05	ND	ND	ND	ND	ND	0.21	0.09	0.42	0.09	0.21	0.10	ND	ND	ND	ND	0.02	ND
Dissolved Phosphate	mg/l	0.02											0.05		0.06	0.21	0.06					ND	
Chlorophyll A	μg/l												34.3		38.9	6.3	40.0					4.3	
Total Organic Carbon	mg/l	3	ND	ND	ND	ND	4.4	4.5	ND	4.9	3.0	3.0	5.6	4.6	5.8	3.7	4.4	ND	ND	ND	ND	ND	3.2
Color	units	3	5	5	15	10	3	4	10	25	4	30	15	15	20	20	10	5	10	5	5	5	5
Total Suspended Solids	mg/l	3	ND	3	6	ND	ND	ND	3	ND	4	ND	10	4	8	ND	10	ND	4	4	3	6	ND
Turbidity	NTU	0.1	0.5	0.3	0.3	0.3	0.1	0.1	0.2	1.0	0.3	0.5	2.0	0.9	2.5	1.7	2.5	0.4	0.5	0.3	0.2	2.2	1.1
Aluminium	μg/l	50	ND	ND	56	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Iron	μg/l	30	33	ND	ND	ND	ND	ND	ND	350	30	ND	ND	ND	ND	ND	ND	ND	48	ND	73	ND	ND
Manganese	μg/l	10	170	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	210	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	μg/l	4	11	18	260	ND	ND	ND	ND	ND	ND			90				4	ND	ND	ND		ND
Barium	μg/l	10	89	21	27	ND	ND	ND	ND	ND	ND			37				ND	14	ND	ND		ND
Cadmium	μg/l	0.1	0.3	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Chromium	μg/l	10	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Copper	μg/l	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead	μg/l	1	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Mercury	μg/l	0.1	ND	ND	0.17	ND	ND	ND	ND	ND	ND			0.19				ND	ND	ND	ND		ND
Selenium	μg/l	1	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Silver	μg/l	1	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Zinc	μg/l	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	18	ND

Notes: The data were sampled by Joanna Field and Simon Page of Jones & Stokes Associates and analyzed by ANLAB Analytical Laboratories (Report No. 136373).

Table 10. JSA 1991 Sampling Program: Results from July 23–25 Lake Sediment Sampling.

Variable:	Units:	Crowley Sed 1:	Crowley Sed 2:	Crowley Sed 3:	Crowley Sed 4:	Crowley Sed 5:	Crowley Sed 6:	Crowley Sed 7:	Crowley Sed 8:	Crowley Avg.:	Grant Lk Sed 1:	Grant Lk Sed 2:	Grant Lk Sed 3:	Grant Lk Sed 4:	Grant Lk Avg.:
Moisture	%	91	91	58	84	80	76	35	85	75	67	74	76	48	66
Laboratory pH	−log(H+)	6.7	6.9	7.7	7.5	7.3	7.9	7.9	7.5	7.4	7.0	6.8	6.5	6.0	6.6
Alkalinity (as CaCO3)	mg/kg	9300	11000	2000	3900	3400	2700	740	4700	4718	<6.1	<7.7	<8.3	<3.8	
Chloride	mg/kg	330	480	55	190	180	280	43	290	231	<30	<38	110	52	81
Sulfate	mg/kg	2400	2200	240	2100	1000	240	70	630	1110	240	220	170	77	177
Hardness (as CaCO3)	mg/kg	8700	9600	1700	4900	3100	2000	280	3900	4273	210	150	170	38	142
Calcium	mg/kg	11000	17000	6000	12000	11000	2600	1800	13000	9300	5800	2700	3200	2300	3500
Magnesium	mg/kg	3300	3900	2400	3800	6000	2600	2000	6000	3750	8800	6200	5000	2700	5675
Sodium	mg/kg	960	1300	400	810	1000	370	550	1100	811	450	230	180	88	237
Potassium	mg/kg	1400	1200	860	1200	2400	880	880	2000	1353	5200	3800	3000	480	3120
Silica	mg/kg	640000	600000	1100000	620000	<21000	340000	680000	680000	665714	940000	810000	880000	1700000	1082500
Boron	mg/kg	44	51	20	69	48	19	18	49	40	27	20	20	8.5	19
Fluoride	mg/kg	120	240	88	190	260	200	140	520	220	180	190	170	92	158
Bromide	mg/kg	1.1	1.1	0.23	<0.6	<0.5	<0.4	0.15	<0.7	0.65	<0.30	<0.38	<0.42	<0.19	
Alk/Hardness Ratio		1.07	1.15	1.18	0.80	1.10	1.35	2.64	1.21	1.31	0.00	0.00	0.00	0.00	0.00
CA/Mg Ratio		3.33	4.36	2.50	3.16	1.83	1.00	0.90	2.17	2.41	0.66	0.44	0.64	0.85	0.65
Ammonia (as N)	mg/kg	790	360	38	120	60	58	5.8	110	193	64	92	46	15	54
Total Kjeldahl Nitrogen	mg/kg	8700	7600	2000	12000	5500	4200	550	5800	5794	1400	2400	3600	1600	2250
Nitrate (as N)	mg/kg	<110	<110	<23	<62	<50	<40	<15	<67		<30	<38	<42	<19	
Total Phosphate	mg/kg	700	680	330	690	600	580	200	310	511	940	1100	960	460	865
Total Organic Carbon	mg/kg	41000	38000	14000	95000	28000	5000	5100	36000	32763	10000	20000	28000	21000	19750
Aluminium	mg/kg	7600	4600	3100	4200	9000	2900	3100	5900	5050	21000	16000	16000	8100	15275
Iron	mg/kg	11000	7100	3800	6200	11000	4100	3700	8000	6863	24000	19000	16000	7500	16625
Manganese	mg/kg	360	280	400	2800	380	280	140	310	619	850	620	710	150	583
Arsenic	mg/kg	81	56	7.8	39	29	<4.2	4.2	11	33	6.7	4.2	5.8	3.5	5
Barium	mg/kg	86	66	74	75	120	50	58	80	76	210	170	170	58	152
Cadmium	mg/kg	<5.6	<5.6	<1.2	<3.1	<5.0	<2.1	<0.77	<3.3		<1.5	<1.9	<2.1	<1.0	
Chromium	mg/kg	<11	<11	3.0	<6.2	9.0	<4.2	2.8	6.7	3	16	13	14	9.0	13
Copper	mg/kg	<11	20	3.1	50	19.0	7.5	4.0	17	17	42	35	33	18	32
Lead	mg/kg	<56	<56	<12	<31	32	<21	<7.7	<33	32	36	35	40	19	33
Mercury	mg/kg	<0.56	<0.56	0.43	<0.31	<0.25	0.62	0.25	<0.33	0.43	<0.15	<0.19	<0.21	<0.1	
Selenium	mg/kg	<5.6	<5.6	<1.2	<3.1	<2.5	<2.1	<0.77	<3.3		<1.5	<1.9	<2.1	<1.0	
Silver	mg/kg	<5.6	<5.6	<1.2	<3.1	<2.5	<2.1	<0.77	<3.3		<1.5	<1.9	<2.1	<1.0	
Zinc	mg/kg	60	33	57	69	60	28	22	40	46	140	130	170	69	127

Notes: The data were sampled by Joanna Field and Simon Page of Jones & Stokes Associates and analyzed by ANLAB Analytical Laboratories (Report No. 136373).

Table 11. JSA 1991 Sampling Program: Results from August 13–15 Water Quality Sampling.

Variable:	Units:	Detection limit:	East Portal:	Big Springs:	Hot Creek:	Mammoth Creek:	Convict Creek:	McGee Creek:	Hilton Creek:	Crooked Creek:	Rock Creek:	Benton Xing:	Crowley Surf 1:	Crowley Bot 1:	Crowley Surf 2:	Crowley Surf 3:	Crowley Surf 4:	Rush Creek:	Parker Creek:	Walker Creek:	Lee Vining Creek:	Grant Lk Surface:	Grant Lk Bottom:
Laboratory Conductivity	µS/cm	1	416	217	549	89	150	103	27	62	34	476	466	510	472	475	472	39	52	38	44	63	59
Field Conductivity	µS/cm	10	343	207	724	72	110	68	24	47	28	459	438	431	444	481	443	31	34	26	28	50	47
Field Temperature	°C	0.1	12.2	16.8	35.4	14.2	18.3	13.0	14.2	17.7	15.6	18.5	19.5	14.6	19.6	21.3	20.1	17.8	15.7	17.1	13.4	20.2	18.6
Field Dissolved Oxygen	mg/l	0.1	7.2	8.7	5.7	7.8	7.3	8.1	7.9	7.7	7.7	9.9	7.4	0.0	7.5	10.3	9.2	8.2			7.8	8.1	9.1
Laboratory pH	−log(H+)	0.1	6.8	7.9	7.4	9.1	8.1	8.1	7.7	7.4	7.3	8.3	9.1	8.5	9.1	9.4	9.2	7.4	7.5	7.6	7.8	8.3	8.5
Field pH	−log(H+)	0.1	7.1	8.5	7.6	7.9	8.0	8.2	8.4	7.7	8.7	8.6	9.3	7.9	9.3	9.6	9.4	8.4	7.9	7.9	8.0	8.6	8.7
Total Dissolved Solids	mg/l	15	250	150	360	54	91	65	20	55	21	290	280	290	280	300	270	28	32	26	31	42	37
Alkalinity (as CaCO3)	mg/l	2	220	88	170	40	60	36	12	26	13	180	170	180	170	170	170	14	14	10	14	20	22
Chloride	mg/l	1	8.7	9.7	50	ND	ND	ND	ND	ND	ND	33	37	35	36	36	38	ND	ND	ND	ND	1.8	1.8
Sulfate	mg/l	2	7.0	7.0	28	3.7	13	11	ND	ND	2.1	16	17	15	17	17	17	2.5	7.4	4.6	4.8	3.3	3.7
Hardness (as CaCO3)	mg/l	1	200	48	55	32	75	47	10	18	8.0	98	68	81	72	71	70	14	20	12	20	24	22
Calcium	mg/l	0.1	44	7.4	12	9.5	27	17	3.7	6.7	3.0	22	16	21	19	17	18	5.4	7.6	4.3	5.7	8.7	8.6
Magnesium	mg/l	0.1	17	7.4	5.9	2.7	0.44	0.49	0,21	0.50	0.22	12	6.5	6.2	6.4	7.1	6.7	0.42	0.51	0.51	0.51	0.79	0.76
Sodium	mg/l	0.5	23	28	94	5.2	1.4	2.1	1.4	4.4	3.1	65	71	78	74	72	72	1.5	1.1	2.0	2.0	2.7	2.5
Potassium	mg/l	0.01	2.8	4.2	8.7	1.1	0.73	0.90	0.48	1.6	0.64	7.7	7.5	8.0	7.7	7.7	7.6	0.55	0.68	0.73	0.70	1.0	0.74
Silica	mg/l	0.1	52	62	62	11	8.8	9.2	5.7	19	7.5	52	24	25	26	27	25	6.0	9.6	7.1	8.5	6.8	6.7
Boron	mg/l	0.02	0.27	0.43	2.2	ND	ND	ND	ND	ND	ND	1.4	1.4	1.4	1.5	1.4	1.5	ND	ND	ND	ND	0.03	0.03
Fluoride	mg/l	0.1	0.3	0.5	2.4								1.4	1.3									
Bromide	mg/l	0.01	0.01	0.01	0.11								0.07	0.07									
Bromine	mg/l	0.01																					
Anion/Cation Ratio			1.00	0.96	0.98	0.93	1.00	0.95	0.82	0.92	0.97	0.84	1.04	0.94	0.98	0.98	1.00	0.74	0.88	0.81	0.88	0.84	0.89
Alk/Hardness Ratio			1.10	1.83	3.09	1.25	0.80	0.77	1.20	1.44	1.63	1.84	2.50	2.22	2.36	2.39	2.43	1.00	0.70	0.83	0.70	0.83	1.00
EC/TDS Ratio			1.66	1.45	1.53	1.65	1.65	1.58	1.35	1.13	1.62	1.64	1.66	1.76	1.69	1.58	1.75	1.39	1.63	1.46	1.42	1.50	1.59
CA/Mg Ratio			2.59	1.00	2.03	3.52	61.36	34.69	17.62	13.40	13.64	1.83	2.46	3.39	2.97	2.39	2.69	12.86	14.90	8.43	11.18	11.01	11.32
Ammonia (as N)	mg/l	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Kjeldahl Nitrogen	mg/l	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.6	1.4	0.7	0.7	0.8	ND	ND	ND	ND	0.6	ND
Nitrate (as N)	mg/l	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Phosphate	mg/l	0.02	ND	0.37	0.27	0.05	ND	ND	ND	ND	ND	0.23	0.09	0.28	0.1	0.09	0.10	ND	0.04	ND	ND	0.02	ND
Dissolved Phosphate	mg/l	0.02											ND		ND	0.02	0.02					ND	
Chlorophyll A	µg/l												31.5		32.9	20.9	46.9					13.3	
Total Organic Carbon	mg/l	3	ND	ND	ND	ND	ND	ND	ND	5.7	ND	5.8	5.1	4.9	12	5.1	9.1	ND	ND	ND	ND	3.5	ND
Color	units	3	5	5	10	5	ND	4	4	5	5	45	15	5	15	20	15	5	ND	10	5	15	5
Total Suspended Solids	mg/l	3	ND	4	6	ND	ND	ND	3	3	ND	ND	7	4	6	9	4	ND	4	4	ND	5	4
Turbidity	NTU	0.1	0.4	0.3	0.3	0.3	ND	0.1	0.1	0.2	0.4	0.5	1.6	1.2	2.2	1.7	2.8	0.3	0.4	0.3	0.2	0.9	2.2
Aluminium	µg/l	50	ND	ND	65									ND									
Iron	µg/l	30	67	ND	ND	48	ND	ND	61	420	ND	58	ND	ND	ND	ND	ND	ND	39	37	51	ND	ND
Manganese	µg/l	10	240	ND	26	ND	ND	ND	ND	ND	ND	24	17	140	21	21	16	ND	ND	ND	ND	11	12
Arsenic	µg/l	4	7	17	250									70									
Barium	µg/l	10	100	22	27									33									
Cadmium	µg/l	0.1	0.3	0.2	ND									0.2									
Chromium	µg/l	10	ND	ND	ND									ND									
Copper	µg/l	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead	µg/l	1	ND	ND	ND									ND									
Mercury	µg/l	0.1	ND	ND	0.15									0.19									
Selenium	µg/l	1	ND	ND	ND									ND									
Silver	µg/l	1	ND	ND	ND									ND									
Zinc	µg/l	10	13	ND	ND	ND	ND	ND	ND	ND	ND	18	ND	ND	ND	ND	ND	16	ND	ND	ND	ND	ND

Notes: The data were sampled by Joanna Field and Randy Stegen of Jones & Stokes Associates and analyzed by ANLAB Analytical Laboratories (Report No. 136884).

Table 12. JSA 1991 Sampling Program: Results from August 27–29 Water Quality Sampling.

Variable:	Units:	Detection limit:	East Portal:	Big Springs:	Hot Creek:	Mammoth Creek:	Convict Creek:	McGee Creek:	Hilton Creek:	Crooked Creek:	Rock Creek:	Benton Xing:	Crowley Surf 1:	Crowley Bot 1:	Crowley Surf 2:	Crowley Surf 3:	Crowley Surf 4:	Rush Creek:	Parker Creek	Walker Creek:	Lee Vining [illegible]	Grant Lk Surface	[illegible]
Laboratory Conductivity	µS/cm	1	423	221	557	95	159	115	30	69	46	444	467	538	477	463	479	39	57	40	47	63	62
Field Conductivity	µS/cm	10	355	192	721	68	132	83	20	60	29	401	462	501	472	429	465	24	36	12	26	50	48
Field Temperature	°C	0.1	12.4	14.9	33.2	15.3	18.0	11.0	10.2	19.0	11.7	15.5	19.4	15.2	20.3	17.8	20.0	17.8	12.4	[illegible]	[illegible]	19.0	18.1
Field Dissolved Oxygen	mg/l	0.1				8.3	8.3	8.2	8.4	8.4	8.2		5.6	0.0	7.4	7.4	7.1	8.6	8.5	8.3	8.5	7.6	6.9
Laboratory pH	−log(H+)	0.1	7.8	8.4	7.7	8.0	8.1	8.2	7.7	7.2	7.2	8.4	9.0	7.8	9.1	9.0	9.1	7.3	7.3	7.3	7.4	7.6	7.6
Field pH	−log(H+)	0.1	7.7	8.6	7.8	8.2	8.3	7.9	7.1	7.8	7.7	8.7	9.4	7.0	9.5	9.5	9.4	7.8	7.7	7.8	7.2	8.5	8.0
Total Dissolved Solids	mg/l	15	260	170	360	62	93	75	19	59	38	280	280	320	290	290	260	25	37	27	32	36	41
Alkalinity (as CaCO3)	mg/l	2	210	92	170	44	62	41	12	30	14	160	160	200	170	170	170	12	14	12	14	21	22
Chloride	mg/l	1	6.3	9.4	49	ND	ND	ND	ND	ND	ND	28	34	36	35	32	36	1.0	ND	ND	ND	1.6	1.4
Sulfate	mg/l	2	6.0	6.6	26	3.4	13	12	ND	1.6	2.1	16	18	18	17	16	18	2.8	8.2	5.1	4.9	3.6	3.6
Hardness (as CaCO3)	mg/l	1	180	47	54	32	70	48	10	20	8	82	65	87	66	84	66	13	20	12	16	22	22
Calcium	mg/l	0.1	38	7.0	12	8.4	27	18	3.8	7.0	3.1	17	16	23	16	16	16	4.7	7.6	4.0	5.5	7.4	7.7
Magnesium	mg/l	0.1	18	7.3	5.7	3.1	0.43	0.52	0.21	0.91	0.26	9.8	6.4	6.6	6.4	9.3	6.4	0.42	0.55	0.54	0.54	0.72	0.73
Sodium	mg/l	0.5	21	25	88	5.4	0.27	1.4	1.6	5.9	4.3	57	77	82	76	65	74	1.4	1.6	2.2	2.6	2.5	2.2
Potassium	mg/l	0.01	3.1	4.2	8.5	1.1	0.67	0.92	0.47	1.5	0.59	6.9	8.0	8.4	8.0	7.7	7.8	0.51	0.69	0.68	0.73	0.79	0.72
Silica	mg/l	0.1	49	54	64	12	8.6	10	6.4	21	8.1	49	24	28	24	45	24	6.0	8.4	6.3	8.2	6.7	7.0
Boron	mg/l	0.02	0.26	0.40	2.1	ND	ND	ND	ND	ND	ND	1.2	1.3	1.3	1.3	1.3	1.3	ND	ND	ND	ND	0.02	ND
Fluoride	mg/l	0.1	0.4	0.5	2.2								1.3	1.4									
Bromide	mg/l	0.01	ND	ND	0.11								0.07	0.08									
Bromine	mg/l	0.01																					
Anion/Cation Ratio			1.05	1.05	1.02	1.00	1.07	1.10	0.79	0.89	0.89	1.02	0.94	0.96	0.98	1.00	0.98	0.97	0.88	0.94	0.84	0.98	1.00
Alk/Hardness Ratio			1.17	1.96	3.15	1.38	0.89	0.85	1.20	1.50	1.75	1.95	2.46	2.30	2.58	2.02	2.58	0.92	0.70	1.00	0.88	0.95	1.00
EC/TDS Ratio			1.63	1.30	1.55	1.53	1.71	1.53	1.58	1.17	1.21	1.59	1.67	1.68	1.64	1.60	1.84	1.56	1.54	1.48	1.47	1.75	1.51
CA/Mg Ratio			2.11	0.96	2.11	2.71	62.79	34.62	18.10	7.69	11.92	1.73	2.50	3.48	2.50	1.72	2.50	11.19	13.82	7.41	10.19	10.28	10.55
Ammonia (as N)	mg/l	0.05	0.16	ND	0.16	ND	ND	ND	ND	0.22	ND	0.12	0.18	1.7	0.06	0.14	ND	ND	ND	ND	ND	ND	0.06
Total Kjeldahl Nitrogen	mg/l	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.5	0.8	2.2	0.7	ND	0.5	ND	ND	ND	ND	ND	ND
Nitrate (as N)	mg/l	0.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Phosphate	mg/l	0.02	0.04	0.35	0.26	0.05	ND	ND	ND	ND	ND	0.21	0.09	0.42	0.09	0.21	0.10	ND	ND	ND	ND	0.02	ND
Dissolved Phosphate	mg/l	0.02											0.05		0.06	0.21	0.06					ND	
Chlorophyll A	µg/l												34.3		38.9	6.3	40.0					4.3	
Total Organic Carbon	mg/l	3	ND	ND	ND	ND	4.4	4.5	ND	4.9	3.0	3.0	5.6	4.6	5.8	3.7	4.4	ND	ND	ND	ND	ND	3.2
Color	units	3	5	5	15	10	3	4	10	25	4	30	15	15	20	20	10	5	10	5	5	5	5
Total Suspended Solids	mg/l	3	ND	3	6	ND	ND	ND	3	ND	4	ND	10	4	8	ND	10	ND	4	4	3	6	ND
Turbidity	NTU	0.1	0.5	0.3	0.3	0.3	0.1	0.1	0.2	1.0	0.3	0.5	2.0	0.9	2.5	1.7	2.5	0.4	0.5	0.3	0.2	2.2	1.1
Aluminium	µg/l	50	ND	ND	56	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Iron	µg/l	30	33	ND	ND	ND	ND	ND	ND	350	30	ND	ND	ND	ND	ND	ND	ND	48	ND	73	ND	ND
Manganese	µg/l	10	170	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	210	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	µg/l	4	11	18	260	ND	ND	ND	ND	ND	ND			90				4	ND	ND	ND		ND
Barium	µg/l	10	89	21	27	ND	ND	ND	ND	ND	ND			37				ND	14	ND	ND		ND
Cadmium	µg/l	0.1	0.3	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Chromium	µg/l	10	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Copper	µg/l	20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead	µg/l	1	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Mercury	µg/l	0.1	ND	ND	0.17	ND	ND	ND	ND	ND	ND			0.19				ND	ND	ND	ND		ND
Selenium	µg/l	1	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Silver	µg/l	1	ND	ND	ND	ND	ND	ND	ND	ND	ND			ND				ND	ND	ND	ND		ND
Zinc	µg/l	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	18	ND

Notes: The data were sampled by Joanna Field and Randy Stegen of Jones & Stokes Associates and analyzed by ANLAB Analytical Laboratories (Report No. 137207).

Table 13. JSA 1991 Sampling Program: Results from September 10–11 Water Quality Sampling.

Variable:	Units:	Detection limit:	East Portal:	Big Springs:	Hot Creek:	Mammoth Creek:	Convict Creek:	McGee Creek:	Hilton Creek:	Crooked Creek:	Rock Creek:	Benton Xing:	Crowley Surf 1:	Crowley Bot 1:	Crowley Surf 2:	Crowley Surf 3:	Crowley Surf 4:	Rush Creek:	Parker Creek:	Walker Creek:	Lee Vining Creek:	Grant Lk Surface:	Grant Lk Bottom:
Laboratory Conductivity	µS/cm	1											466	546	471	478	472					59	60
Field Conductivity	µS/cm	10											502	536	507	518	511					48	48
Field Temperature	°C	0.1											18.2	15.9	18.9	18.4	18.3					16.4	16.0
Field Dissolved Oxygen	mg/l	0.1											5.5	0.0	6.7	7.9	4.5					5.9	
Laboratory pH	−log(H+)	0.1											8.9	7.6	8.9	8.9	8.8					6.8	6.9
Field pH	−log(H+)	0.1											9.4	7.8	9.4	9.5	9.3					7.4	
Total Dissolved Solids	mg/l	15											280	310	270	280	290					35	35
Alkalinity (as CaCO3)	mg/l	2											170	210	170	170	170					22	22
Chloride	mg/l	1											40	33	32	33	33					1.7	1.6
Sulfate	mg/l	2											17	19	18	18	18					3.5	3.7
Hardness (as CaCO3)	mg/l	1											66	91	74	68	74					22	22
Calcium	mg/l	0.1											17	25	17	17	17					7.9	8.1
Magnesium	mg/l	0.1											6.4	7.0	6.5	7.3	6.5					0.74	0.75
Sodium	mg/l	0.5											86	69	80	76	66					2.4	2.2
Potassium	mg/l	0.01											7.9	8.8	8.2	8.4	8.1					0.74	0.73
Silica	mg/l	0.1											22	28	21	24	22					5.9	5.9
Boron	mg/l	0.02											1.3	1.4	1.4	1.4	1.4					ND	ND
Fluoride	mg/l	0.1											1.3	1.3	1.4	1.3	1.4					ND	ND
Bromide	mg/l	0.01											0.06	0.08									
Bromine	mg/l	0.01																					
Anion/Cation Ratio													0.92	1.00	0.87	0.94	1.04					0.97	0.95
Alk/Hardness Ratio													2.58	2.31	2.30	2.50	2.30					1.00	1.00
EC/TDS Ratio													1.66	1.76	1.74	1.71	1.63					1.69	1.71
CA/Mg Ratio													2.66	3.57	2.62	2.33	2.62					10.68	10.80
Ammonia (as N)	mg/l	0.05											0.08	2.6	0.07	0.07	0.15					ND	ND
Total Kjeldahl Nitrogen	mg/l	0.5											0.7	4.1	1.0	0.9	0.9					ND	ND
Nitrate (as N)	mg/l	0.2											ND	ND	ND	ND	ND					ND	ND
Total Phosphate	mg/l	0.02											0.10	0.65	0.10	0.12	0.12					ND	ND
Dissolved Phosphate	mg/l	0.02											0.04		0.07	0.09	0.07					ND	
Chlorophyll A	µg/l												29.6		33.1	21.0	26.8					9.0	
Total Organic Carbon	mg/l	3											5.3	4.5	6.6	5.6	7.4					ND	ND
Color	units	3											15	10	15	15	5					5	3
Total Suspended Solids	mg/l	3											8	15	11	7	7					3	4
Turbidity	NTU	0.1											2.0	22	2.0	2.2	2.0					1.2	1.1
Aluminium	µg/l	50												ND									ND
Iron	µg/l	30											ND	39	ND	ND	ND					ND	44
Manganese	µg/l	10											ND	310	ND	ND	ND					ND	39
Arsenic	µg/l	4												110									ND
Barium	µg/l	10												40									ND
Cadmium	µg/l	0.1												ND									ND
Chromium	µg/l	10												ND									ND
Copper	µg/l	20											ND	ND	ND	ND	ND					ND	ND
Lead	µg/l	1												ND									ND
Mercury	µg/l	0.1												0.20									ND
Selenium	µg/l	1												ND									ND
Silver	µg/l	10												ND									ND
Zinc	µg/l	10											ND	37	ND	ND	ND					ND	ND

Notes: The data were sampled by Doug Brewer and Joanna Field of Jones & Stokes Associates and analyzed by ANLAB Analytical Laboratories (Report No. 137528).

Table 14. JSA 1991 Sampling Program: Results from September 24–25 Water Quality Sampling.

Variable:	Units:	Detection limit:	East Portal:	Big Springs:	Hot Creek:	Mammoth Creek:	Convict Creek:	McGee Creek:	Hilton Creek:	Crooked Creek:	Rock Creek:	Benton Xing:	Crowley Surf 1:	Crowley Bot 1:	Crowley Surf 2:	Crowley Surf 3:	Crowley Surf 4:	Rush Creek:	Parker Creek:	Walker Creek:	Lee Vining Creek:	Grant Lk Surface:	Grant Lk Bottom:
Laboratory Conductivity	µS/cm	1											470	512	476	463	474					58	58
Field Conductivity	µS/cm	10											398	402	408	428	412					48	39
Field Temperature	°C	0.1											17.7	16	18	19.3	18.5					17.3	16.1
Field Dissolved Oxygen	mg/l	0.1											5.7	0.1	7.1	8.3	8.0					7.8	7.1
Laboratory pH	−log(H+)	0.1											8.8	8.5	9.0	9.0	9.0					8.5	8.0
Field pH	−log(H+)	0.1											9.3	7.8	9.3	9.4	9.4					7.9	8.1
Total Dissolved Solids	mg/l	15											280	300	290	290	280					37	34
Alkalinity (as CaCO3)	mg/l	2											170	180	170	170	170					22	21
Chloride	mg/l	1											37	36	36	34	35					1.7	1.6
Sulfate	mg/l	2											19	18	19	18	18					3.3	3.6
Hardness (as CaCO3)	mg/l	1											76	73	71	79	75					30	38
Calcium	mg/l	0.1											17	17	16	15	17					7.9	8.0
Magnesium	mg/l	0.1											6.8	6.8	6.6	7.2	6.6					0.73	0.73
Sodium	mg/l	0.5											67	68	68	69	68					2.4	2.2
Potassium	mg/l	0.01											7.5	7.8	7.5	7.3	7.4					0.77	0.81
Silica	mg/l	0.1											22	25	20	32	21					5.4	5.4
Boron	mg/l	0.02											1.3	1.4	1.3	1.3	1.3					ND	ND
Fluoride	mg/l	0.1											1.4	1.5									
Bromide	mg/l	0.01											0.06	0.06									
Bromine	mg/l	0.01																					
Anion/Cation Ratio													1.07	1.04	1.09	1.02	1.07					0.93	0.95
Alk/Hardness Ratio													2.24	2.47	2.39	2.15	2.27					0.73	0.55
EC/TDS Ratio													1.68	1.71	1.64	1.60	1.69					1.57	1.71
CA/Mg Ratio													2.50	2.50	2.42	2.08	2.58					10.82	10.96
Ammonia (as N)	mg/l	0.05											0.08	0.50	ND	ND	ND					ND	ND
Total Kjeldahl Nitrogen	mg/l	0.5											0.8	1.2	0.7	0.7	0.8					ND	ND
Nitrate (as N)	mg/l	0.2											ND	ND	ND	ND	ND					ND	ND
Total Phosphate	mg/l	0.02											0.09	0.15	0.10	0.17	0.14					ND	ND
Dissolved Phosphate	mg/l	0.02											0.05		0.05	0.15	0.10					ND	
Chlorophyll A	µg/l												12.7		13.5	4.3	12.5					6.4	
Total Organic Carbon	mg/l	3											5.1	6.0	5.8	5.4	6.7					3.9	3.7
Color	units	3											15	15	15	15	15					5	4
Total Suspended Solids	mg/l	3											4	ND	5	4	6					ND	3
Turbidity	NTU	0.1											1.2	0.4	1.5	1.1	1.5					0.6	0.6
Aluminium	µg/l	50												ND									ND
Iron	µg/l	30											320	54	140	120	65					60	79
Manganese	µg/l	10											15	230	15	29	18					25	30
Arsenic	µg/l	4												90									ND
Barium	µg/l	10												34									ND
Cadmium	µg/l	0.1												ND									0.29
Chromium	µg/l	10												ND									ND
Copper	µg/l	20											ND	ND	ND	ND	ND					ND	ND
Lead	µg/l	1												ND									ND
Mercury	µg/l	0.1												ND									ND
Selenium	µg/l	1												ND									ND
Silver	µg/l	1												ND									ND
Zinc	µg/l	10											ND	ND	ND	ND	ND					ND	ND

Notes: The data were sampled by Joanna Field and Debra Percy of Jones & Stokes Associates and analyzed by ANLAB Analytical Laboratories (Report No. 137896).

Table 15. Mono Lake Salinity (g/l) at Various Elevations

Mono Lake Elevation (ft)	Average TDS (g/l)	Specific Gravity LADWP	Mono Lake Elevation (ft)	Average TDS (g/l)	Specific Gravity LADWP	Mono Lake Elevation (ft)	Average TDS (g/l)	Specific Gravity LADWP
6301	660.6	1.5060	6351	143.6	1.113142	6401	60.1	1.049651
6302	630.1	1.4829	6352	140.7	1.110942	6402	59.2	1.048986
6303	601.6	1.4612	6353	137.9	1.108811	6403	58.3	1.048337
6304	575.1	1.4411	6354	135.2	1.106746	6404	57.5	1.047703
6305	550.3	1.4222	6355	132.6	1.104745	6405	56.7	1.047085
6306	527.1	1.4046	6356	130.0	1.102805	6406	55.9	1.046481
6307	505.3	1.3880	6357	127.5	1.100922	6407	55.1	1.045891
6308	484.9	1.3725	6358	125.1	1.099095	6408	54.4	1.045315
6309	465.7	1.3580	6359	122.8	1.097320	6409	53.6	1.044752
6310	447.7	1.3443	6360	120.5	1.095595	6410	52.9	1.044203
6311	430.8	1.3314	6361	118.3	1.093918	6411	52.2	1.043666
6312	414.8	1.3192	6362	116.2	1.092287	6412	51.5	1.043141
6313	399.7	1.3078	6363	114.1	1.090700	6413	50.8	1.042628
6314	385.5	1.2970	6364	112.0	1.089154	6414	50.2	1.042127
6315	372.1	1.2868	6365	110.1	1.087648	6415	49.5	1.041636
6316	359.3	1.2771	6366	108.1	1.086178	6416	48.9	1.041157
6317	347.3	1.2679	6367	106.2	1.084745	6417	48.3	1.040687
6318	335.8	1.2592	6368	104.4	1.083344	6418	47.7	1.040228
6319	324.9	1.2510	6369	102.6	1.081971	6419	47.1	1.039779
6320	314.6	1.2431	6370	100.8	1.080623	6420	46.5	1.039339
6321	304.8	1.2356	6371	99.1	1.079297	6421	45.9	1.038908
6322	295.5	1.2285	6372	97.4	1.077991	6422	45.4	1.038486
6323	286.6	1.2218	6373	95.7	1.076706	6423	44.8	1.038072
6324	278.1	1.2153	6374	94.0	1.075442	6424	44.3	1.037666
6325	270.0	1.2092	6375	92.4	1.074198	6425	43.8	1.037268
6326	262.3	1.2033	6376	90.8	1.072972	6426	43.3	1.036887
6327	254.9	1.1977	6377	89.2	1.071765	6427	42.8	1.036504
6328	247.8	1.1924	6378	87.6	1.070578	6428	42.3	1.036128
6329	241.1	1.1872	6379	86.1	1.069411	6429	41.8	1.035759
6330	234.6	1.1823	6380	84.6	1.068267	6430	41.3	1.035396
6331	228.5	1.1776	6381	83.1	1.067147	6431	40.8	1.035036
6332	222.5	1.1731	6382	81.6	1.066052	6432	40.4	1.034684
6333	216.9	1.1688	6383	80.2	1.064982	6433	39.9	1.034338
6334	211.4	1.1647	6384	78.9	1.063937	6434	39.5	1.033999
6335	206.2	1.1607	6385	77.5	1.062916	6435	39.0	1.033666
6336	201.1	1.1568	6386	76.2	1.061919	6436	38.6	1.033339
6337	196.3	1.1532	6387	74.9	1.060947	6437	38.2	1.033019
6338	191.6	1.1496	6388	73.7	1.060000	6438	37.8	1.032704
6339	187.1	1.1462	6389	72.5	1.059077	6439	37.4	1.032395
6340	182.7	1.1429	6390	71.3	1.058177	6440	37.0	1.032092
6341	178.5	1.1397	6391	70.1	1.057299			
6342	174.5	1.1366	6392	69.0	1.056444			
6343	170.6	1.1336	6393	67.9	1.055611			
6344	166.8	1.1308	6394	66.8	1.054798			
6345	163.1	1.1280	6395	65.8	1.054007			
6346	159.6	1.1253	6396	64.8	1.053235			
6347	156.2	1.1227	6397	63.8	1.052482			
6348	152.9	1.1202	6398	62.8	1.051748			
6349	149.7	1.1178	6399	61.9	1.051032			
6350	146.6	1.1154	6400	61.0	1.050333			

Table 16. Comparison of Mono Lake Water with Ocean Water

	Mono Lake Water	(%)	Ocean Water	(%)
Standardized TDS (g/l)	100		34.5	
Specific gravity (@25 C)	1.08		1.025	
Sodium (mg/l)	39,260	39.3	10,500	30.3
Calcium (mg/l)	4	0.004	410	1.2
Magnesium (mg/l)	44	0.044	1,350	3.9
Potassium (mg/l)	1,756	1.756	390	1.1
Chloride (mg/l)	23,050	23.05	19,000	54.9
Sulfate (mg/l)	13.135	13.13	2,700	7.8
Bicarbonate (mg/l)	23,825	23.8	142	0.41
Bromide (mg/l)	52*	0.052	67	0.19
Fluoride (mg/l)	65	0.065	1.3	0.004
Phosphate (mg/l)	88	0.088	0.27	
Iodide (mg/l)	13*	0.013	0.06	
Arsenic (mg/l)	17	0.017	0.003	
Silica (mg/l)	28	0.028	6.4	0.018
Boron (mg/l)	475	0.475	4.5	0.013
Organic carbon (mg/l)	62*	0.062	0.1	
Strontium (mg/l)	156*	0.156	8	0.02
Lithium (mg/l)	13*	0.013	0.17	0.0006
Iron (mg/l)	0.4*		0.003	
Manganese	0.02*		0.002	
Aluminum	0.05		0.001	
Copper	0.1		0.003	
Zinc	--		0.01	
Nickel	0.002		0.007	
Tin	0.04		0.0008	
Cobalt	0.001		0.0004	
Lead	--		0.00003	
Mercury	--		0.0002	
Molybdenum	0.001		0.01	
Barium	--		0.02	
Gold	--		0.00001	
Silver	--		0.0003	
Cesium	--		0.0003	

Notes: Ocean composition from Goldberg (1971).

Mono Lake composition from LADWP data 1974-1990 adjusted to 100 g/l and converted from ppm to mg/l.

* Mason (1967) analyses.

Table 17. Water Quality Summary of Mono Lake (1974–1991).

		Samples	Mean	Minimum		Median		Maximum	Previous Analyses	
		(n)		0% IQR	25% IQR	50% IQR	75% IQR	100% IQR		
		LADWP	LADWP	LADWP	LADWP	LADWP	LADWP	LADWP	Russell	Mason
Variable	Units	74–91	74–91	74–91	74–91	74–91	74–91	74–91	1883	1967
Specific Conductance	µS/cm	234	79742	44509	71585	80757	89837	106422		
Total Dissolved Solids	mg/l	203	110870	82097	102166	104874	108078	179841	53.5	71
Alkalinity (as HCO3)	mg/l	240	39580	29495	38874	39707	40459	48128	26524	28260
Hardness (as CaCO3)	mg/l	207	193	106	178	194	216	291		
Calcium	mg/l	238	4.7	0.1	3.6	4.3	3.6	0.1	38	
Magnesium	mg/l	238	44	26	40	44	48	68	184	79
Sodium	mg/l	239	39223	28459	37933	39259	40202	52288	37141	36842
Potassium	mg/l	240	1781	1187	1667	1756	1901	2562	1813	1840
Sulfate	mg/l	240	12972	9476	12527	13135	13622	16071	12589	12894
Chloride	mg/l	255	22721	11542	22395	23047	23453	29045	22838	23000
Silica	mg/l	97	22.4	1.3	8.6	28.1	36.7	63.1	132	
Boron	mg/l	233	485	324	438	474	537	732	84	506
Fluoride	mg/l	232	71	45	62	65	69	135		63
Phosphate	mg/l	126	89	22	82	88	103	182		79
Arsenic	mg/l	231	17	4	14	17	20	26		13
Iron	mg/l	154	0.9	0.1	0.5	0.7	0.9	8.2		0.4

Table 18. Average Temperatures in Mono Lake Tributaries (°C).

DFG Data (1):

Location	Jul 1987	Aug 1987	Sep 1987	Oct 1987	Nov 1987	Dec 1987	Jan 1988	Feb 1988	Mar 1988	Apr 1988	May 1988	Jun 1988	Jul 1988	Aug 1988
Rush Creek at Grant Outlet	16.7	17.2	15.6	12.8		1.7	2.2	2.8	4.4	8.3	12.2	15.0	18.9	19.4
Rush Creek at Mono Lake	16.7	17.2	15.0	12.2	6.7	1.1	1.7	4.4	6.1	9.4	14.4	17.2	20.0	19.4

1991 JSA Data (2):

Location	05/01	05/15	06/04	06/19	07/10	07/23	08/13	08/27
Rush Creek above Grant Lake	8.8	10.9	12.2	13.2	18.0	18.2	17.8	17.8
Rush Creek at Grant Outlet	7.9	9.9	12.9	14.8	18.2	18.2	18.6	18.1
Parker Creek above diversion	7.5	10.5	14.3	11.5	13.6	14.6	15.7	12.4
Walker Creek above diversion	7.7	9.2	15.4	13.2	17.7	17.3	17.1	12.6
Lee Vining Creek below diversion	6.3	9.6	7.4	9.9	13.5	13.1	13.4	11

1991 Data (3):

Location	Jul 1991	Aug 1991	Sep 1991	Oct 1991
Rush Creek at Grant Outlet		18.7	16.2	14.6
Rush Creek at Mono Lake	19.0	18.2	15.6	13.4
Parker Creek above diversion	14.5	14.5	12.3	9.7
Walker Creek above diversion	16.1	14.4	11.9	10.2
Lee Vining Creek below diversion		12.0	9.8	8.2
Lee Vining Creek at Mono Lake	15.0	14.4	11.8	9.4

Notes:

(1): Department of Fish and Game Stream Evaluation Report No. 91–2, Volume 1.
The July 1987 to August 1988 IFIM Study was conducted by Beak Consultants Incorporated.
Values in this table were estimated from report graphs of continous data and converted from °F to °C.

(2): Instantanous data collected during Jones & Stokes 1991 Sampling Program

(3): Calculated averages of continous data

Table 19. Water Quality Summary of Lee Vining Creek (1934 to 1991).

Variable	Units	Samples (n) LADWP 34–47	Samples (n) JSA 91	Mean LADWP 34–47	Mean JSA 91	Minimum 0% IQR LADWP 34–47	Minimum 0% IQR JSA 91	25% IQR LADWP 34–47	25% IQR JSA 91	Median 50% IQR LADWP 34–47	Median 50% IQR JSA 91	75% IQR LADWP 34–47	75% IQR JSA 91	Maximum 100% IQR LADWP 34–47	Maximum 100% IQR JSA 91	Detection Limit LADWP 34–47	Detection Limit JSA 91	% > Detection Limit LADWP 34–47	% > Detection Limit JSA 91
Specific Conductance	µS/cm	103	8	44	40	25	26	36	30	43	44	52	53	85	57		1		100
Total Organic Carbon	mg/l	0	8		3.0		ND		ND		ND		ND		3.0		3		13
Color	units	107	8	7	4	0	ND	5	3	7	5	10	5	25	5		3		75
Turbidity	NTU	107	8	3	0.4	0	0.1	2	0.2	3	0.3	4	0.3	17	1.6		0.1		100
Total Suspended Solids	mg/l	0	8		4		ND		ND		ND		3		6		3		38
Total Dissolved Solids	mg/l	0	8		28		20		23		31		34		37		15		100
Alkalinity (as CaCO3)	mg/l	107	8	18	11	8	6	15	8	18	14	20	14	40	16		2		100
Hardness (as CaCO3)	mg/l	106	8	22	15	3	9	18	11	23	16	26	19	40	20		1		100
Calcium	mg/l	106	8	5	4.9	0.0	3.3	4	3.6	5	5.5	7	6.6	10	6.6		0.1		100
Magnesium	mg/l	105	8	2	0.5	0.1	0.3	2	0.3	2	0.5	3	0.6	7	0.7		0.1		100
Sodium	mg/l	99	8	4	1.7	0.0	0.8	2	1.3	4	1.8	5	2.2	17	2.6		0.5		100
Potassium	mg/l	44	8	1	0.61	0.0	0.41	0.0	0.50	1	0.70	1	0.79	2	0.79		0.01		100
Sulfate	mg/l	98	8	5	4.8	0.0	2.9	3	4.0	5	4.8	7	7.0	14	7.0		2		100
Chloride	mg/l	107	8	2	1	0.0	ND	0.2	ND	1	ND	4	ND	8	1		1		13
Silica	mg/l	97	8	9	6.7	3	4.4	5	4.7	10	7.7	10	8.4	30	8.5		0.1		100
Boron	mg/l	66	8	0.06	0.02	0.00	ND	0.00	ND	0.02	ND	0.05	ND	0.83	0.02		0.02		13
Fluoride	mg/l	87	4	0.04	ND	0.00	ND	0.00	ND	0.00	ND	0.00	ND	0.25	ND		0.1		0
Bromide	mg/l	0	3		ND		ND		ND		ND		ND		ND		0.01		0
Ammonia (as N)	mg/l	0	8		ND		ND		ND		ND		ND		ND		0.05		0
Total Kjeldahl Nitrogen	mg/l	107	8	0.16	ND	0.03	ND	0.10	ND	0.12	ND	0.17	ND	1.26	ND		0.5		0
Nitrate (as N)	mg/l	107	8	0.02	ND	0.00	ND	0.00	ND	0.00	ND	0.00	ND	0.60	ND		0.2		0
Total Phosphate	mg/l	0	8		0.02		ND		ND		ND		ND		0.02		0.02		13
Dissolved Phosphate	mg/l	54	0	0.06		0.00		0.02		0.03		0.05		0.97					
Silver	µg/l	0	4		ND		ND		ND		ND		ND		ND		1		0
Aluminium	µg/l	0	4		108		ND		ND		75		140		140		50		50
Arsenic	µg/l	0	4		ND		ND		ND		ND		ND		ND		4		0
Barium	µg/l	0	4		ND		ND		ND		ND		ND		ND		10		0
Cadmium	µg/l	0	4		ND		ND		ND		ND		ND		ND		0.1		0
Chromium	µg/l	0	4		ND		ND		ND		ND		ND		ND		10		0
Copper	µg/l	0	8		ND		ND		ND		ND		ND		ND		20		0
Iron	µg/l	41	8	113	70	50	ND	50	ND	100	51	150	86	400	110		30		63
Mercury	µg/l	0	4		ND		ND		ND		ND		ND		ND		0.1		0
Manganese	µg/l	0	8		ND		ND		ND		ND		ND		ND		10		0
Lead	µg/l	0	4		ND		ND		ND		ND		ND		ND		1		0
Selenium	µg/l	0	4		ND		ND		ND		ND		ND		ND		1		0
Zinc	µg/l	0	8		ND		ND		ND		ND		ND		ND		10		0

Table 20. Water Quality Summary of Walker Creek (1991).

		Samples	Mean	Minimum		Median		Maximum	Detection	%>Detection
				0% IQR	25% IQR	50% IQR	75% IQR	100% IQR	Limit	Limit
		JSA	JSA	JSA	JSA	JSA	JSA	JSA	JSA	JSA
Variable	Units	91	91	91	91	91	91	91	91	91
Specific Conductance	µS/cm	8	44	37	38	40	51	61	1	100
Total Organic Carbon	mg/l	8	3.2	ND	ND	ND	3.1	3.3	3	25
Color	units	8	6	5	5	10	10	10	3	100
Turbidity	NTU	8	1.2	0.3	0.5	0.5	0.8	5.8	0.1	100
Total Suspended Solids	mg/l	8	8	ND	4	5	7	26	3	88
Total Dissolved Solids	mg/l	8	32	22	27	30	42	44	15	100
Alkalinity (as CaCO3)	mg/l	8	12	8	10	12	15	16	2	100
Hardness (as CaCO3)	mg/l	8	14	8.5	12	12	15	22	1	100
Calcium	mg/l	8	4.7	3.8	4.0	4.3	4.8	7.8	0.1	100
Magnesium	mg/l	8	0.60	0.49	0.51	0.56	0.81	0.81	0.1	100
Sodium	mg/l	8	2.3	1.6	2.0	2.2	3.0	3.2	0.5	100
Potassium	mg/l	8	0.79	0.64	0.68	0.73	1.00	1.10	0.01	100
Sulfate	mg/l	8	5.9	4.6	5.0	5.8	6.0	10.0	2	100
Chloride	mg/l	8	1.0	ND	ND	ND	1.0	1.0	1	63
Silica	mg/l	8	8.6	6.3	7.1	7.9	12.0	13.0	0.1	100
Boron	mg/l	8	ND	ND	ND	ND	ND	ND	0.02	0
Fluoride	mg/l	4	ND	ND	ND	ND	ND	ND	0.1	0
Bromide	mg/l	3	ND	ND	ND	ND	ND	ND	0.01	0
Ammonia (as N)	mg/l	8	ND	ND	ND	ND	ND	ND	0.05	0
Total Kjeldahl Nitrogen	mg/l	8	ND	ND	ND	ND	ND	ND	0.5	0
Nitrate (as N)	mg/l	8	ND	ND	ND	ND	ND	ND	0.2	0
Total Phosphate	mg/l	8	0.04	ND	ND	ND	0.02	0.07	0.02	38
Dissolved Phosphate	mg/l	0								
Silver	µg/l	4	ND	ND	ND	ND	ND	ND	1	0
Aluminium	µg/l	4	165	ND	ND	120	210	210	50	50
Arsenic	µg/l	4	ND	ND	ND	ND	ND	ND	4	0
Barium	µg/l	4	26	ND	ND	ND	26	26	10	25
Cadmium	µg/l	4	ND	ND	ND	ND	ND	ND	0.1	0
Chromium	µg/l	4	ND	ND	ND	ND	ND	ND	10	0
Copper	µg/l	8	ND	ND	ND	ND	ND	ND	20	0
Iron	µg/l	8	87	ND	ND	ND	78	150	30	38
Mercury	µg/l	4	ND	ND	ND	ND	ND	ND	0.1	0
Manganese	µg/l	8	ND	ND	ND	ND	ND	ND	10	0
Lead	µg/l	4	ND	ND	ND	ND	ND	ND	1	0
Selenium	µg/l	4	ND	ND	ND	ND	ND	ND	1	0
Zinc	µg/l	8	ND	ND	ND	ND	ND	ND	10	0

Table 21. Water Quality Summary of Parker Creek (1991).

		Samples	Mean	Minimum		Median		Maximum	Detection	% > Detection
				0% IQR	25% IQR	50% IQR	75% IQR	100% IQR	Limit	Limit
		JSA	JSA	JSA	JSA	JSA	JSA	JSA	JSA	JSA
Variable	**Units**	91	91	91	91	91	91	91	91	91
Specific Conductance	µS/cm	8	54	46	48	52	64	66	1	100
Total Organic Carbon	mg/l	8	4.5	ND	ND	ND	4.2	4.8	3	25
Color	units	8	6	ND	ND	3	10	10	3	50
Turbidity	NTU	8	1.5	0.3	0.5	0.6	1.4	7.3	0.1	100
Total Suspended Solids	mg/l	8	9	ND	4	4	4	40	3	88
Total Dissolved Solids	mg/l	8	37	26	32	38	42	46	15	100
Alkalinity (as CaCO3)	mg/l	8	13	10	10	14	18	18	2	100
Hardness (as CaCO3)	mg/l	8	19	14	18	20	22	23	1	100
Calcium	mg/l	8	6.8	3.9	6.5	7.6	7.7	7.8	0.1	100
Magnesium	mg/l	8	0.57	0.45	0.51	0.55	0.69	0.74	0.1	100
Sodium	mg/l	8	1.8	1.0	1.2	1.6	2.6	2.9	0.5	100
Potassium	mg/l	8	0.78	0.51	0.55	0.69	0.93	1.50	0.01	100
Sulfate	mg/l	8	7.8	6.0	7.4	8.0	8.2	9.5	2	100
Chloride	mg/l	8	1.0	ND	ND	ND	ND	1.0	1	13
Silica	mg/l	8	8.9	5.4	7.7	9.6	11.0	13.0	0.1	100
Boron	mg/l	8	ND	ND	ND	ND	ND	ND	0.02	0
Fluoride	mg/l	4	ND	ND	ND	ND	ND	ND	0.1	0
Bromide	mg/l	3	ND	ND	ND	ND	ND	ND	0.01	0
Ammonia (as N)	mg/l	8	ND	ND	ND	ND	ND	ND	0.05	0
Total Kjeldahl Nitrogen	mg/l	8	1.3	ND	ND	ND	ND	1.3	0.5	13
Nitrate (as N)	mg/l	8	ND	ND	ND	ND	ND	ND	0.2	0
Total Phosphate	mg/l	8	0.06	ND	ND	ND	0.04	0.08	0.02	25
Dissolved Phosphate	mg/l	0								
Silver	µg/l	4	ND	ND	ND	ND	ND	ND	1	0
Aluminium	µg/l	4	280	ND	ND	130	430	430	50	50
Arsenic	µg/l	4	ND	ND	ND	ND	ND	ND	4	0
Barium	µg/l	4	16	ND	14	15	19	19	10	75
Cadmium	µg/l	4	1.8	ND	ND	ND	1.8	1.8	0.1	25
Chromium	µg/l	4	1	ND	ND	ND	1	1	10	25
Copper	µg/l	8	ND	ND	ND	ND	ND	ND	20	0
Iron	µg/l	8	94	ND	ND	39	130	160	30	50
Mercury	µg/l	4	ND	ND	ND	ND	ND	ND	0.1	0
Manganese	µg/l	8	ND	ND	ND	ND	ND	ND	10	0
Lead	µg/l	4	1	ND	ND	ND	4	4	1	25
Selenium	µg/l	4	ND	ND	ND	ND	ND	ND	1	0
Zinc	µg/l	8	ND	ND	ND	ND	ND	ND	10	0

Table 22. Water Quality Summary of Rush Creek (1991).

Variable	Units	Samples JSA 91	Mean JSA 91	Minimum 0% IQR JSA 91	25% IQR JSA 91	Median 50% IQR JSA 91	75% IQR JSA 91	Maximum 100% IQR JSA 91	Detection Limit JSA 91	%>Detection Limit JSA 91
Specific Conductance	µS/cm	8	57	39	45	51	81	92	1	100
Total Organic Carbon	mg/l	8	5.5	ND	ND	ND	3.5	9.5	3	38
Color	units	8	6	ND	5	5	5	10	3	88
Turbidity	NTU	8	0.5	0.3	0.3	0.4	0.6	1.4	0.1	100
Total Suspended Solids	mg/l	8	6	ND	ND	ND	7	7	3	38
Total Dissolved Solids	mg/l	8	38	25	30	31	56	60	15	100
Alkalinity (as CaCO3)	mg/l	8	20	12	16	18	30	34	2	100
Hardness (as CaCO3)	mg/l	8	21	13	17	20	31	34	1	100
Calcium	mg/l	8	7.3	4.7	6.2	7.2	10	11	0.1	100
Magnesium	mg/l	8	0.67	0.42	0.50	0.59	1.00	1.20	0.1	100
Sodium	mg/l	8	2.1	1.3	1.5	1.8	3.5	3.6	0.5	100
Potassium	mg/l	8	0.70	0.51	0.57	0.63	0.90	1.00	0.01	100
Sulfate	mg/l	8	3.6	2.5	3.1	3.9	4.0	5.0	2	100
Chloride	mg/l	8	2.0	ND	ND	1	3	3	1	63
Silica	mg/l	8	7.8	6.0	6.4	7.1	11	11	0.1	100
Boron	mg/l	8	0.04	ND	ND	ND	0.04	0.04	0.02	25
Fluoride	mg/l	4	ND	ND	ND	ND	ND	ND	0.1	0
Bromide	mg/l	3	ND	ND	ND	ND	ND	ND	0.01	0
Ammonia (as N)	mg/l	8	ND	ND	ND	ND	ND	ND	0.05	0
Total Kjeldahl Nitrogen	mg/l	8	ND	ND	ND	ND	ND	ND	0.5	0
Nitrate (as N)	mg/l	8	ND	ND	ND	ND	ND	ND	0.2	0
Total Phosphate	mg/l	8	0.09	ND	ND	ND	0	0	0.02	25
Dissolved Phosphate	mg/l	0								
Silver	µg/l	4	ND	ND	ND	ND	ND	ND	1	0
Aluminium	µg/l	4	120	ND	ND	ND	120	120	50	25
Arsenic	µg/l	4	4	ND	ND	ND	4	4	4	25
Barium	µg/l	4	ND	ND	ND	ND	ND	ND	10	0
Cadmium	µg/l	4	1.6	ND	ND	ND	1.6	1.6	0.1	25
Chromium	µg/l	4	2	ND	ND	ND	2	2	1	25
Copper	µg/l	8	ND	ND	ND	ND	ND	ND	20	0
Iron	µg/l	8	103	ND	ND	ND	96	110	30	25
Mercury	µg/l	4	ND	ND	ND	ND	ND	ND	0.1	0
Manganese	µg/l	8	35	ND	ND	ND	29	41	10	25
Lead	µg/l	4	1	ND	ND	ND	1	1	1	25
Selenium	µg/l	4	ND	ND	ND	ND	ND	ND	1	0
Zinc	µg/l	8	14	ND	ND	ND	12	16	10	25

Table 23. Water Quality Summary of Grant Lake Surface (1991).

		Samples	Mean	Minimum 0% IQR	25% IQR	Median 50% IQR	75% IQR	Maximum 100% IQR	Detection Limit	%>Detection Limit
		JSA	JSA	JSA	JSA	JSA	JSA	JSA	JSA	JSA
Variable	Units	91	91	91	91	91	91	91	91	91
Specific Conductance	µS/cm	10	63	58	62	63	63	69	1	100
Total Organic Carbon	mg/l	10	3.7	ND	ND	3.5	3.8	4.4	3	60
Color	units	10	7	ND	4	5	5	15	3	90
Turbidity	NTU	10	1.42	0.6	0.9	1.2	1.6	3.2	0.1	100
Total Suspended Solids	mg/l	10	6.4	ND	ND	5	8	11	3	70
Total Dissolved Solids	mg/l	10	40.6	35	36	40	42	53	15	100
Alkalinity (as CaCO3)	mg/l	10	22.1	20	20	22	23	26	2	100
Hardness (as CaCO3)	mg/l	10	23.5	22	22	23	23	30	1	100
Calcium	mg/l	10	7.9	7.4	7.7	7.9	8.1	8.7	0.1	100
Magnesium	mg/l	10	0.8	0.72	0.74	0.79	0.85	0.95	0.1	100
Sodium	mg/l	10	2.6	2.3	2.4	2.5	2.7	3.3	0.5	100
Potassium	mg/l	10	0.9	0.74	0.77	0.81	0.96	1.2	0.01	100
Sulfate	mg/l	10	4.0	3	3.3	4	4	7.6	2	100
Chloride	mg/l	10	1.9	1.6	1.7	2	2	2	1	100
Silica	mg/l	10	6.5	5.4	6.4	6.7	6.9	7.4	0.1	100
Boron	mg/l	10	0.02	ND	ND	0.02	0.02	0.04	0.02	70
Fluoride	mg/l	5		ND	ND	ND	ND	ND	0.1	0
Bromide	mg/l	3		ND	ND	ND	ND	ND	0.01	0
Ammonia (as N)	mg/l	10	0.12	ND	ND	ND	ND	0.12	0.05	10
Total Kjeldahl Nitrogen	mg/l	10	0.8	ND	ND	ND	ND	1	0.5	20
Nitrate (as N)	mg/l	10		ND	ND	ND	ND	ND	0.2	0
Total Phosphate	mg/l	10	0.03	ND	ND	0.02	0.02	0.05	0.02	50
Dissolved Phosphate	mg/l	10		ND	ND	ND	ND	ND	0.02	0
Chlorophyll a	µg/l	6	5.8	0.9	1	6.4	9	13.3	0.5	100
Silver	µg/l	0							1	
Aluminium	µg/l	0							50	
Arsenic	µg/l	0							4	
Barium	µg/l	0							10	
Cadmium	µg/l	0							0.1	
Chromium	µg/l	0							10	
Copper	µg/l	10		ND	ND	ND	ND	ND	20	0
Iron	µg/l	10	104	ND	ND	31	60	330	30	50
Mercury	µg/l	0							0.1	
Manganese	µg/l	10	22.5	ND	ND	ND	15	39	10	40
Lead	µg/l	0							1	
Selenium	µg/l	0							1	
Zinc	µg/l	10	24.3	ND	ND	ND	20	30	10	40

Table 24. Water Quality Summary of Grant Lake Outlet (1940 – 1991).

		Samples (n)		Mean		Minimum 0% IQR		25% IQR		Median 50% IQR		75% IQR		Maximum 100% IQR		Detection Limit		% > Detection Limit	
Variable	Units	LADWP 40–90	JSA 91	LADWP 40–90	JSA 91	LADWP 40–90	JSA 91	LADWP 40–90	JSA 91	LADWP 40–90	JSA 91	LADWP 40–90	JSA 91	LADWP 40–90	JSA 91	LADWP 40–90	JSA 91	LADWP 40–90	JSA 91
Specific Conductance	µS/cm	354	10	59	61	40	58	52	60	56	61	63	62	165	63		1		100
Total Organic Carbon	mg/l	2	10	0.9	2	0.8	ND	0.8	ND	0.9	3	0.9	4	0.9	4		3		100
Color	units	351	10	6	5	0	ND	1	3	5	5	5	5	38	15		3		100
Turbidity	NTU	351	10	3.0	1	0.0	1	1.0	1	2.0	1	3.6	2	28	3		0.1		100
Total Suspended Solids	mg/l	0	10		4		ND		ND		4		4		10		3		100
Total Dissolved Solids	mg/l	0	10		37		31		34		37		41		47		15		100
Alkalinity (as CaCO3)	mg/l	353	10	18	22	10	20	15	22	18	22	20	22	31	26		2		100
Hardness (as CaCO3)	mg/l	354	10	21	24	12	20	18	22	20	23	23	23	41	38		1		100
Calcium	mg/l	354	10	6.6	8	0.0	7	5.6	8	6.4	8	7.2	8	12	9		0.1		100
Magnesium	mg/l	353	10	1.0	1	0.0	1	0.5	1	0.8	1	1.1	1	5	1		0.1		100
Sodium	mg/l	354	10	2.7	2	0.0	2	2.0	2	2.5	3	3.5	3	10	3		0.5		100
Potassium	mg/l	345	10	0.7	1	0.0	1	0.5	1	0.7	1	1	1	4	1		0.01		100
Sulfate	mg/l	353	10	4.8	4	0.0	3	3.0	4	4.5	4	6.0	4	18	4		2		100
Chloride	mg/l	354	10	1.8	2	0.0	1	1.0	2	1.4	2	2.0	2	9.2	2		1		100
Silica	mg/l	352	10	6	6	1	5	5	6	6	7	7	7	20	7		0.1		100
Boron	mg/l	210	10	0.04	0	0.00	ND	0.00	ND	0.02	ND	0.04	0	0.33	0		0.02		100
Fluoride	mg/l	354	5	0.05	0	0.00	ND	0.00	ND	0.02	ND	0.10	ND	0.40	ND		0.1		100
Bromide	mg/l	0	3		0		ND		ND		ND		ND		ND		0.01		100
Ammonia (as N)	mg/l	0	10		0		ND		ND		ND		ND		0		0.05		100
Total Kjeldahl Nitrogen	mg/l	350	10	0.22	0	0.02	ND	0.12	ND	0.20	ND	0.26	ND	0.96	ND		0.5		100
Nitrate (as N)	mg/l	342	10	0.06	0	0.00	ND	0.00	ND	0.05	ND	0.10	ND	0.45	ND		0.2		100
Total Phosphate	mg/l	0	10		0		ND		ND		ND		0		0		0.02		40
Dissolved Phosphate	mg/l	174	0	0.025		0.000		0.007		0.016		0.026		0.490					
Silver	µg/l	0	6		0		ND		ND		ND		ND		ND		1		0
Aluminium	µg/l	0	6		92		ND		ND		120		200		230		50		50
Arsenic	µg/l	90	6	10	ND	10	ND	10	ND	10	ND	10	ND	20	ND		4		0
Barium	µg/l	0	6		ND		ND		ND		ND		ND		ND		10		0
Cadmium	µg/l	0	6		0		ND		ND		0		0		0		0.1		50
Chromium	µg/l	0	6		ND		ND		ND		ND		ND		ND		10		0
Copper	µg/l	0	10		ND		ND		ND		ND		ND		ND		20		0
Iron	µg/l	353	10	38	45	0	ND	10	ND	20	36	50	64	300	230		30		50
Mercury	µg/l	0	6		ND		ND		ND		ND		ND		ND		0.1		0
Manganese	µg/l	0	10		13		ND		ND		12		30		39		10		50
Lead	µg/l	0	6		ND		ND		ND		ND		ND		ND		1		0
Selenium	µg/l	0	6		ND		ND		ND		ND		ND		ND		1		0
Zinc	µg/l	0	10		ND		ND		ND		ND		ND		ND		10		0

Table 25. JSA 1991 Sampling Program: Results from July 23–25 Grant Lake Sediment Sampling.

Variable:	Units:	Grant Lk Sed 1:	Grant Lk Sed 2:	Grant Lk Sed 3:	Grant Lk Sed 4:	Grant Lk Avg.:	Igneous Rocks (b)	Soil Mean (c)	Soil Range (c)	Soil Mean (d)	Soil Range (d)	Sediment Mean (d)	Sediment Range (d)
Moisture	%	67	74	76	48	66							
Laboratory pH	−log(H+)	7.0	6.8	6.5	6.0	6.6							
Alkalinity (as CaCO3)	mg/kg	<6.1	<7.7	<8.3	<3.8								
Chloride	mg/kg	<30	<38	110	52	81	305						
Sulfate	mg/kg	240	220	170	77	177	410						
Hardness (as CaCO3)	mg/kg	210	150	170	38	142							
Calcium	mg/kg	5800	2700	3200	2300	3500	36200	24000	(<150−320000)				
Magnesium	mg/kg	8800	6200	5000	2700	5675	17600	9200	(50−100000)				
Sodium	mg/kg	450	230	180	88	237	28100	12000	(<500−100000)				
Potassium	mg/kg	5200	3800	3000	480	3120	25700	23000	(50−70000)				
Silica	mg/kg	940000	810000	880000	1700000	1082500	285000						
Boron	mg/kg	27	20	20	8.5	19	7.5	34	(20−300)	23	(5.8−91)	0.8	(<0.4−2.7)
Fluoride	mg/kg	180	190	170	92	158	715						
Bromide	mg/kg	<0.30	<0.38	<0.42	<0.19		2.4						
Alk/Hardness Ratio		0.00	0.00	0.00	0.00	0.00							
CA/Mg Ratio		0.66	0.44	0.64	0.85	0.65							
Ammonia (as N)	mg/kg	64	92	46	15	54	46						
Total Kjeldahl Nitrogen	mg/kg	1400	2400	3600	1600	2250							
Nitrate (as N)	mg/kg	<30	<38	<42	<19								
Total Phosphate	mg/kg	940	1100	960	460	865	1.1	420	(20−6000)				
Total Organic Carbon	mg/kg	10000	20000	28000	21000	19750							
Aluminium	mg/kg	21000	16000	16000	8100	15275	79500	66000	(700−>100000)				
Iron	mg/kg	24000	19000	16000	7500	16625	42200	25000	(100−100000)				
Manganese	mg/kg	850	620	710	150	583	937	560	(<1−7000)				
Arsenic	mg/kg	6.7	4.2	5.8	3.5	5	1.8			5.5	(1.2−22)	6.3	(0.6−16)
Barium	mg/kg	210	170	170	58	152	595	554	(15−5000)	580	(200−1,700)	240	(67−520)
Cadmium	mg/kg	<1.5	<1.9	<2.1	<1.0		0.19					<2	
Chromium	mg/kg	16	13	14	9.0	13	198	53	(1−1500)	41	(8.5−200)	49	(21−170)
Copper	mg/kg	42	35	33	18	32	97	25	(1−300)	21	(4.9−90)	36	(19−67)
Lead	mg/kg	36	35	40	19	33	16	20	(10−700)	17	(5.2−55)	5	(<4−46)
Mercury	mg/kg	<0.15	<0.19	<0.21	<0.1		0.33			0.046	(.0085−.25)	0.04	(<0.02−0.22)
Selenium	mg/kg	<1.5	<1.9	<2.1	<1.0		0.05			0.23	(0.39−1.4)	0.6	(0.1−0.7)
Silver	mg/kg	<1.5	<1.9	<2.1	<1.0		0.15						
Zinc	mg/kg	140	130	170	69	127	80	54	(25−2000)	55	(17−180)	53	(23−77)

Notes:

a. Data sampled by Joanna Field and Simon Page of Jones & Stokes Associates and analyzed by ANLAB Analytical Laboratories (Report # 136373)

b. Horns and Adams 1966, USGS Paper 2254, Study and Interpretation of the Chemical Characteristics of Natural Waters

c. Shacklettte 1971, USGS Paper 574−D, Elemental Composition of Surficial Materials in the Conterminous United States

d. Shacklette and Boerngen 1984, USGS Paper 1270, Element Concentrations in Soils and Other Surficial Materials on the Conterminous United States (Western United States).

e. TTLC: Total Threshold Limit Concentration (Human Health Standard)

Table 26. Water Quality Summary of East Portal (1940 – 1991).

		Samples (n)		Mean		Minimum 0% IQR		25% IQR		Median 50% IQR		75% IQR		Maximum 100% IQR		Detection Limit		% > Detection Limit	
		LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWI	JSA
Variable	Units	40–82	91	40–82	91	40–82	91	40–82	91	40–82	91	40–82	91	40–82	91	40–82	91	40–82	91
Specific Conductance	µS/cm	291	8	177	422	26	408	91	416	116	423	162	430	623	433		1		100
Total Organic Carbon	mg/l	0	8		ND		ND		ND		ND		ND		ND		3		0
Color	units	0	8		5		ND		ND		3		5		5		3		50
Turbidity	NTU	48	8	4	1.1	0	0.4	2	0.5	3	1.4	4	1.6	20	2.0		0.1		100
Total Suspended Solids	mg/l	0	8		9		ND		ND		ND		ND		9		3		13
Total Dissolved Solids	mg/l	0	8		263		240		260		260		280		280		15		100
Alkalinity (as CaCO3)	mg/l	177	8	85	213	25	200	35	210	45	210	183	220	243	220		2		100
Hardness (as CaCO3)	mg/l	289	8	73	181	16	170	34	180	44	180	64	180	206	200		1		100
Calcium	mg/l	149	8	24	40	5	38	12	39	14	40	42	42	47	44		0.1		100
Magnesium	mg/l	140	8	10	18	1.3	17	3.3	18	4.5	18	19	18	24	18		0.1		100
Sodium	mg/l	49	8	18	22	2	20	17	21	19	22	21	23	28	23		0.5		100
Potassium	mg/l	34	8	2	3.1	1	2.8	2	2.9	2	3.1	3	3.4	4	3.6		0.01		100
Sulfate	mg/l	50	8	8	6.7	0	6.0	6	6.3	8	7.0	10	7.0	16	7.0		2		100
Chloride	mg/l	50	8	6	7.3	0.6	6.0	4	7.0	6	7.7	7	8.0	14	8.7		1		100
Silica	mg/l	52	8	28	50	5	41	15	49	30	52	40	54	60	57		0.1		100
Boron	mg/l	105	8	0.10	0.27	0.00	0.25	0.03	0.26	0.07	0.27	0.16	0.28	0.40	0.29		0.02		100
Fluoride	mg/l	49	8	0.2	0.4	0.0	0.3	0.1	0.3	0.2	0.4	0.2	0.4	0.5	0.4		0.1		100
Bromide	mg/l	0	7		0.01		ND		ND		0.01		0.01		0.02		0.01		71
Ammonia (as N)	mg/l	0	8		0.12		ND		ND		ND		0.08		0.16		0.05		25
Total Kjeldahl Nitrogen	mg/l	48	8	0.12	ND	0.04	ND	0.07	ND	0.08	ND	0.14	ND	0.39	ND		0.5		0
Nitrate (as N)	mg/l	50	8	0.04	0.61	0.00	ND	0.00	ND	0.02	ND	0.04	0.21	0.40	1.00		0.2		25
Total Phosphate	mg/l	0	8		0.04		ND		0.02		0.04		0.06		0.08		0.02		88
Dissolved Phosphate	mg/l	41	0	0.22		0.01		0.08		0.12		0.18		2.25					
Silver	µg/l	0	8		ND		ND		ND		ND		ND		ND		1		0
Aluminium	µg/l	0	8		68		ND		ND		ND		60		76		50		25
Arsenic	µg/l	7	8	8	13	2	7	7	11	8	16	10	17	13	20		4		100
Barium	µg/l	0	8		102		89		96		100		110		120		10		100
Cadmium	µg/l	0	8		0.3		0.3		0.3		0.3		0.4		0.4		0.1		100
Chromium	µg/l	0	8		ND		ND		ND		ND		ND		ND		10		0
Copper	µg/l	0	8		ND		ND		ND		ND		ND		ND		20		0
Iron	µg/l	49	8	148	144	0	ND	20	36	50	58	250	380	1000	390		30		88
Mercury	µg/l	0	8		ND		ND		ND		ND		ND		ND		0.1		0
Manganese	µg/l	0	8		224		170		220		230		240		260		10		100
Lead	µg/l	0	8		ND		ND		ND		ND		ND		ND		1		0
Selenium	µg/l	0	8		ND		ND		ND		ND		ND		ND		1		0
Zinc	µg/l	0	8		14		ND		ND		13		15		16		10		50

Table 27. Water Quality Summary of Big Springs (1933 – 1991).

		Samples		Mean		Minimum				Median				Maximum		Detection		% > Detection	
		(n)				0% IQR		25% IQR		50% IQR		75% IQR		100% IQR		Limit		Limit	
		LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA
Variable	Units	33–40	91	33–40	91	33–40	91	33–40	91	33–40	91	33–40	91	33–40	91	33–40	91	33–40	91
Specific Conductance	µS/cm	63	8	173	206	100	166	173	208	181	217	188	221	202	223		1		100
Total Organic Carbon	mg/l	0	8		1.7		ND		ND		ND		3.5		10		3		100
Color	units	66	8	9	8	0	ND	3	5	7	10	10	10	100	15		3		100
Turbidity	NTU	66	8	11	0.8	0	0.3	2	0.4	5	0.5	8	1.6	350	2.1		0.1		100
Total Suspended Solids	mg/l	0	8		15		ND		4		5		11		82		3		100
Total Dissolved Solids	mg/l	0	8		151		120		150		160		160		170		15		100
Alkalinity (as CaCO3)	mg/l	77	8	71	84	13	65	68	85	73	88	78	89	95	92		2		100
Hardness (as CaCO3)	mg/l	77	8	48	45	28	38	45	45	49	47	52	48	66	50		1		100
Calcium	mg/l	77	8	7	6.7	4	5.8	6	6.6	7	6.7	8	7.0	9	7.4		0.1		100
Magnesium	mg/l	77	8	8	6.8	4	5.4	7	6.9	8	7.2	9	7.3	12	7.4		0.1		100
Sodium	mg/l	63	8	24	25	10	18	21	24	24	26	27	28	45	28		0.5		100
Potassium	mg/l	5	8	4	4.2	3	3.7	3	4.2	4	4.2	5	4.6	5	4.7		0.01		100
Sulfate	mg/l	76	8	6	6.8	0	6.0	4	6.6	6	7.0	7	7.0	16	8.0		2		100
Chloride	mg/l	77	8	10	9	0.9	7	9	9	10	9.4	12	11	17	11		1		100
Silica	mg/l	57	8	43	52	20	42	40	47	40	54	50	56	100	62		0.1		100
Boron	mg/l	75	8	0.40	0.40	0.13	0.28	0.35	0.40	0.41	0.42	0.48	0.43	0.78	0.45		0.02		100
Fluoride	mg/l	48	8	0.42	0.5	0.00	0.4	0.35	0.4	0.40	0.5	0.50	0.5	0.75	0.5		0.1		100
Bromide	mg/l	0	7		0.01		ND		ND		ND		0.01		0.02		0.01		43
Ammonia (as N)	mg/l	0	8		0.05		ND		ND		ND		ND		0.05		0.05		13
Total Kjeldahl Nitrogen	mg/l	66	8	0.18	0.9	0.01	ND	0.07	ND	0.10	ND	0.14	0.8	1.56	0.9		0.5		25
Nitrate (as N)	mg/l	66	8	0.01	ND	0.00	ND	0.00	ND	0.00	ND	0.00	ND	0.10	ND		0.2		0
Total Phosphate	mg/l	0	8		0.35		0.30		0.34		0.36		0.37		0.40		0.02		100
Dissolved Phosphate	mg/l	8	0	0.59		0.05		0.25		0.70		0.98		1.23					
Silver	µg/l	0	8		ND		ND		ND		ND		ND		ND		1		0
Aluminium	µg/l	0	8		125		ND		ND		ND		54		270		50		38
Arsenic	µg/l	0	8		17		12		17		17		19		20		4		100
Barium	µg/l	0	8		23		20		21		22		24		27		10		100
Cadmium	µg/l	0	8		0.3		ND		ND		ND		0.2		0.4		0.1		38
Chromium	µg/l	0	8		ND		ND		ND		ND		ND		ND		10		0
Copper	µg/l	0	8		ND		ND		ND		ND		ND		ND		20		0
Iron	µg/l	58	8	15	49	0	ND	0	ND	0	ND	0	40	250	57		30		25
Mercury	µg/l	0	8		0.4		ND		ND		ND		ND		0.4		0.1		13
Manganese	µg/l	0	8		ND		ND		ND		ND		ND		ND		10		0
Lead	µg/l	0	8		ND		ND		ND		ND		ND		ND		1		0
Selenium	µg/l	0	8		ND		ND		ND		ND		ND		ND		1		0
Zinc	µg/l	0	8		ND		ND		ND		ND		ND		ND		10		0

Table 28. Water Quality Summary of Mammoth Creek (1940 – 1991).

Variable	Units	Samples (n)		Mean		Minimum 0% IQR		25% IQR		Median 50% IQR		75% IQR		Maximum 100% IQR		Detection Limit		% > Detection Limit	
		LADWP 40–80	JSA 91	LADWP 40–80	JSA 91	LADWP 40–80	JSA 91	LADWP 40–80	JSA 91	LADWP 40–80	JSA 91	LADWP 40–80	JSA 91	LADWP 40–80	JSA 91	LADWP 40–80	JSA 91	LADWP 40–80	JSA 91
Specific Conductance	µS/cm	159	8	124	97	48	57	93	71	127	89	155	136	309	178		1		100
Total Organic Carbon	mg/l	110	8	2.3	4.8	0.4	ND	1.4	ND	2.2	ND	2.7	4.1	9.0	7.1		3		38
Color	units	176	8	5	11	0	5	3	10	5	10	5	15	20	15		3		100
Turbidity	NTU	174	8	1.9	2.3	0.2	0.3	0.5	0.4	1.0	0.5	2.0	0.7	17.0	15		0.1		100
Total Suspended Solids	mg/l	0	8		26		ND		ND		7		12		75		3		50
Total Dissolved Solids	mg/l	0	8		61		36		50		54		82		110		15		100
Alkalinity (as CaCO3)	mg/l	135	8	55	44	0	24	40	32	58	40	70	61	100	85		2		100
Hardness (as CaCO3)	mg/l	60	8	46	34	24	21	38	26	46	32	52	47	76	58		1		100
Calcium	mg/l	46	8	11	8.3	5	6.0	10	6.8	11	8.4	12	10	17	12		0.1		100
Magnesium	mg/l	46	8	4.8	3.2	1.0	1.3	3.0	2.0	4.9	2.7	6.0	5.1	11	6.9		0.1		100
Sodium	mg/l	213	8	8.7	6.0	0.5	2.7	6.0	4.3	8.5	5.2	11	8.7	18	13		0.5		100
Potassium	mg/l	45	8	2.0	1.5	0.3	0.75	1.5	0.91	2.1	1.1	2.7	2.3	3.5	2.6		0.01		100
Sulfate	mg/l	47	8	6.2	4.0	2.0	2.8	3.7	3.1	5.0	3.7	8.0	5.0	16	7.0		2		100
Chloride	mg/l	213	8	1.1	ND	0.0	ND	0.4	ND	0.4	ND	1.1	ND	9	ND		1		0
Silica	mg/l	35	8	22	15	9.4	8.6	18	11	23	12	28	25	34	30		0.1		100
Boron	mg/l	27	8	0.09	ND	0.00	ND	0.02	ND	0.07	ND	0.16	ND	0.23	ND		0.02		0
Fluoride	mg/l	49	4	0.13	0.1	0.00	ND	0.00	0.1	0.11	0.1	0.21	0.1	0.58	0.1		0.1		75
Bromide	mg/l	0	2		ND		ND		ND		ND		ND		ND		0.01		0
Ammonia (as N)	mg/l	181	8	0.00	ND	0.00	ND	0.00	ND	0.00	ND	0.00	ND	0.07	ND		0.05		0
Total Kjeldahl Nitrogen	mg/l	183	8	0.12	ND	0.00	ND	0.08	ND	0.12	ND	0.16	ND	0.56	ND		0.5		0
Nitrate (as N)	mg/l	209	8	0.20	ND	0.00	ND	0.00	ND	0.02	ND	0.40	ND	1.90	ND		0.2		0
Total Phosphate	mg/l	0	8		0.09		0.04		0.04		0.05		0.08		0.30		0.02		100
Dissolved Phosphate	mg/l	85	0	0.12		0.01		0.05		0.09		0.13		1.70					
Silver	µg/l	0	4		ND		ND		ND		ND		ND		ND		1		0
Aluminium	µg/l	0	4		189		ND		ND		77		300		300		50		50
Arsenic	µg/l	168	4	12	6	0	ND	10	ND	10	6	10	6	50	6		4		50
Barium	µg/l	0	4		29		ND		ND		ND		29		29		10		25
Cadmium	µg/l	0	4		0.8		ND		ND		ND		0.8		0.8		0.1		25
Chromium	µg/l	0	4		ND		ND		ND		ND		ND		ND		10		0
Copper	µg/l	0	8		ND		ND		ND		ND		ND		ND		20		0
Iron	µg/l	44	8	63	84	0	ND	0	ND	60	ND	100	74	200	130		30		38
Mercury	µg/l	0	4		0.8		ND		ND		ND		0.8		0.8		0.1		25
Manganese	µg/l	0	8		39		ND		ND		ND		ND		39		10		13
Lead	µg/l	0	4		2		ND		ND		ND		2		2		1		25
Selenium	µg/l	0	4		ND		ND		ND		ND		ND		ND		1		0
Zinc	µg/l	0	8		ND		ND		ND		ND		ND		ND		10		0

Table 29. Water Quality Summary of Hot Creek (1965 – 1991).

		Samples			Mean			Minimum						Median						Maximum				% > Det
		(n)						0% IQR			25% IQR			50% IQR			75% IQR			100% IQR			Limit	Limit
		LADWP	JSA	USGS	LADWP	JSA	USGS	LADWP	JSA	USGS	LADWP	JSA	USGS	LADWP	JSA	USGS	LADWP	JSA	USGS	LADWP	JSA	USGS	JSA	JSA
Variable	**Units**	65–90	91	82–91	65–90	91	82–91	65–90	91	82–91	65–90	91	82–91	65–90	91	82–91	65–90	91	82–91	65–90	91	82–91	91	91
Specific Conductance	µS/cm	165	8	0	454	506		174	345		384	444		485	557		533	616		672	618		1	100
Total Organic Carbon	mg/l	29	8	0	2.0	4.1		0.7	ND		1.1	ND		1.6	3.3		2.5	4.6		5.6	6.1		3	63
Color	units	163	8	0	8	12		1	3		5	5		6	15		10	15		25	25		3	100
Turbidity	NTU	163	8	0	2.9	1.9		0.4	0.3		1.0	0.5		2.0	1.0		4.0	1.4		16.0	9.2		0.1	100
Total Suspended Solids	mg/l	0	8	0		12			6			6			6			8			50		3	100
Total Dissolved Solids	mg/l	0	8	19		325	306		210	193		280	276		360	311		400	350		400	408	15	100
Alkalinity (as CaCO3)	mg/l	163	8	29	142	154	255	34	100	61	123	140	134	152	170	152	168	180	524	208	190	560	2	100
Hardness (as CaCO3)	mg/l	163	8	20	50	54	52	28	43	32	47	53	53	50	55	56	54	58	57	71	59	58	1	100
Calcium	mg/l	163	8	20	11	12	12	4	10	8	10	12	12	12	12	13	12	13	13	16	13	13	0.1	100
Magnesium	mg/l	163	8	20	5.2	5.5	5.4	2.2	4.2	2.9	4.9	5.6	5.0	5.2	5.9	5.7	5.7	6.0	6.0	10	6.1	6.3	0.1	100
Sodium	mg/l	163	8	20	76	81	65	22	47	20	61	74	53	81	94	69	92	100	78	123	100	100	0.5	100
Potassium	mg/l	163	8	20	6.3	7.9	6.3	1.3	5.9	2.5	5.3	6.7	5.3	6.8	8.5	6.3	7.6	9.5	7.8	9.4	11	9.0	0.01	100
Sulfate	mg/l	163	8	26	23	26	24	8.2	17	8	19	22	19	24	28	24	28	32	30	76	33	38	2	100
Chloride	mg/l	163	8	88	37	45	43	4.9	20	5	29	42	37	40	50	47	46	57	52	67	59	65	1	100
Silica	mg/l	147	8	19	51	55	57	18	39	39	44	47	51	53	62	58	60	64	65	75	71	69	0.1	100
Boron	mg/l	191	8	87	1.6	2.0	2.0	0.35	1.2	0.4	1.2	1.6	1.7	1.6	2.2	2.1	1.9	2.5	2.4	2.9	2.6	2.9	0.02	100
Fluoride	mg/l	233	8	8	1.71	2.0	1.4	0.38	1.2	0.5	1.35	1.6	0.7	1.80	2.2	1.7	2.10	2.5	2.1	3.80	2.6	2.2	0.1	100
Bromide	mg/l	0	7	0		0.09			0.06			0.08			0.10			0.11			0.12		0.01	100
Ammonia (as N)	mg/l	0	8	0		0.11			ND			0.07			0.08			0.16			0.17		0.05	75
Total Kjeldahl Nitrogen	mg/l	149	8	0	0.21	1.3		0.03	ND		0.12	ND		0.16	ND		0.25	ND		0.72	1.3		0.5	13
Nitrate (as N)	mg/l	164	8	11	0.13	0.31	0.58	0.00	ND	0.12	0.03	ND	0.20	0.06	ND	0.22	0.14	ND	0.37	1.80	0.31	3.90	0.2	13
Total Phosphate	mg/l	0	8	0		0.26			0.19			0.24			0.27			0.28			0.31		0.02	100
Dissolved Phosphate	mg/l	144	0	13	0.18		0.14	0.00		0.08	0.13		0.11	0.17		0.13	0.23		0.16	0.64		0.24		
Silver	µg/l	0	8	0		ND			ND			ND			ND			ND			ND		1	0
Aluminium	µg/l	0	8	0		97			ND			56			78			110			180		50	75
Arsenic	µg/l	201	8	49	172	224	193	10	120	52	120	140	140	180	250	170	230	320	260	370	330	350	4	100
Barium	µg/l	0	8	0		31			ND			27			31			35			36		10	88
Cadmium	µg/l	0	8	0		0.1			ND			ND			ND			ND			0.1		0.1	13
Chromium	µg/l	0	8	0		ND			ND			ND			ND			ND			ND		10	0
Copper	µg/l	0	8	0		ND			ND			ND			ND			ND			ND		20	0
Iron	µg/l	161	8	16	67	58	26	10	ND	6	20	ND	17	40	42	21	100	83	32	600	89	70	30	63
Mercury	µg/l	0	8	3.0		0.23	0.2		ND	0.1		ND	0.1		ND	0.1		0.17	0.3		0.30	0.3	0.1	38
Manganese	µg/l	0	8	15		50	22		ND	9		ND	16		ND	20		51	30		73	37	10	38
Lead	µg/l	0	8	0		1			ND			ND			ND			ND			1		1	13
Selenium	µg/l	0	8	0		ND			ND			ND			ND			ND			ND		1	0
Zinc	µg/l	0	8	12		ND	26		ND	4		ND	7		ND	8		ND	12		ND	220	10	0

Table 30. Water Quality Summary of Benton Crossing (1973 – 1991).

		Samples (n)		Mean		Minimum 0% IQR		25% IQR		Median 50% IQR		75% IQR		Maximum 100% IQR		Detection Limit		% > Detection Limit	
Variable	Units	LADWP 73–90	JSA 91	LADWP 73–90	JSA 91	LADWP 73–90	JSA 91	LADWP 73–90	JSA 91	LADWP 73–90	JSA 91	LADWP 73–90	JSA 91	LADWP 73–90	JSA 91	LADWP 73–90	JSA 91	LADWP 73–90	JSA 91
Specific Conductance	µS/cm	83	8	295	452	164	375	214	418	277	476	374	503	560	531		1		100
Total Organic Carbon	mg/l	39	8	2.0	6.8	0.7	3.0	1.0	5.8	1.3	6.6	2.9	8.4	8.7	12.0		3		100
Color	units	82	8	15	38	2	30	6	35	12	40	17	45	70	45		3		100
Turbidity	NTU	82	8	1.4	1.9	0.3	0.5	0.8	1.0	1.0	1.3	1.5	2.5	11	6.5		0.1		100
Total Suspended Solids	mg/l	0	8		16		ND		4		5		23		34		3		75
Total Dissolved Solids	mg/l	0	8		286		240		260		290		330		330		15		100
Alkalinity (as CaCO3)	mg/l	83	8	111	169	60	140	79	160	104	180	143	190	190	200		2		100
Hardness (as CaCO3)	mg/l	83	8	60	91	33	74	46	82	56	98	74	99	100	110		1		100
Calcium	mg/l	67	8	13	19	8	15	10	17	13	19	16	20	24	22		0.1		100
Magnesium	mg/l	67	8	6.9	11	2.9	9	5.4	10	6.3	12	9.2	12	12	13		0.1		100
Sodium	mg/l	67	8	39	59	20	48	25	56	35	62	51	65	74	72		0.5		100
Potassium	mg/l	67	8	4.4	7.0	2.4	5.7	3.2	6.4	4.1	7.0	5.7	7.7	8.2	8.9		0.01		100
Sulfate	mg/l	67	8	12	15	4.6	12	8.2	14	11	16	15	17	23	18		2		100
Chloride	mg/l	67	8	17	30	7.4	19	11	28	16	33	22	35	38	35		1		100
Silica	mg/l	12	8	41	49	27	39	33	49	38	51	54	55	57	55		0.1		100
Boron	mg/l	11	8	0.63	1.2	0.32	1.0	0.40	1.1	0.41	1.3	0.94	1.4	1.1	1.4		0.02		100
Fluoride	mg/l	67	4	0.81	1.2	0.37	1.0	0.57	1.1	0.78	1.3	1.0	1.3	1.4	1.3		0.1		100
Bromide	mg/l	0	2		0.05		0.04		0.04		0.05		0.05		0.05		0.01		100
Ammonia (as N)	mg/l	0	8		0.10		ND		ND		ND		0.07		0.12		0.05		25
Total Kjeldahl Nitrogen	mg/l	26	8	0.19	0.6	0.01	ND	0.11	ND	0.20	0.5	0.24	0.5	0.37	0.8		0.5		50
Nitrate (as N)	mg/l	69	8	0.08	ND	0.01	ND	0.01	ND	0.04	ND	0.10	ND	0.50	ND		0.2		0
Total Phosphate	mg/l	0	8		0.22		0.18		0.21		0.23		0.24		0.24		0.02		100
Dissolved Phosphate	mg/l	83	0	0.20		0.08		0.13		0.16		0.23		0.79					
Silver	µg/l	0	0																
Aluminium	µg/l	0	0																
Arsenic	µg/l	83	0	60		10		40		60		80		170					
Barium	µg/l	0	0																
Cadmium	µg/l	0	0																
Chromium	µg/l	0	0																
Copper	µg/l	0	8		ND		ND		ND		ND		ND		ND		20		0
Iron	µg/l	75	8	36	74	10	ND	20	37	30	50	50	120	120	140		30		75
Mercury	µg/l	0	0																
Manganese	µg/l	0	8		46		ND		ND		16		82		95		10		63
Lead	µg/l	0	0																
Selenium	µg/l	0	0																
Zinc	µg/l	0	8		18		ND		ND		ND		ND		18		10		13

Table 31. Water Quality Summary of Convict Creek (1941 – 1991).

Variable	Units	Samples (n) LADWP 41–83	Samples (n) JSA 91	Mean LADWP 41–83	Mean JSA 91	Minimum 0% IQR LADWP 41–83	Minimum 0% IQR JSA 91	25% IQR LADWP 41–83	25% IQR JSA 91	Median 50% IQR LADWP 41–83	Median 50% IQR JSA 91	75% IQR LADWP 41–83	75% IQR JSA 91	Maximum 100% IQR LADWP 41–83	Maximum 100% IQR JSA 91	Detection Limit LADWP 41–83	Detection Limit JSA 91	% > Detection Limit LADWP 41–83	% > Detection Limit JSA 91
Specific Conductance	µS/cm	56	8	144	160	117	150	135	152	146	159	154	171	189	173		1		100
Total Organic Carbon	mg/l	2	8	0.6	4.4	0.5	ND	0.5	ND	0.6	ND	0.6	ND	0.6	4.4		3		13
Color	units	23	8	2	3	1	ND	1	ND	1	3	3	3	5	4		3		50
Turbidity	NTU	23	8	0.9	0.4	0.1	ND	0.3	0.2	1.0	0.2	1.0	0.3	3.0	1.2		0.1		88
Total Suspended Solids	mg/l	0	8		5		ND		ND		ND		ND		5		3		13
Total Dissolved Solids	mg/l	0	8		98		88		91		100		110		110		15		100
Alkalinity (as CaCO3)	mg/l	23	8	59	64	50	59	58	61	60	64	61	68	65	70		2		100
Hardness (as CaCO3)	mg/l	57	8	65	70	55	26	62	70	65	75	68	80	80	81		1		100
Calcium	mg/l	57	8	25	28	20	27	23	27	25	28	26	29	30	30		0.1		100
Magnesium	mg/l	57	8	0.6	0.46	0.0	0.42	0.1	0.43	0.5	0.45	0.8	0.50	3.2	0.50		0.1		100
Sodium	mg/l	55	8	2.2	1.4	0.0	0.27	1.0	1.4	1.7	1.5	3.0	1.6	11	1.9		0.5		100
Potassium	mg/l	54	8	0.6	0.76	0.0	0.65	0.4	0.67	0.6	0.74	0.8	0.84	1.8	0.99		0.01		100
Sulfate	mg/l	55	8	12	14	7	13	10	13	11	14	12	14	26	15		2		100
Chloride	mg/l	56	8	1.3	ND	0.0	ND	0.4	ND	1.0	ND	2.0	ND	4.3	ND		1		0
Silica	mg/l	52	8	9.3	12	4.8	8.1	7.4	8.6	9.0	8.9	10	9.5	30	38		0.1		100
Boron	mg/l	44	8	0.03	ND	0.00	ND	0.00	ND	0.02	ND	0.05	ND	0.14	ND		0.02		0
Fluoride	mg/l	56	4	0.06	ND	0.00	ND	0.00	ND	0.07	ND	0.10	ND	0.22	ND		0.1		0
Bromide	mg/l	0	2		0.05		ND		ND		0.05		0.05		0.05		0.01		50
Ammonia (as N)	mg/l	0	8		ND		ND		ND		ND		ND		ND		0.05		0
Total Kjeldahl Nitrogen	mg/l	22	8	0.09	1.8	0.00	ND	0.08	ND	0.08	ND	0.08	ND	0.16	1.8		0.5		13
Nitrate (as N)	mg/l	32	8	0.07	ND	0.00	ND	0.02	ND	0.05	ND	0.10	ND	0.34	ND		0.2		0
Total Phosphate	mg/l	0	8		ND		ND		ND		ND		ND		ND		0.02		0
Dissolved Phosphate	mg/l	29	0	0.012		0.003		0.003		0.010		0.016		0.082					
Silver	µg/l	0	4		ND		ND		ND		ND		ND		ND		1		0
Aluminium	µg/l	0	4		ND		ND		ND		ND		ND		ND		50		0
Arsenic	µg/l	17	4	12	6	10	ND	10	ND	10	5	10	7	40	7		4		50
Barium	µg/l	0	4		ND		ND		ND		ND		ND		ND		10		0
Cadmium	µg/l	0	4		0.7		ND		ND		ND		0.7		0.7		0.1		25
Chromium	µg/l	0	4		ND		ND		ND		ND		ND		ND		10		0
Copper	µg/l	0	8		ND		ND		ND		ND		ND		ND		20		0
Iron	µg/l	53	8	13	ND	0	ND	10	ND	10	ND	20	ND	50	ND		30		0
Mercury	µg/l	0	4		ND		ND		ND		ND		ND		ND		0.1		0
Manganese	µg/l	0	8		ND		ND		ND		ND		ND		ND		10		0
Lead	µg/l	0	4		ND		ND		ND		ND		ND		ND		1		0
Selenium	µg/l	0	4		ND		ND		ND		ND		ND		ND		1		0
Zinc	µg/l	0	8		ND		ND		ND		ND		ND		ND		10		0

Table 32. Water Quality Summary of McGee Creek (1941 – 1991).

Variable	Units	Samples (n) LADWP 41–83	Samples (n) JSA 91	Mean LADWP 41–83	Mean JSA 91	Minimum 0% IQR LADWP 41–83	Minimum 0% IQR JSA 91	25% IQR LADWP 41–83	25% IQR JSA 91	Median 50% IQR LADWP 41–83	Median 50% IQR JSA 91	75% IQR LADWP 41–83	75% IQR JSA 91	Maximum 100% IQR LADWP 41–83	Maximum 100% IQR JSA 91	Detection Limit LADWP 41–83	Detection Limit JSA 91	% > Detection Limit LADWP 41–83	% > Detection Limit JSA 91
Specific Conductance	µS/cm	59	8	122	90	63	56	111	69	129	95	134	115	175	122		1		100
Total Organic Carbon	mg/l	1	8	0.5	3.7	0.5	ND	0.5	ND	0.5	ND	0.5	3.3	0.5	4.5		3		38
Color	units	23	8	2	6	1	ND	1	3	1	4	3	5	6	15		3		75
Turbidity	NTU	23	8	1.0	0.8	0.1	0.1	0.4	0.3	1.0	0.3	1.7	0.6	3.0	4.5		0.1		100
Total Suspended Solids	mg/l	0	8		8.2		ND		ND		4.0		4.0		26		3		63
Total Dissolved Solids	mg/l	0	8		59		40		55		59		75		78		15		100
Alkalinity (as CaCO3)	mg/l	58	8	44	31	24	20	41	25	45	33	50	40	63	41		2		100
Hardness (as CaCO3)	mg/l	59	8	52	38	26	24	48	32	54	39	56	48	75	50		1		100
Calcium	mg/l	58	8	20	14	10	8.2	19	11	20	14	21	18	26	19		0.1		100
Magnesium	mg/l	58	8	0.7	0.42	0.0	0.24	0.1	0.30	0.5	0.49	0.9	0.52	3.9	0.62		0.1		100
Sodium	mg/l	56	8	2.5	1.7	0.0	0.79	1.8	1.4	2.5	1.8	3.5	2.1	5.0	2.6		0.5		100
Potassium	mg/l	55	8	0.8	0.79	0.0	0.56	0.6	0.63	0.8	0.90	1.0	0.94	2.0	1.1		0.01		100
Sulfate	mg/l	56	8	13	9.4	5	5.0	11	7.0	13	10	14	12	32	14		2		100
Chloride	mg/l	58	8	1.0	ND	0.0	ND	0.4	ND	0.7	ND	1.0	ND	4.3	ND		1		0
Silica	mg/l	53	8	10	8.6	6.4	6.4	10	6.7	11	9.2	11	10	13	11		0.1		100
Boron	mg/l	41	8	0.05	ND	0.00	ND	0.00	ND	0.02	ND	0.06	ND	0.47	ND		0.02		0
Fluoride	mg/l	56	4	0.1	ND	0.0	ND	0.0	ND	0.1	ND	0.1	ND	0.5	ND		0.1		0
Bromide	mg/l	0	2		ND		ND		ND		ND		ND		ND		0.01		0
Ammonia (as N)	mg/l	0	8		0.05		ND		ND		ND		ND		0.05		0.05		13
Total Kjeldahl Nitrogen	mg/l	23	8	0.07	0.5	0.00	ND	0.04	ND	0.08	ND	0.08	ND	0.20	0.5		0.5		13
Nitrate (as N)	mg/l	34	8	0.08	ND	0.00	ND	0.02	ND	0.09	ND	0.10	ND	0.20	ND		0.2		0
Total Phosphate	mg/l	0	8		0.05		ND		ND		ND		ND		0.05		0.02		13
Dissolved Phosphate	mg/l	30	0	0.018		0.003		0.003		0.010		0.013		0.110					
Silver	µg/l	0	4		ND		ND		ND		ND		ND		ND		1		0
Aluminium	µg/l	0	4		230		ND		ND		100		360		360		50		50
Arsenic	µg/l	19	4	11	ND	10	ND	10	ND	10	ND	10	ND	20	ND		4		0
Barium	µg/l	0	4		ND		ND		ND		ND		ND		ND		10		0
Cadmium	µg/l	0	4		ND		ND		ND		ND		ND		ND		0.1		0
Chromium	µg/l	0	4		ND		ND		ND		ND		ND		ND		10		0
Copper	µg/l	0	8		ND		ND		ND		ND		ND		ND		20		0
Iron	µg/l	54	8	13	67	0	ND	10	ND	10	ND	20	50	60	84		30		25
Mercury	µg/l	0	4		ND		ND		ND		ND		ND		ND		0.1		0
Manganese	µg/l	0	8		ND		ND		ND		ND		ND		ND		10		0
Lead	µg/l	0	4		ND		ND		ND		ND		ND		ND		1		0
Selenium	µg/l	0	4		ND		ND		ND		ND		ND		ND		1		0
Zinc	µg/l	0	8		ND		ND		ND		ND		ND		ND		10		0

Table 33. Water Quality Summary of Hilton Creek (1947 – 1991).

		Samples (n)		Mean		Minimum 0% IQR		25% IQR		Median 50% IQR		75% IQR		Maximum 100% IQR		Detection Limit		% > Detection Limit	
Variable	Units	LADWP 47–80	JSA 91	LADWP 47–80	JSA 91	LADWP 47–80	JSA 91	LADWP 47–80	JSA 91	LADWP 47–80	JSA 91	LADWP 47–80	JSA 91	LADWP 47–80	JSA 91	LADWP 47–80	JSA 91	LADWP 47–80	JSA 91
Specific Conductance	µS/cm	57	8	43	29	24	22	38	24	44	27	48	35	62	43		1		100
Total Organic Carbon	mg/l	1	8	1.2	6.2	1.2	ND	1.2	ND	1.2	ND	0.0	4.3	1.2	10		3		38
Color	units	23	8	6	10	1	4	1	10	5	10	7	15	25	20		3		100
Turbidity	NTU	23	8	1.5	0.6	0.1	0.1	0.5	0.3	1.0	0.6	2.0	0.7	5.5	2		0.1		100
Total Suspended Solids	mg/l	0	8		6		ND		3		4		10		13		3		88
Total Dissolved Solids	mg/l	0	8		21		15		17		20		23		35		15		100
Alkalinity (as CaCO3)	mg/l	24	8	16	12	10	9	14	9	16	12	18	15	20	19		2		100
Hardness (as CaCO3)	mg/l	57	8	15	10	7	8	12	8	14	10	17	12	22	15		1		100
Calcium	mg/l	56	8	5.1	3.6	2.4	2.8	4.7	3.0	4.8	3.7	6.0	4.4	8.0	5.4		0.1		100
Magnesium	mg/l	56	8	0.5	0.24	0.0	0.14	0.1	0.16	0.4	0.21	0.8	0.42	1.7	0.45		0.1		100
Sodium	mg/l	54	8	2.3	1.6	0.0	1.2	1.5	1.4	2.4	1.6	3.0	1.9	6.0	2.2		0.5		100
Potassium	mg/l	54	8	0.5	0.55	0.0	0.37	0.4	0.42	0.5	0.48	0.8	0.86	2.0	0.87		0.01		100
Sulfate	mg/l	53	8	2.7	ND	0.0	ND	1.0	ND	2.0	ND	3.7	ND	15	ND		2		0
Chloride	mg/l	55	8	0.9	ND	0.0	ND	0.4	ND	0.4	ND	1.0	ND	6	ND		1		0
Silica	mg/l	51	8	9.0	6.2	6.0	4.3	8.0	5.1	8.8	5.7	10	9.2	15	9.2		0.1		100
Boron	mg/l	44	8	0.03	ND	0.00	ND	0.00	ND	0.02	ND	0.04	ND	0.12	ND		0.02		0
Fluoride	mg/l	55	4	0.06	ND	0.00	ND	0.00	ND	0.08	ND	0.10	ND	0.20	ND		0.1		0
Bromide	mg/l	0	2		ND		ND		ND		ND		ND		ND		0.01		0
Ammonia (as N)	mg/l	0	8		ND		ND		ND		ND		ND		ND		0.05		0
Total Kjeldahl Nitrogen	mg/l	23	8	0.11	4	0.03	ND	0.08	ND	0.12	ND	0.12	ND	0.24	4		0.5		13
Nitrate (as N)	mg/l	33	8	0.08	ND	0.00	ND	0.02	ND	0.09	ND	0.11	ND	0.20	ND		0.2		0
Total Phosphate	mg/l	0	8		0.04		ND		ND		ND		0.03		0.06		0.02		38
Dissolved Phosphate	mg/l	23	0	0.015		0.003		0.003		0.010		0.016		0.100					
Silver	µg/l	0	4		ND		ND		ND		ND		ND		ND		1		0
Aluminium	µg/l	0	4		67		ND		ND		54		80		80		50		50
Arsenic	µg/l	19	4	10	ND	10	ND	10	ND	10	ND	10	ND	10	ND		4		0
Barium	µg/l	0	4		ND		ND		ND		ND		ND		ND		10		0
Cadmium	µg/l	0	4		0.6		ND		ND		0.1		1.1		1.1		0.1		50
Chromium	µg/l	0	4		ND		ND		ND		ND		ND		ND		10		0
Copper	µg/l	0	8		ND		ND		ND		ND		ND		ND		20		0
Iron	µg/l	52	8	33	111	0	ND	10	ND	20	ND	50	71	150	200		30		38
Mercury	µg/l	0	4		ND		ND		ND		ND		ND		ND		0.1		0
Manganese	µg/l	0	8		ND		ND		ND		ND		ND		ND		10		0
Lead	µg/l	0	4		ND		ND		ND		ND		ND		ND		1		0
Selenium	µg/l	0	4		ND		ND		ND		ND		ND		ND		1		0
Zinc	µg/l	0	8		ND		ND		ND		ND		ND		ND		10		0

Table 34. Water Quality Summary of Crooked Creek (1991).

Variable	Units	Samples JSA 91	Mean JSA 91	Minimum 0% IQR JSA 91	25% IQR JSA 91	Median 50% IQR JSA 91	75% IQR JSA 91	Maximum 100% IQR JSA 91	Detection Limit JSA 91	%>Detection Limit JSA 91
Specific Conductance	µS/cm	8	74	43	57	62	121	128	1	100
Total Organic Carbon	mg/l	8	7.3	ND	4.9	7.5	8.5	8.9	3	75
Color	units	8	6	5	25	25	45	45	3	100
Turbidity	NTU	8	1.1	0.2	1.0	1.1	1.6	2.2	0.1	100
Total Suspended Solids	mg/l	8	8	ND	3	4	11	17	3	75
Total Dissolved Solids	mg/l	8	61	37	46	55	100	100	15	100
Alkalinity (as CaCO3)	mg/l	8	33	16	26	26	58	59	2	100
Hardness (as CaCO3)	mg/l	8	21	12	18	20	30	30	1	100
Calcium	mg/l	8	7.1	3.8	6.1	6.7	9.9	11	0.1	100
Magnesium	mg/l	8	0.85	0.50	0.81	0.84	1.20	1.20	0.1	100
Sodium	mg/l	8	6.6	1.1	4.4	4.6	14	15	0.5	100
Potassium	mg/l	8	2.1	1.1	1.5	1.6	3.1	3.6	0.01	100
Sulfate	mg/l	8	1.9	ND	ND	1.6	2.0	2.1	2	50
Chloride	mg/l	8	1	ND	ND	ND	ND	1	1	13
Silica	mg/l	8	21	11	16	19	32	38	0.1	100
Boron	mg/l	8	ND	ND	ND	ND	ND	ND	0.02	0
Fluoride	mg/l	4	0.2	ND	0.1	0.2	0.2	0.2	0.1	75
Bromide	mg/l	2	ND	ND	ND	ND	ND	ND	0.01	0
Ammonia (as N)	mg/l	8	0.22	ND	ND	ND	ND	0.22	0.05	13
Total Kjeldahl Nitrogen	mg/l	8	0.60	ND	ND	ND	ND	0.60	0.5	13
Nitrate (as N)	mg/l	8	ND	ND	ND	ND	ND	ND	0.2	0
Total Phosphate	mg/l	8	0.04	ND	ND	0.02	0.06	0.06	0.02	50
Dissolved Phosphate	mg/l									
Silver	µg/l	4	ND	ND	ND	ND	ND	ND	1	0
Aluminium	µg/l	4	89	ND	ND	ND	89	89	50	25
Arsenic	µg/l	4	ND	ND	ND	ND	ND	ND	4	0
Barium	µg/l	4	ND	ND	ND	ND	ND	ND	10	0
Cadmium	µg/l	4	ND	ND	ND	ND	ND	ND	0.1	0
Chromium	µg/l	4	ND	ND	ND	ND	ND	ND	10	0
Copper	µg/l	8	ND	ND	ND	ND	ND	ND	20	0
Iron	µg/l	8	347	94	230	350	590	670	30	100
Mercury	µg/l	4	ND	ND	ND	ND	ND	ND	0.1	0
Manganese	µg/l	8	42	ND	ND	ND	36	48	10	25
Lead	µg/l	4	ND	ND	ND	ND	ND	ND	1	0
Selenium	µg/l	4	ND	ND	ND	ND	ND	ND	1	0
Zinc	µg/l	8	ND	ND	ND	ND	ND	ND	10	0

Table 35. Water Quality Summary of Rock Creek (1941 – 1991).

		Samples (n)		Mean		Minimum 0% IQR		25% IQR		Median 50% IQR		75% IQR		Maximum 100% IQR		Detection Limit		% > Detection Limit	
		LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA
Variable	Units	41–80	91	41–80	91	41–80	91	41–80	91	41–80	91	41–80	91	41–80	91	41–80	91	41–80	91
Specific Conductance	µS/cm	53	8	75	36	24	22	59	26	74	34	95	47	135	61		1		100
Total Organic Carbon	mg/l	3	8	0.8	4.2	0.5	ND	0.6	ND	0.6	3.0	1.2	4.8	1.2	5.8		3		50
Color	units	19	8	21	12	1	4	5	5	10	10	30	20	80	30		3		100
Turbidity	NTU	19	8	2.5	1.1	0.1	0.3	1.3	0.4	2.0	0.6	3.2	1.9	8.0	4.0		0.1		100
Total Suspended Solids	mg/l	0	8		5		ND		ND		4		4		6		3		50
Total Dissolved Solids	mg/l	0	8		27		15		18		23		38		51		15		100
Alkalinity (as CaCO3)	mg/l	53	8	28	14	8.8	8	24	10	25	13	35	22	58	25		2		100
Hardness (as CaCO3)	mg/l	54	8	20	9	6.0	6	15	7	18	8	23	12	39	13		1		100
Calcium	mg/l	54	8	6.3	3.0	2.4	2.2	4.8	2.4	6.0	3.0	7.2	3.8	13	4.7		0.1		100
Magnesium	mg/l	54	8	0.9	0.28	0.1	0.16	0.5	0.19	0.8	0.22	1.3	0.47	2.9	0.58		0.1		100
Sodium	mg/l	52	8	6.8	3.4	0.0	1.8	5.5	2.5	7.0	3.1	8.6	4.7	12	6.3		0.5		100
Potassium	mg/l	51	8	1.3	0.67	0.0	0.41	0.8	0.48	1.2	0.59	1.8	1.0	3.9	1.2		0.01		100
Sulfate	mg/l	53	8	4.7	2.8	0.0	ND	3.1	ND	5.0	2.1	6.2	3.0	12	4.0		2		50
Chloride	mg/l	53	8	1.7	ND	0.0	ND	1.0	ND	1.4	ND	2.0	ND	5.7	ND		1		0
Silica	mg/l	51	8	17	8.1	6	4.5	14	6.2	16	7.5	19	12	35	15		0.1		100
Boron	mg/l	40	8	0.03	ND	0.00	ND	0.01	ND	0.02	ND	0.04	ND	0.10	ND		0.02		0
Fluoride	mg/l	53	4	0.15	0.1	0.00	ND	0.10	ND	0.15	ND	0.20	0.1	0.40	0.1		0.1		25
Bromide	mg/l	0	2		ND		ND		ND		ND		ND		ND		0.01		0
Ammonia (as N)	mg/l	0	8		ND		ND		ND		ND		ND		ND		0.05		0
Total Kjeldahl Nitrogen	mg/l	21	8	0.21	ND	0.01	ND	0.08	ND	0.14	ND	0.23	ND	1.00	ND		0.5		0
Nitrate (as N)	mg/l	51	8	0.06	ND	0.00	ND	0.00	ND	0.02	ND	0.09	ND	0.43	ND		0.2		0
Total Phosphate	mg/l	0	8		0.02		ND		ND		ND		ND		0.02		0.02		13
Dissolved Phosphate	mg/l	20	0	0.042		0.003		0.020		0.030		0.078		0.098					
Silver	µg/l	0	4		ND		ND		ND		ND		ND		ND		1		0
Aluminium	µg/l	0	4		70		ND		ND		55		85		85		50		50
Arsenic	µg/l	19	4	11	ND	10	ND	10	ND	10	ND	10	ND	20	ND		4		0
Barium	µg/l	0	4		ND		ND		ND		ND		ND		ND		10		0
Cadmium	µg/l	0	4		ND		ND		ND		ND		ND		ND		0.1		0
Chromium	µg/l	0	4		ND		ND		ND		ND		ND		ND		10		0
Copper	µg/l	0	8		ND		ND		ND		ND		ND		ND		20		0
Iron	µg/l	51	8	222	97	10	ND	100	ND	200	ND	300	120	1000	140		30		38
Mercury	µg/l	0	4		ND		ND		ND		ND		ND		ND		0.1		0
Manganese	µg/l	0	8		ND		ND		ND		ND		ND		ND		10		0
Lead	µg/l	0	4		ND		ND		ND		ND		ND		ND		1		0
Selenium	µg/l	0	4		ND		ND		ND		ND		ND		ND		1		0
Zinc	µg/l	0	8		ND		ND		ND		ND		ND		ND		10		0

Table 36. Water Quality Summary of Crowley Lake Surface at the Dam Arm (1991).

Variable	Units	Samples JSA 91	Mean JSA 91	Minimum 0% IQR JSA 91	25% IQR JSA 91	Median 50% IQR JSA 91	75% IQR JSA 91	Maximum 100% IQR JSA 91	Detection Limit JSA 91	%>Detection Limit JSA 91
Specific Conductance	µS/cm	10	483	466	467	482	501	510	1	100
Total Organic Carbon	mg/l	10	6.4	4.6	5.1	5.6	7.7	11	3	100
Color	units	10	14	10	10	15	15	15	3	100
Turbidity	NTU	10	1.9	1.0	1.3	1.6	2.0	4.0	0.1	100
Total Suspended Solids	mg/l	10	7	ND	4	7	8	11	3	90
Total Dissolved Solids	mg/l	10	291	280	280	280	310	310	15	100
Alkalinity (as CaCO3)	mg/l	10	175	160	170	180	180	190	2	100
Hardness (as CaCO3)	mg/l	10	73	65	68	76	77	80	1	100
Calcium	mg/l	10	19	16	17	20	20	21	0.1	100
Magnesium	mg/l	10	6.5	6.3	6.4	6.4	6.5	6.8	0.1	100
Sodium	mg/l	10	74	66	71	73	75	86	0.5	100
Potassium	mg/l	10	8.0	7.5	7.7	8.0	8.1	9.2	0.01	100
Sulfate	mg/l	10	19	17	18	19	20	21	2	100
Chloride	mg/l	10	37	34	35	38	38	40	1	100
Silica	mg/l	10	24	21	22	24	25	26	0.1	100
Boron	mg/l	10	1.4	1.3	1.3	1.4	1.4	1.5	0.02	100
Fluoride	mg/l	10	1.3	0.1	1.3	1.4	1.4	1.6	0.1	100
Bromide	mg/l	10	0.07	ND	0.06	0.07	0.08	0.08	0.01	90
Ammonia (as N)	mg/l	10	0.10	ND	ND	ND	0.08	0.18	0.05	40
Total Kjeldahl Nitrogen	mg/l	10	0.8	ND	0.6	0.7	0.8	1.1	0.5	90
Nitrate (as N)	mg/l	10	ND	ND	ND	ND	ND	ND	0.2	0
Total Phosphate	mg/l	10	0.10	0.09	0.09	0.10	0.10	0.12	0.02	100
Dissolved Phosphate	mg/l	10	0.05	ND	0.03	0.05	0.07	0.08		90
Chlorophyll a	µg/l	6	31	13	30	34	35	41		100
Silver	µg/l	0								
Aluminium	µg/l	0								
Arsenic	µg/l	0								
Barium	µg/l	0								
Cadmium	µg/l	0								
Chromium	µg/l	0								
Copper	µg/l	10	ND	ND	ND	ND	ND	ND	20	0
Iron	µg/l	10	139	ND	ND	ND	36	320	30	30
Mercury	µg/l	0								
Manganese	µg/l	10	15	ND	ND	ND	15	17	10	40
Lead	µg/l	0								
Selenium	µg/l	0								
Zinc	µg/l	10	31	ND	ND	ND	ND	34	10	20

Table 37. Water Quality Summary of Crowley Lake Surface at Chalk Cliffs (1991).

Variable	Units	Samples JSA 91	Mean JSA 91	Minimum 0% IQR JSA 91	25% IQR JSA 91	Median 50% IQR JSA 91	75% IQR JSA 91	Maximum 100% IQR JSA 91	Detection Limit JSA 91	%>Detection Limit JSA 91
Specific Conductance	µS/cm	9	489	471	474	477	517	519	1	100
Total Organic Carbon	mg/l	9	6.8	5.2	5.8	5.9	8.3	12	3	100
Color	units	9	15	10	15	15	15	20	3	100
Turbidity	NTU	9	2.1	1.1	1.5	2.0	2.5	4.6	0.1	100
Total Suspended Solids	mg/l	9	6	4	4	6	10	11	3	100
Total Dissolved Solids	mg/l	9	294	270	280	290	320	320	15	100
Alkalinity (as CaCO3)	mg/l	9	177	170	170	180	180	190	2	100
Hardness (as CaCO3)	mg/l	9	75	66	71	74	80	80	1	100
Calcium	mg/l	9	19	16	17	19	21	21	0.1	100
Magnesium	mg/l	9	6.5	6.4	6.4	6.5	6.6	6.7	0.1	100
Sodium	mg/l	9	75	66	74	75	80	80	0.5	100
Potassium	mg/l	9	8.0	7.5	7.7	7.9	8.2	9.2	0.01	100
Sulfate	mg/l	9	19	17	17	18	20	21	2	100
Chloride	mg/l	9	37	32	35	36	40	46	1	100
Silica	mg/l	9	23	20	21	24	26	27	0.1	100
Boron	mg/l	9	1.4	1.3	1.3	1.4	1.5	1.5	0.02	100
Fluoride	mg/l	4	1.4	1.4	1.4	1.4	1.4	1.4	0.1	100
Bromide	mg/l	2	0.09	0.08	0.08	0.09	0.09	0.09	0.01	100
Ammonia (as N)	mg/l	9	0.07	ND	ND	ND	0.07	0.07	0.05	33
Total Kjeldahl Nitrogen	mg/l	9	0.8	ND	0.6	0.7	1.0	1.2	0.5	89
Nitrate (as N)	mg/l	9	ND	ND	ND	ND	ND	ND	0.2	0
Total Phosphate	mg/l	9	0.10	0.08	0.09	0.10	0.11	0.14	0.02	100
Dissolved Phosphate	mg/l	9	0.06	ND	0.03	0.06	0.09	0.10	0.02	89
Chlorophyll a	µg/l	6	36	13	16	33	39	80		100
Silver	µg/l	0								
Aluminium	µg/l	0								
Arsenic	µg/l	0								
Barium	µg/l	0								
Cadmium	µg/l	0								
Chromium	µg/l	0								
Copper	µg/l	9	ND	ND	ND	ND	ND	ND	20	0
Iron	µg/l	9	89	ND	ND	ND	37	140	30	22
Mercury	µg/l	0								
Manganese	µg/l	9	18	ND	ND	ND	17	21	10	33
Lead	µg/l	0								
Selenium	µg/l	0								
Zinc	µg/l	9	13	ND	ND	ND	12	13	10	22

Table 38. Water Quality Summary of Crowley Lake Surface at Green Banks (1991).

Variable	Units	Samples JSA 91	Mean JSA 91	Minimum 0% IQR JSA 91	25% IQR JSA 91	Median 50% IQR JSA 91	75% IQR JSA 91	Maximum 100% IQR JSA 91	Detection Limit JSA 91	%>Detection Limit JSA 91
Specific Conductance	µS/cm	9	491	471	474	477	517	519	1	100
Total Organic Carbon	mg/l	9	6.0	5.2	5.8	5.9	8.3	12	3	100
Color	units	9	19	10	15	15	15	20	3	100
Turbidity	NTU	9	1.7	1.1	1.5	2.0	2.5	4.6	0.1	100
Total Suspended Solids	mg/l	9	10	4	4	6	10	11	3	100
Total Dissolved Solids	mg/l	9	302	270	280	290	320	320	15	100
Alkalinity (as CaCO3)	mg/l	9	180	170	170	180	180	190	2	100
Hardness (as CaCO3)	mg/l	9	81	66	71	74	80	80	1	100
Calcium	mg/l	9	19	16	17	19	21	21	0.1	100
Magnesium	mg/l	9	7.9	6.4	6.4	6.5	6.6	6.7	0.1	100
Sodium	mg/l	9	74	66	74	75	80	80	0.5	100
Potassium	mg/l	9	8.0	7.5	7.7	7.9	8.2	9.2	0.01	100
Sulfate	mg/l	9	18	17	17	18	20	21	2	100
Chloride	mg/l	9	36	32	35	36	40	46	1	100
Silica	mg/l	9	33	20	21	24	26	27	0.1	100
Boron	mg/l	9	1.4	1.3	1.3	1.4	1.5	1.5	0.02	100
Fluoride	mg/l	4	1.4	1.4	1.4	1.4	1.4	1.4	0.1	100
Bromide	mg/l	2	0.09	0.08	0.08	0.09	0.09	0.09	0.01	100
Ammonia (as N)	mg/l	9	0.07	ND	ND	ND	0.07	0.07	0.05	33
Total Kjeldahl Nitrogen	mg/l	9	0.8	ND	0.6	0.7	1.0	1.2	0.5	89
Nitrate (as N)	mg/l	9	ND	ND	ND	ND	ND	ND	0.2	0
Total Phosphate	mg/l	9	0.15	0.08	0.09	0.10	0.11	0.14	0.02	100
Dissolved Phosphate	mg/l	9	0.12	ND	0.03	0.06	0.09	0.10	0.02	89
Chlorophyll a	µg/l	6	12	13	16	33	39	80		100
Silver	µg/l	0								
Aluminium	µg/l	0								
Arsenic	µg/l	0								
Barium	µg/l	0								
Cadmium	µg/l	0								
Chromium	µg/l	0								
Copper	µg/l	9	ND	ND	ND	ND	ND	ND	20	0
Iron	µg/l	9	89	ND	ND	ND	37	140	30	22
Mercury	µg/l	0								
Manganese	µg/l	9	18	ND	ND	ND	17	21	10	33
Lead	µg/l	0								
Selenium	µg/l	0								
Zinc	µg/l	9	13	ND	ND	ND	12	13	10	22

Table 39. Water Quality Summary of Crowley Lake Surface at McGee Bay (1991).

Variable	Units	Samples JSA 91	Mean JSA 91	Minimum 0% IQR JSA 91	25% IQR JSA 91	Median 50% IQR JSA 91	75% IQR JSA 91	Maximum 100% IQR JSA 91	Detection Limit JSA 91	% > Detection Limit JSA 91
Specific Conductance	µS/cm	9	491	473	479	491	518	520	1	100
Total Organic Carbon	mg/l	9	5.9	4.4	4.6	6.7	7.0	9.1	3	100
Color	units	9	14	10	15	15	15	20	3	100
Turbidity	NTU	9	2.0	1.0	2.0	2.5	2.5	2.8	0.1	100
Total Suspended Solids	mg/l	9	6	4	6	6	10	10	3	100
Total Dissolved Solids	mg/l	9	287	260	270	290	310	340	15	100
Alkalinity (as CaCO3)	mg/l	9	178	170	170	180	190	190	2	100
Hardness (as CaCO3)	mg/l	9	73	66	69	74	80	82	1	100
Calcium	mg/l	9	18	16	17	20	20	22	0.1	100
Magnesium	mg/l	9	6.5	6.4	6.4	6.5	6.7	6.7	0.1	100
Sodium	mg/l	9	75	73	74	75	77	79	0.5	100
Potassium	mg/l	9	8.0	7.6	7.8	7.8	8.3	9.1	0.01	100
Sulfate	mg/l	9	18	17	18	18	21	21	2	100
Chloride	mg/l	9	39	36	36	38	41	56	1	100
Silica	mg/l	9	24	21	24	24	25	29	0.1	100
Boron	mg/l	9	1.4	1.3	1.3	1.4	1.5	1.5	0.02	100
Fluoride	mg/l	3	1.4	1.4	1.4	1.4	1.4	1.4	0.1	100
Bromide	mg/l	2	0.09	0.08	0.08	0.09	0.09	0.09	0.01	100
Ammonia (as N)	mg/l	9	ND	ND	ND	ND	ND	ND	0.05	0
Total Kjeldahl Nitrogen	mg/l	9	0.6	0.5	0.5	0.7	0.8	0.9	0.5	100
Nitrate (as N)	mg/l	9	ND	ND	ND	ND	ND	ND	0.2	0
Total Phosphate	mg/l	9	0.10	0.09	0.10	0.10	0.10	0.11	0.02	100
Dissolved Phosphate	mg/l	9	0.06	0.03	0.06	0.06	0.08	0.09	0.02	100
Chlorophyll a	µg/l	6	23	15	27	40	40	47		100
Silver	µg/l	0								
Aluminium	µg/l	0								
Arsenic	µg/l	0								
Barium	µg/l	0								
Cadmium	µg/l	0								
Chromium	µg/l	0								
Copper	µg/l	9	ND	ND	ND	ND	ND	ND	20	0
Iron	µg/l	9	ND	ND	ND	ND	ND	ND	30	0
Mercury	µg/l	0								
Manganese	µg/l	9	17	ND	ND	ND	16	17	10	22
Lead	µg/l	0								
Selenium	µg/l	0								
Zinc	µg/l	9	12	ND	ND	ND	ND	12	10	11

Table 40. Water Quality Summary of Crowley Lake Outlet (1940 – 1991).

		Samples (n)		Mean		Minimum 0% IQR		25% IQR		Median 50% IQR		75% IQR		Maximum 100% IQR		Detection Limit		% > Detection Limit	
		LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA	LADWP	JSA
Variable	Units	40–91	91	40–91	91	40–91	91	40–91	91	40–91	91	40–91	91	40–91	91	40–91	91	40–91	91
Specific Conductance	µS/cm	0	10		521		508		512		519		522		546		1		100
Total Organic Carbon	mg/l	65	10	2.6	6.0	1.4	4.4	2.1	4.6	2.6	5.9	3.0	6.2	5.3	10		3		100
Color	units	538	10	12	12	1	5	5	10	10	10	15	15	40	15		3		100
Turbidity	NTU	538	10	3.8	3.0	0.3	0.4	1.6	0.6	3.0	1.0	4.0	1.2	65	22		0.1		100
Total Suspended Solids	mg/l	0	10		6		ND		ND		4		4		15		3		70
Total Dissolved Solids	mg/l	0	10		312		290		300		310		320		340		15		100
Alkalinity (as CaCO3)	mg/l	538	10	121	187	68	170	108	180	118	190	130	190	215	210		2		100
Hardness (as CaCO3)	mg/l	539	10	70	82	38	73	64	80	69	82	76	84	109	91		1		100
Calcium	mg/l	528	10	20	21	10	17	19	20	20	22	22	23	32	25		0.1		100
Magnesium	mg/l	528	10	4.8	6.6	1.5	6.2	3.9	6.4	4.5	6.6	5.4	6.8	11	7.0		0.1		100
Sodium	mg/l	528	10	40.7	74	19	67	33	69	38	76	46	78	106	82		0.5		100
Potassium	mg/l	522	10	4.3	8.2	1.9	7.5	3.6	7.7	4.2	8.2	5.0	8.4	15	9.2		0.01		100
Sulfate	mg/l	524	10	13	19	3.6	15	10	18	12	19	15	20	41	21		2		100
Chloride	mg/l	524	10	19	37	8.5	33	15	35	18	37	21	38	45	40		1		100
Silica	mg/l	449	10	24	26	4	23	19	25	23	26	28	28	55	28		0.1		100
Boron	mg/l	434	10	0.73	1.4	0.31	1.3	0.57	1.4	0.69	1.4	0.85	1.5	1.6	1.5		0.02		100
Fluoride	mg/l	524	10	0.71	1.4	0.31	1.3	0.60	1.3	0.70	1.4	0.80	1.5	1.4	1.5		0.1		100
Bromide	mg/l	0	10		0.08		ND		0.07		0.08		0.08		0.08		0.01		90
Ammonia (as N)	mg/l	0	10		0.94		ND		0.19		0.58		1.0		2.6		0.05		80
Total Kjeldahl Nitrogen	mg/l	465	10	0.430	1.4	0.040	ND	0.280	0.5	0.400	1.2	0.520	1.4	1.768	4.1		0.5		90
Nitrate (as N)	mg/l	511	10	0.113	ND	0.000	ND	0.020	ND	0.090	ND	0.158	ND	1.900	ND		0.2		0
Total Phosphate	mg/l	0	10		0.25		0.10		0.15		0.23		0.28		0.65		0.02		100
Dissolved Phosphate	mg/l	303	0	0.125		0.003		0.069		0.105		0.170		0.600					
Silver	µg/l	0	10		ND		ND		ND		ND		ND		ND		1		0
Aluminium	µg/l	0	10		57		ND		ND		ND		ND		57		50		10
Arsenic	µg/l	325	10	44	94	4	70	30	90	40	94	51	110	150	110		4		100
Barium	µg/l	0	10		32		25		27		34		37		40		10		100
Cadmium	µg/l	0	10		0.3		ND		ND		ND		ND		0.3		0.1		20
Chromium	µg/l	0	10		ND		ND		ND		ND		ND		ND		10		0
Copper	µg/l	0	10		ND		ND		ND		ND		ND		ND		20		0
Iron	µg/l	530	10	40	42	0	ND	10	ND	30	ND	50	38	440	54		30		40
Mercury	µg/l	0	10		0.19		ND		ND		0.18		0.19		0.3		0.1		60
Manganese	µg/l	0	10		121		ND		12		34		210		310		10		80
Lead	µg/l	0	10		ND		ND		ND		ND		ND		ND		1		0
Selenium	µg/l	0	10		ND		ND		ND		ND		ND		ND		1		0
Zinc	µg/l	0	10		21		ND		ND		ND		10		37		10		30

Table 41. Estimated Arsenic Discharges to Crowley Lake

Source	Range of Concentration (μg/l)	Annual Loading (tons)
Hot Creek*	60-1,100	
Gorge only		8.3
Including Mammoth Creek		9.5
Little Hot Creek	600	0.3
Big Springs, East Portal	10-50	2.0
Alkali Lakes and Pond	350-680	1.4
North Landing Runoff	360	0.3
Whitmore Hot Springs	300	0.4
Leighton Springs	70-130	0.2
Convict, McGee, Hilton Creeks	10	0.4
Total		14.5

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* Contribution by Hot Creek along 65%.

Source: U.S. Geological Survey 1976.

Table 42. JSA 1991 Sampling Program: Results from July 23–25 Crowley Lake Sediment Sampling.

Variable:	Units:	Crowley Sed 1: (a)	Crowley Sed 2: (a)	Crowley Sed 3: (a)	Crowley Sed 4: (a)	Crowley Sed 5: (a)	Crowley Sed 6: (a)	Crowley Sed 7: (a)	Crowley Sed 8: (a)	Crowley Avg:	Igneous Rocks (b)	Soil Mean (c)	Soil Range (c)	Soil Mean (d)	Soil Range (d)	Sediment Mean (d)	Sediment Range (d)	TTLC (e)
Moisture	%	91	91	58	84	80	76	35	85	75								
Laboratory pH	−log(H+)	6.7	6.9	7.7	7.5	7.3	7.9	7.9	7.5	7.4								
Alkalinity (as CaCO3)	mg/kg	9300	11000	2000	3900	3400	2700	740	4700	4718								
Chloride	mg/kg	330	480	55	190	180	280	43	290	231	305							
Sulfate	mg/kg	2400	2200	240	2100	1000	240	70	630	1110	410							
Hardness (as CaCO3)	mg/kg	8700	9600	1700	4900	3100	2000	280	3900	4273								
Calcium	mg/kg	11000	17000	6000	12000	11000	2600	1800	13000	9300	36200	24000	(<150−320000)					
Magnesium	mg/kg	3300	3900	2400	3800	6000	2600	2000	6000	3750	17600	9200	(50−100000)					
Sodium	mg/kg	960	1300	400	810	1000	370	550	1100	811	28100	12000	(<500−100000)					
Potassium	mg/kg	1400	1200	860	1200	2400	880	880	2000	1353	25700	23000	(50−70000)					
Silica	mg/kg	640000	600000	1100000	620000	<21000	340000	680000	680000	665714	285000							
Boron	mg/kg	44	51	20	69	48	19	18	49	40	7.5	34	(20−300)	23	(5.8−91)	0.8	(<0.4−2.7)	
Fluoride	mg/kg	120	240	88	190	260	200	140	520	220	715							
Bromide	mg/kg	1.1	1.1	0.23	<0.6	<0.5	<0.4	0.15	<0.7	0.65	2.4							
Alk/Hardness Ratio		1.07	1.15	1.18	0.80	1.10	1.35	2.64	1.21	1.31								
CA/Mg Ratio		3.33	4.36	2.50	3.16	1.83	1.00	0.90	2.17	2.41								
Ammonia (as N)	mg/kg	790	360	38	120	60	58	5.8	110	193	46							
Total Kjeldahl Nitrogen	mg/kg	8700	7600	2000	12000	5500	4200	550	5800	5794								
Nitrate (as N)	mg/kg	<110	<110	<23	<62	<50	<40	<15	<67									
Total Phosphate	mg/kg	700	680	330	690	600	580	200	310	511	1.1	420	(20−6000)					
Total Organic Carbon	mg/kg	41000	38000	14000	95000	28000	5000	5100	36000	32763								
Aluminium	mg/kg	7600	4600	3100	4200	9000	2900	3100	5900	5050	79500	66000	(700−>100000)					
Iron	mg/kg	11000	7100	3800	6200	11000	4100	3700	8000	6863	42200	25000	(100−100000)					
Manganese	mg/kg	360	280	400	2800	380	280	140	310	619	937	560	(<1−7000)					
Arsenic	mg/kg	81	56	7.8	39	29	<4.2	4.2	11	33	1.8			5.5	(1.2−22)	6.3	(0.6−16)	500
Barium	mg/kg	86	66	74	75	120	50	58	80	76	595	554	(15−5000)	580	(200−1,700)	240	(67−520)	
Cadmium	mg/kg	<5.6	<5.6	<1.2	<3.1	<5.0	<2.1	<0.77	<3.3		0.19					<2		
Chromium	mg/kg	<11	<11	3.0	<6.2	9.0	<4.2	2.8	6.7	3	198	53	(1−1500)	41	(8.5−200)	49	(21−170)	
Copper	mg/kg	<11	20	3.1	50	19.0	7.5	4.0	17	17	97	25	(1−300)	21	(4.9−90)	36	(19−67)	
Lead	mg/kg	<56	<56	<12	<31	32	<21	<7.7	<33	32	16	20	(10−700)	17	(5.2−55)	5	(<4−46)	
Mercury	mg/kg	<0.56	<0.56	0.43	<0.31	<0.25	0.62	0.25	<0.33	0.43	0.33			0.046	(.0085−.25)	0.04	(<0.02−0.22)	20
Selenium	mg/kg	<5.6	<5.6	<1.2	<3.1	<2.5	<2.1	<0.77	<3.3		0.05			0.23	(0.39−1.4)	0.6	(0.1−0.7)	
Silver	mg/kg	<5.6	<5.6	<1.2	<3.1	<2.5	<2.1	<0.77	<3.3		0.15							
Zinc	mg/kg	60	33	57	69	60	28	22	40	46	80	54	(25−2000)	55	(17−180)	53	(23−77)	

Notes:

a. Data sampled by Joanna Field and Simon Page of Jones & Stokes Associates and analyzed by ANLAB Analytical Laboratories (Report # 136373)

b. Horns and Adams 1966, USGS Paper 2254, Study and Interpretation of the Chemical Characteristics of Natural Waters

c. Shacklettte 1971, USGS Paper 574−D, Elemental Composition of Surficial Materials in the Conterminous United States

d. Shacklette and Boerngen 1984, USGS Paper 1270, Element Concentrations in Soils and Other Surficial Materials on the Conterminous United States (Western United States).

e. TTLC: Total Threshold Limit Concentration (Human Health Standard)

Table 43. Water Quality Summary of Tinemaha Outlet (1940 – 1991).

		Samples (n)			Mean			Minimum 0% IQR			25% IQR			Median 50% IQR			75% IQR			Maximum 100% IQR		
		LADWP	LADWP	USGS	LADWP	LADWP	USGS	LADWP	LADWP	USGS	LADWP	LADWP	USGS	LADWP	LADWP	USGS	LADWP	LADWP	USGS	LADWP	LADWP	USGS
Variable	Units	40–91	74–86	74–86	40–91	74–86	74–86	40–91	74–86	74–86	40–91	74–86	74–86	40–91	74–86	74–86	40–91	74–86	74–86	40–91	74–86	74–86
Specific Conductance	µS/cm	505	148	103	316	286	287	153	160	158	283	254	259	310	285	288	345	316	320	747	454	422
Total Organic Carbon	mg/l	55	25	37	2.2	2.9	4.7	0.6	1.8	0.0	1.7	2.2	3.5	2.0	2.6	4.3	2.6	3.8	5.9	4.6	4.6	14.0
Color	units	507	148	0	22	23		1	2		11	15		20	20		28	25		240	70	
Turbidity	NTU	507	148	58	12.1	7	6.5	0.2	1.1	0.4	5	3.6	3.4	9	5.7	5.1	15	9.5	9.0	140	50	25.0
Total Suspended Solids	mg/l	0	0	81			39			6			14			21			44			518
Total Dissolved Solids	mg/l	0	0	100			182			82			162			182			200			268
Alkalinity (as CaCO3)	mg/l	507	148	30	110	101	96	52	52	62	100	91	87	109	102	100	120	112	103	283	154	132
Hardness (as CaCO3)	mg/l	507	148	90	76	68	71	40	40	6	69	62	64	76	69	72	82	74	79	182	92	110
Calcium	mg/l	511	148	101	23	21	22	12	12	1	21	19	19	23	21	22	24	23	24	36	28	32
Magnesium	mg/l	508	147	100	4.6	4.0	4.0	1.2	1.2	0.9	3.9	3.4	3.4	4.5	3.9	4.0	5.1	4.4	4.5	24	13	6.3
Sodium	mg/l	504	147	100	36	32	32	13	13	6	30	27	27	34	31	32	40	37	37	92	62	54
Potassium	mg/l	506	147	101	3.9	3.4	3.9	1.1	1.6	1.8	3.3	2.9	3.4	3.8	3.2	3.8	4.4	3.8	4.3	10	5.8	5.9
Sulfate	mg/l	504	147	99	24	21	23	7.3	7.3	5	18	16	18	22	20	21	28	24	26	84	51	46
Chloride	mg/l	507	147	101	15	13	13	3.2	3.2	4	12	10	11	15	12	13	18	15	16	46	30	25
Silica	mg/l	411	90	101	24	23	23	4	10	13	21	20	20	23	23	24	26	25	27	57	32	35
Boron	mg/l	262	91	0	0.48	0.4		0.10	0.1		0.38	0.3		0.46	0.4		0.57	0.5		1.11	1.0	
Fluoride	mg/l	506	146	101	0.59	0.6	0.6	0.27	0.3	0.4	0.51	0.5	0.5	0.60	0.6	0.6	0.66	0.7	0.7	1.10	1.0	0.9
Bromide	mg/l	0	0	0																		
Ammonia (as N)	mg/l	0	0	39			0.07			0.00			0.02			0.04			0.07			0.78
Total Kjeldahl Nitrogen	mg/l	417	95	88	0.39	0.25	0.63	0.04	0.04	0.14	0.24	0.16	0.40	0.33	0.24	0.55	0.49	0.32	0.72	1.93	0.64	2.40
Nitrate (as N)	mg/l	478	140	42	0.12	0.14	0.11	0.00	0.00	0.00	0.02	0.07	0.06	0.09	0.10	0.10	0.16	0.18	0.12	1.40	0.90	0.71
Total Phosphate	mg/l	0	0	99			0.09			0.03			0.06			0.08			0.11			0.44
Dissolved Phosphate	mg/l	250	132	65	0.089	0.09	0.06	0.000	0.00	0.00	0.050	0.05	0.04	0.075	0.08	0.05	0.110	0.10	0.08	0.420	0.40	0.18
Silver	µg/l	0	0	35			1			0			0			1			1			1
Aluminium	µg/l	0	0	15			18			10			10			20			20			30
Arsenic	µg/l	232	144	47	23	22	24	10	10	5	10	10	20	20	20	24	30	30	30	60	50	45
Barium	µg/l	0	0	35			27			7			18			20			24			100
Cadmium	µg/l	0	0	47			2			0			1			1			2			15
Chromium	µg/l	0	0	47			2			0			0			0			1			10
Copper	µg/l	0	0	47			6			0			3			5			8			20
Iron	µg/l	505	145	47	136	168	37	0	10	10	30	20	20	90	60	30	200	250	50	1200	1200	130
Mercury	µg/l	0	0	46			0.3			0.0			0.1			0.1			0.5			1.6
Manganese	µg/l	0	0	46			7			1			4			7			10			30
Lead	µg/l	0	0	45			7			0			1			3			6			150
Selenium	µg/l	0	0	47			1			0			1			1			1			1
Zinc	µg/l	0	0	46			16			0			7			11			20			50

Table 44. Water Quality Summary of Laws Wellfield.

Variable	Units	Samples (n)	Mean	Minimum 0% IQR	25% IQR	Median 50% IQR	75% IQR	Maximum 100% IQR
Capacity	cfs	18	3.5	1.2	2.2	3	4.4	10.1
pH	−log(H+)	18	7.7	7.4	7.6	7.7	7.8	7.9
Temperature	°C	49	19.7	14.5	17.8	19.5	21.1	27.8
Specific Conductance	μS/cm	60	535	366	466	528	569	843
Color	units	60	2	1	1	1	3	7
Alkalinity	mg/l	60	164	92	138	150	195	290
Hardness (as CaCO3)	mg/l	60	163	50	127	168	200	280
Calcium	mg/l	59	50	16	42	50	59	93
Magnesium	mg/l	38	10.5	1.0	5.4	9.8	15	39
Sodium	mg/l	38	49	22	32	47	61	102
Potassium	mg/l	38	5.9	1.6	4.7	5.6	6.9	17
Sulfate	mg/l	60	85	20	64	78	106	176
Chloride	mg/l	60	13	2.8	7.1	12	17	27
Silica	mg/l	38	58	20	48	59	70	108
Boron	mg/l	60	0.28	0.07	0.16	0.25	0.37	0.83
Fluoride	mg/l	60	0.47	0.03	0.19	0.24	0.42	3.10
Ammonia (as N0	mg/l	33	0.03	0.00	0.01	0.01	0.04	0.52
Total Kjeldahl Nitrogen	mg/l	32	0.11	0.00	0.02	0.07	0.13	0.88
Nitrate (as N)	mg/l	59	0.35	0.10	0.23	0.31	0.41	1.06
Total Phosphate	mg/l	33	0.04	0.01	0.02	0.03	0.06	0.10
Arsenic	μg/l	30	11	10	10	10	10	30
Iron	μg/l	58	29	10	10	10	10	810

Table 45. Water Quality Summary of Bishop–Warm Springs Wellfield.

Variable	Units	Samples (n)	Mean	Minimum 0% IQR	25% IQR	Median 50% IQR	75% IQR	Maximum 100% IQR
Capacity	cfs	11	2.6	0.6	2.0	2.5	3.8	4.0
pH	−log(H+)	13	7.7	7.1	7.3	7.7	8.2	9.2
Temperature	°C	29	16.2	4.5	15.0	16.5	17.8	23.5
Specific Conductance	µS/cm	38	219	145	170	206	281	338
Color	units	35	2	1	1	1	3	8
Alkalinity	mg/l	38	86	55	68	88	106	128
Hardness (as CaCO3)	mg/l	38	53	10	36	46	68	123
Calcium	mg/l	38	16.8	1.3	9.6	18	22	38
Magnesium	mg/l	25	2.5	0.1	1.0	1.5	4.4	7.6
Sodium	mg/l	25	21	7	12	17	26	48
Potassium	mg/l	25	2.4	1.2	1.7	2.3	3.1	4.5
Sulfate	mg/l	38	11	6.2	7.8	10	13	21
Chloride	mg/l	38	4.1	1.1	2.1	3.6	6	10
Silica	mg/l	24	33	19	23	29	44	57
Boron	mg/l	37	0.08	0.00	0.04	0.06	0.12	0.24
Fluoride	mg/l	38	1.12	0.10	0.41	0.83	1.70	4.10
Ammonia (as N0	mg/l	21	0.01	0.00	0.01	0.01	0.01	0.04
Total Kjeldahl Nitrogen	mg/l	21	0.11	0.02	0.04	0.07	0.15	0.40
Nitrate (as N)	mg/l	38	0.99	0.16	0.30	0.68	1.49	3.40
Total Phosphate	mg/l	20	0.05	0.01	0.03	0.05	0.08	0.14
Arsenic	µg/l	15	19	10	10	10	20	80
Iron	µg/l	34	36	10	10	10	10	600

Table 46. Water Quality Summary of Big Pine–Crater Mountain Wellfield.

Variable	Units	Samples (n)	Mean	Minimum 0% IQR	25% IQR	Median 50% IQR	75% IQR	Maximum 100% IQR
Capacity	cfs	22	5.0	1.1	2.0	3.4	5.4	16.1
pH	–log(H+)	34	7.4	6.7	7.1	7.3	7.6	8.4
Temperature	°C	71	15.8	13.0	15.0	15.6	16.5	20.6
Specific Conductance	µS/cm	78	327	117	218	318	420	587
Color	units	67	3	1	1	1	3	40
Alkalinity	mg/l	77	133	50	91	122	175	269
Hardness (as CaCO3)	mg/l	78	98	37	72	102	120	200
Calcium	mg/l	78	26	11	19	26	31	53
Magnesium	mg/l	53	7.8	2.2	4.9	7.8	10	17
Sodium	mg/l	54	28	5.5	11	28	44	74
Potassium	mg/l	53	3.6	1.1	2.6	3.5	4.6	7.3
Sulfate	mg/l	78	18	3.7	10	17	22	47
Chloride	mg/l	77	12	2	6	11	17	42
Silica	mg/l	52	31	18	25	32	36	465
Boron	mg/l	78	0.22	0.01	0.07	0.20	0.35	0.81
Fluoride	mg/l	75	0.23	0.05	0.15	0.21	0.30	0.70
Ammonia (as N0	mg/l	42	0.06	0.00	0.01	0.01	0.10	0.39
Total Kjeldahl Nitrogen	mg/l	42	0.11	0.02	0.06	0.08	0.14	0.43
Nitrate (as N)	mg/l	74	0.69	0.01	0.27	0.67	0.97	2.08
Total Phosphate	mg/l	42	0.07	0.02	0.04	0.07	0.09	0.15
Arsenic	µg/l	37	10	10	10	10	10	20
Iron	µg/l	72	40	10	10	10	20	400

Table 47. Water Quality Summary of Tinemaha–Haiwee Wellfields.

Variable	Units	Samples (n)	Mean	Minimum 0% IQR	25% IQR	Median 50% IQR	75% IQR	Maximum 100% IQR
Capacity	cfs	56	3.6	0.2	1.8	3.2	4.0	17.4
pH	−log(H+)	74	7.5	6.5	7.1	7.6	7.8	8.4
Temperature	°C	162	16.5	11.0	15.0	16.2	18.0	20.6
Specific Conductance	μS/cm	196	288	97	154	186	240	1630
Color	units	187	3	0	1	1	3	60
Alkalinity	mg/l	197	99	30	58	68	82	543
Hardness (as CaCO3)	mg/l	196	84	24	48	57	72	470
Calcium	mg/l	196	23	8	14	18	22	96
Magnesium	mg/l	143	6.7	0.7	2.4	3.7	5.1	45
Sodium	mg/l	142	27	3	10	14	20	188
Potassium	mg/l	141	3.0	0.6	1.0	1.4	4.4	18
Sulfate	mg/l	196	18	1.0	9.0	15	20	116
Chloride	mg/l	196	18	0.5	2.1	5	8.9	231
Silica	mg/l	141	29	14	24	26	30	109
Boron	mg/l	193	0.29	0.00	0.03	0.08	0.18	3.28
Fluoride	mg/l	193	0.26	0.01	0.12	0.18	0.37	1.20
Ammonia (as N0	mg/l	114	0.04	0.00	0.00	0.01	0.01	1.56
Total Kjeldahl Nitrogen	mg/l	119	0.11	0.01	0.03	0.05	0.10	1.70
Nitrate (as N)	mg/l	194	0.34	0.00	0.18	0.29	0.45	1.17
Total Phosphate	mg/l	118	0.06	0.01	0.03	0.05	0.07	0.21
Arsenic	μg/l	107	11	10	10	10	10	80
Iron	μg/l	183	29	10	10	10	10	1200

Table 48. Water Quality Summary of Combined Wellfields.

Variable	Units	Samples (n)	Mean	Minimum 0% IQR	25% IQR	Median 50% IQR	75% IQR	Maximum 100% IQR
Capacity	cfs	107	3.8	0.2	2.0	3.1	4.0	17.4
pH	−log(H+)	139	7.5	6.5	7.2	7.5	7.8	9.2
Temperature	°C	157	16.5	4.5	15.0	16.5	18.0	27.8
Specific Conductance	μS/cm	192	288	97	169	229	440	1630
Color	units	182	3	0	1	1	3	60
Alkalinity	mg/l	192	99	30	63	87	144	543
Hardness (as CaCO3)	mg/l	191	84	10	51	68	123	470
Calcium	mg/l	191	23	1.3	16	20	34	96
Magnesium	mg/l	142	6.9	0.1	2.7	4.2	8.3	45
Sodium	mg/l	141	27	3	11	17	37	188
Potassium	mg/l	140	3.1	0.6	1.3	2.8	4.8	18
Sulfate	mg/l	191	19	1.0	9.9	16	30	176
Chloride	mg/l	192	18	0.5	2.8	6.4	13	231
Silica	mg/l	140	29	14	25	28	38	465
Boron	mg/l	189	0.61	0.00	0.05	0.11	0.24	3.28
Fluoride	mg/l	188	0.56	0.01	0.14	0.22	0.40	4.10
Ammonia (as N0	mg/l	113	0.34	0.00	0.01	0.01	0.02	1.56
Total Kjeldahl Nitrogen	mg/l	118	0.37	0.00	0.04	0.06	0.11	1.70
Nitrate (as N)	mg/l	189	0.63	0.00	0.20	0.32	0.60	3.40
Total Phosphate	mg/l	116	0.34	0.01	0.03	0.05	0.08	0.21
Arsenic	μg/l	107	11	10	10	10	10	80
Iron	μg/l	178	30	10	10	10	10	1200

Table 49. Summary of Water Supply Data by Source for the Los Angeles Department of Water and Power (1941-1990)

	Source (Year of Occurrence)		
Volume (1,000 af/yr)	Groundwater	LA Aqueduct	MWD
Minimum	38.5 (1942)	190.1 (1941)	0.1 (1941)
Maximum	136.3 (1989)	520.1 (1984)	395.0 (1990)
Mean	95.4	360.0	62.0

Note: Compiled from Teigen pers. comm.

Table 50. Water Quality Summary of LAA Filtration Plant (1940 – 1991).

Variable	Units	Samples (n) LADWP 40-91	Mean LADWP 40-91	Minimum 0% IQR LADWP 40-91	25% IQR LADWP 40-91	Median 50% IQR LADWP 40-91	75% IQR LADWP 40-91	Maximum 100% IQR LADWP 40-91	Detection Limits LADWP 40-91	% > Detection Limit LADWP 40-91
Specific Conductance	µS/cm	677	340	173	305	337	368	618		
Total Organic Carbon	mg/l	139	2.1	0.6	1.6	2.0	2.4	4.5		
Color	units	691	12	0	5	10	16	50		
Turbidity	NTU	691	5.2	0.0	2.2	4.0	7.0	28.0		
Total Suspended Solids	mg/l	0								
Total Dissolved Solids	mg/l	30	228	168	220	232	238	273		
Alkalinity (as CaCO3)	mg/l	316	108	55	99	110	121	168		
Hardness (as CaCO3)	mg/l	668	87	49	78	86	95	130		
Calcium	mg/l	668	25	15	22	25	26	36		
Magnesium	mg/l	668	6.1	0.1	4.9	5.9	7	13		
Sodium	mg/l	667	37	3	32	36	41	88		
Potassium	mg/l	657	4.0	1.1	3.5	4.0	4.5	7.9		
Sulfate	mg/l	691	28	11	21	26	31	220		
Chloride	mg/l	692	18	6	15	17	20	47		
Silica	mg/l	567	20	2	17	21	24	40		
Boron	mg/l	547	0.49	0.13	0.41	0.50	0.56	0.89		
Fluoride	mg/l	665	0.59	0.16	0.52	0.60	0.65	0.96		
Bromide	mg/l	105	0.14	0.01	0.10	0.10	0.20	0.40		
Ammonia (as N)	mg/l	0								
Total Kjeldahl Nitrogen	mg/l	598	0.30	0.00	0.24	0.29	0.37	0.83		
Nitrate (as N)	mg/l	670	0.08	0.00	0.00	0.02	0.11	1.58		
Total Phosphate	mg/l	0								
Dissolved Phosphate	mg/l	330	0.07	0.00	0.05	0.06	0.08	0.28		
Silver	µg/l	166	13	10	10	10	10	100		
Aluminium	µg/l	15	100	100	100	100	100	100		
Arsenic	µg/l	494	22	0	14	20	30	66		
Barium	µg/l	178	96	10	100	100	100	100		
Cadmium	µg/l	179	2	1	2	2	2	16		
Chromium	µg/l	153	10	10	10	10	10	40		
Copper	µg/l	196	57	10	20	50	90	300		
Iron	µg/l	600	61	0	10	40	80	600		
Mercury	µg/l	176	0.1	0.0	0.1	0.1	0.1	0.7		
Manganese	µg/l	179	12	1	10	10	10	60		
Lead	µg/l	180	10	5	10	10	10	50		
Selenium	µg/l	177	3	2	3	3	3	8		
Zinc	µg/l	183	16	2	10	10	20	130		

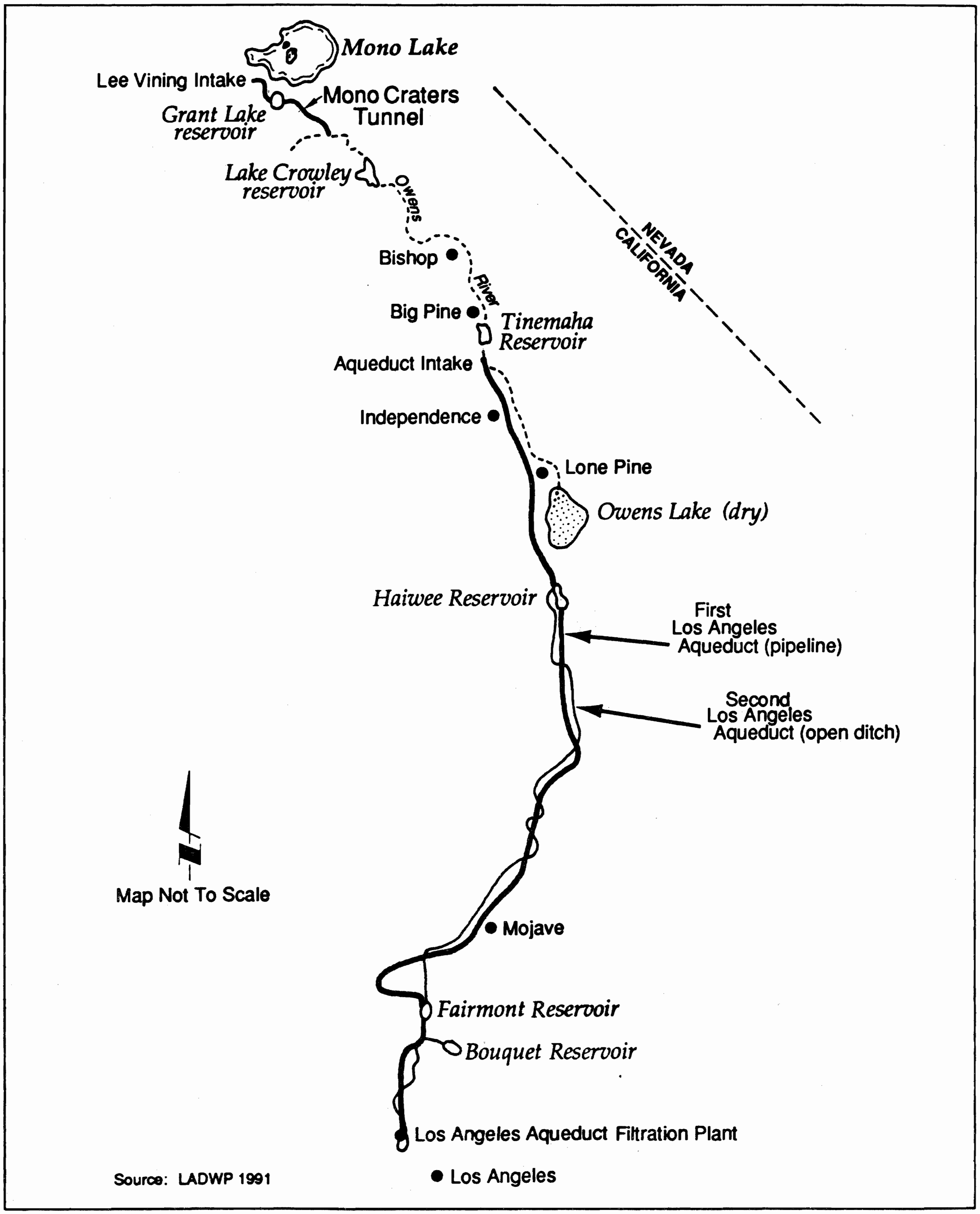
Table 51. Water Quality Summary of Metropolitan Water District (1985–1990).

Variable	Units	Samples (n)		Mean		Minimum 0% IQR		25% IQR		Median 50% IQR		75% IQR		Maximum 100% IQR		Detection Limit		%>Detection Limit	
		CR 85–90	SWP 85–90	CR 85–90	SWP 85–90	CR 85–90	SWP 85–90	CR 85–90	SWP 85–90	CR 85–90	SWP 85–90	CR 85–90	SWP 85–90	CR 85–90	SWP 85–90	CR 85–90	SWP 85–90	CR 85–90	SWP 85–90
Specific Conductance	μS/cm	65	65	887	536	834	376	852	468	880	518	931	615	958	722			100	100
Total Dissolved Solids	mg/l	65	65	556	301	520	235	535	263	549	289	586	339	609	410			100	100
Alkalinity (as CaCO3)	mg/l	65	65	130	87	123	77	129	80	131	85	132	91	137	129			100	100
Hardness (as CaCO3)	mg/l	65	65	279	132	259	92	270	123	277	132	291	141	300	160			▪	▪
Calcium	mg/l	65	65	69	29	64	23	67	27	69	28	71	31	78	42			▪	▪
Magnesium	mg/l	65	65	26	14	24	6.5	25	13	25.5	14	26	16	28.5	19			▪	▪
Sodium	mg/l	65	65	79	54	71	33	75	44	78	49	83	67	91	88			▪	▪
Potassium	mg/l	65	65	4	3	3.3	1.6	3.8	2.7	4	3.2	4.1	3.7	4.5	4.8			▪	▪
Chloride	mg/l	65	65	63	70	55	18	58	55	62	62	67	97	77	128			▪	▪
Boron	mg/l	11	11	0.11	0.25	0.06	0.17	0.1	0.19	0.1	0.22	0.15	0.28	0.17	0.52			▪	▪
Fluoride	mg/l	65	65	0.3	0.21	0.21	0.1	0.28	0.15	0.29	0.18	0.31	0.21	0.37	0.75			▪	▪
Nitrate (as N)	mg/l	64	63	0.75	2.1	0.1	0.2	0.55	1.85	0.75	2.3	1	2.45	1.3	3.2			▪	▪
Iron (a)	μg/l	6	6	108.0	61.7	67	45	80	45	109	60	140	75	162	95			▪	▪
Arsenic	μg/l	6	6	3.0	2.2	2	2	3	2	3	2	3	2	4	3			▪	▪
Barium	μg/l	6	6	140.2	36.7	88	22	107	30	157	39	168	44	171	52			▪	▪
Copper	μg/l	6	6	25.0	4.5	16	ND	19	ND	25	ND	28	12	41	15			▪	33

Notes:

(a) Values for iron, arsenic, barium, and copper are fiscal year averages.

Figures



Source: LADWP 1991

Figure 1. The Los Angeles Aqueduct System.

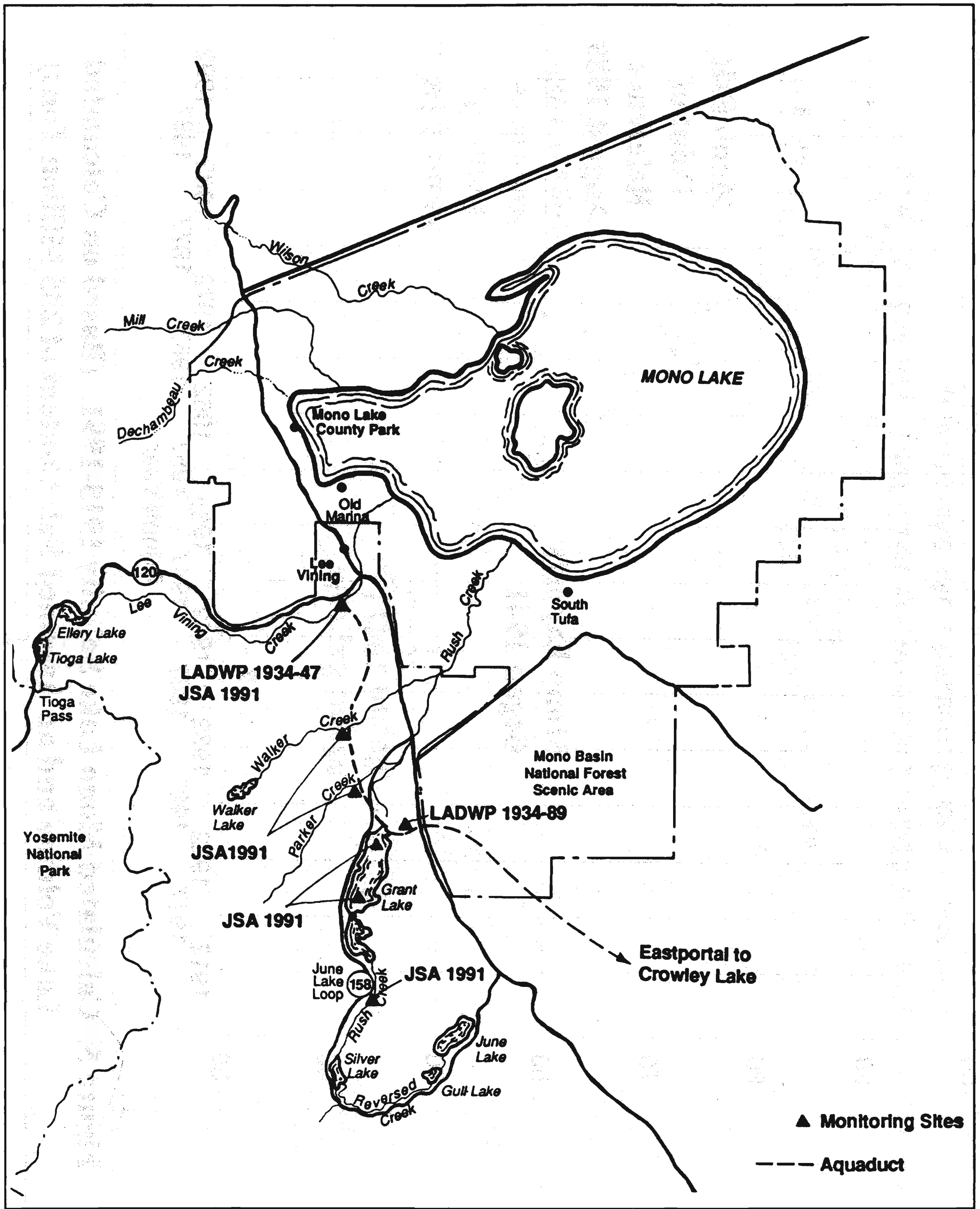


Figure 2. Location of Monitoring Sites in the Mono Lake Basin.

Figure 3. Measured Mono Lake Elevation 1913-1991. (Based on Historical USGS Datum)

Figure 4. Calculated Mono Lake Volume 1913-1991. (Based on Pelagos Bathymetry and Measured Lake Elevations)

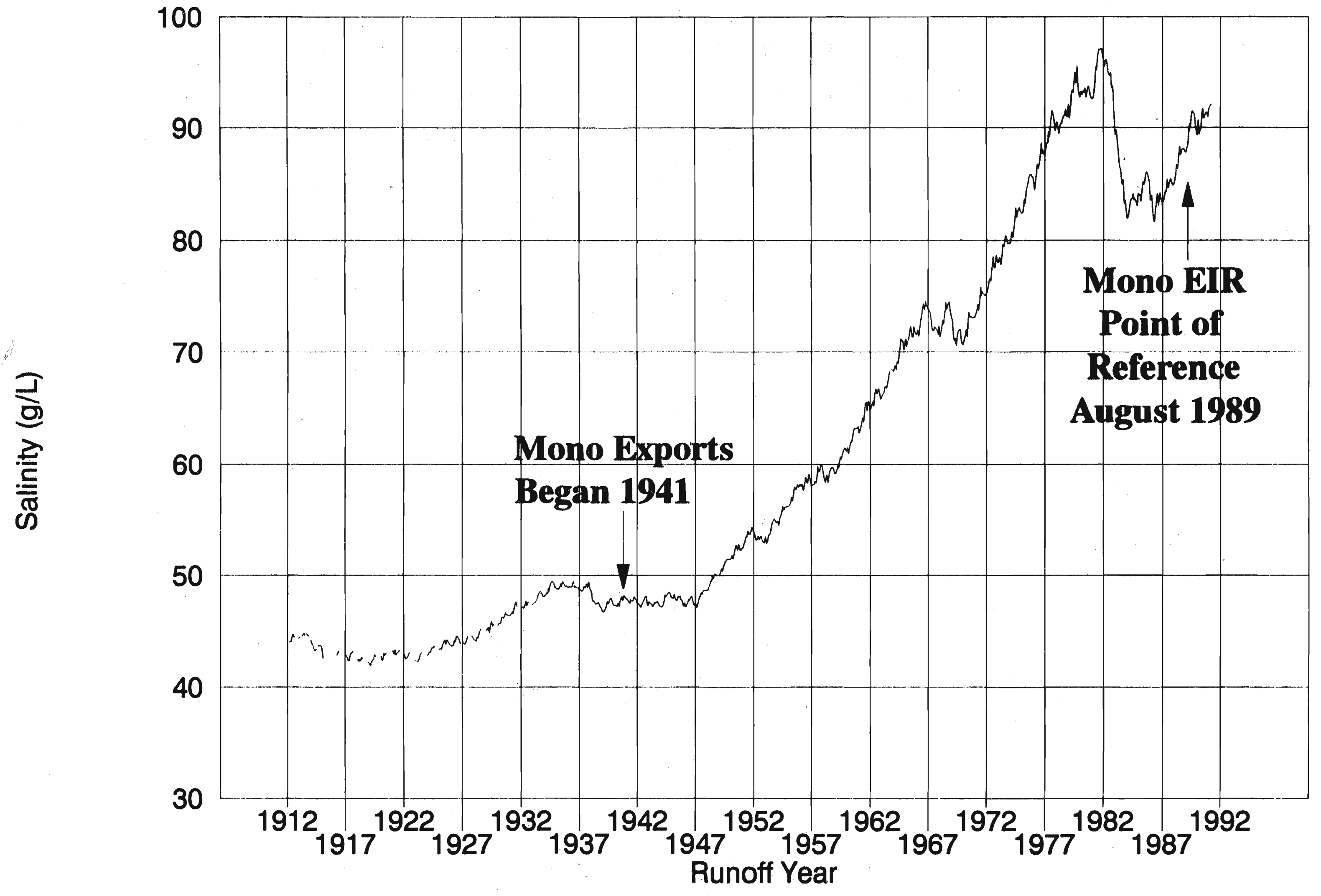


Figure 5. Calculated Mono Lake Salinity 1913-1991. (Based on Calculated Lake Volume and an Assumed Salt Content of 285 Million Tons)

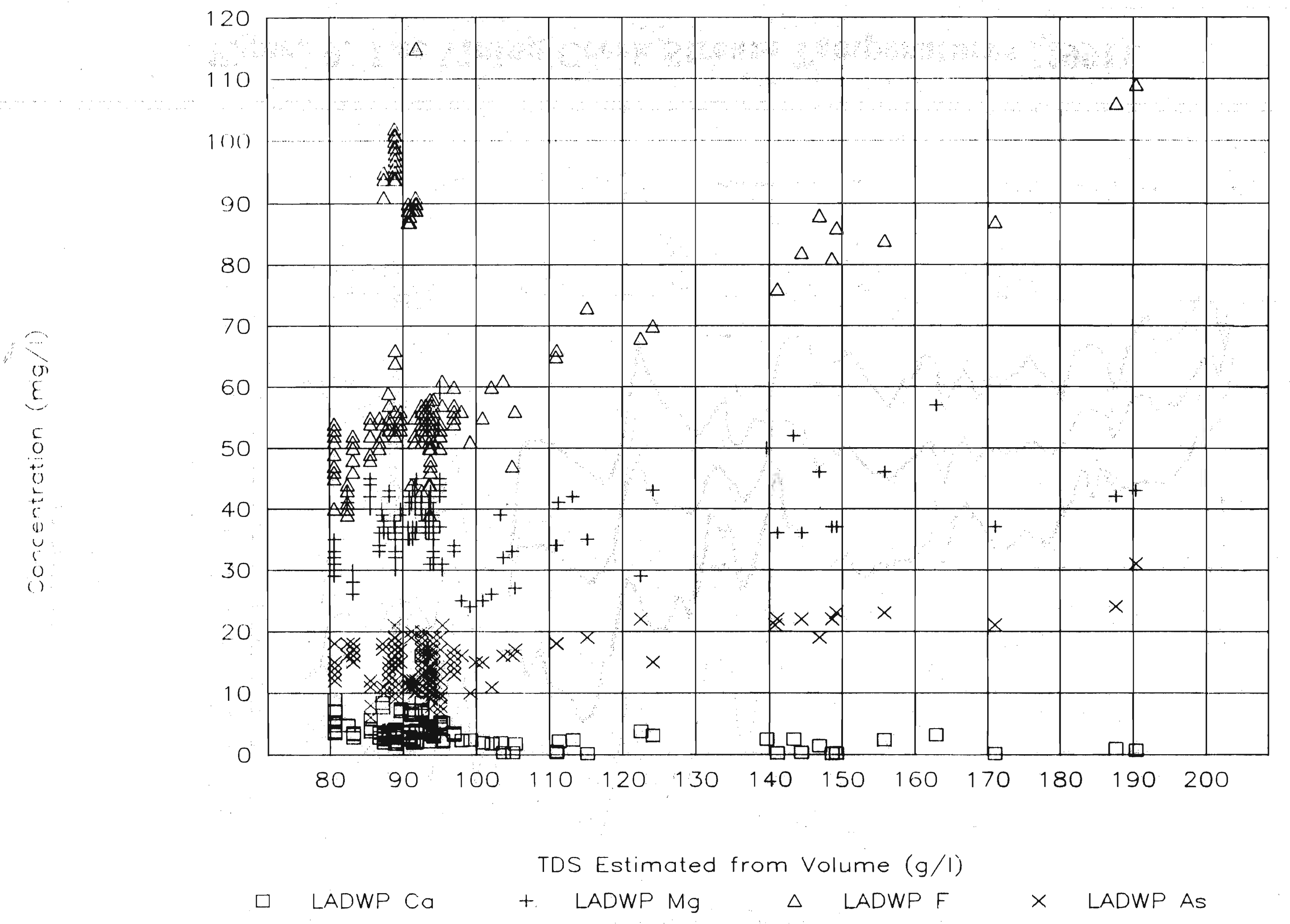


Figure 6. Mono Lake Calcium, Magnesium, Fluoride, and Arsenic as a Function of Salinity (1974-1990).

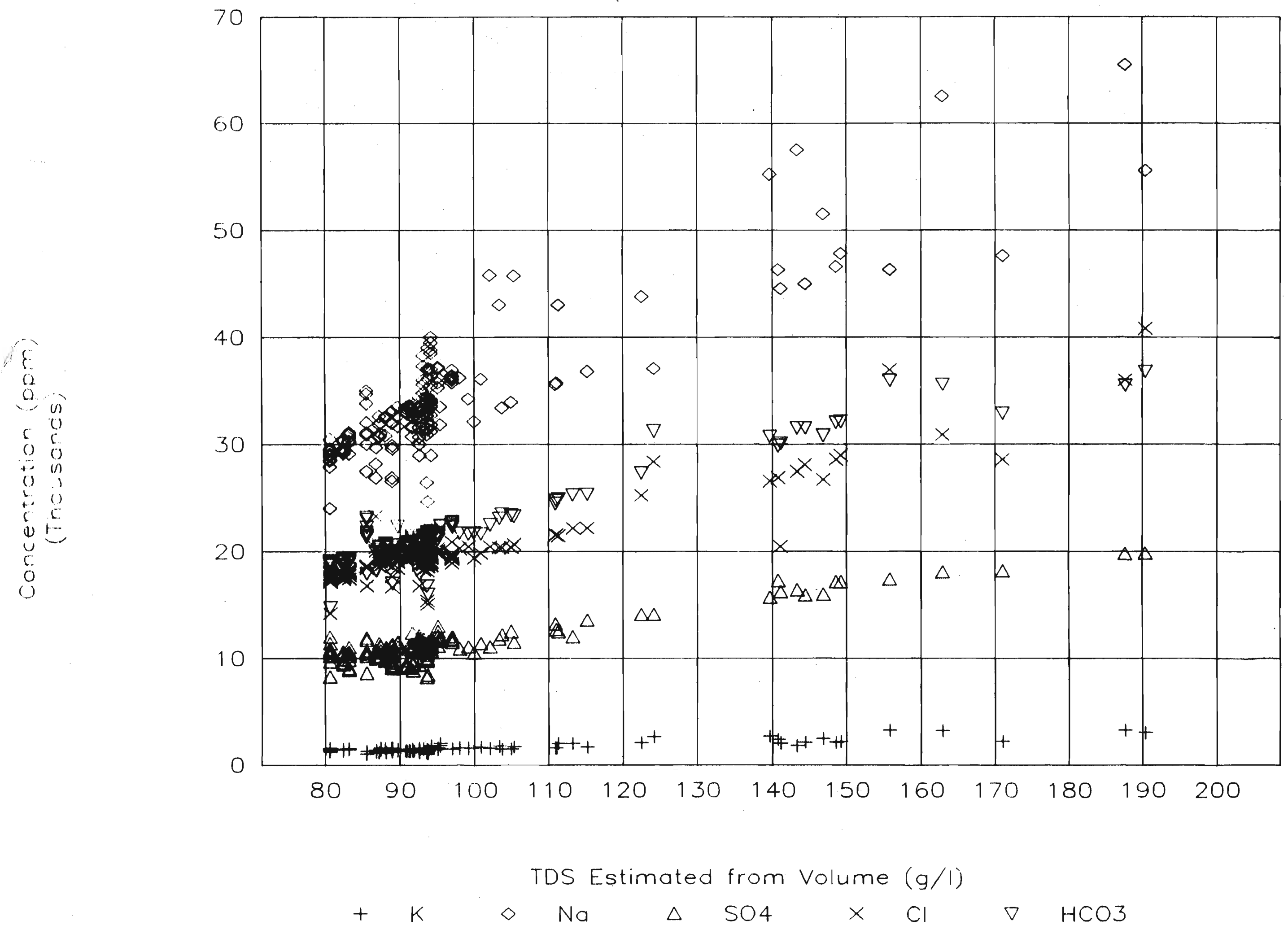


Figure 7. Mono Lake Potassium, Sodium, Sulfate, Chloride, and Alkalinity as a Function of Salinity (1974-1990).

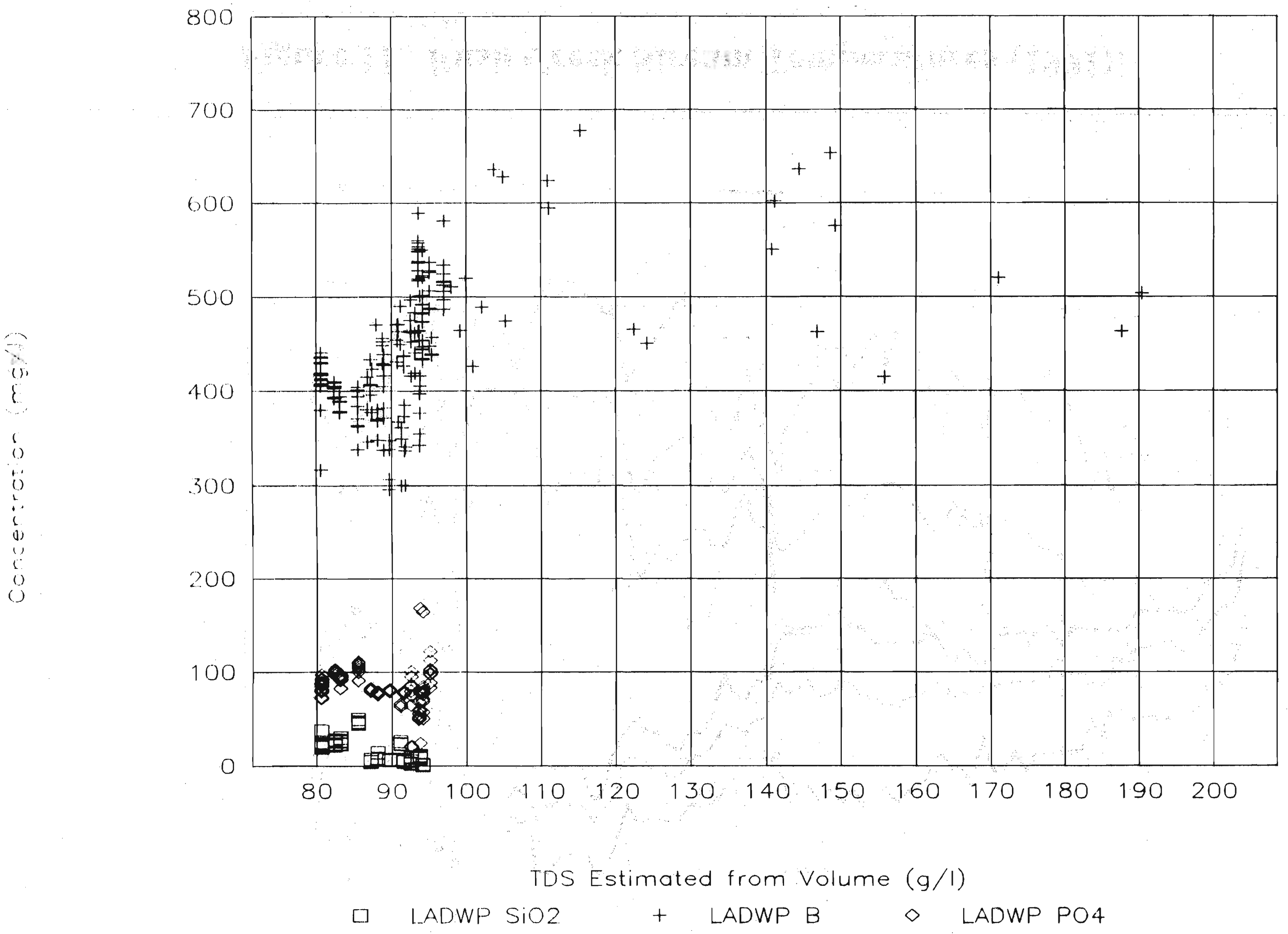


Figure 8. Mono Lake Silica, Boron, and Phosphate as a Function Salinity (1974-1990).

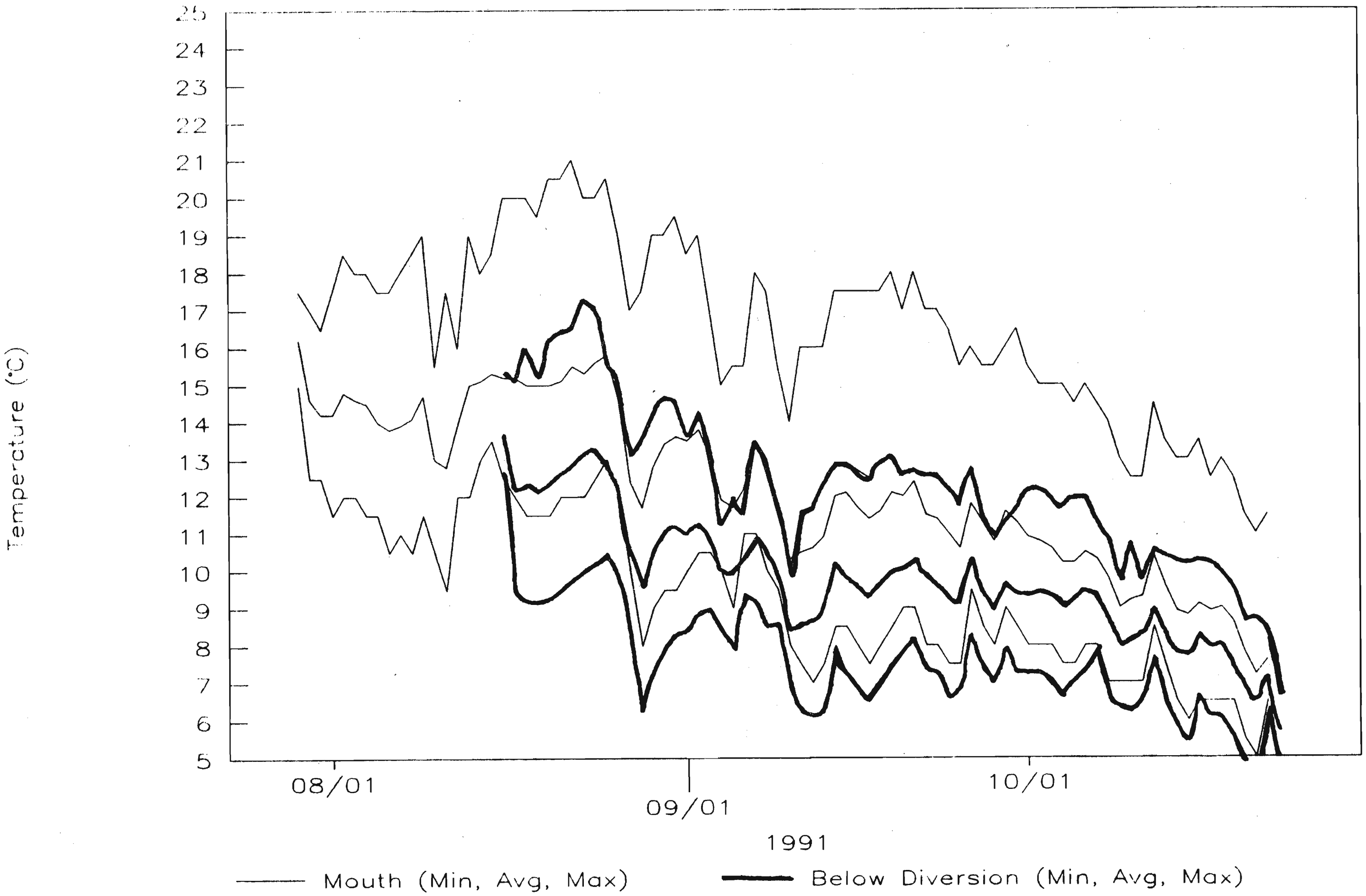


Figure 9. Lee Vining Creek Stream Temperatures (1991).

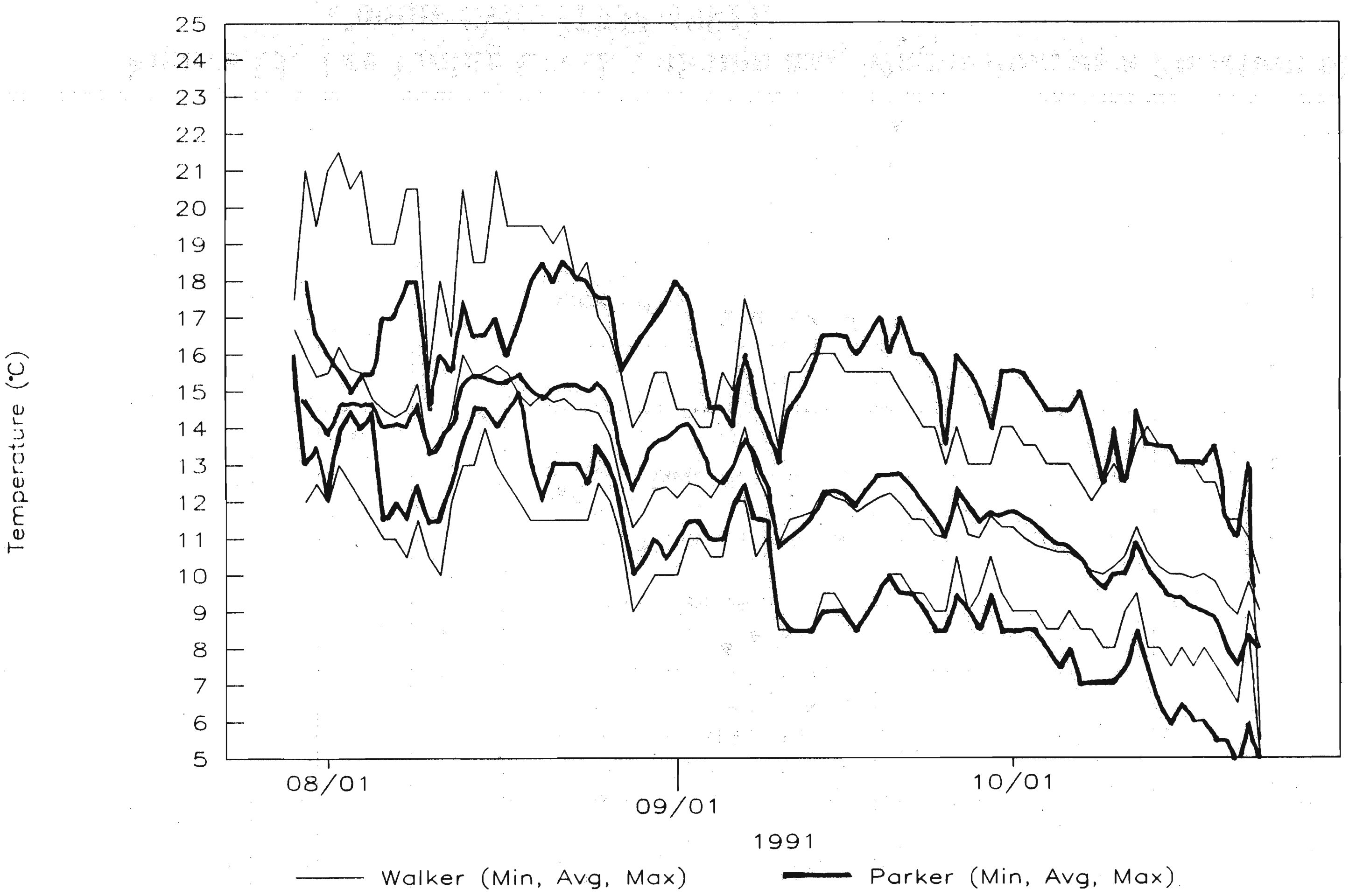


Figure 10. Walker and Parker Creeks Stream Temperatures (1991).

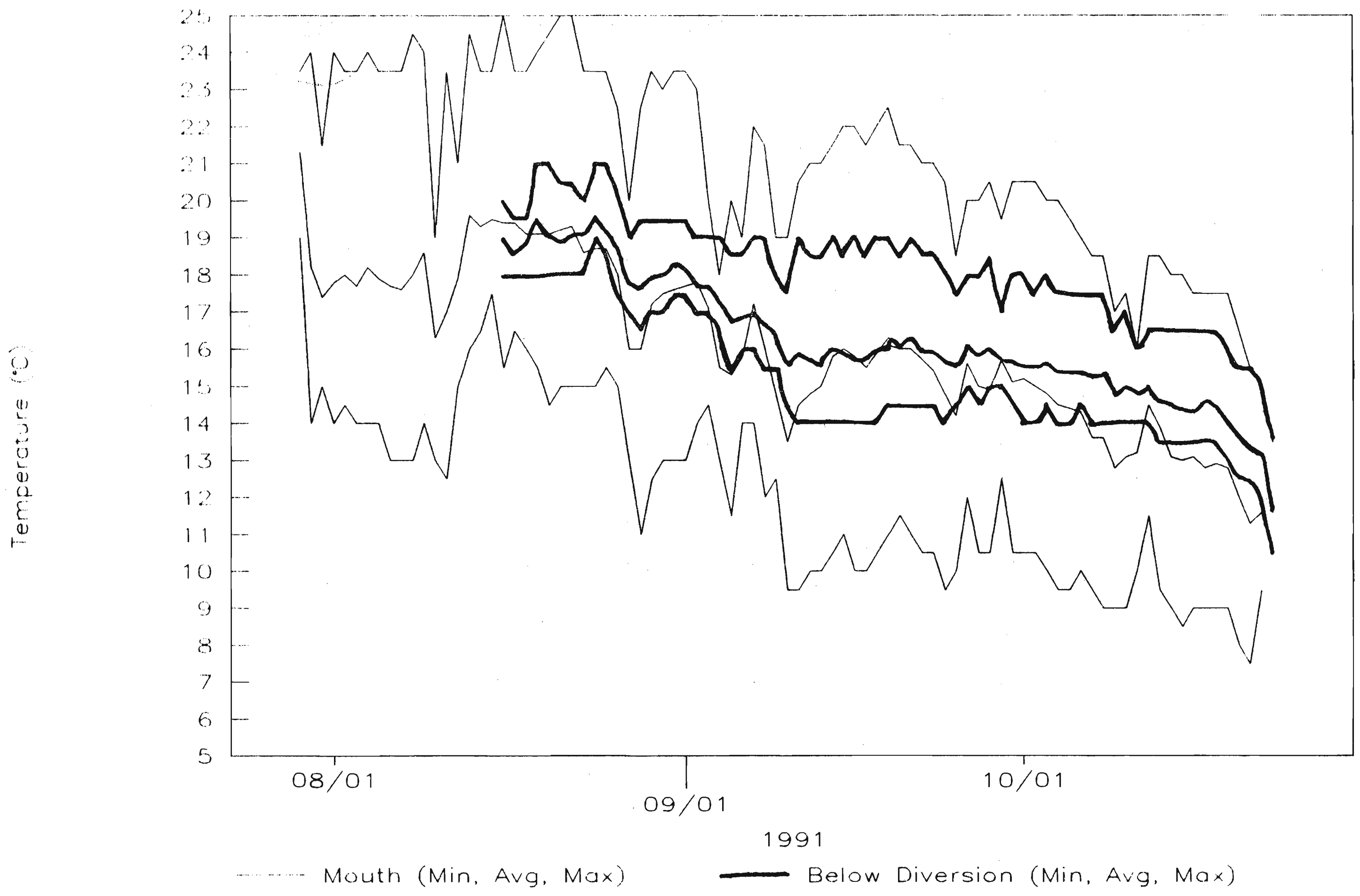


Figure 11. Rush Creek Stream Temperatures (1991).

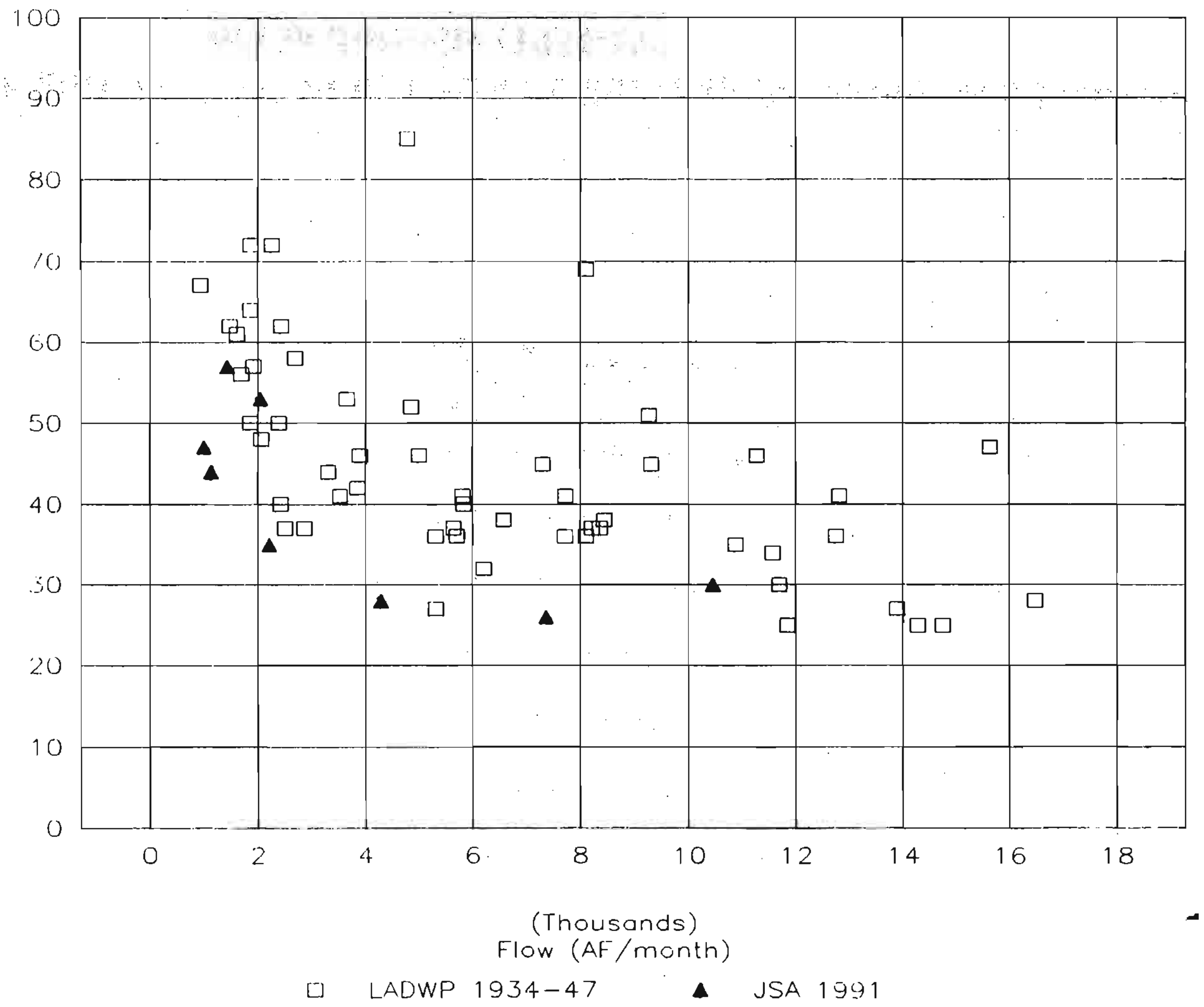


Figure 12. Lee Vining Creek Conductivity as a Function of Flow (1934-1991).

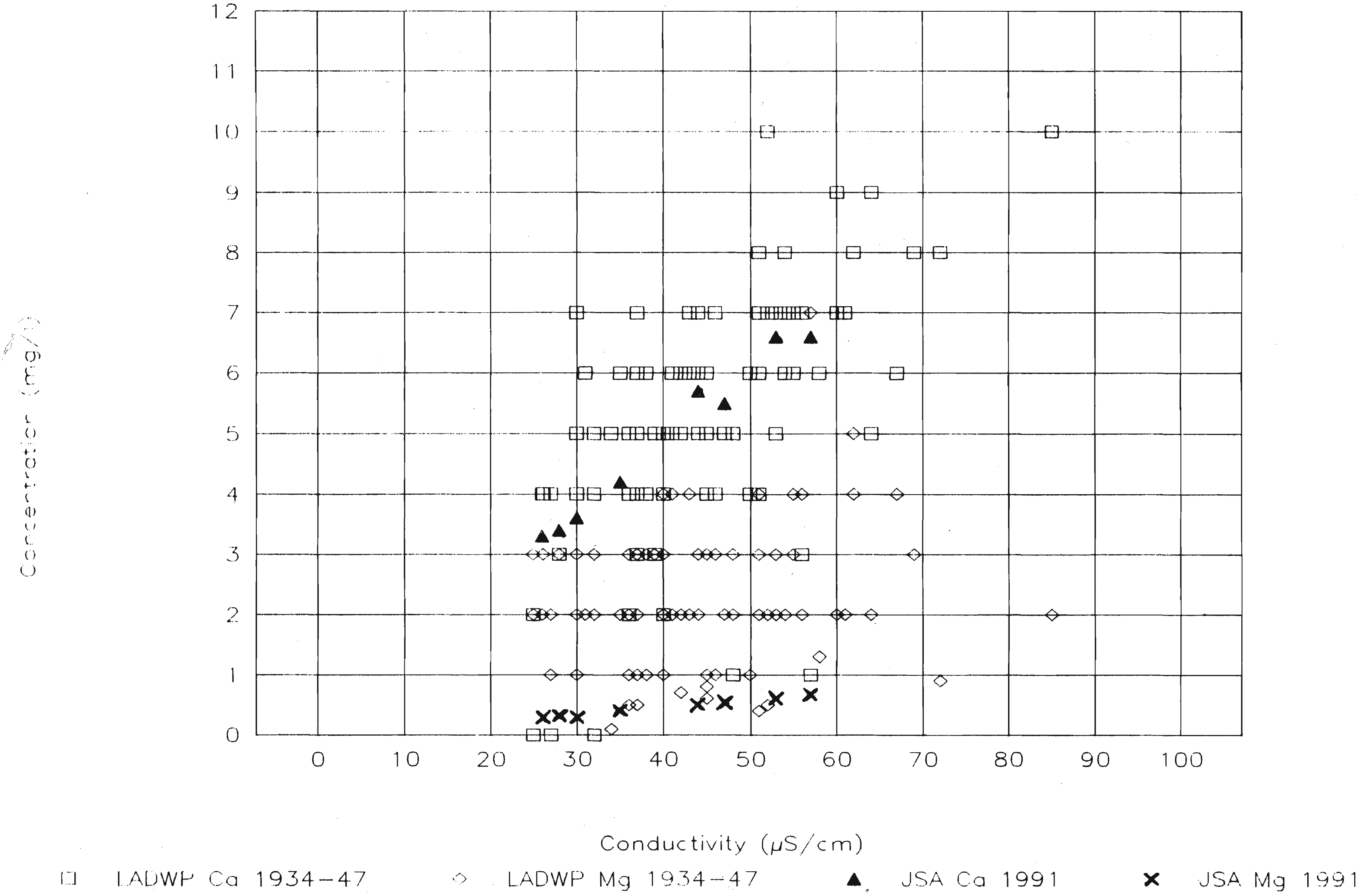


Figure 13. Lee Vining Creek Calcium and Magnesium as a Function of Conductivity (1934-1991).

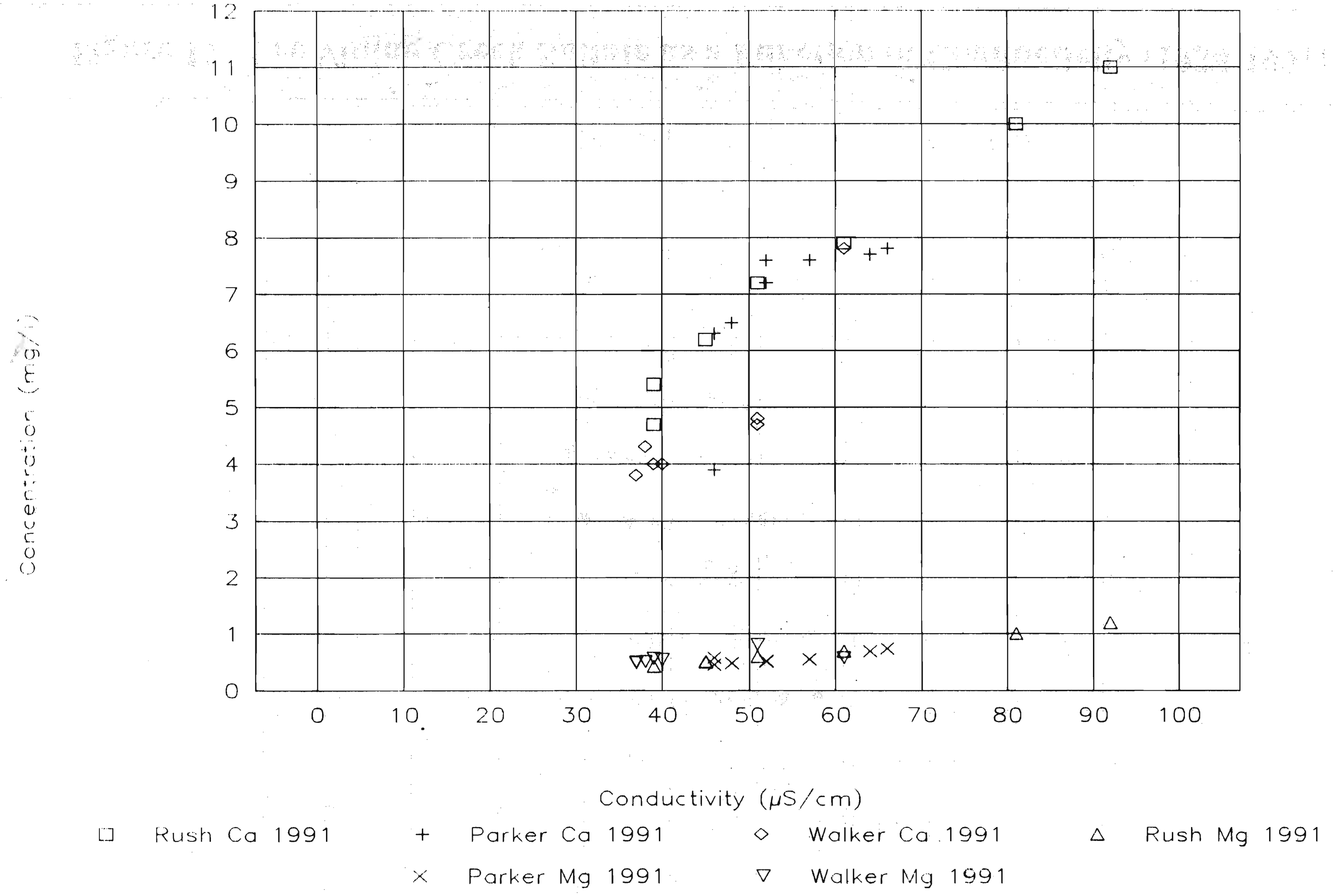


Figure 14. Walker, Parker, and Rush Creeks Calcium and Magnesium as a Function of Conductivity (1991).

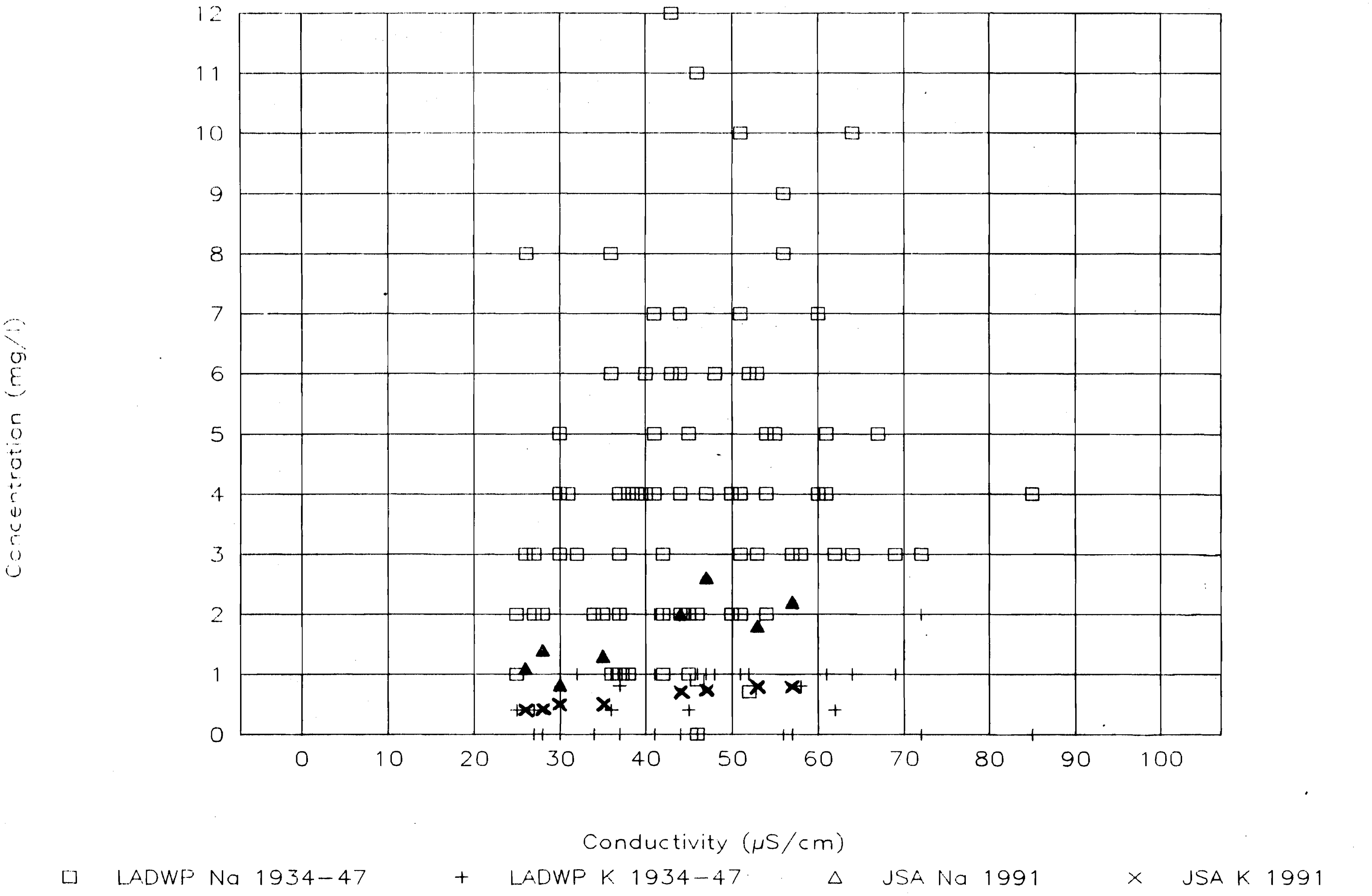


Figure 15. Lee Vining Creek Sodium and Potassium as a Function of Conductivity (1934-1991).

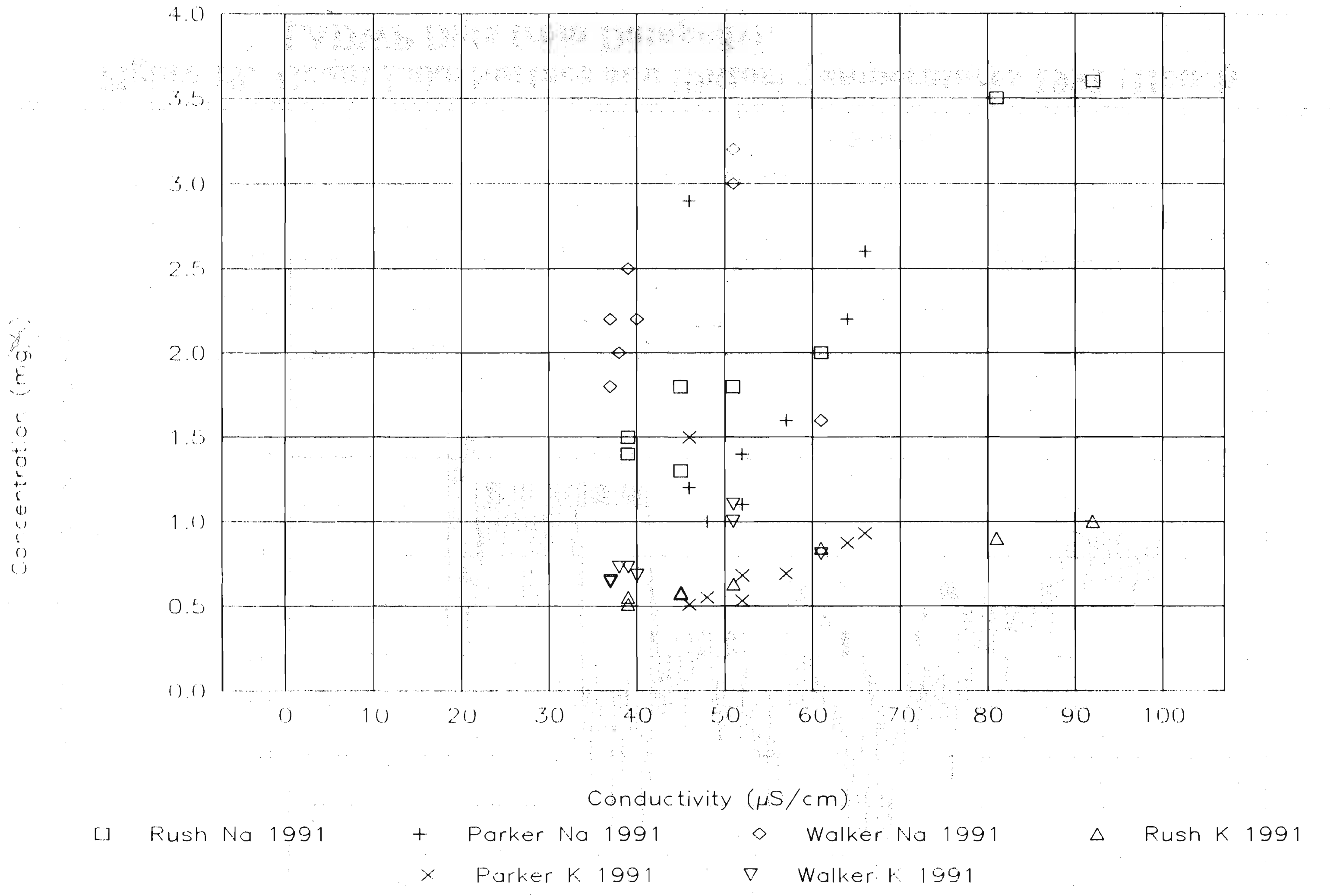


Figure 16. Walker, Parker, and Rush Creeks Sodium and Potassium as a Function of Conductivity (1991).

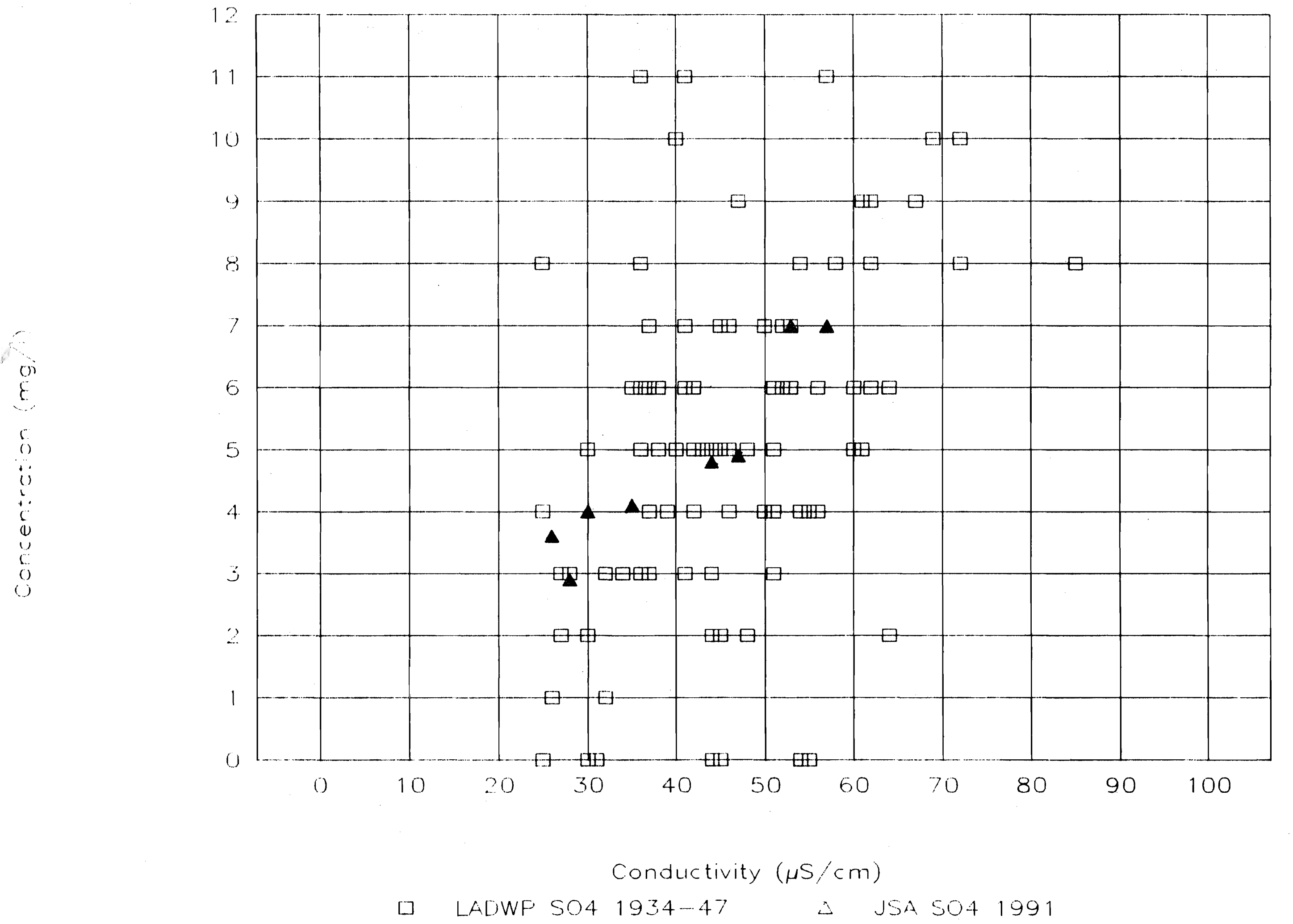


Figure 17. Lee Vining Creek Sulfate as a Function of Conductivity (1934-1991).

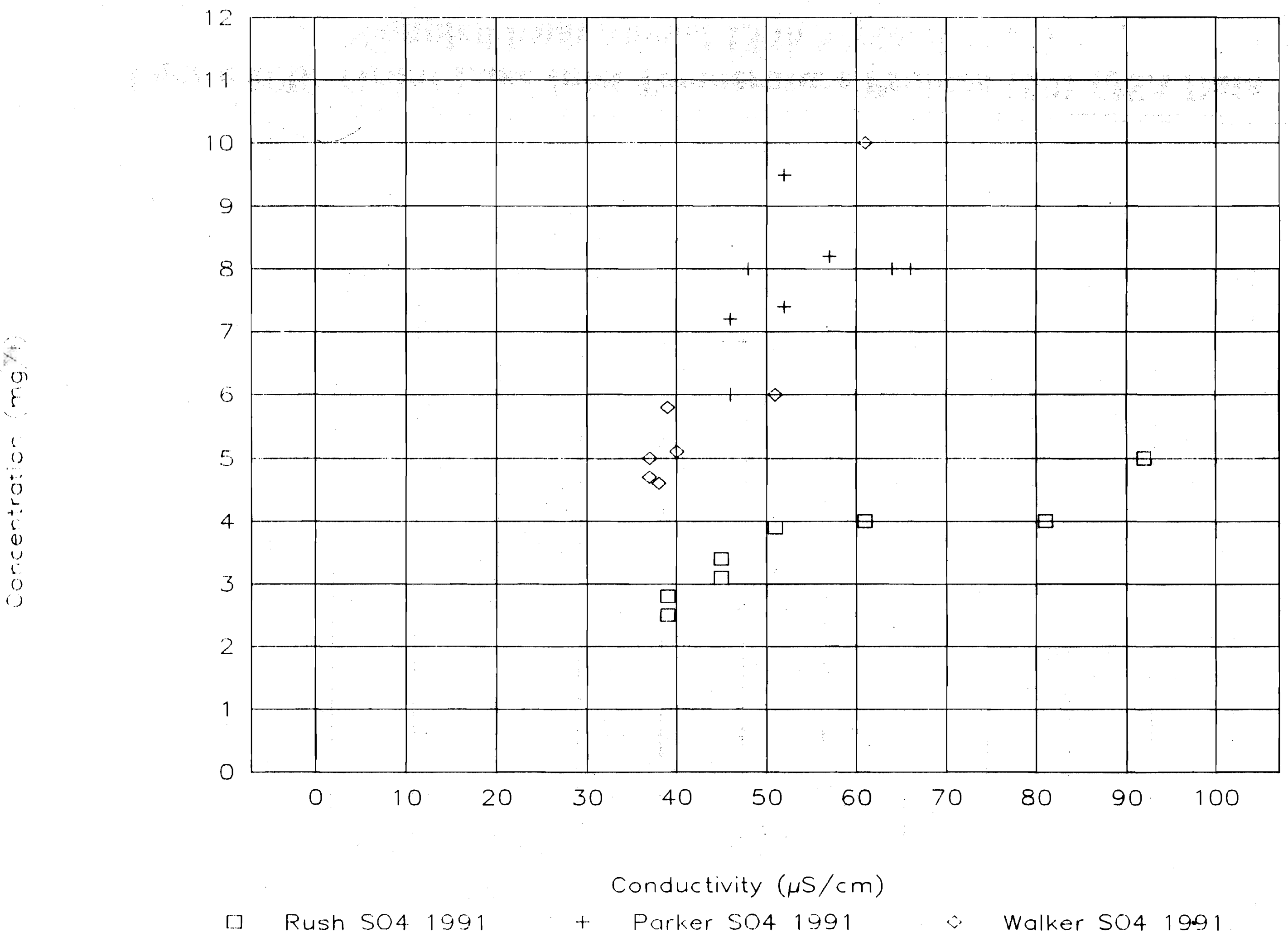


Figure 18. Walker, Parker, and Rush Creeks Sulfate as a Function of Conductivity (1991).

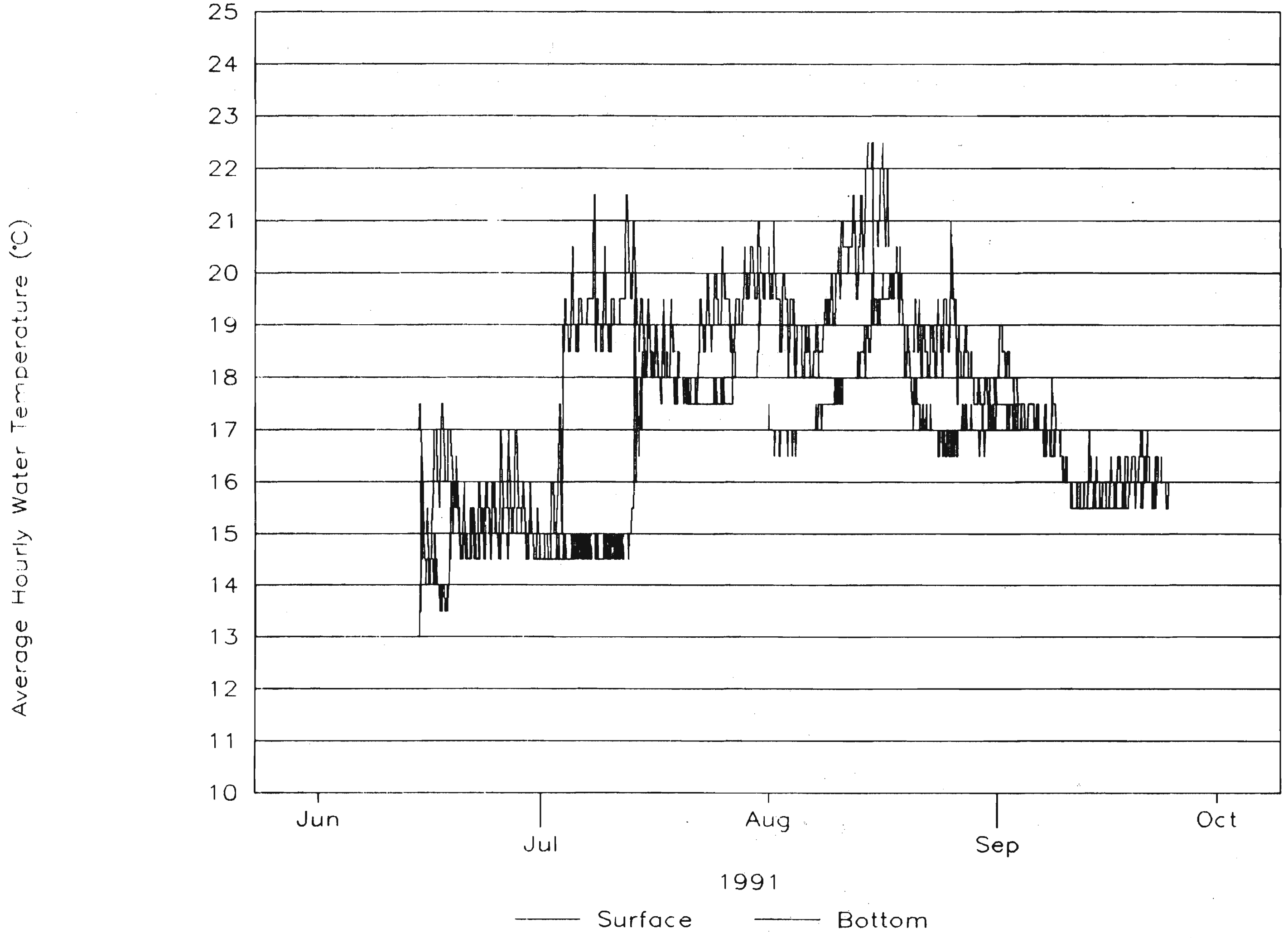


Figure 19. Grant Lake Surface and Bottom Temperatures 1991 (Hourly LADWP Data from Datapods).

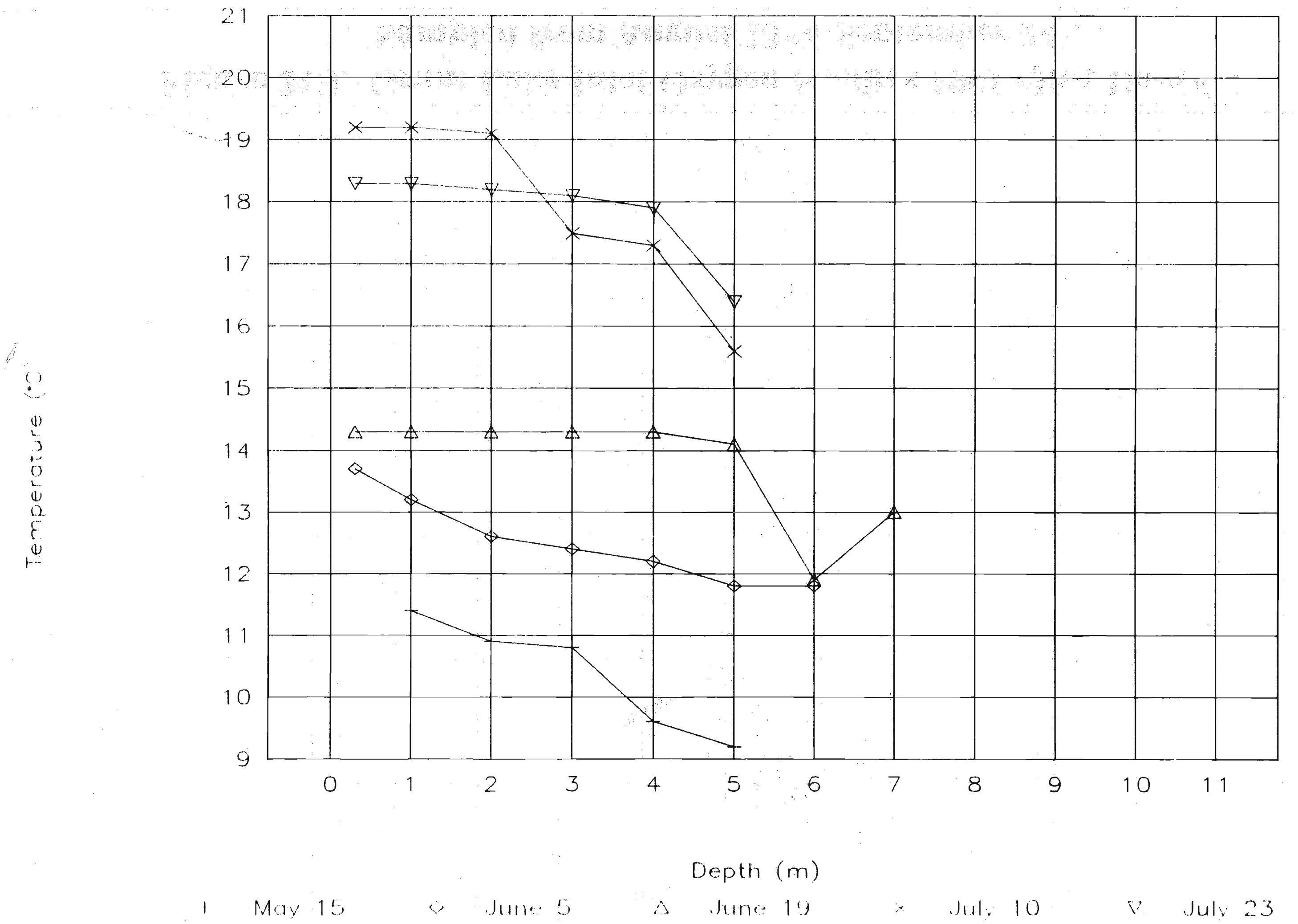


Figure 20A. Grant Lake Inlet Temperature Profiles 1991
(JSA Data Sampled from May 15 to July 23).

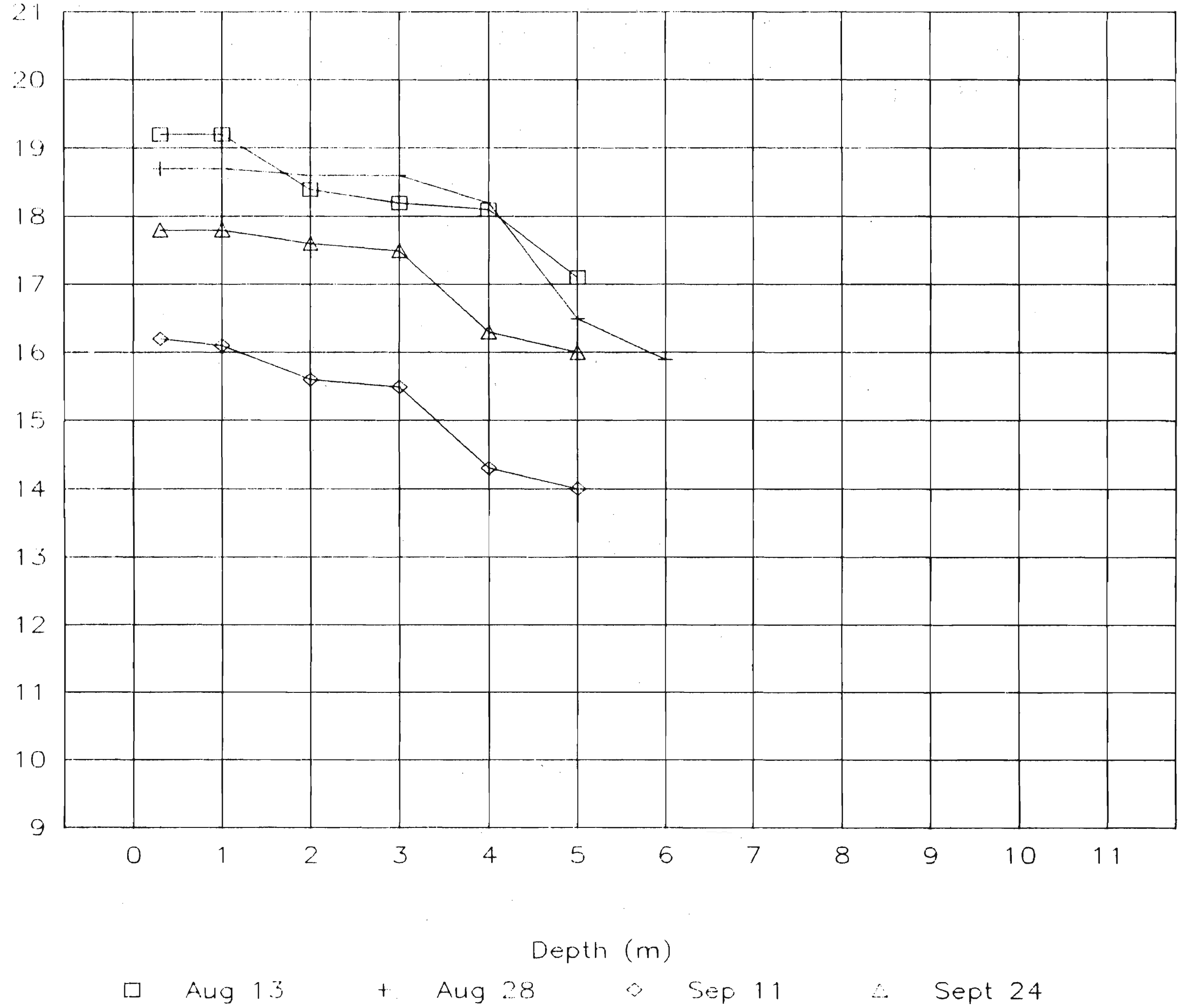


Figure 20B. Grant Lake Inlet Temperature Profiles 1991 (JSA Data Sampled from August 13 to September 24).

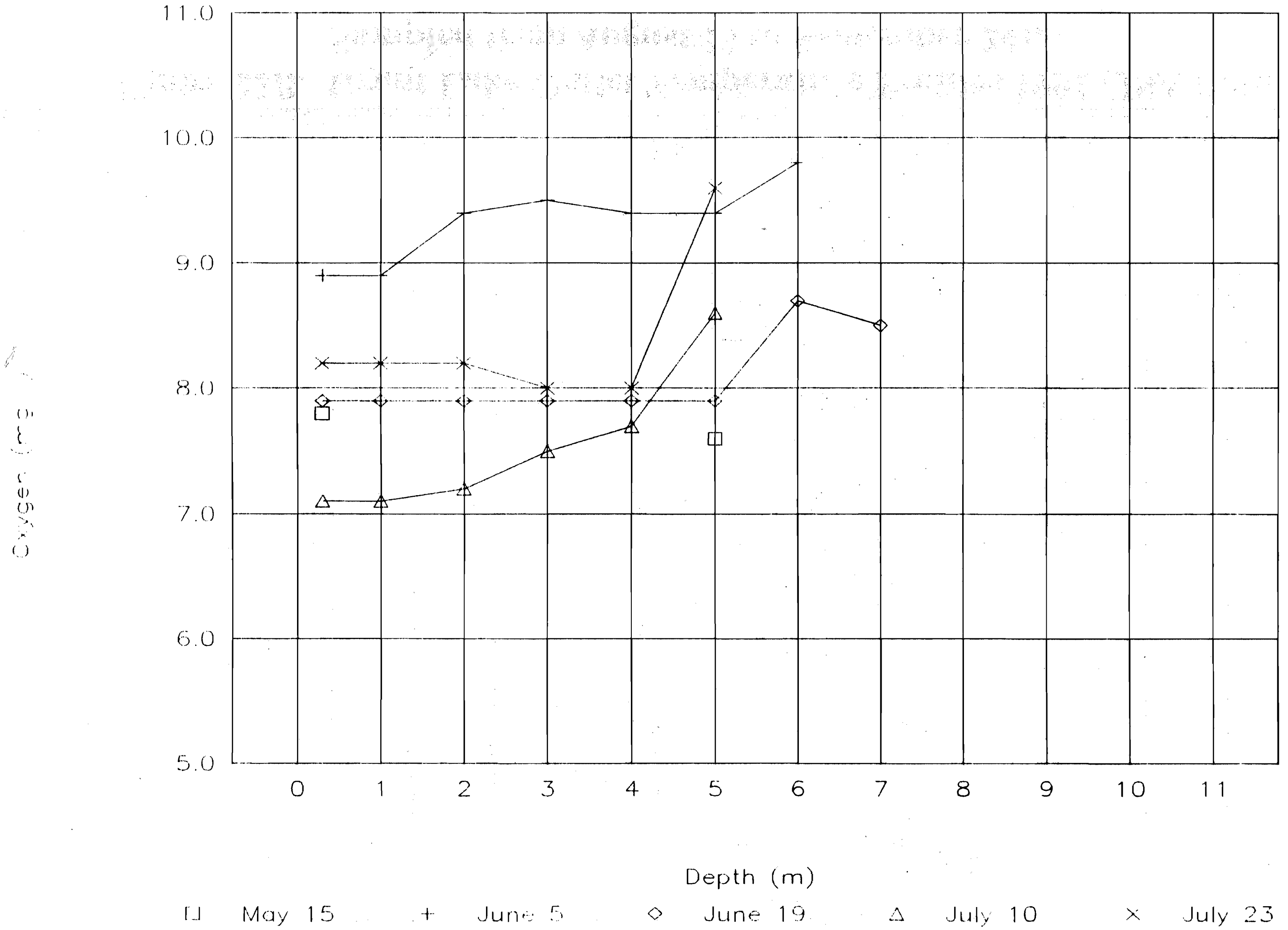


Figure 21A. Grant Lake Inlet Oxygen Profiles 1991 (JSA Data Sampled from May 15 to July 23).

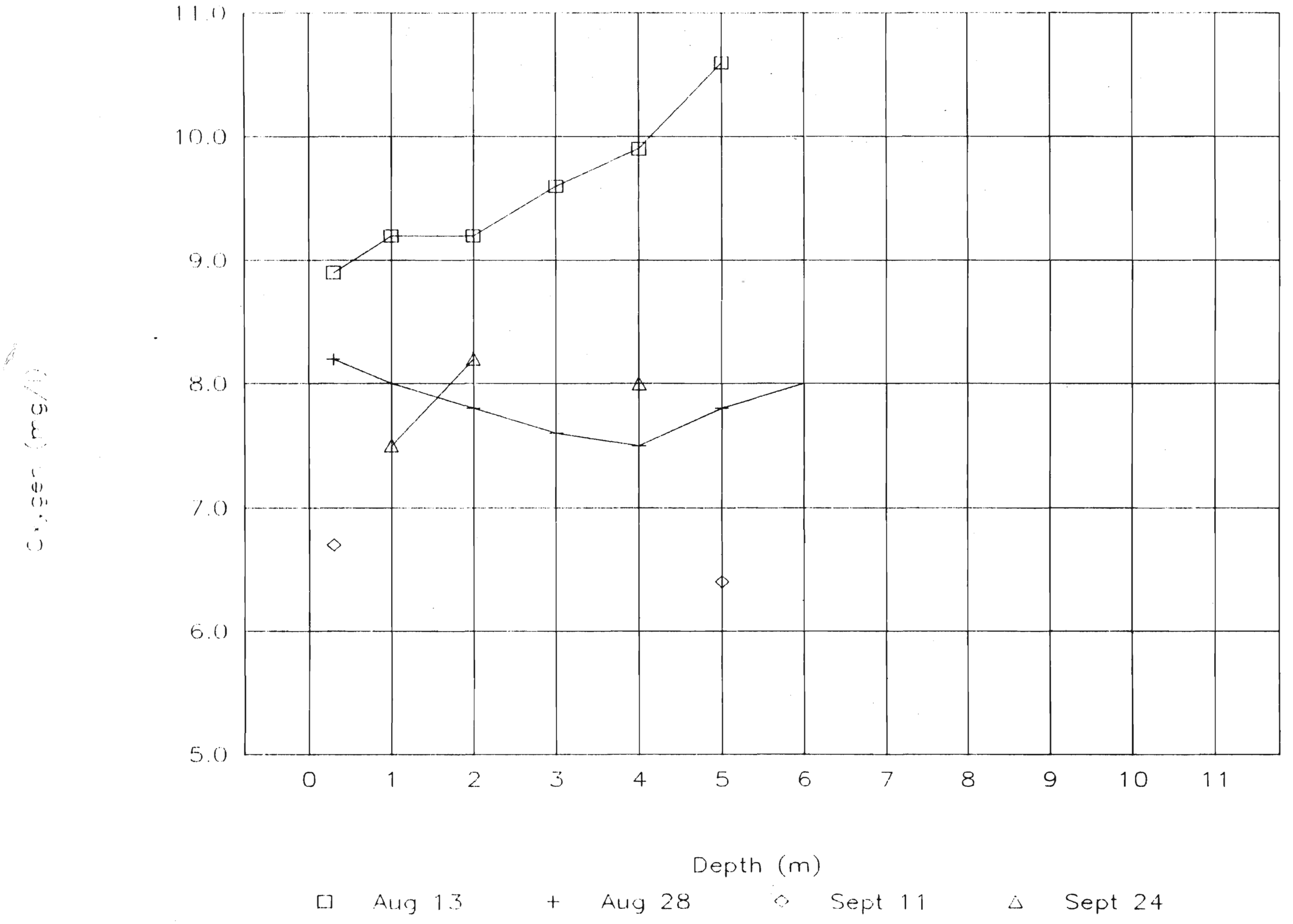


Figure 21B. Grant Lake Inlet Oxygen Profiles 1991 (JSA Data Sampled from August 13 to September 24).

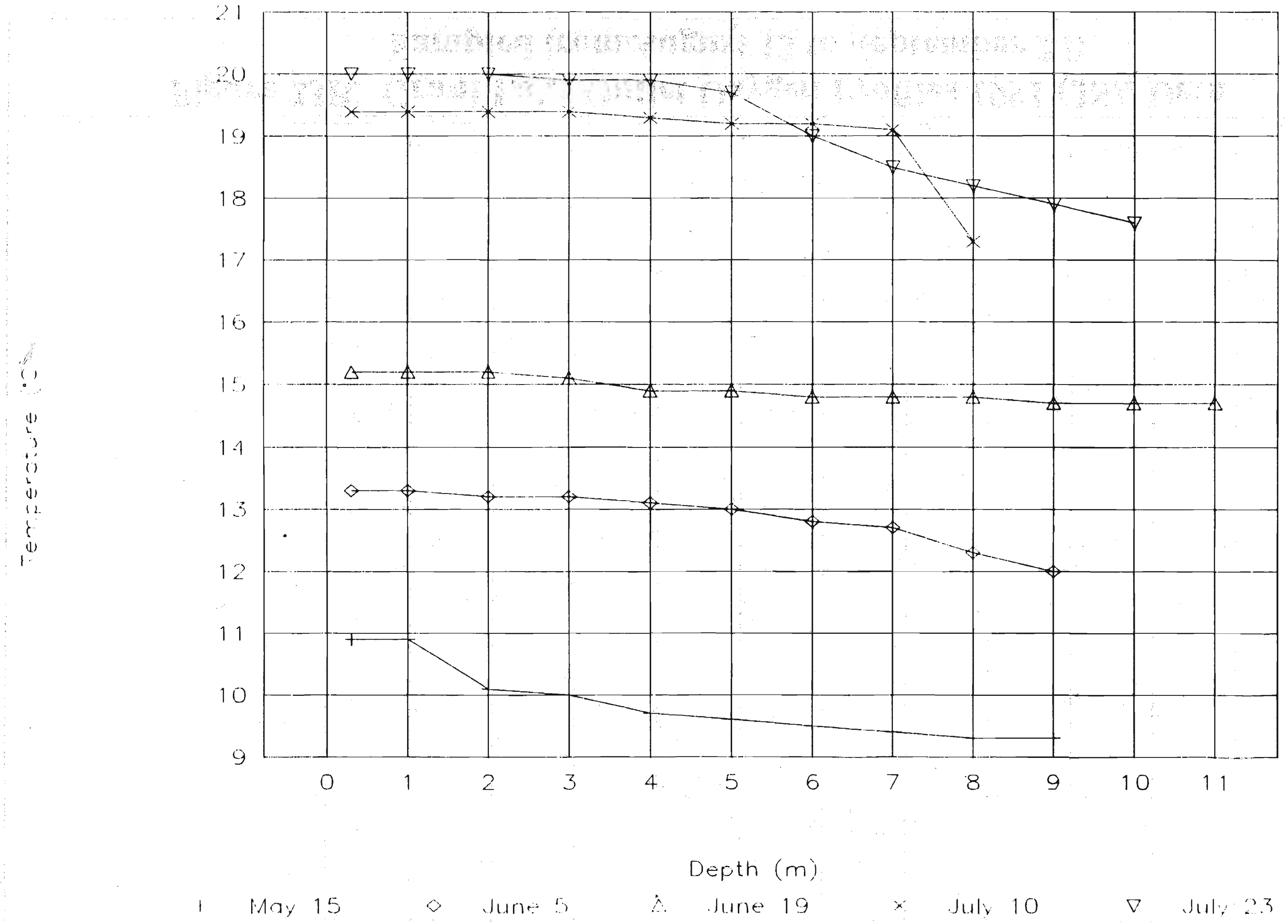


Figure 22A. Grant Lake Outlet Temperature Profiles 1991 (JSA Data Sampled from May 15 to July 23).

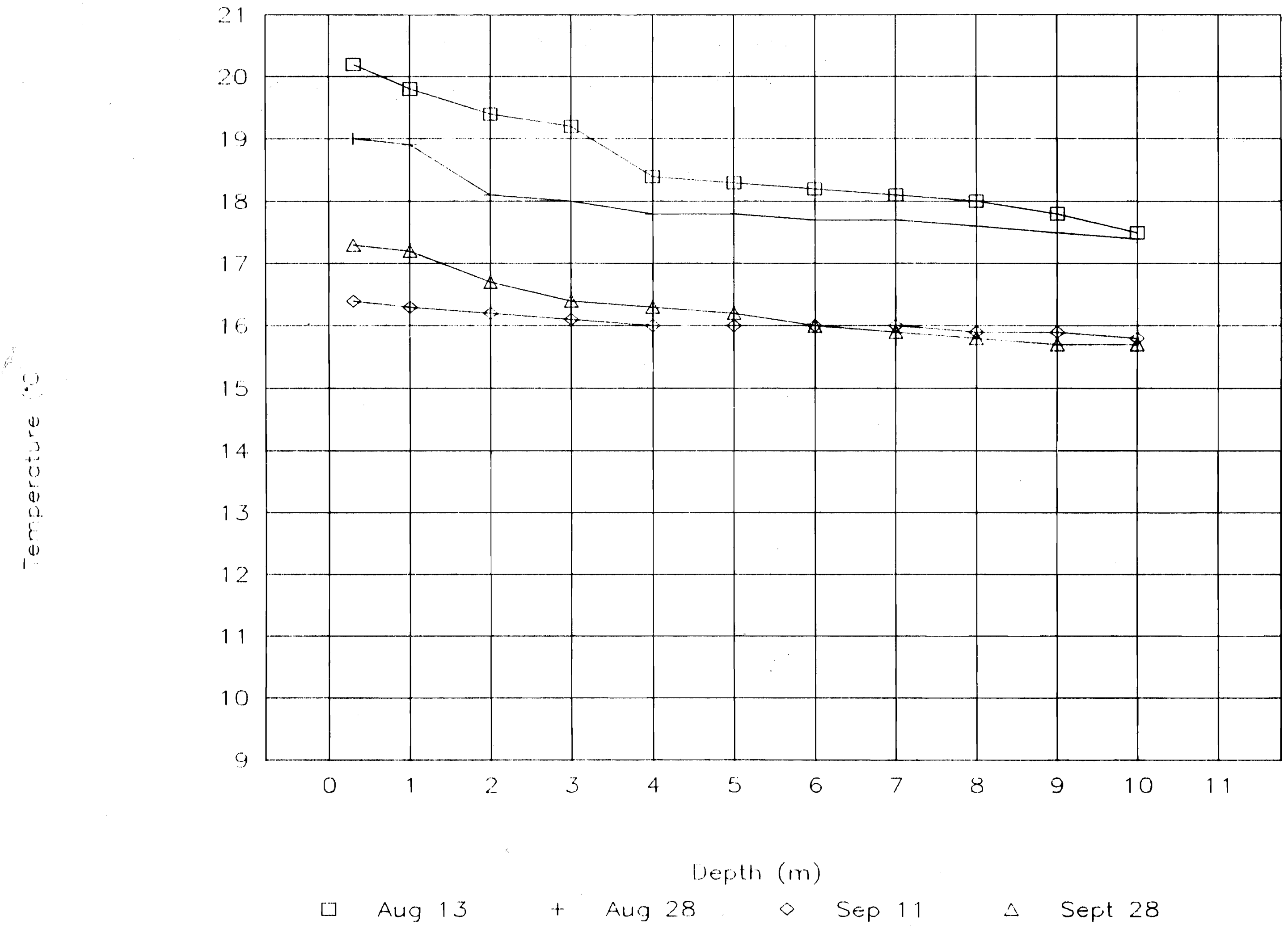


Figure 22B. Grant Lake Outlet Temperature Profiles 1991 (JSA Data Sampled from August 13 to September 24).

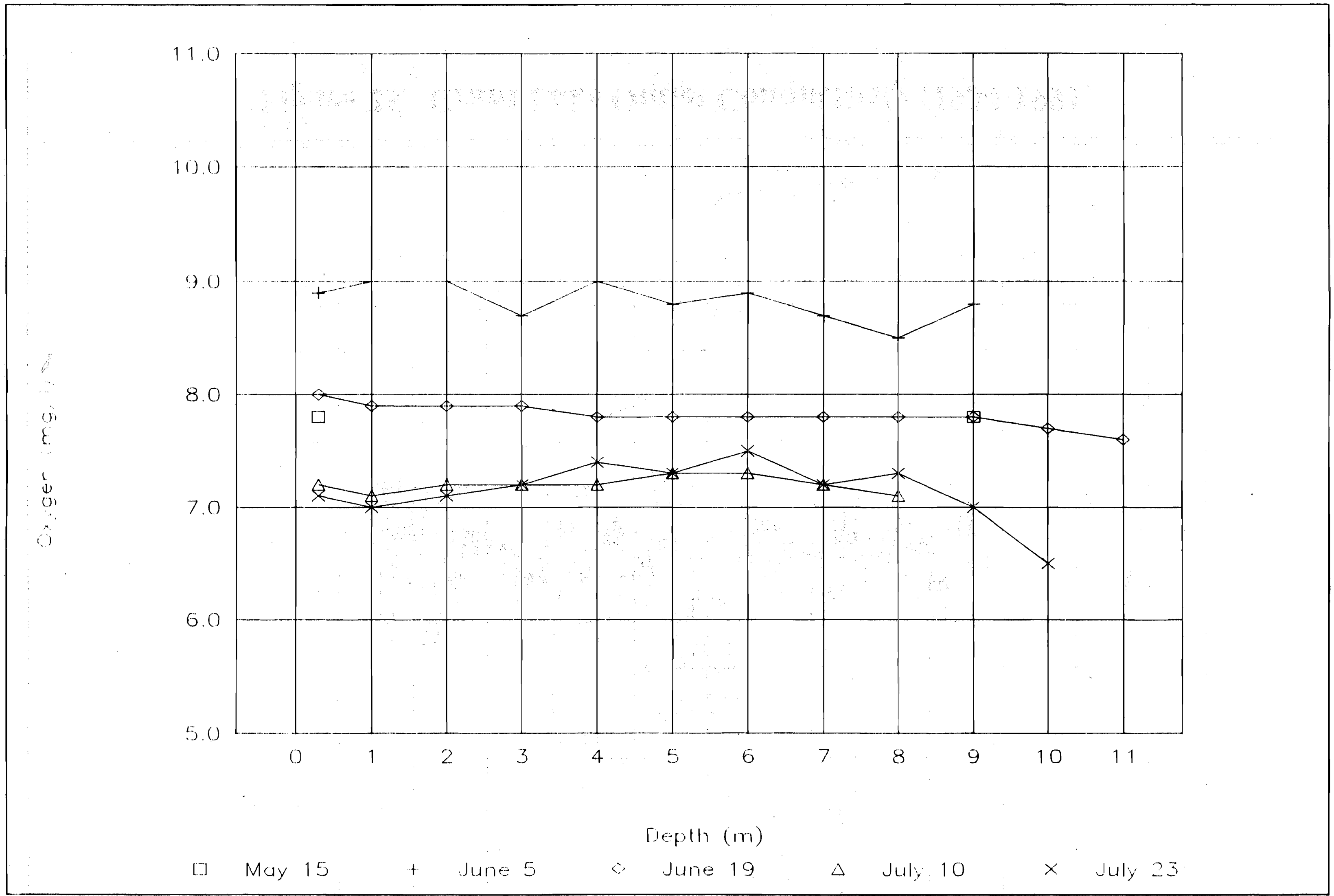


Figure 23A. Grant Lake Outlet Oxygen Profiles 1991 (JSA Data Sampled from May 15 to July 23).

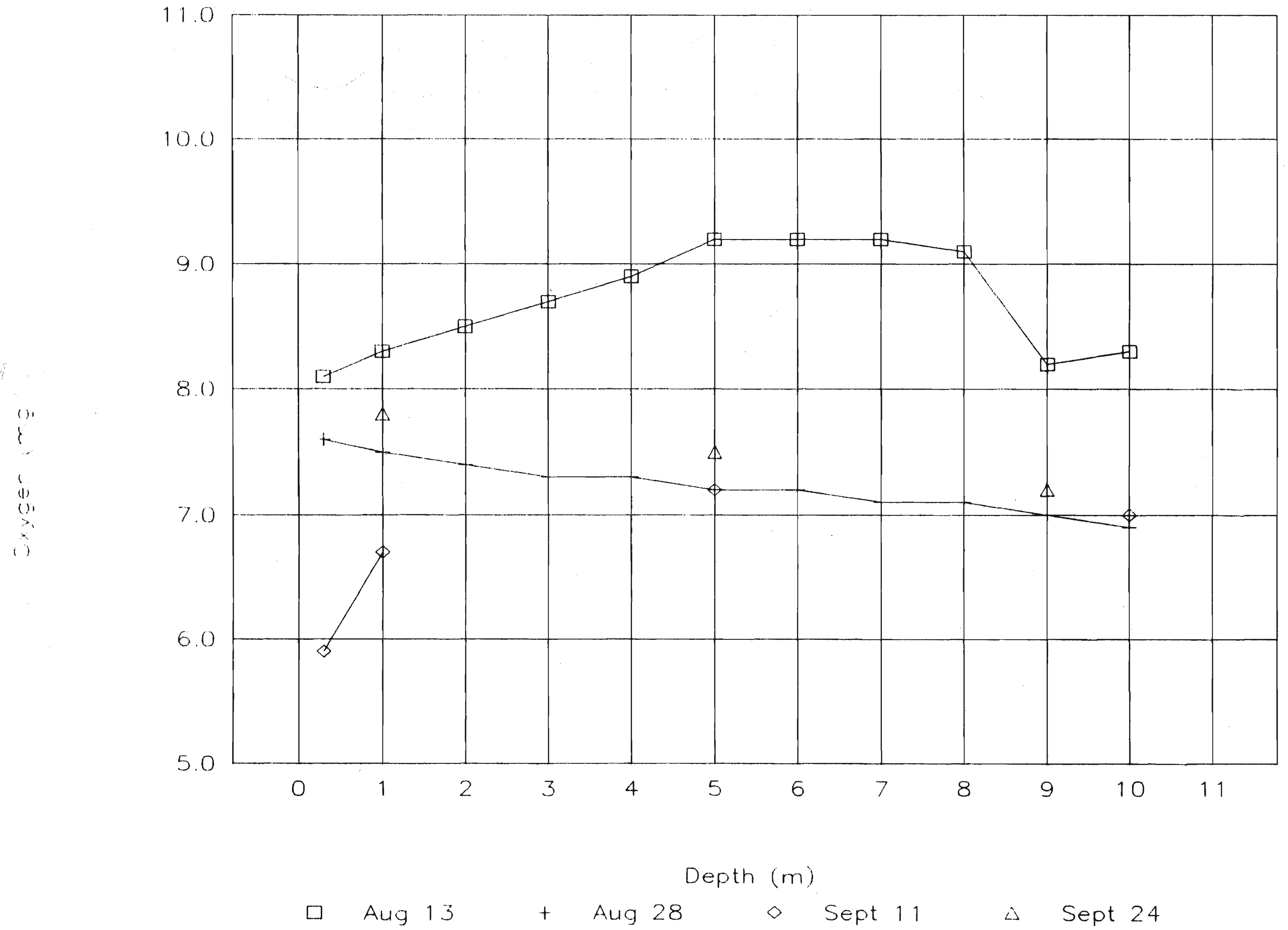


Figure 23B. Grant Lake Outlet Oxygen Profiles 1991 (JSA Data Sampled from August 13 to September 24).

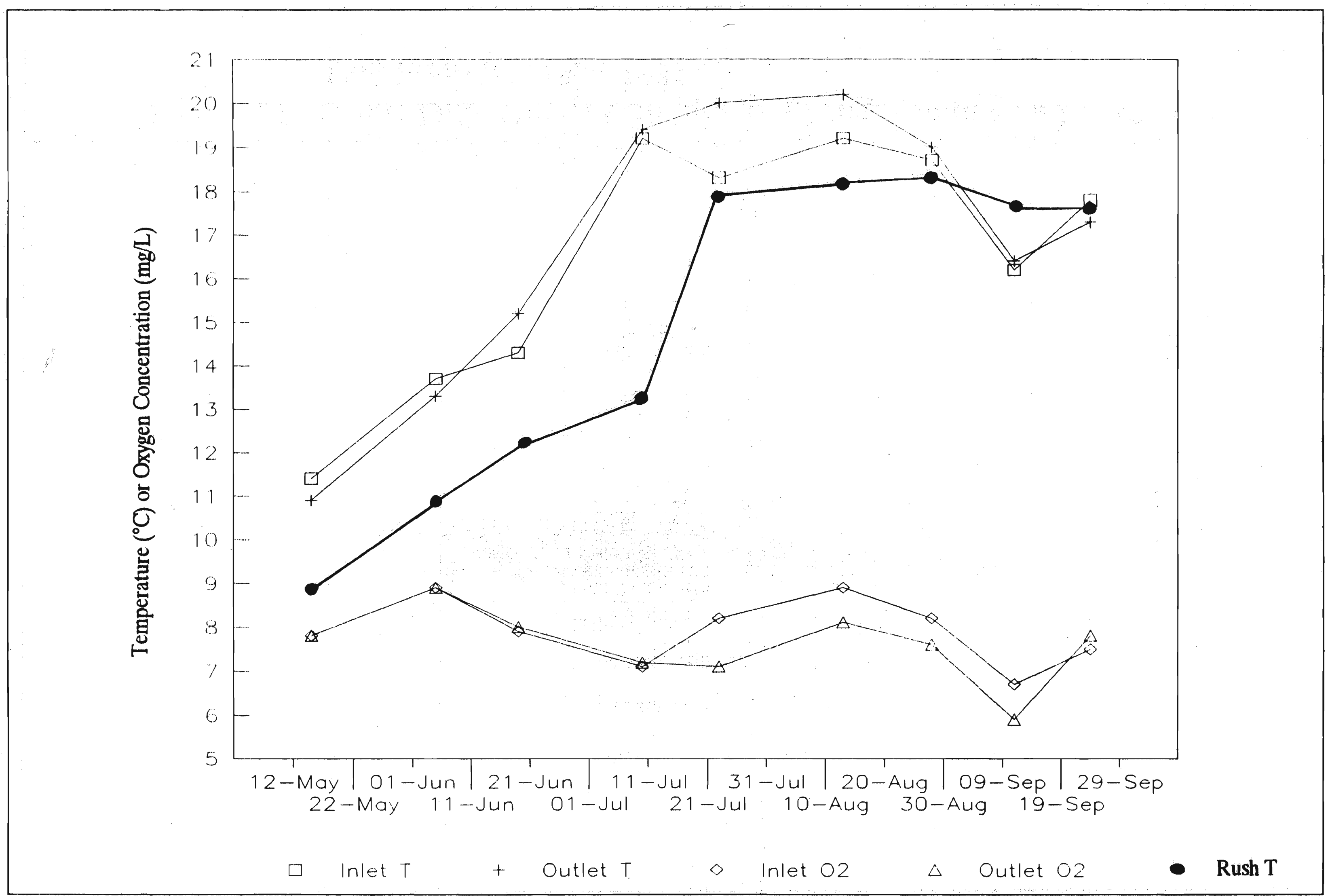


Figure 24. Comparison between Grant Lake Inlet and Outlet Surface Temperatures and Oxygen Concentrations 1991 (JSA Data Sampled from May 15 to September 24).

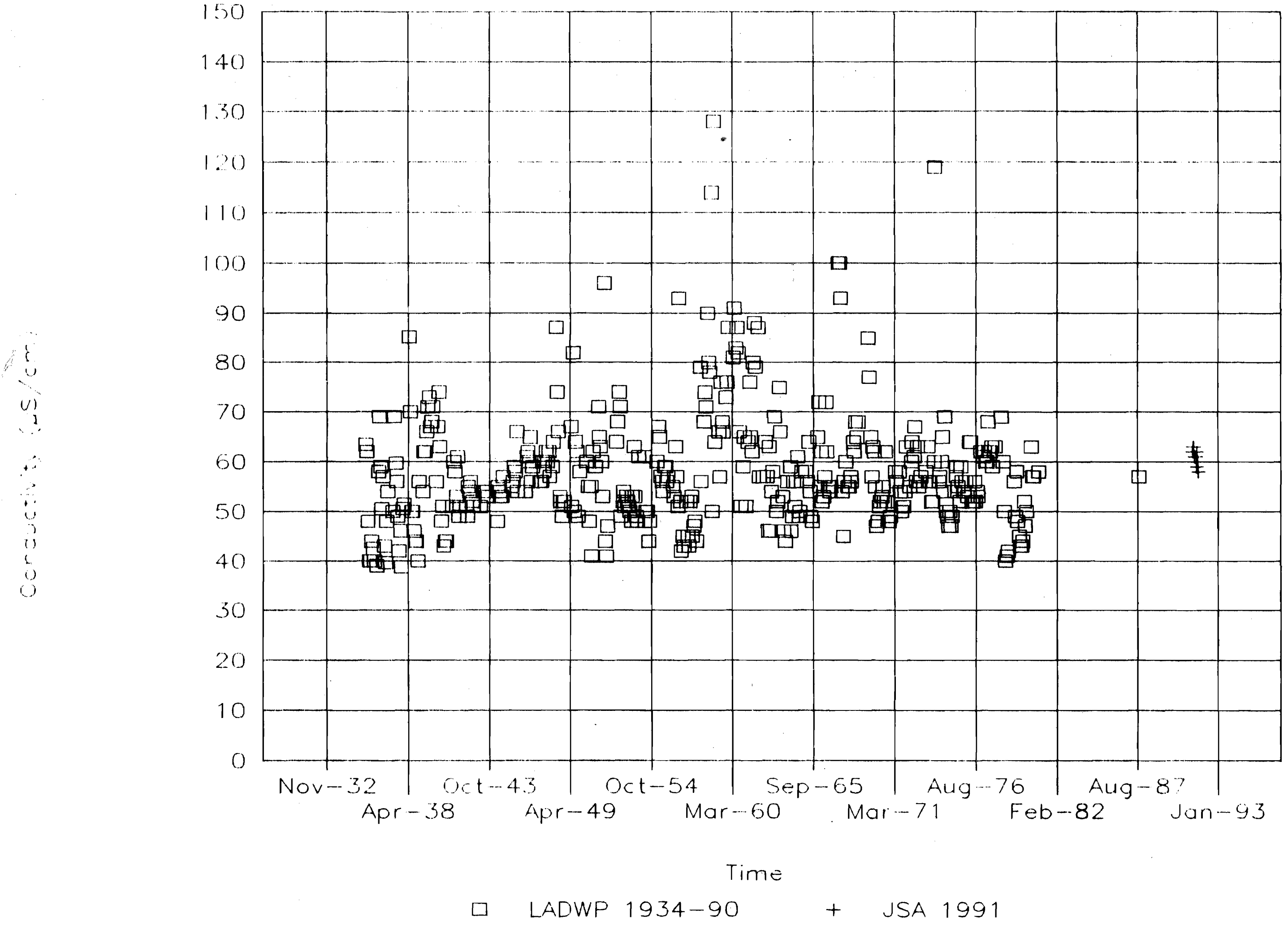


Figure 25. Grant Lake Outlet Conductivity (1934-1991).

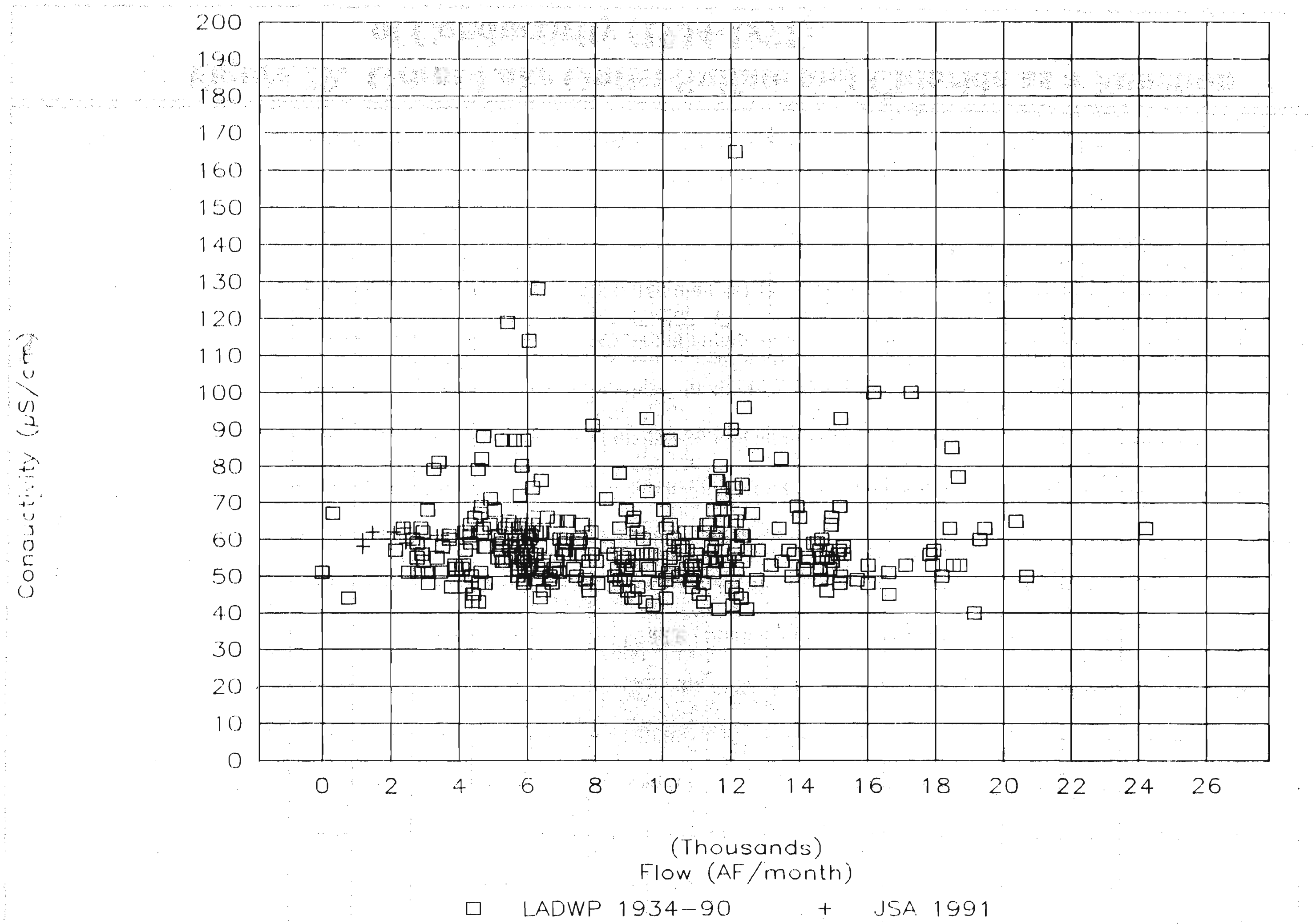


Figure 26. Grant Lake Outlet Conductivity as a Function of Flow (1934-1991).

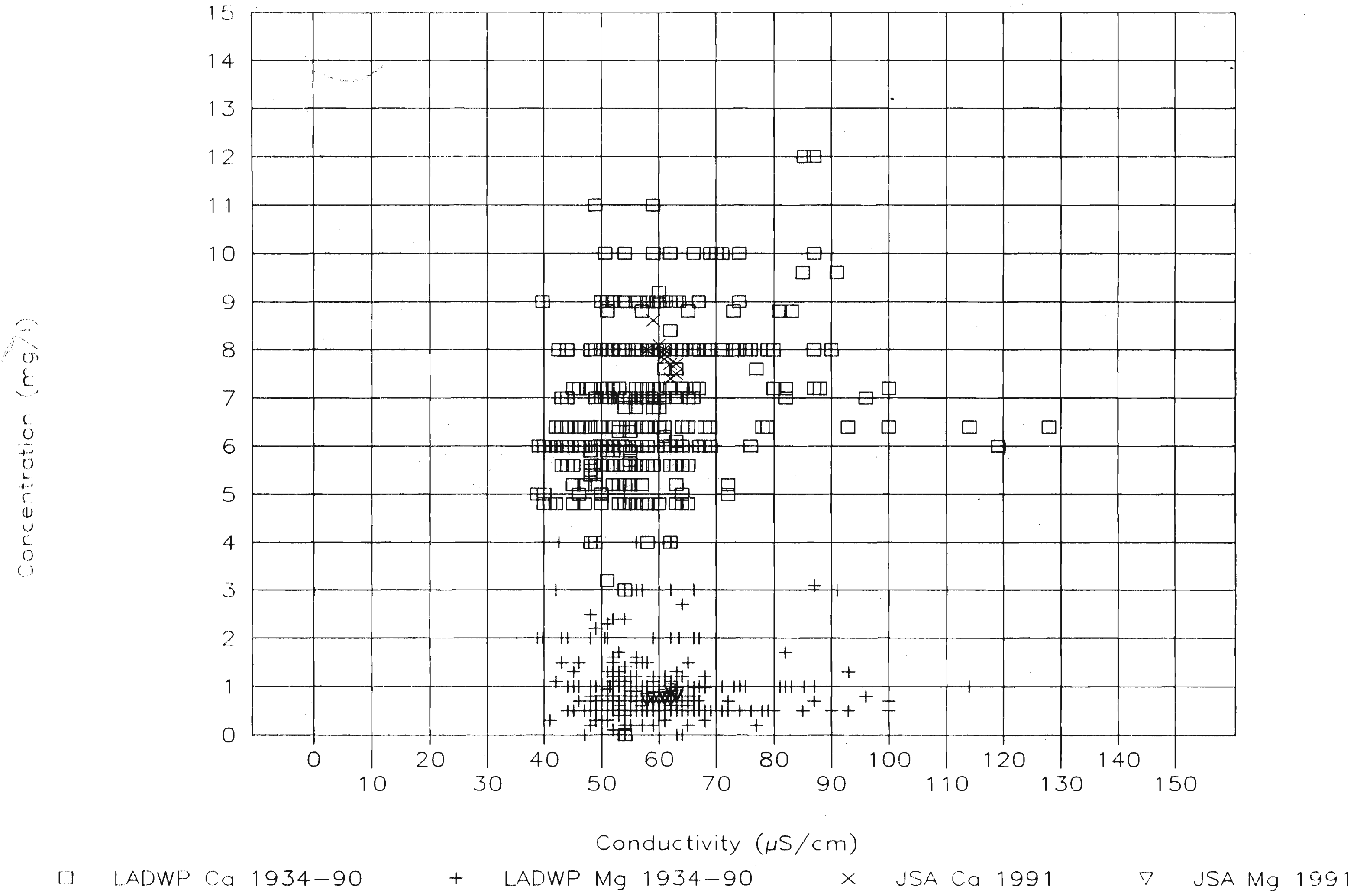


Figure 27. Grant Lake Outlet Calcium and Magnesium as a Function of Conductivity (1934-1991).

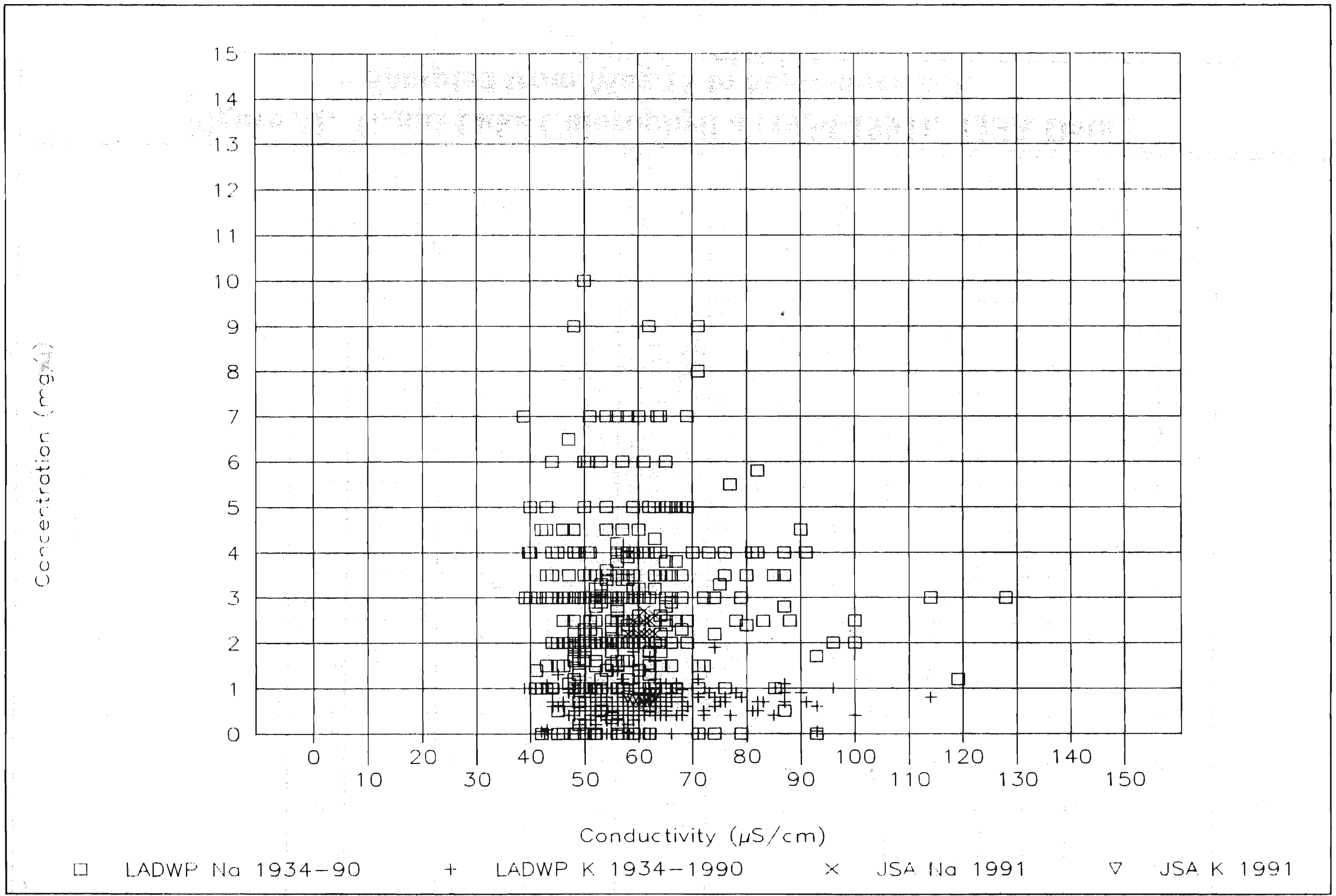


Figure 28. Grant Lake Outlet Sodium and Potassium as a Function of Conductivity (1934-1991).

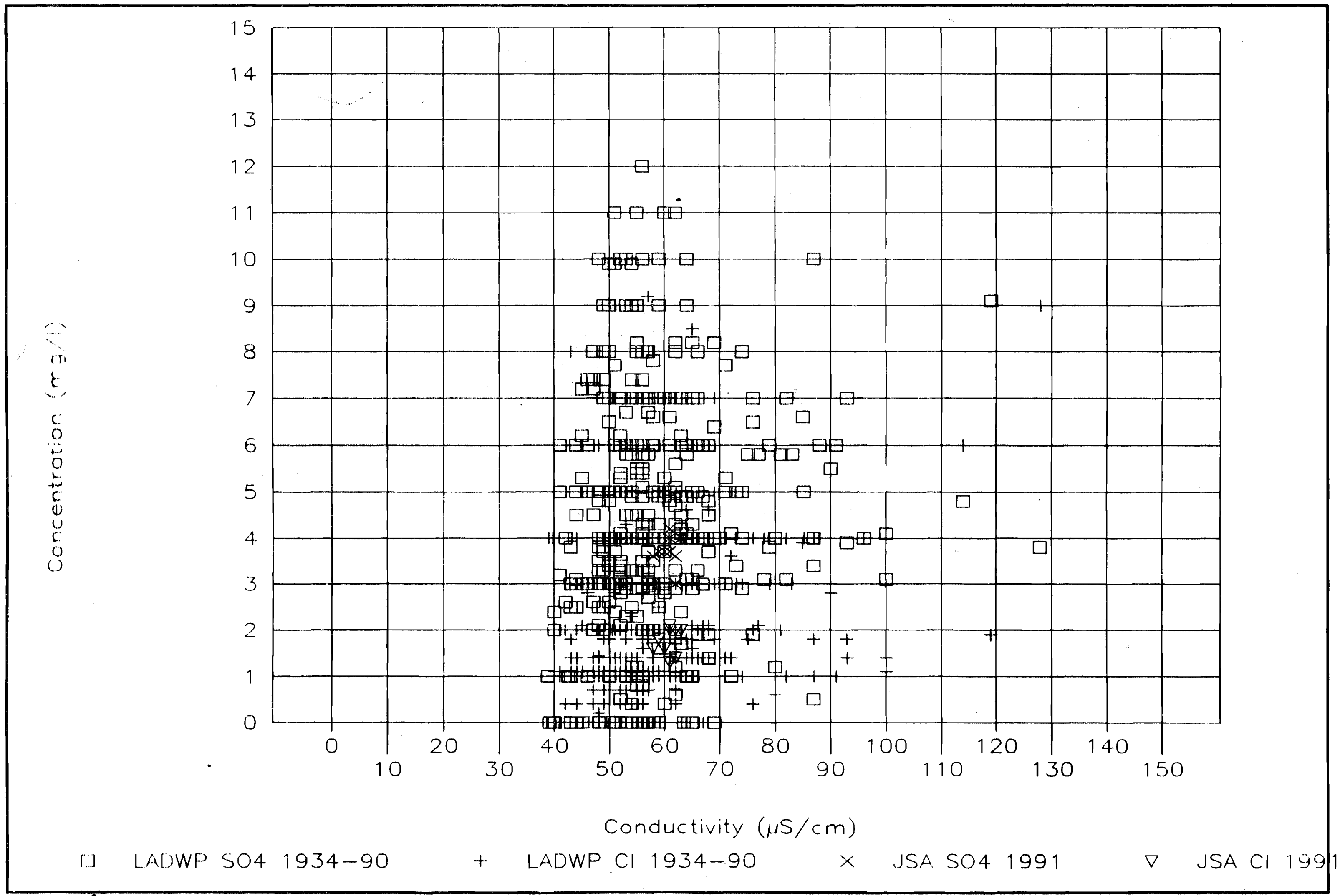


Figure 29. Grant Lake Outlet Sulfate and Chloride as a Function of Conductivity (1934-1991).

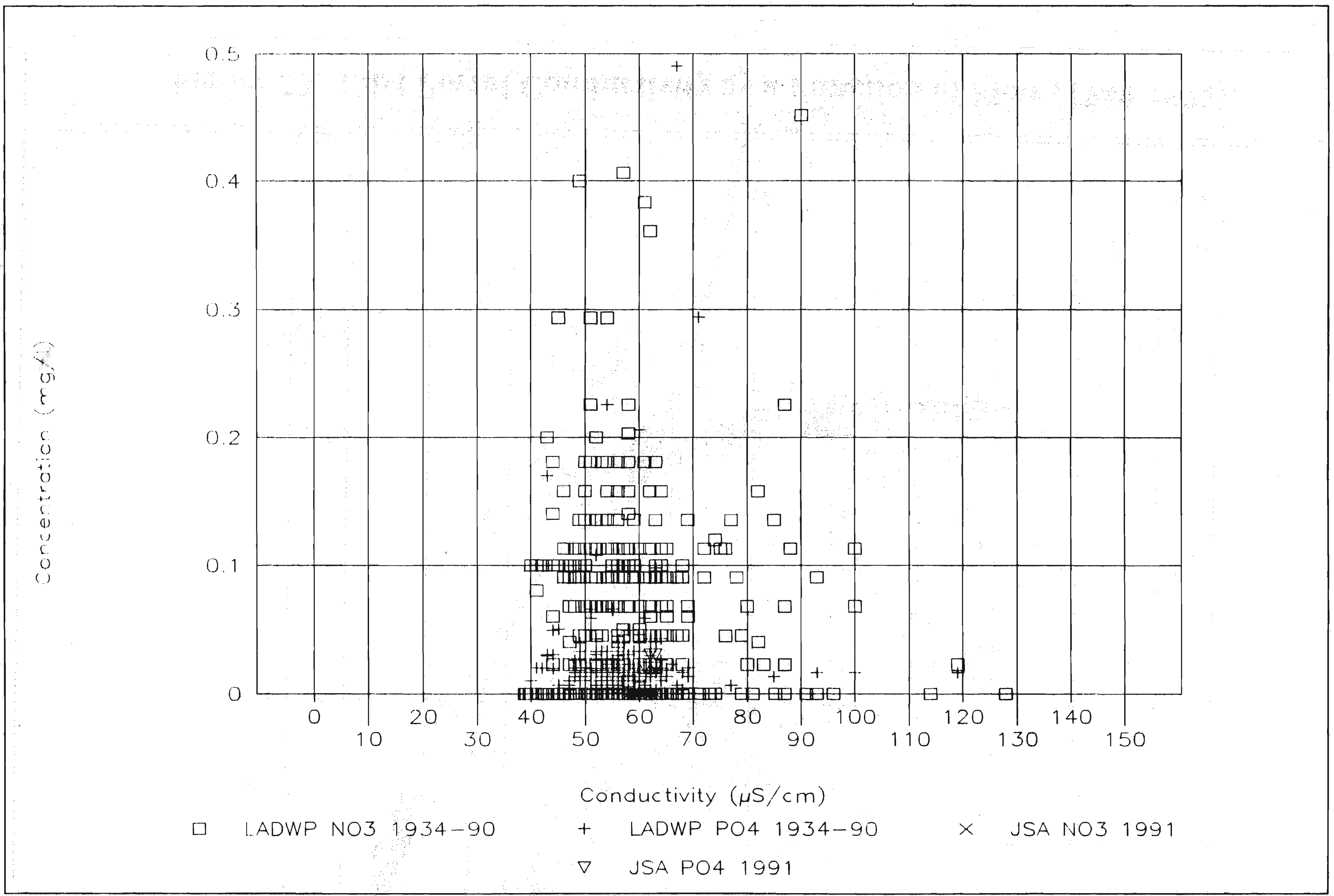


Figure 30. Grant Lake Outlet Nitrate and Phosphate as a Function of Conductivity (1934-1991).

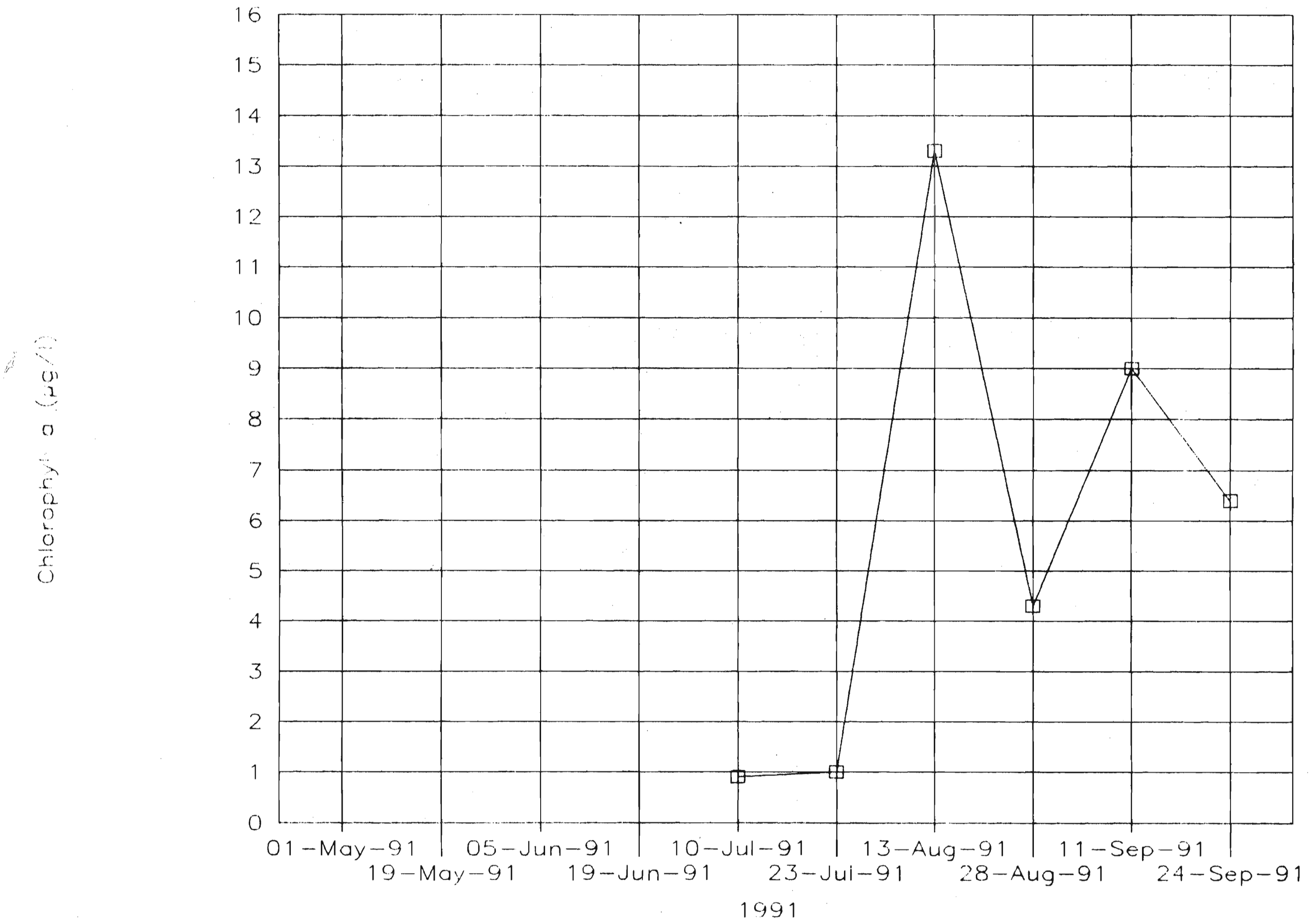
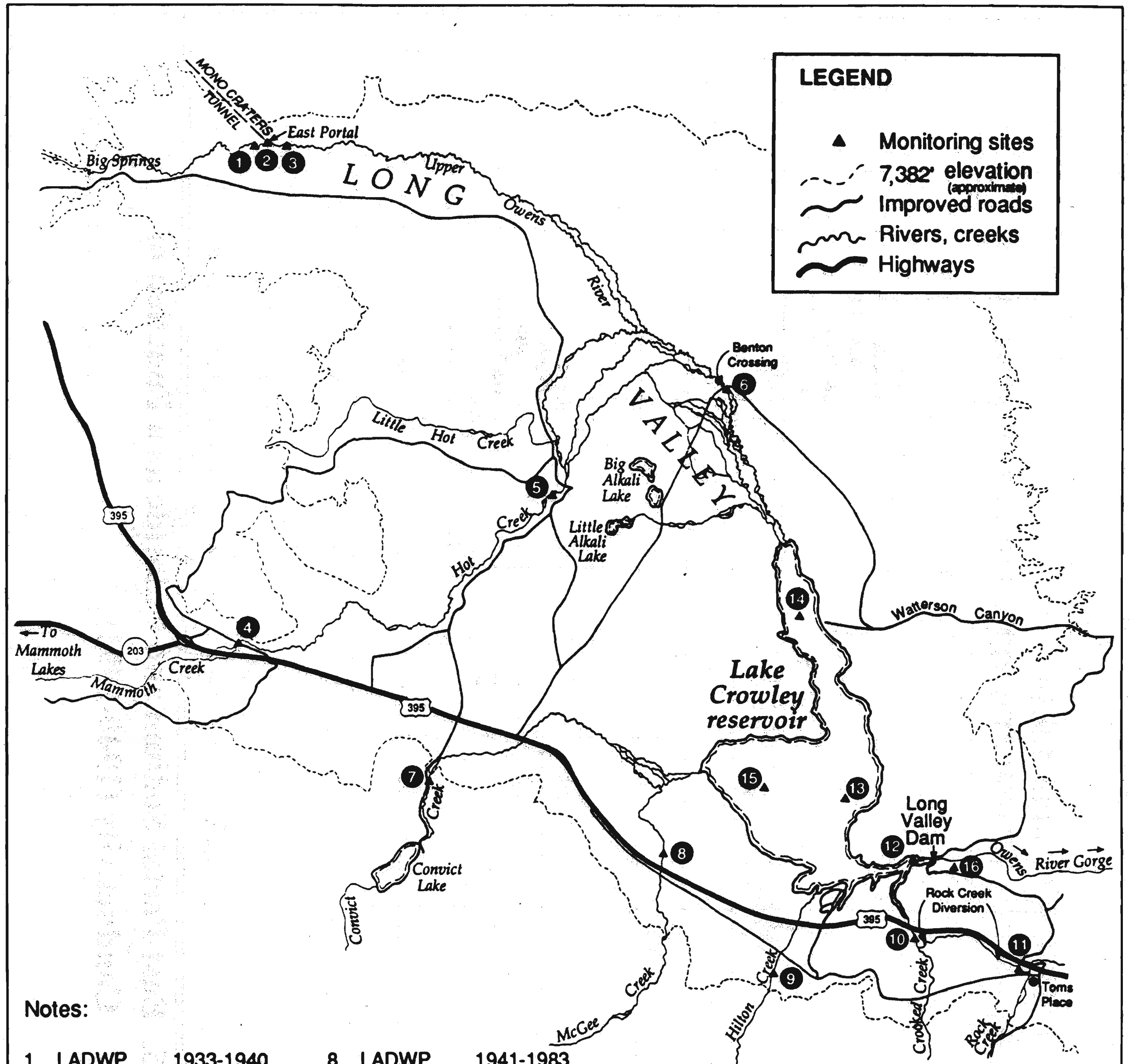


Figure 31. Grant Lake Chlorophyll a (1934-1991). (JSA Data Sampled from May 15 to September 24).



Notes:

1	LADWP	1933-1940
	JSA	1991
2	LADWP	1936-1982
	JSA	1991
3	LADWP	1940-1988
4	LADWP	1933-1980
	JSA	1991
5	LADWP	1965-1990
	USGS	1982-1991
	JSA	1991
6	LADWP	1973-1980
	JSA	1991
7	LADWP	1933-1983
	JSA	1991
8	LADWP	1941-1983
	JSA	1991
9	LADWP	1947-1980
	JSA	1991
10	JSA	1991
11	LADWP	1941-1980
	JSA	1991
12	JSA	1991
13	JSA	1991
14	JSA	1991
15	JSA	1991
16	LADWP	1940-1991
	JSA	1991

Figure 32. Location of Monitoring Sites in the Upper Owens River Basin.

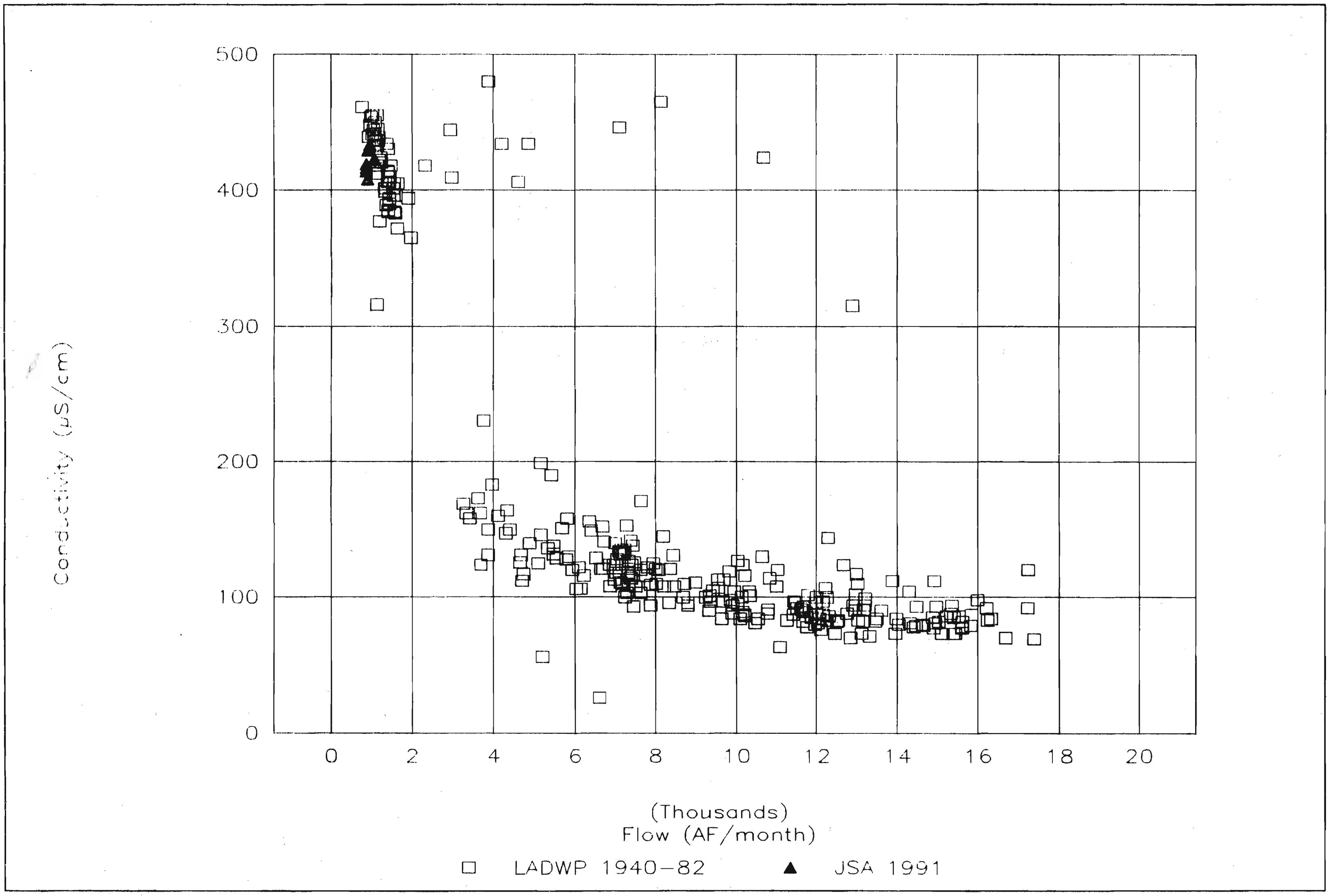


Figure 33. East Portal Conductivity as a Function of Flow (1940-1991).

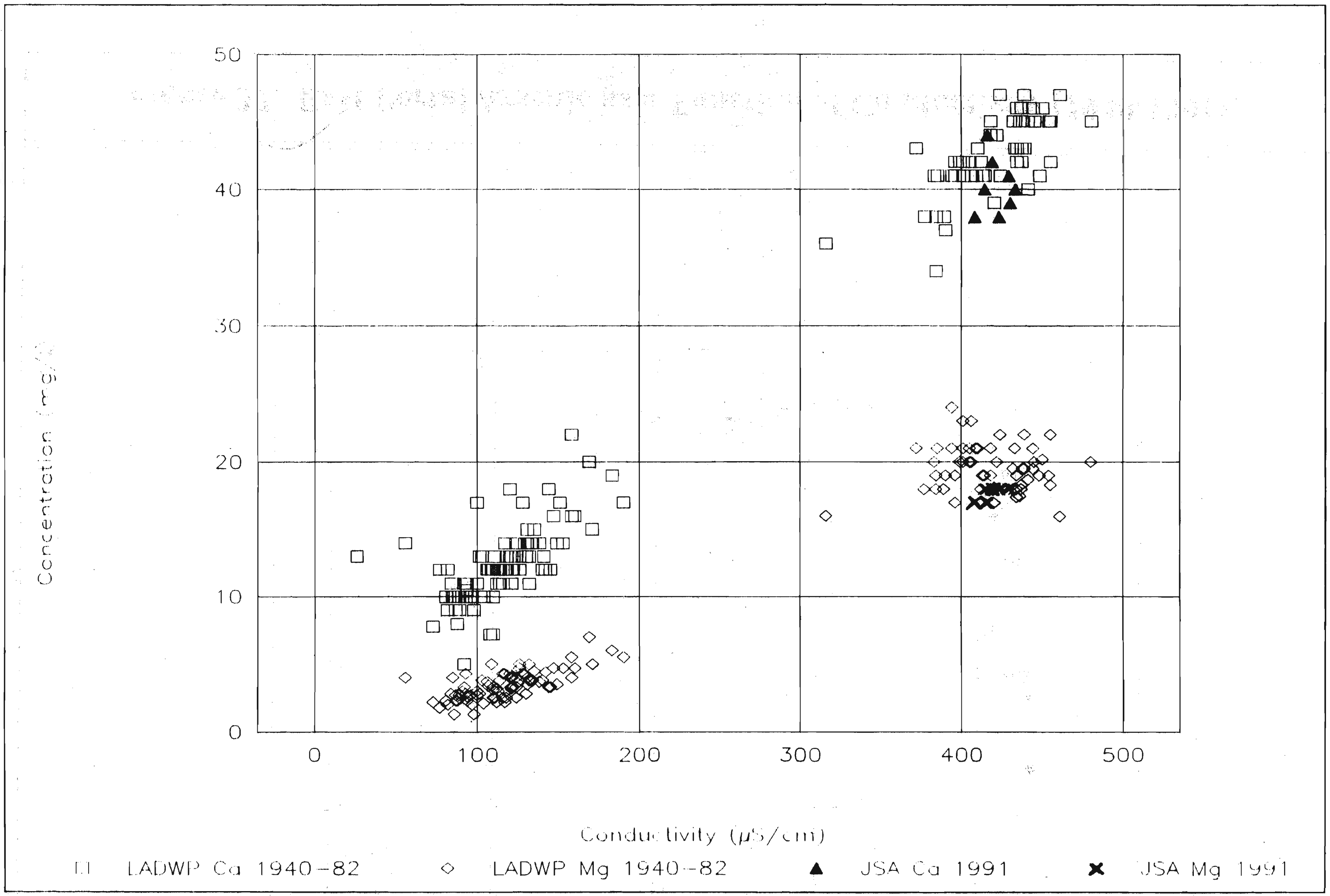


Figure 34. East Portal Calcium and Magnesium as a Function of Conductivity (1940-1991).

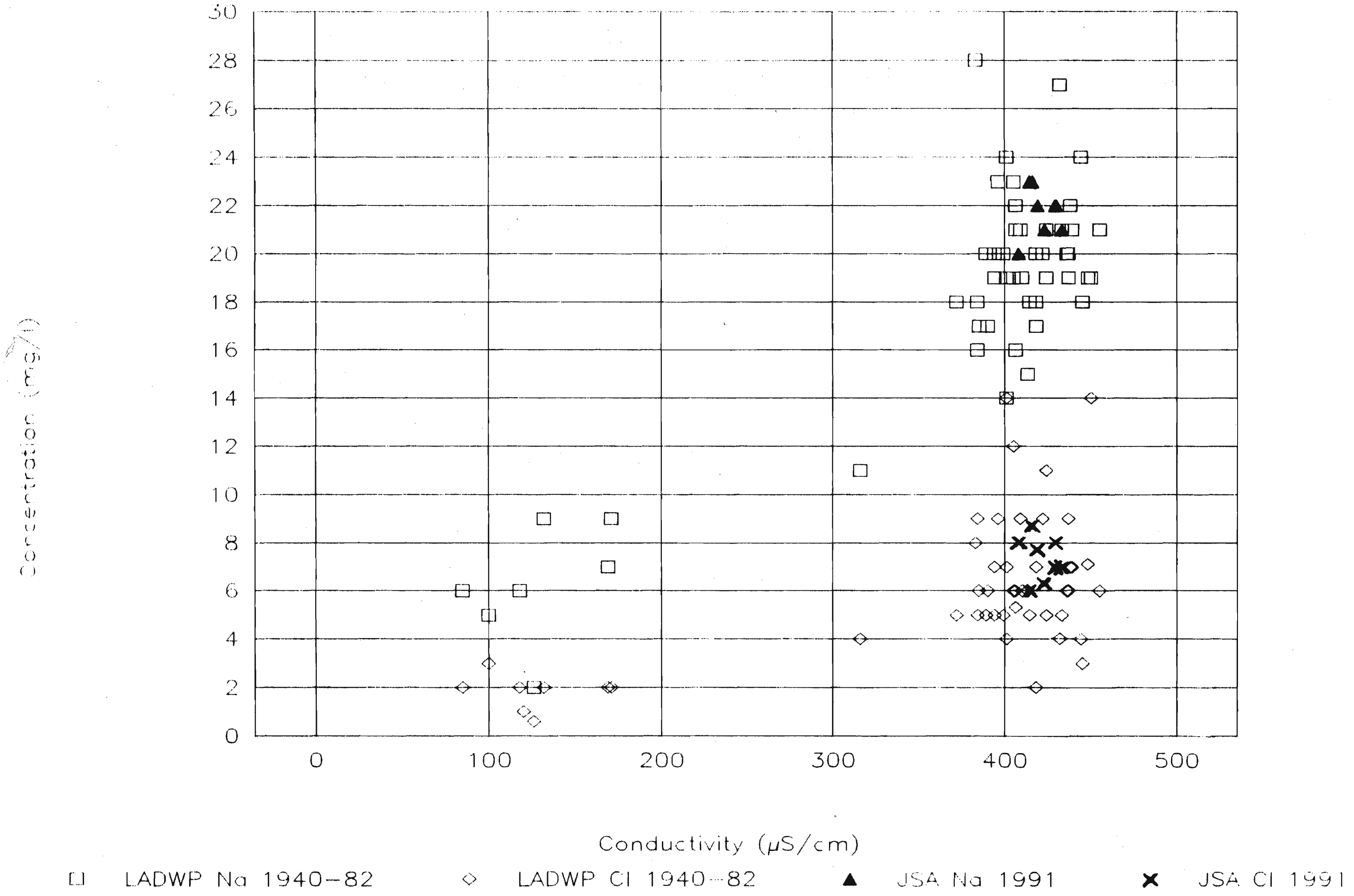


Figure 35. East Portal Sodium and Chloride as a Function of Conductivity (1940-1991).

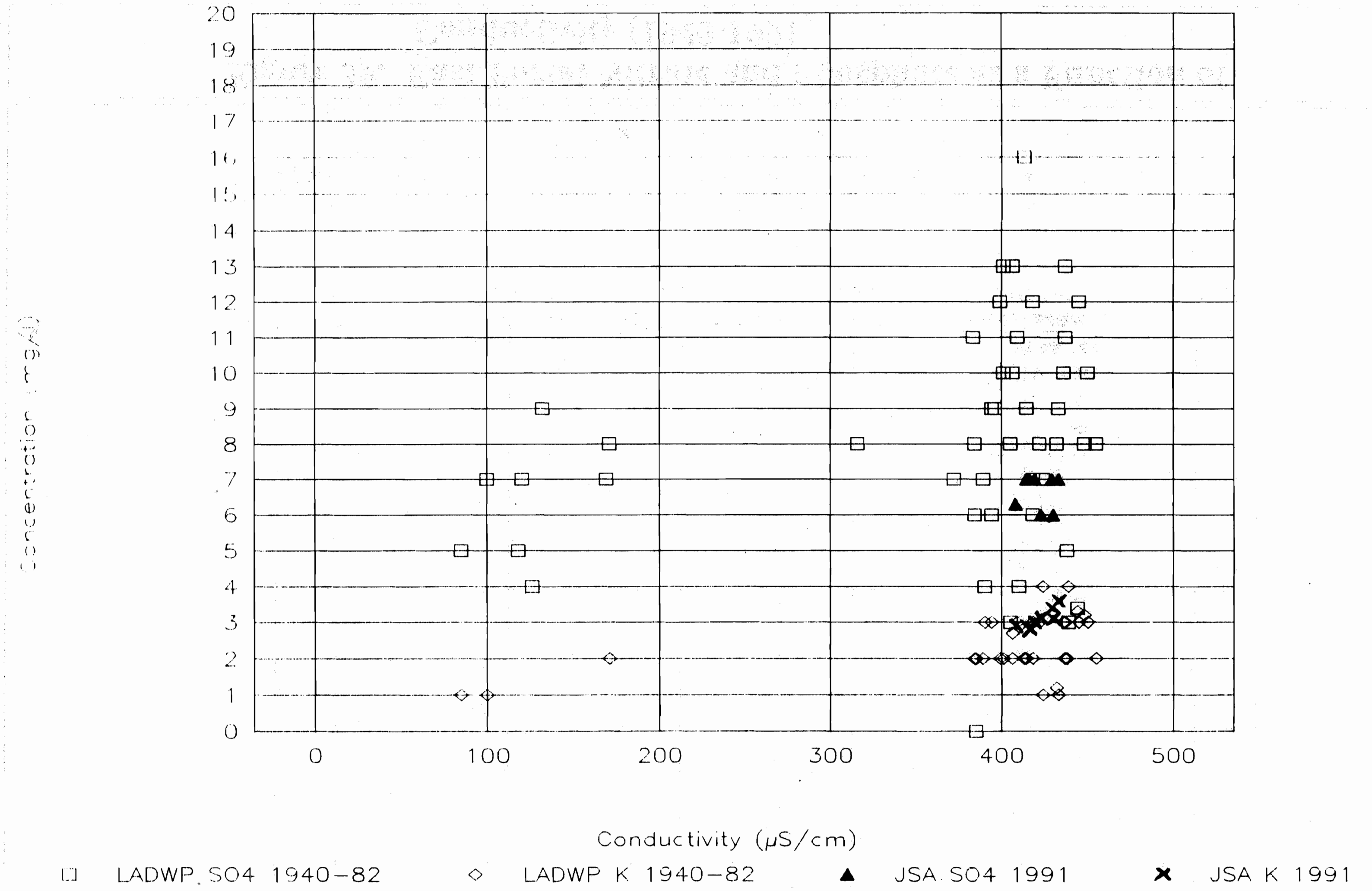


Figure 36. East Portal Sulfate and Potassium as a Function of Conductivity (1940-1991).

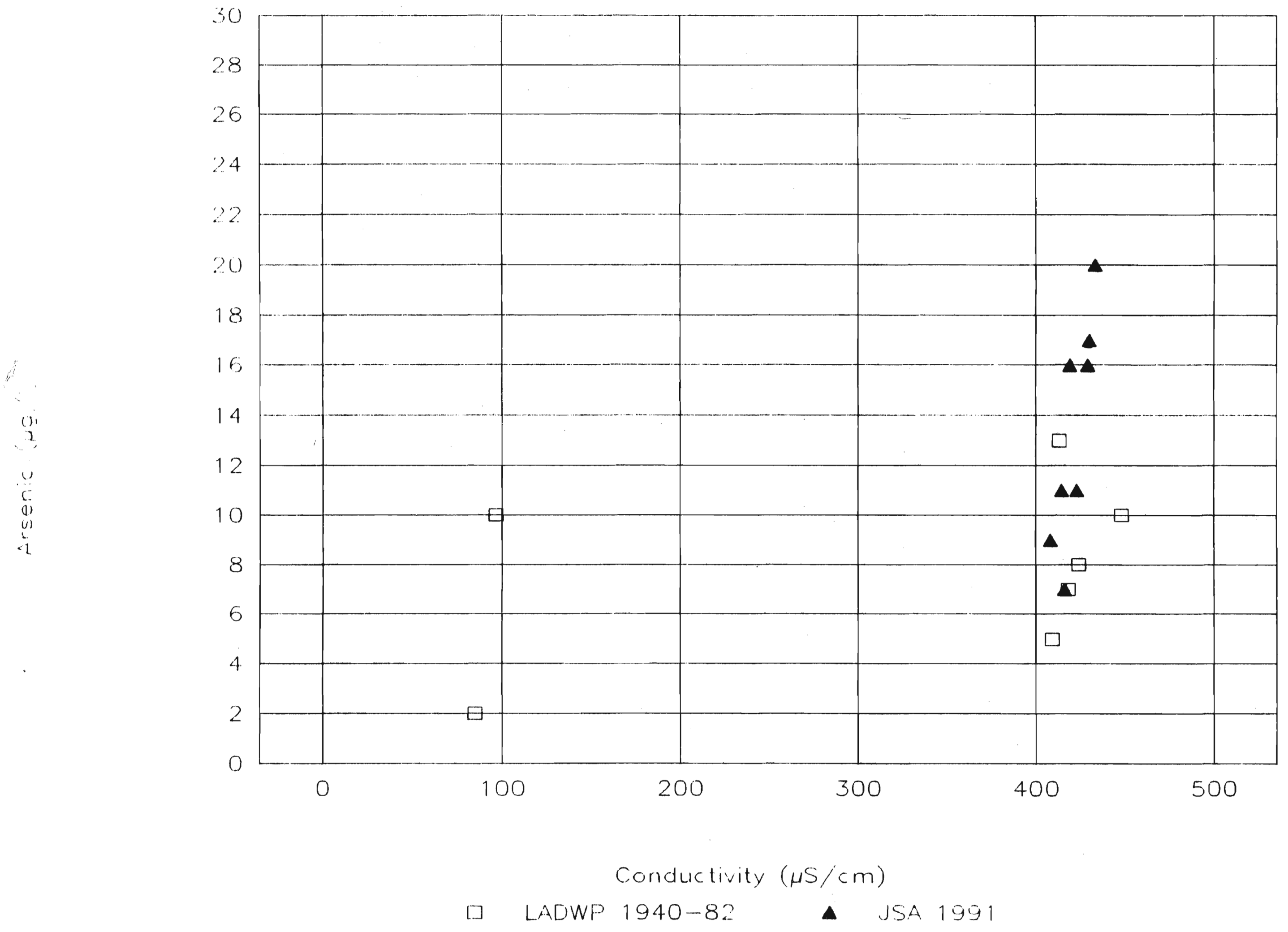


Figure 37. East Portal Arsenic as a Function of Conductivity (1940-1991).

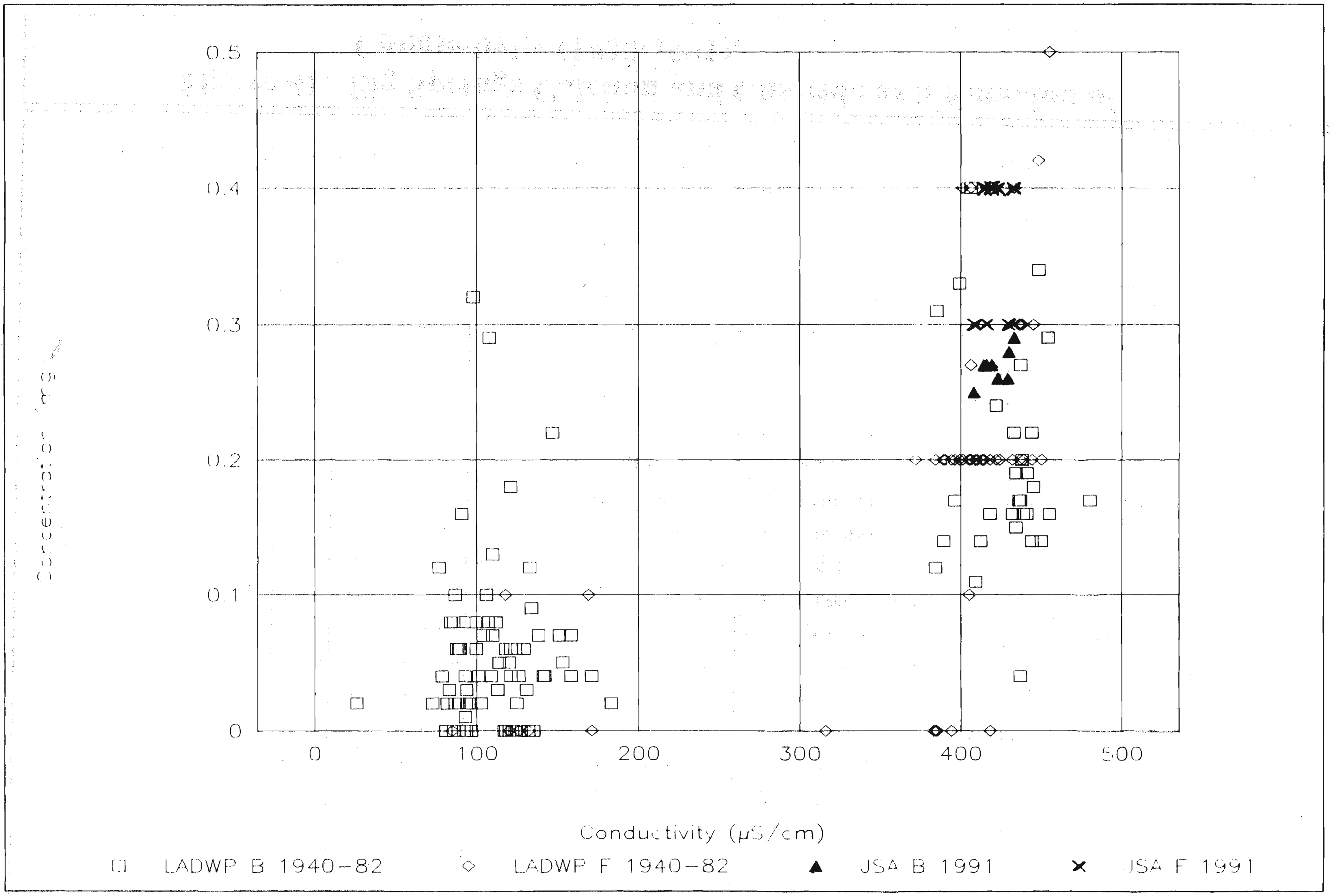


Figure 38. East Portal Boron and Fluoride as a Function of Conductivity (1940-1991).

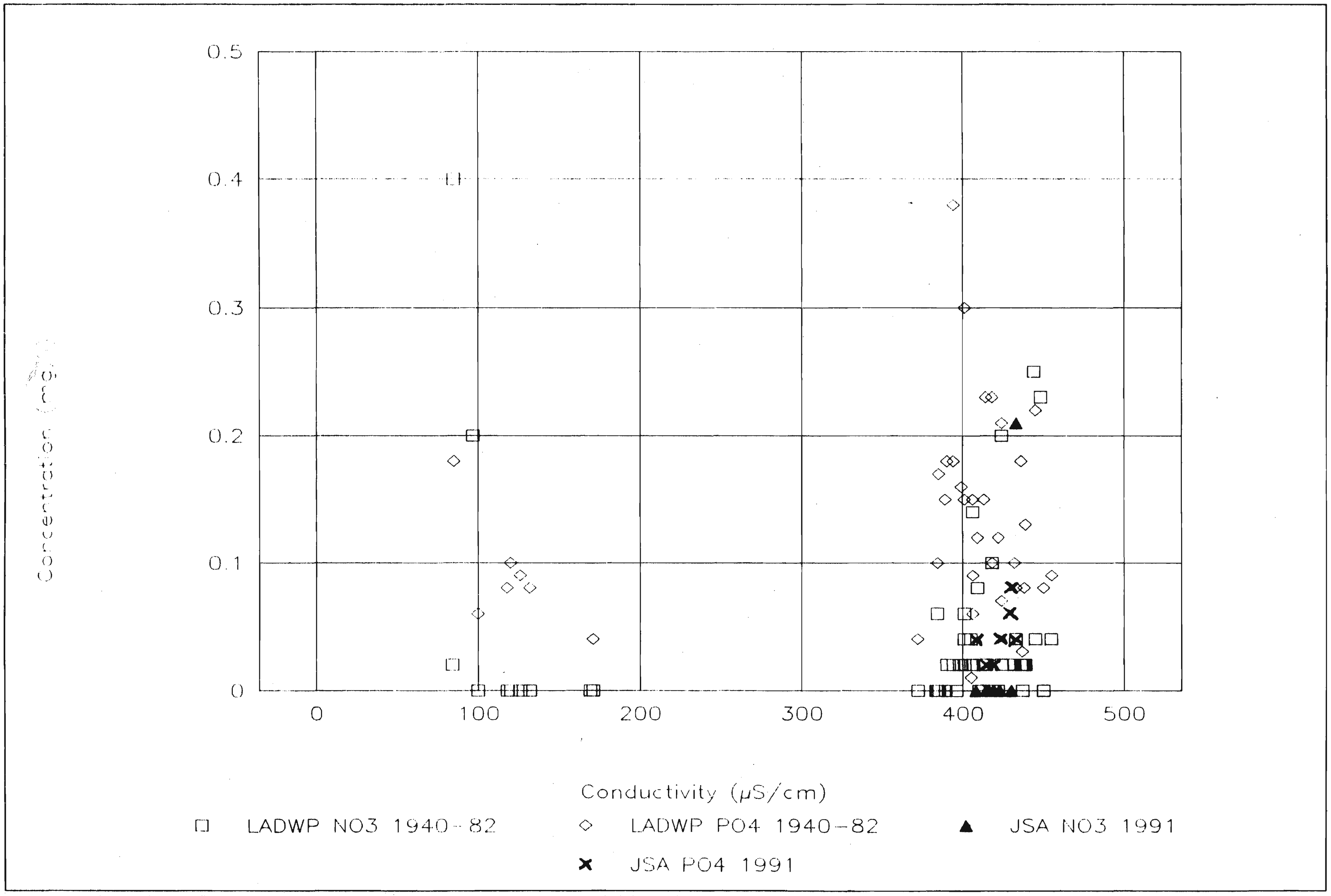


Figure 39. East Portal Nitrate and Phosphate as a Function of Conductivity (1940-1991).

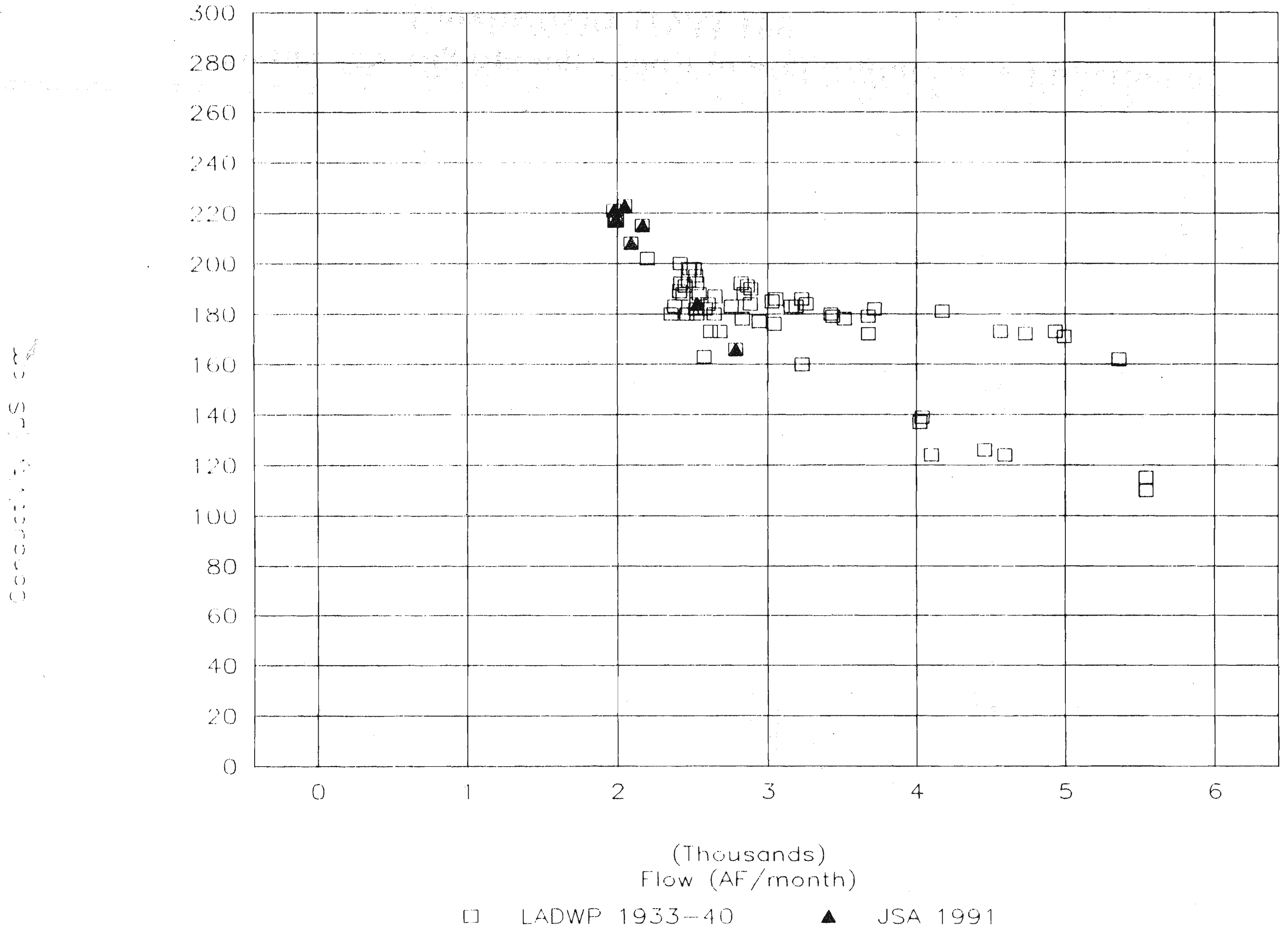


Figure 40. Big Springs Conductivity as a Function of Flow (1933-1991).

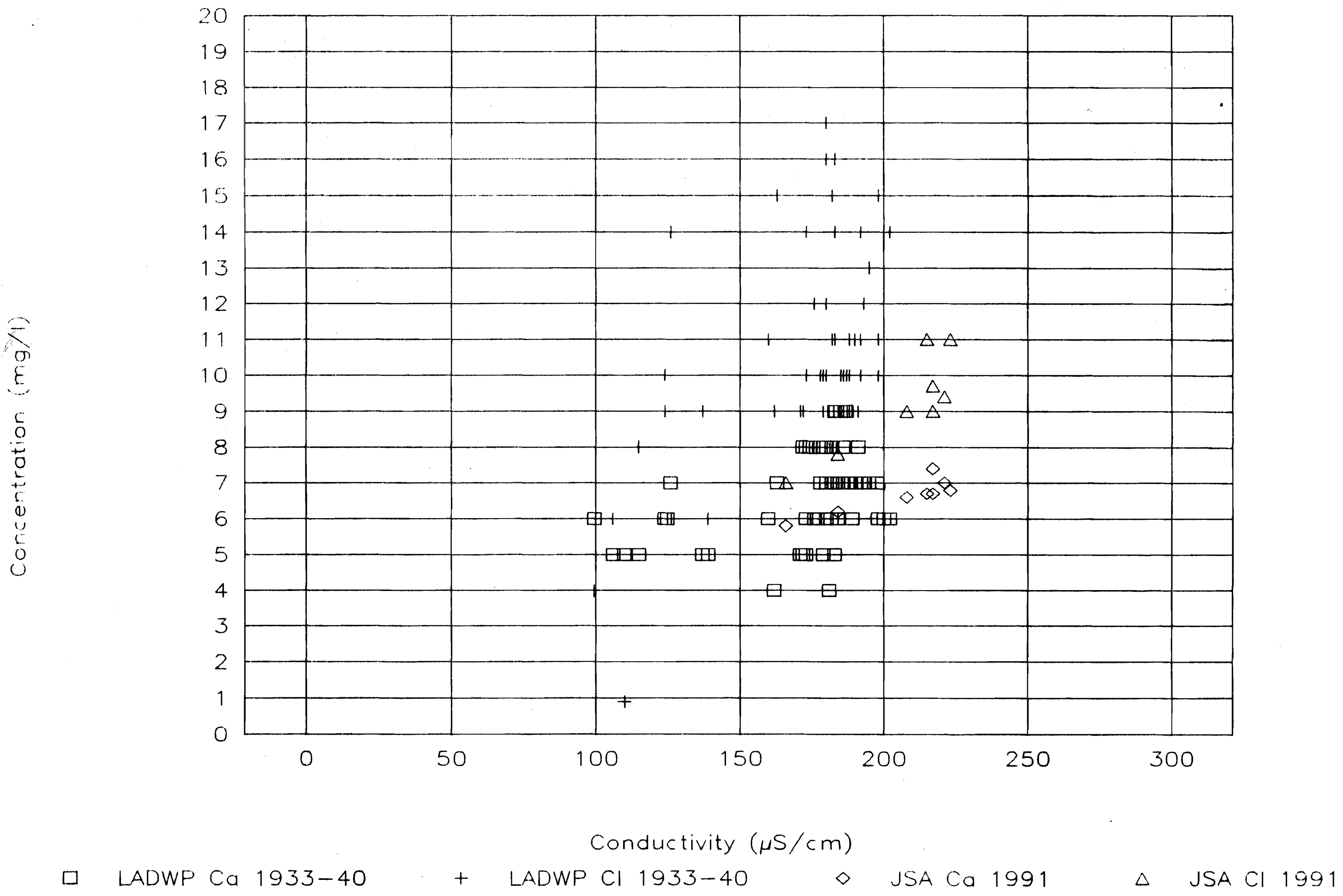


Figure 41. Big Springs Calcium and Chloride as a Function of Conductivity (1933-1991).

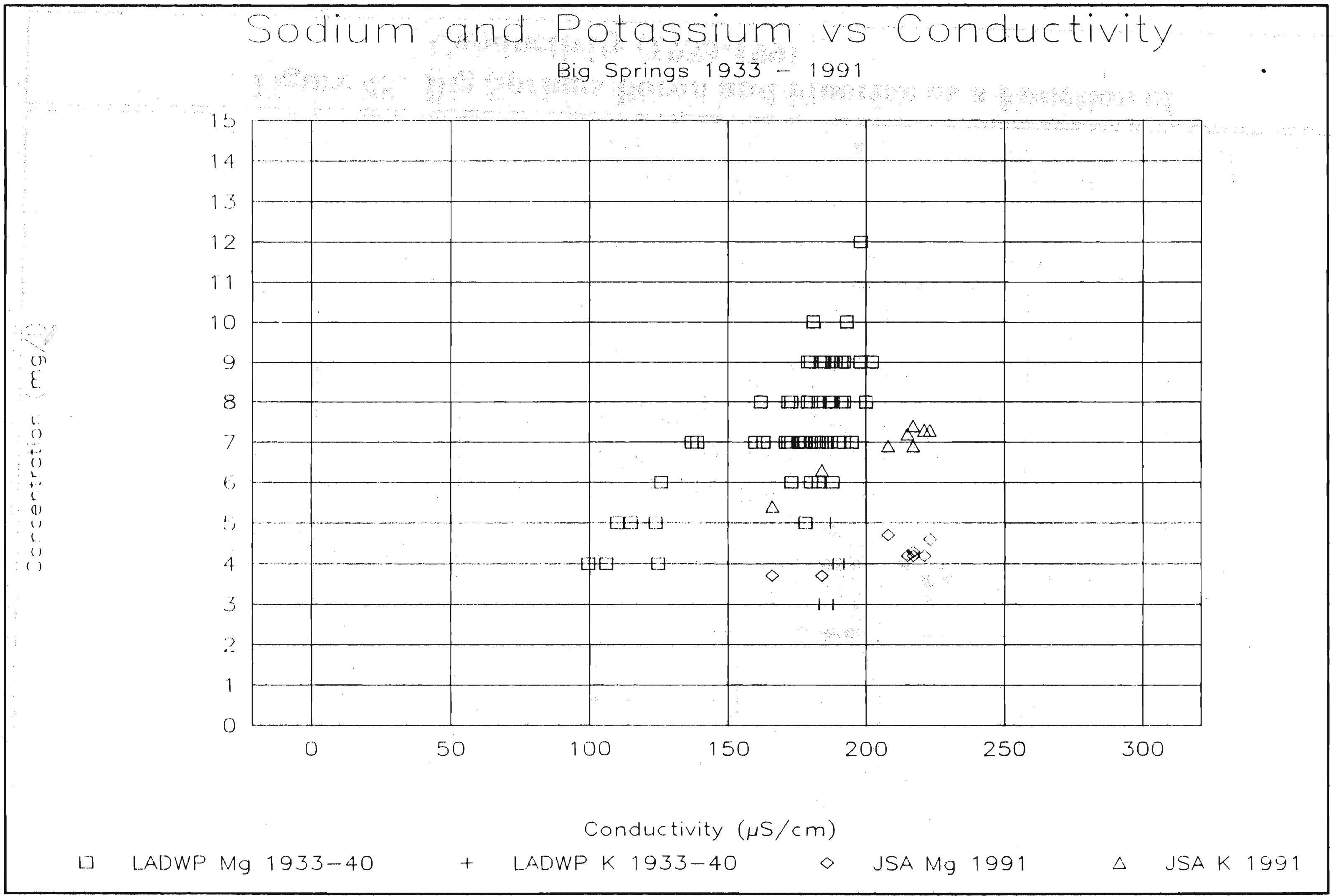


Figure 42. Big Springs Magnesium and Potassium as a Function of Conductivity (1933-1991).

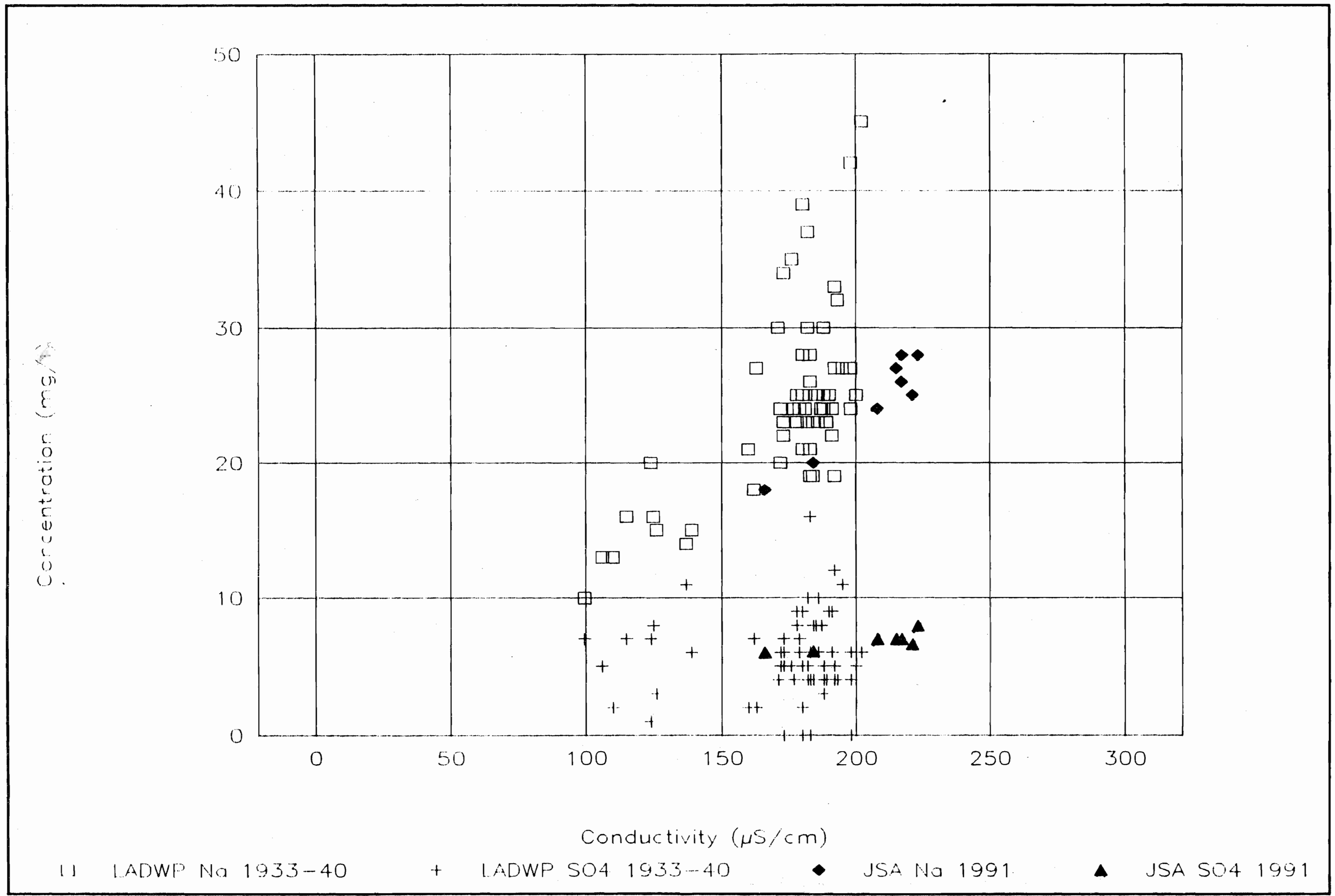


Figure 43. Big Springs Sodium and Sulfate as a Function of Conductivity (1933-1991)

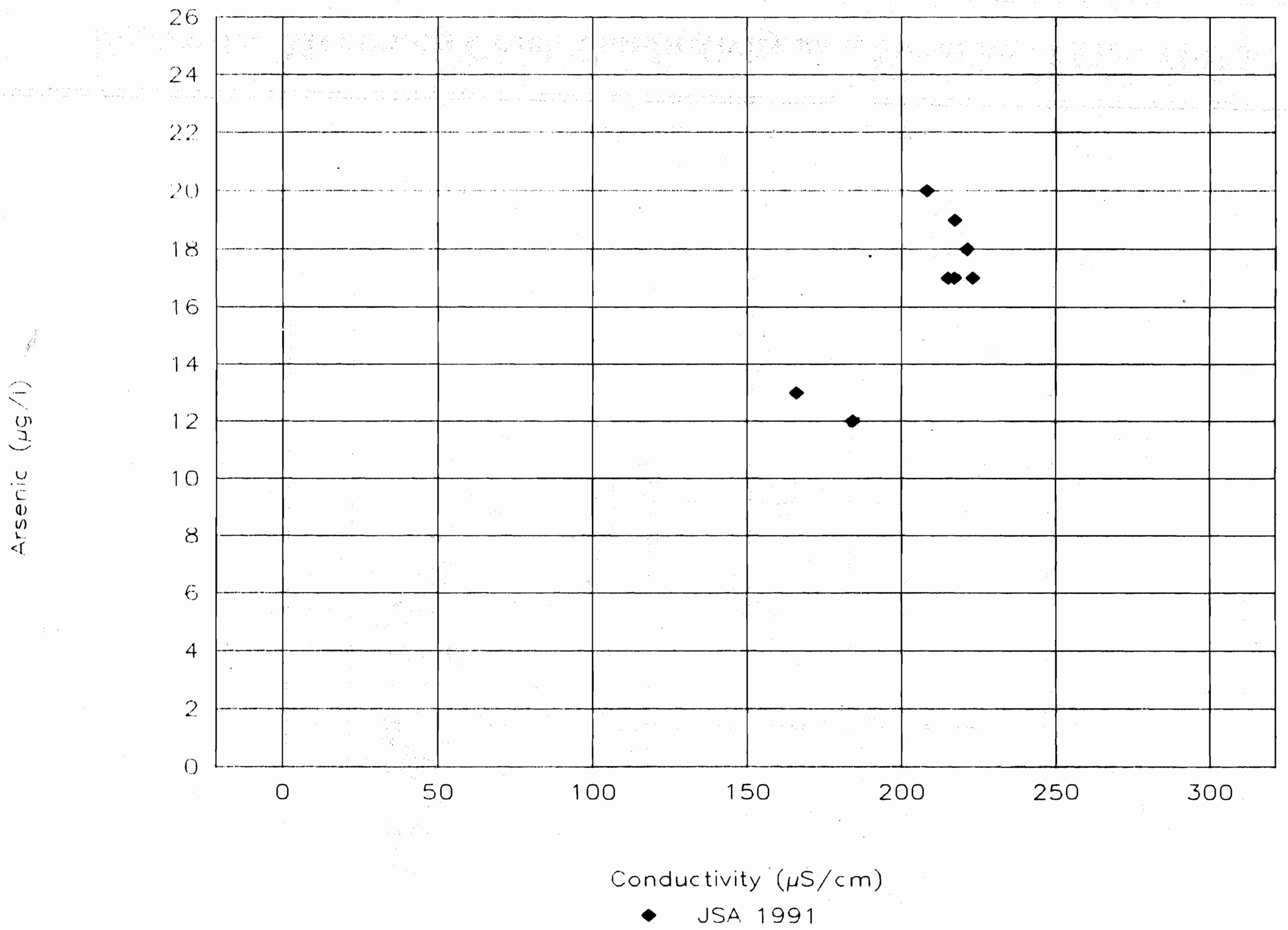


Figure 44. Big Springs Arsenic as a Function of Conductivity (1933-1991).

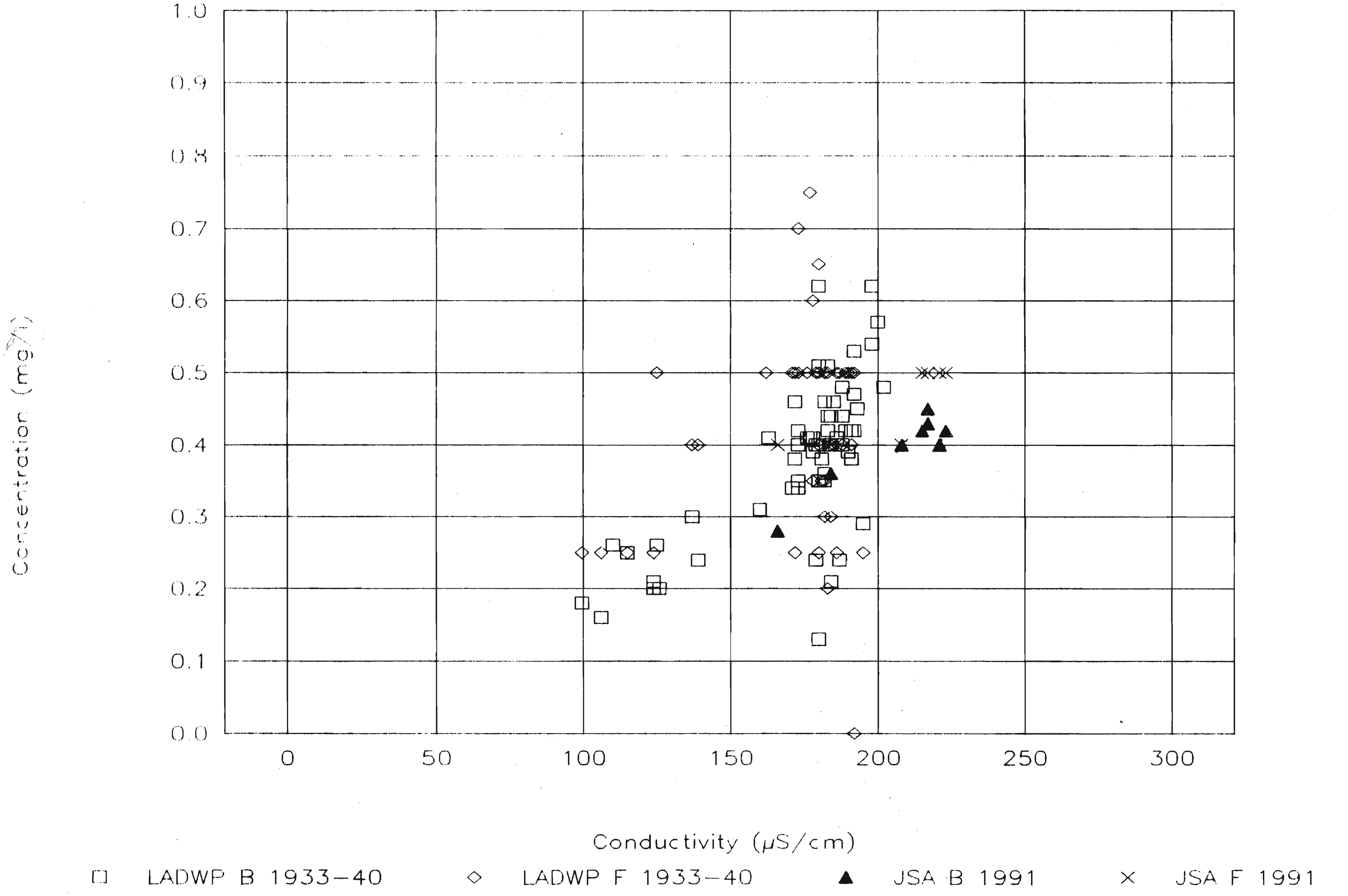


Figure 45. Big Springs Boron and Fluoride as a Function of Conductivity (1933-1991).

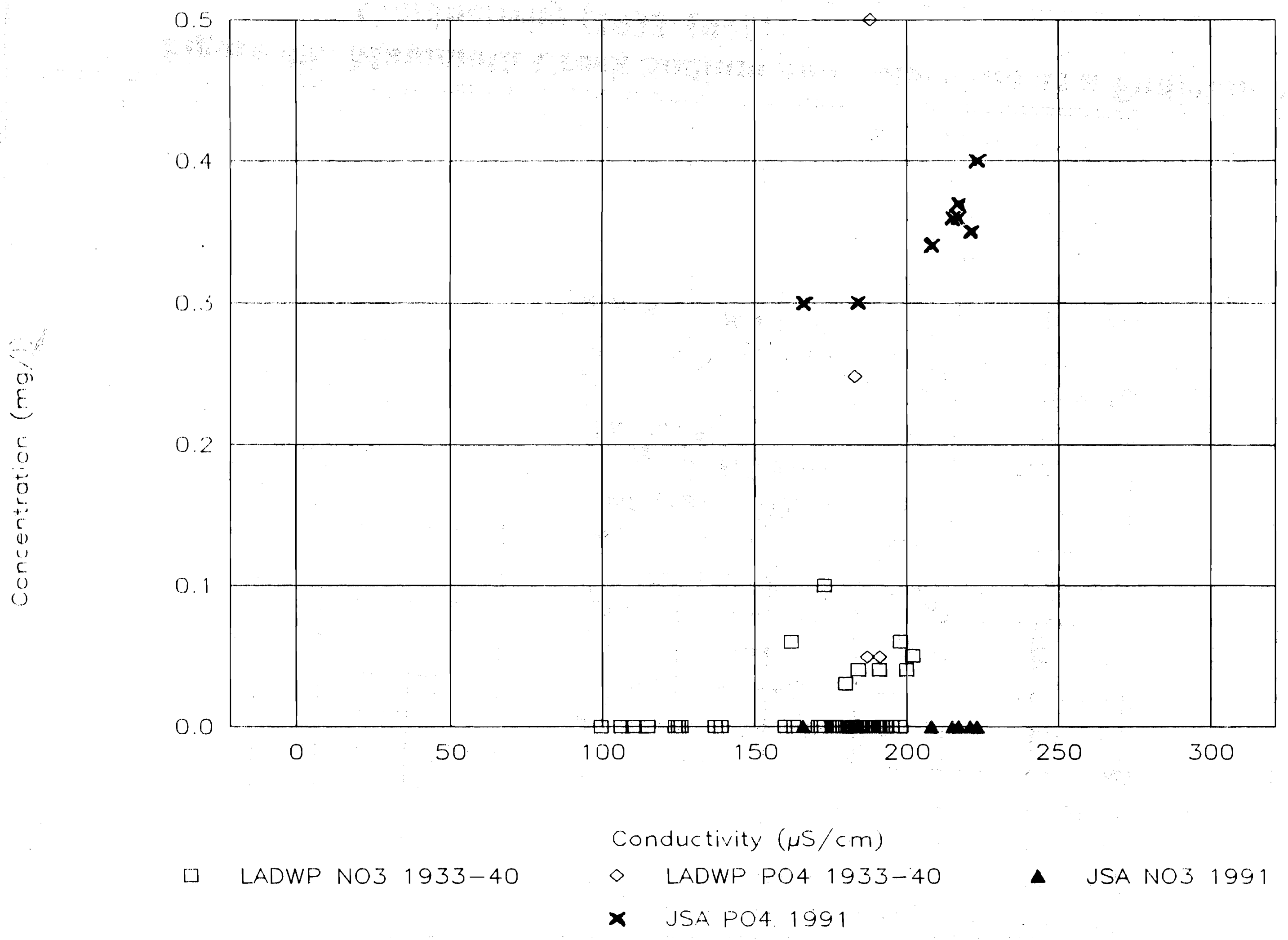


Figure 46. Big Springs Nitrate and Phosphate as a Function of Conductivity (1933-1991).

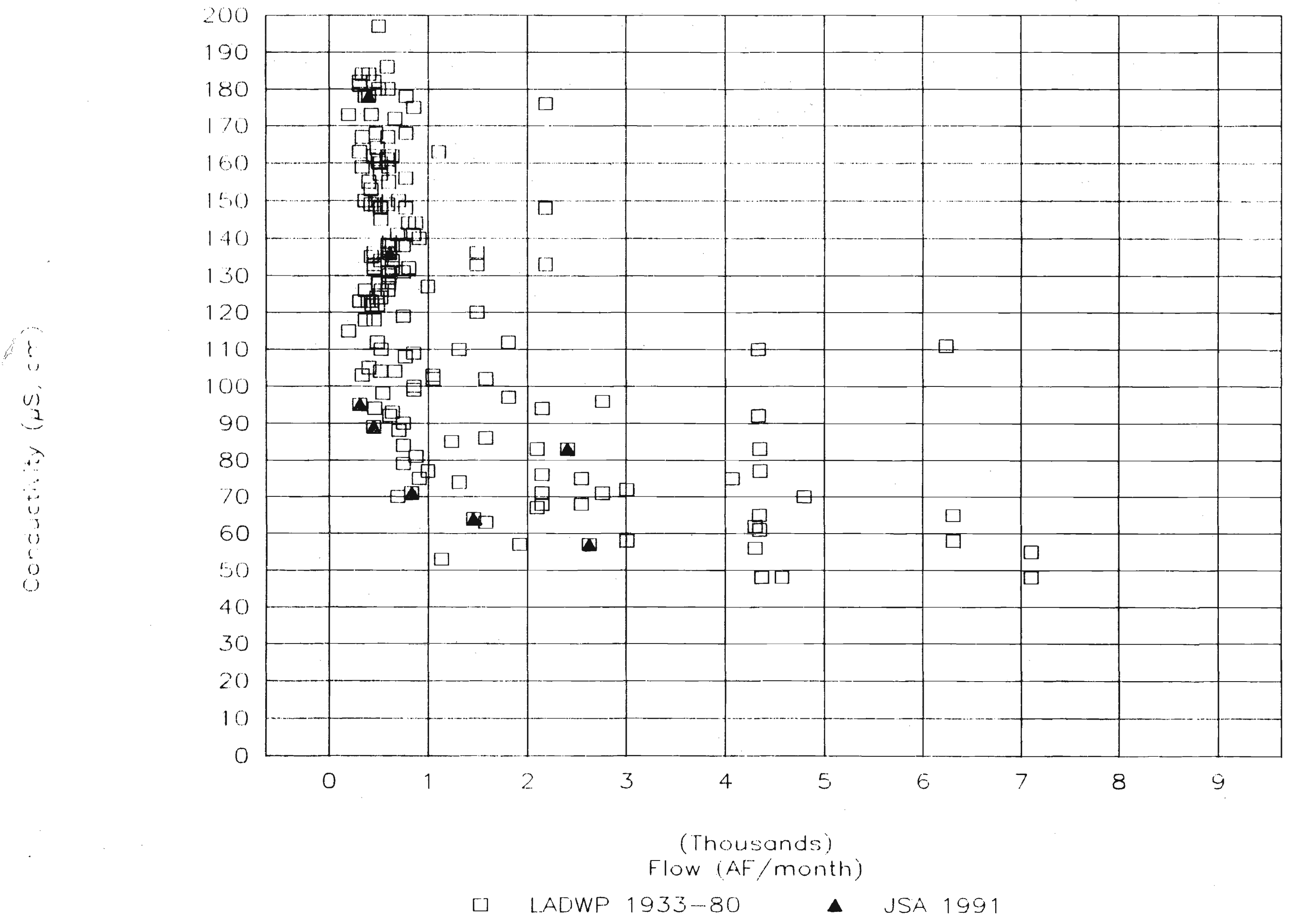


Figure 47. Mammoth Creek Conductivity as a Function of Flow (1933-1991).

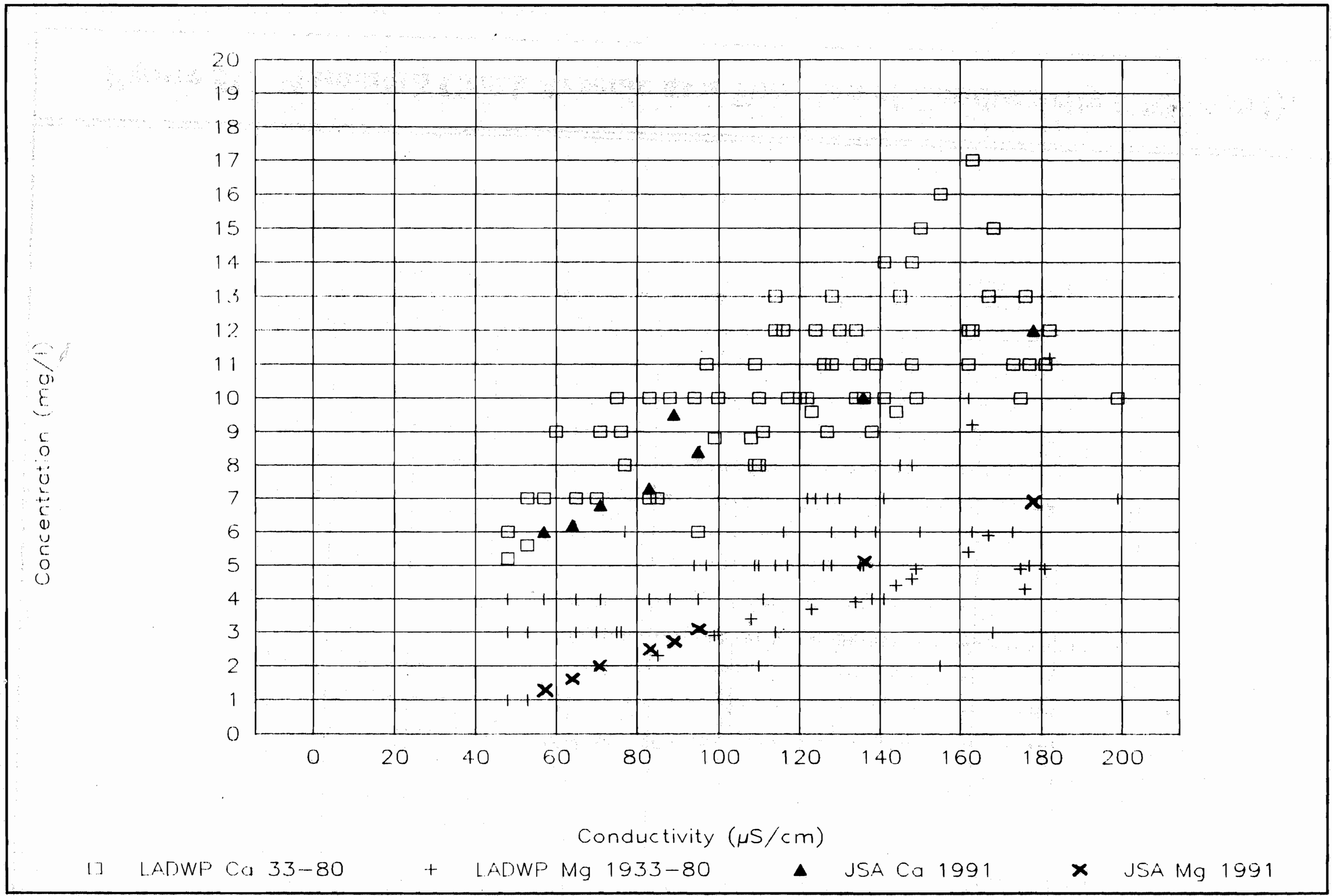


Figure 48. Mammoth Creek Calcium and Magnesium as a Function of Conductivity (1933-1991).

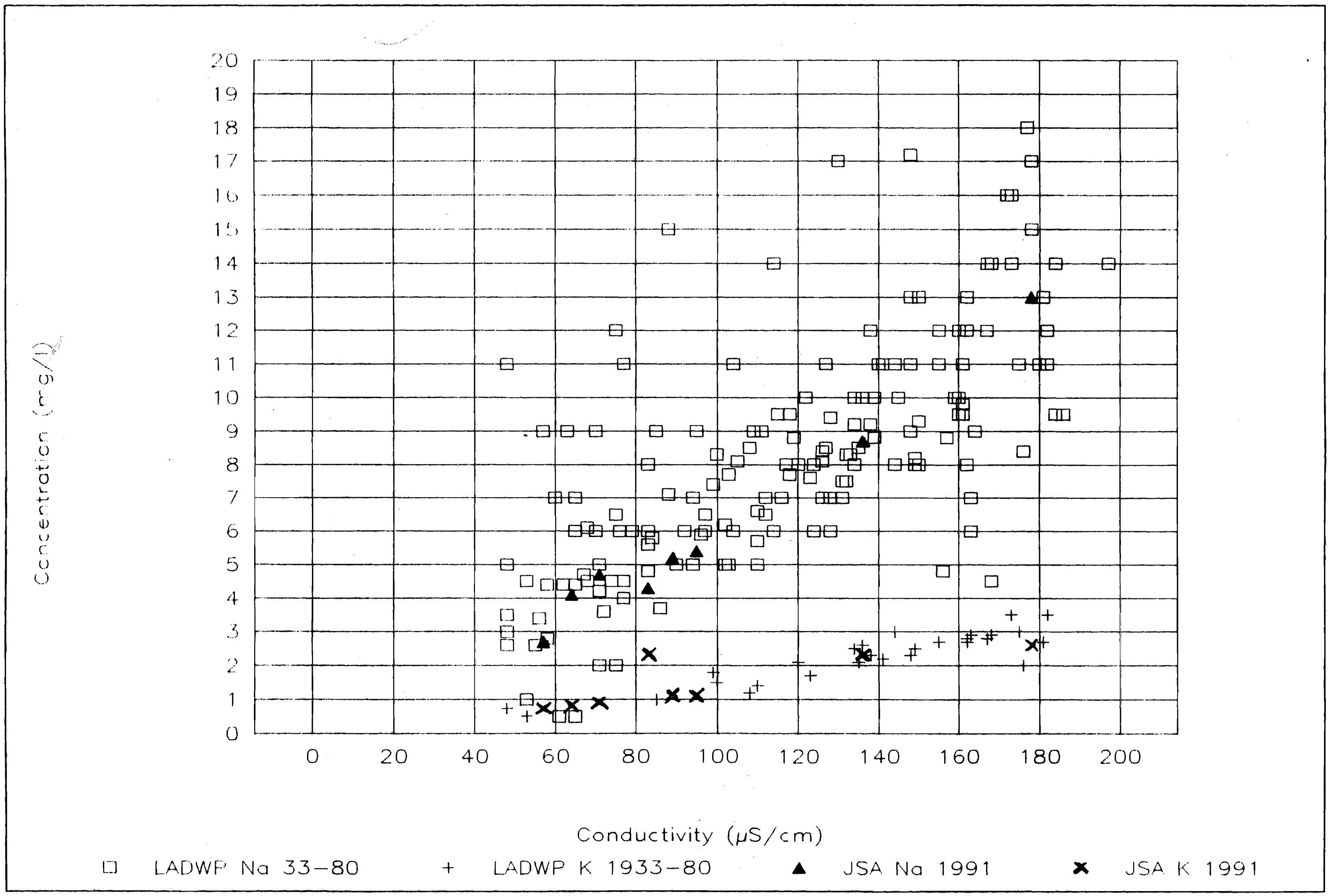


Figure 49. Mammoth Creek Sodium and Potassium as a Function of Conductivity (1933-1991).

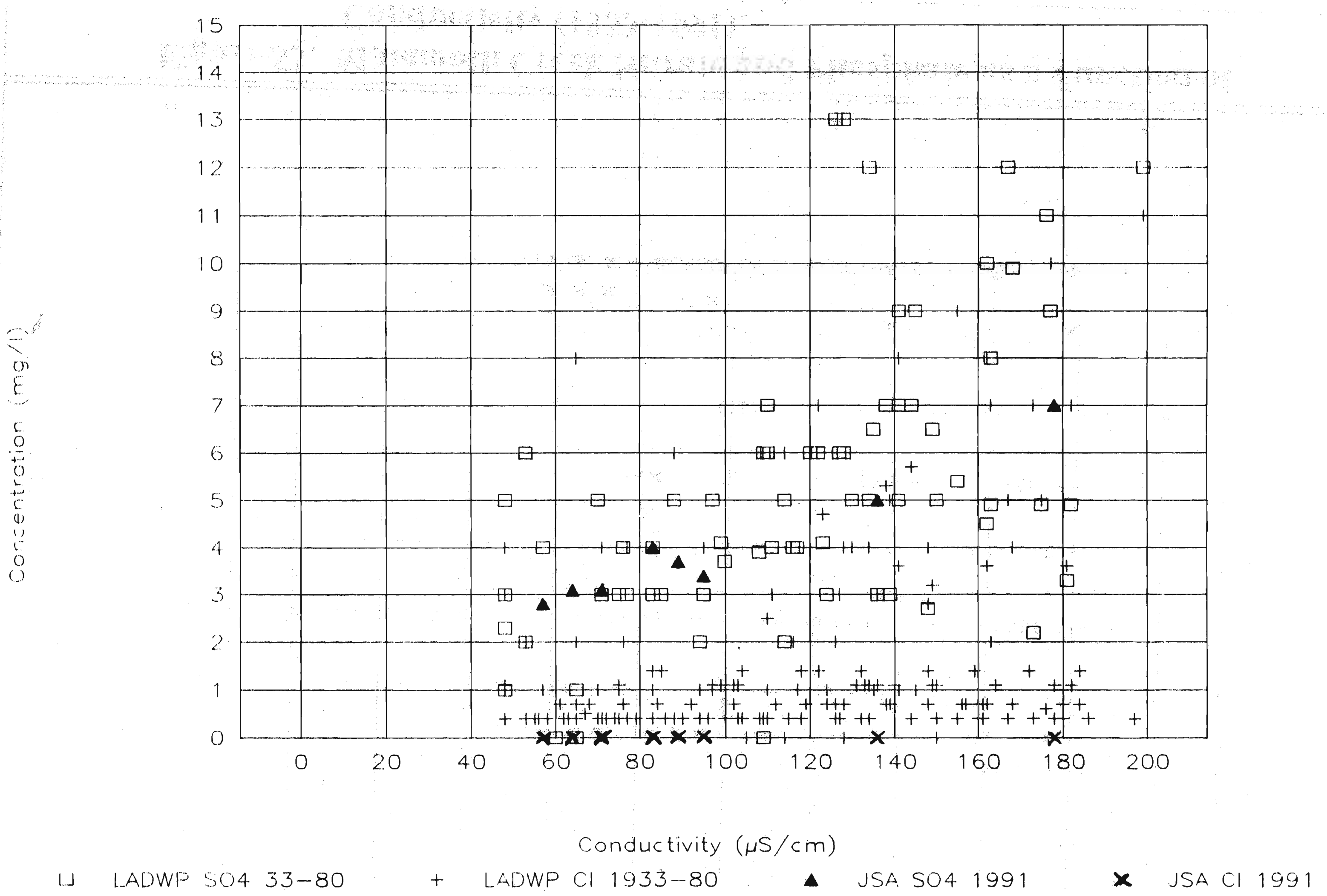


Figure 50. Mammoth Creek Sulfate and Chloride as a Function of Conductivity (1933-1991).

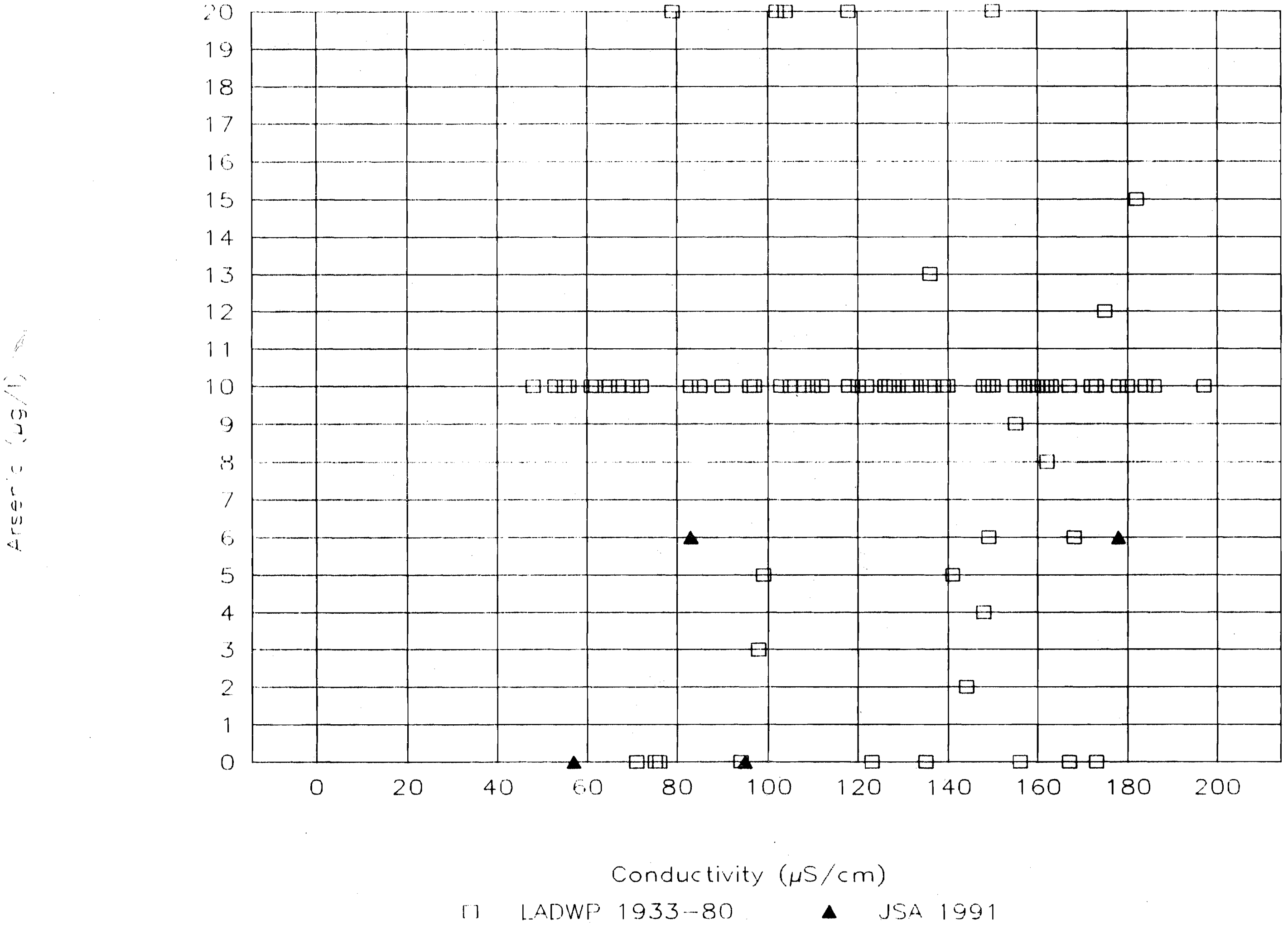


Figure 51. Mammoth Creek Arsenic as a Function of Conductivity (1933-1991).

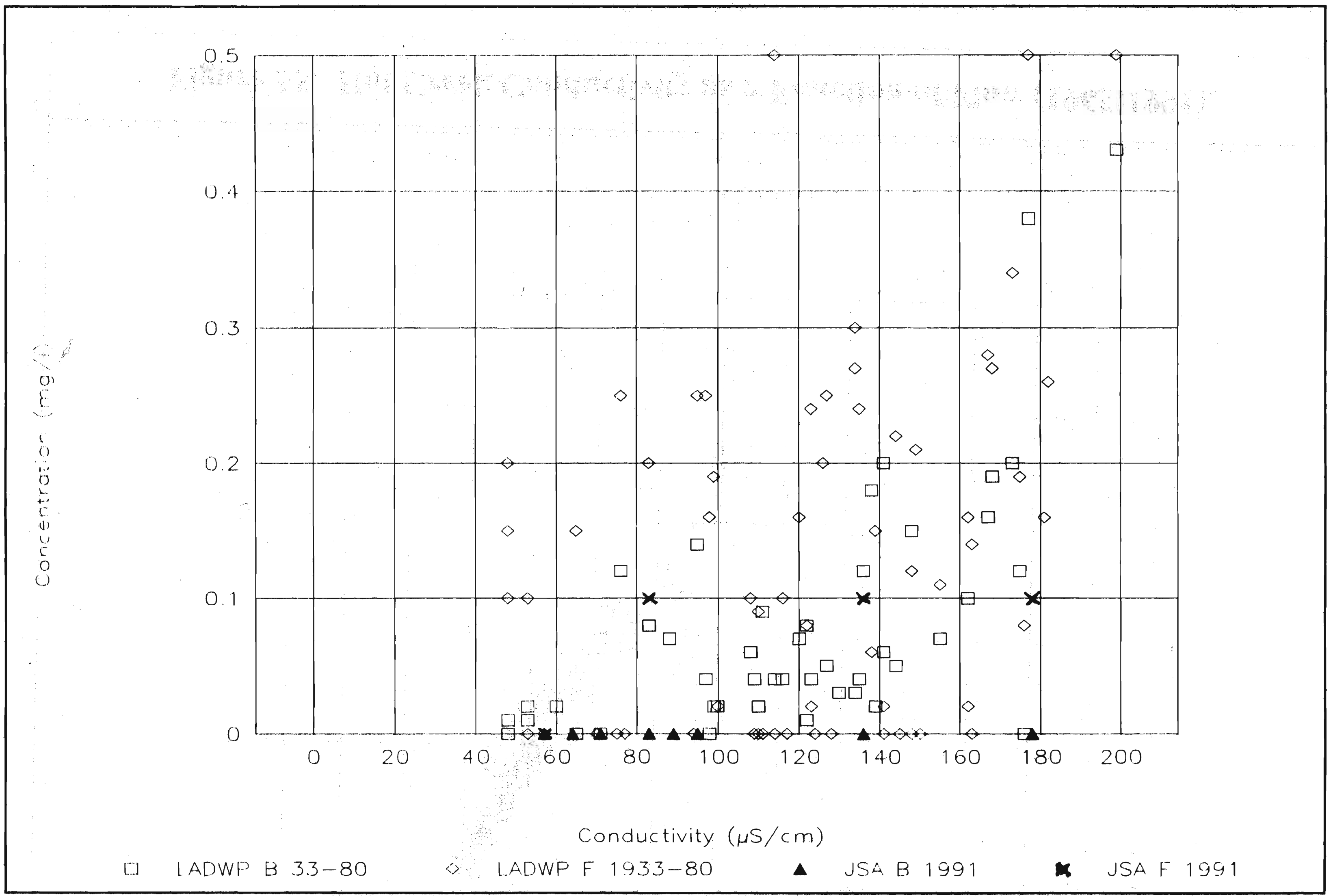


Figure 52. Mammoth Creek Boron and Fluoride as a Function of Conductivity (1933-1991).

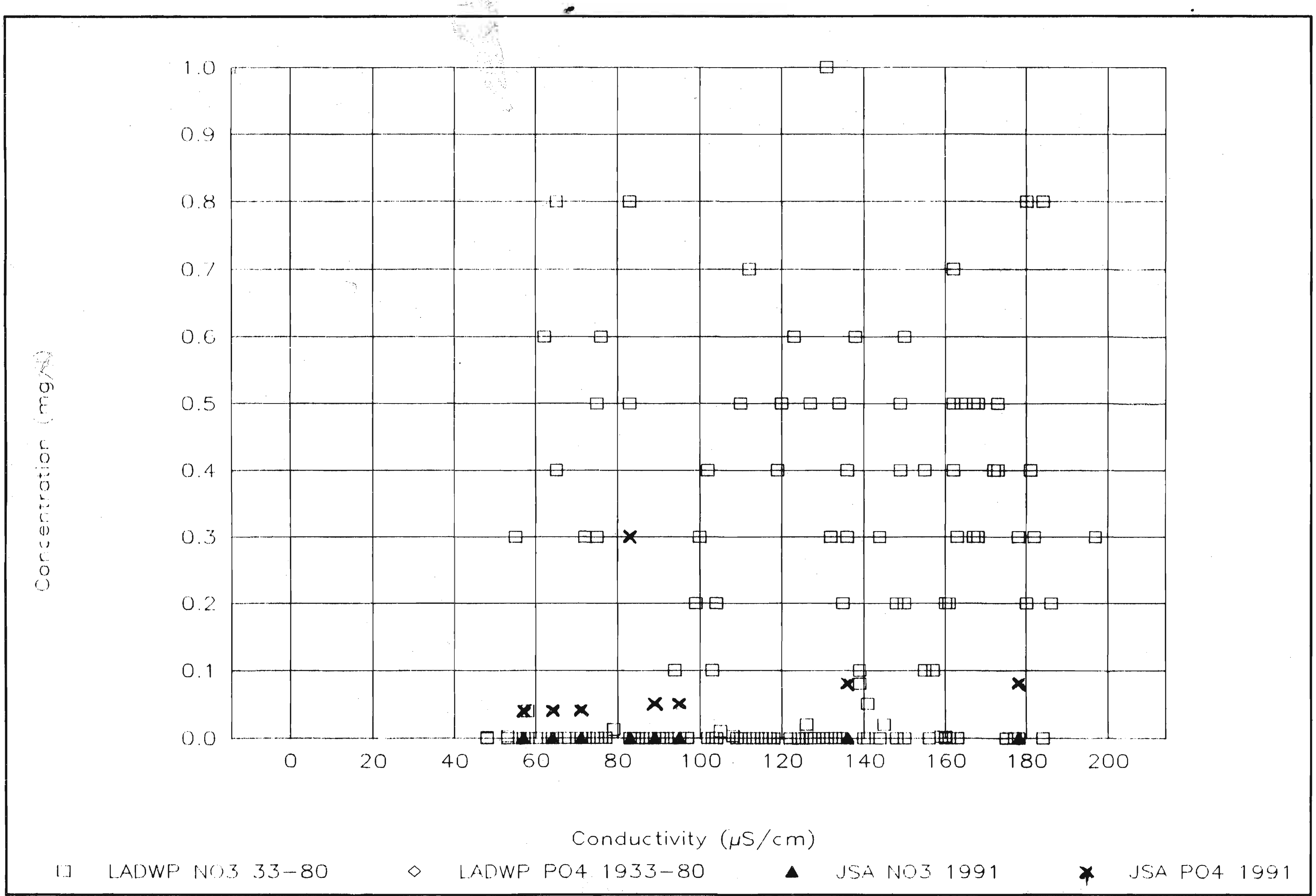


Figure 53. Mammoth Creek Nitrate and Phosphate as a Function of Conductivity (1933-1991).

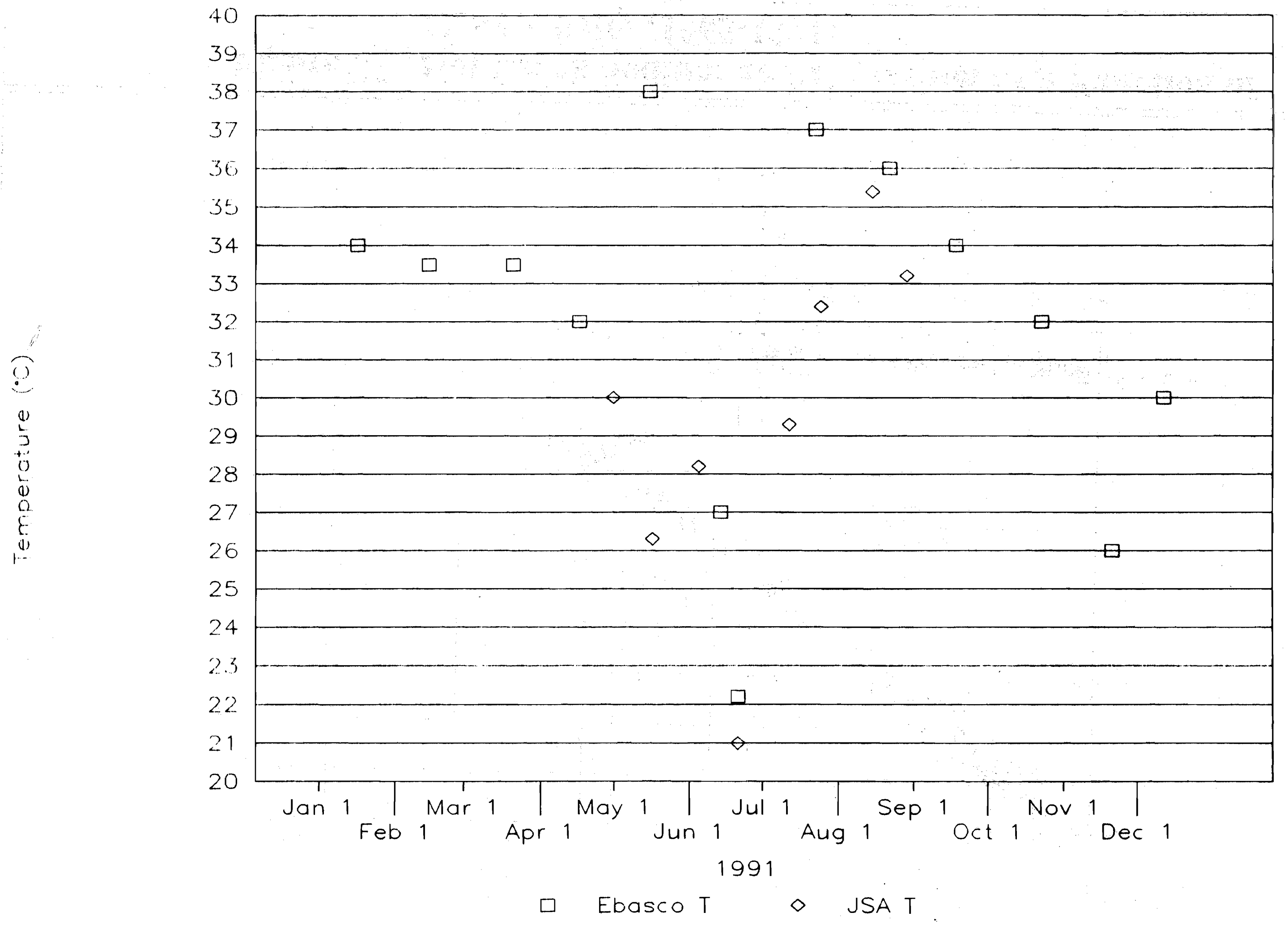


Figure 54. Hot Creek Stream Temperatures (1991).

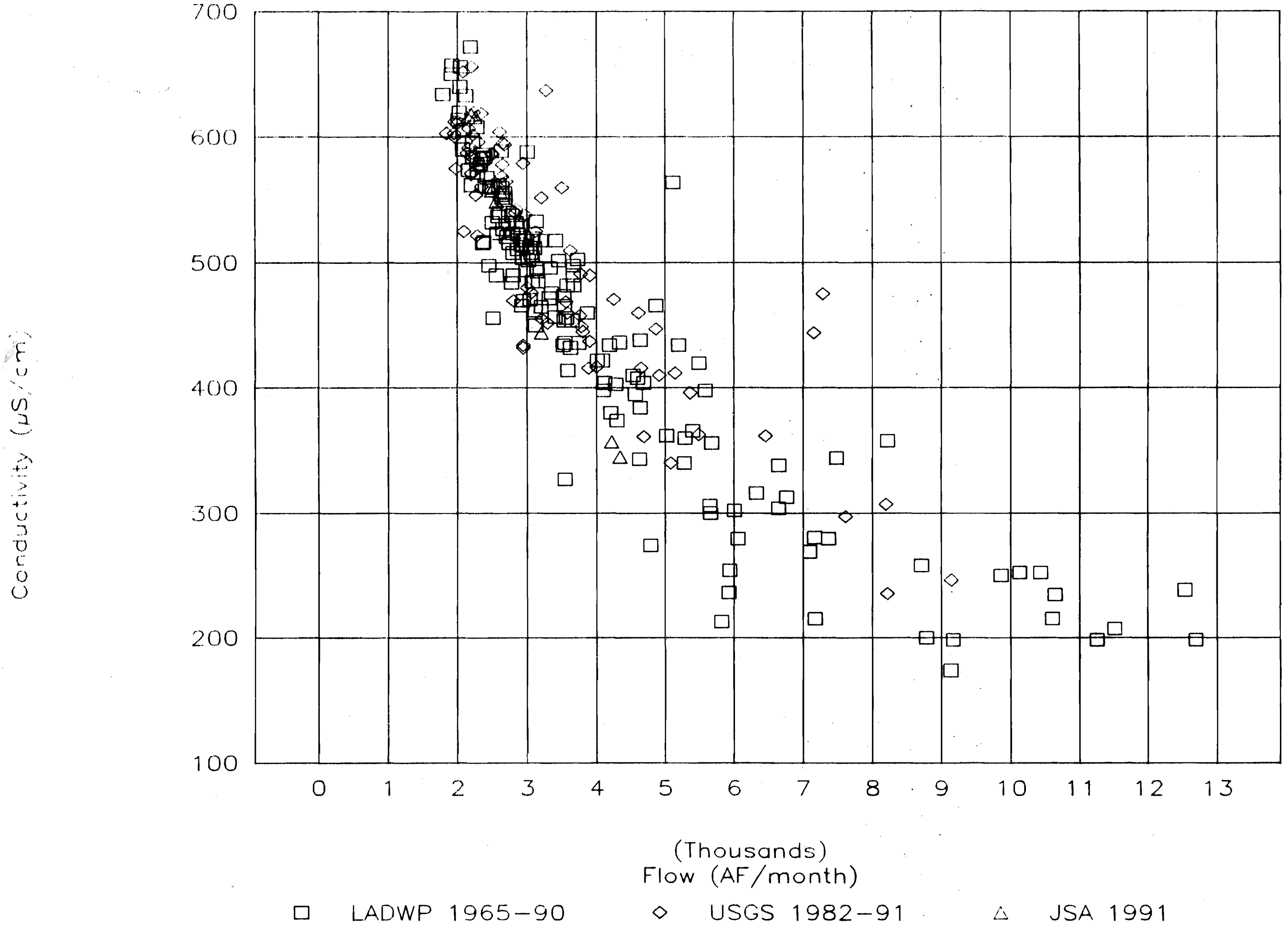


Figure 55. Hot Creek Conductivity as a Function of Flow (1965-1991).

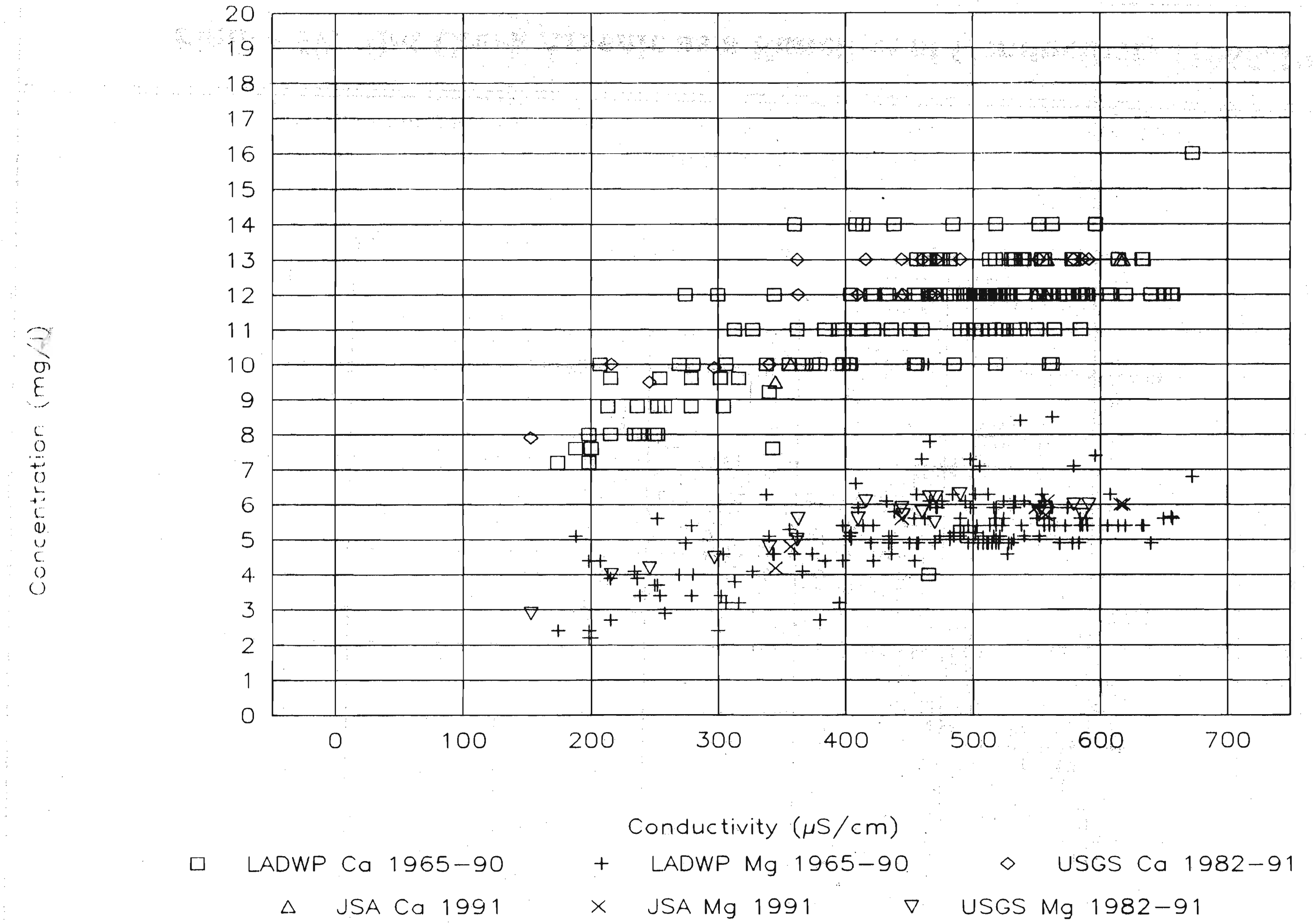


Figure 56. Hot Creek Calcium and Magnesium as a Function of Conductivity (1965-1991).

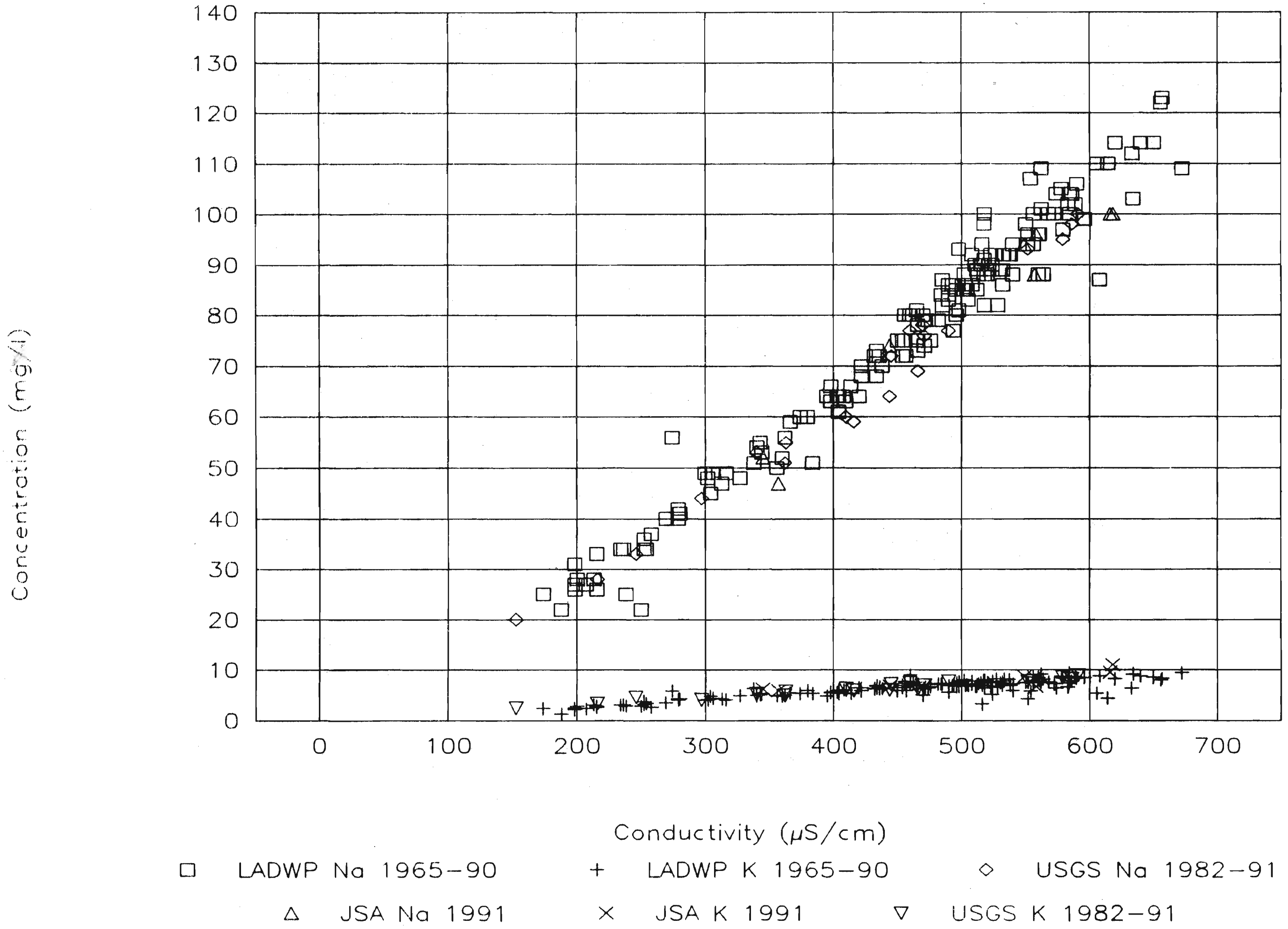


Figure 57. Hot Creek Sodium and Potassium as a Function of Conductivity (1965-1991).

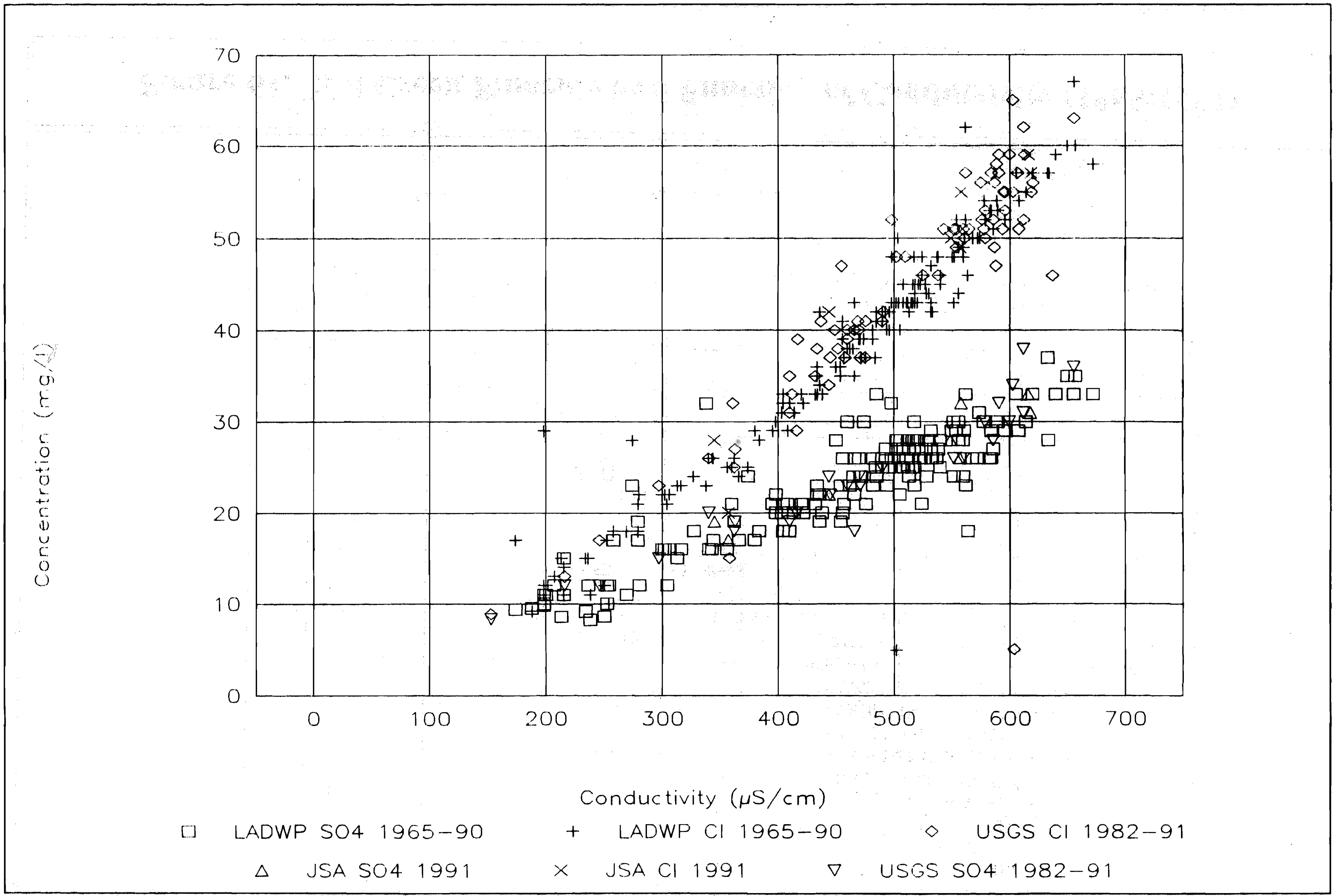


Figure 58. Hot Creek Sulfate and Chloride as a Function of Conductivity (1965-1991).

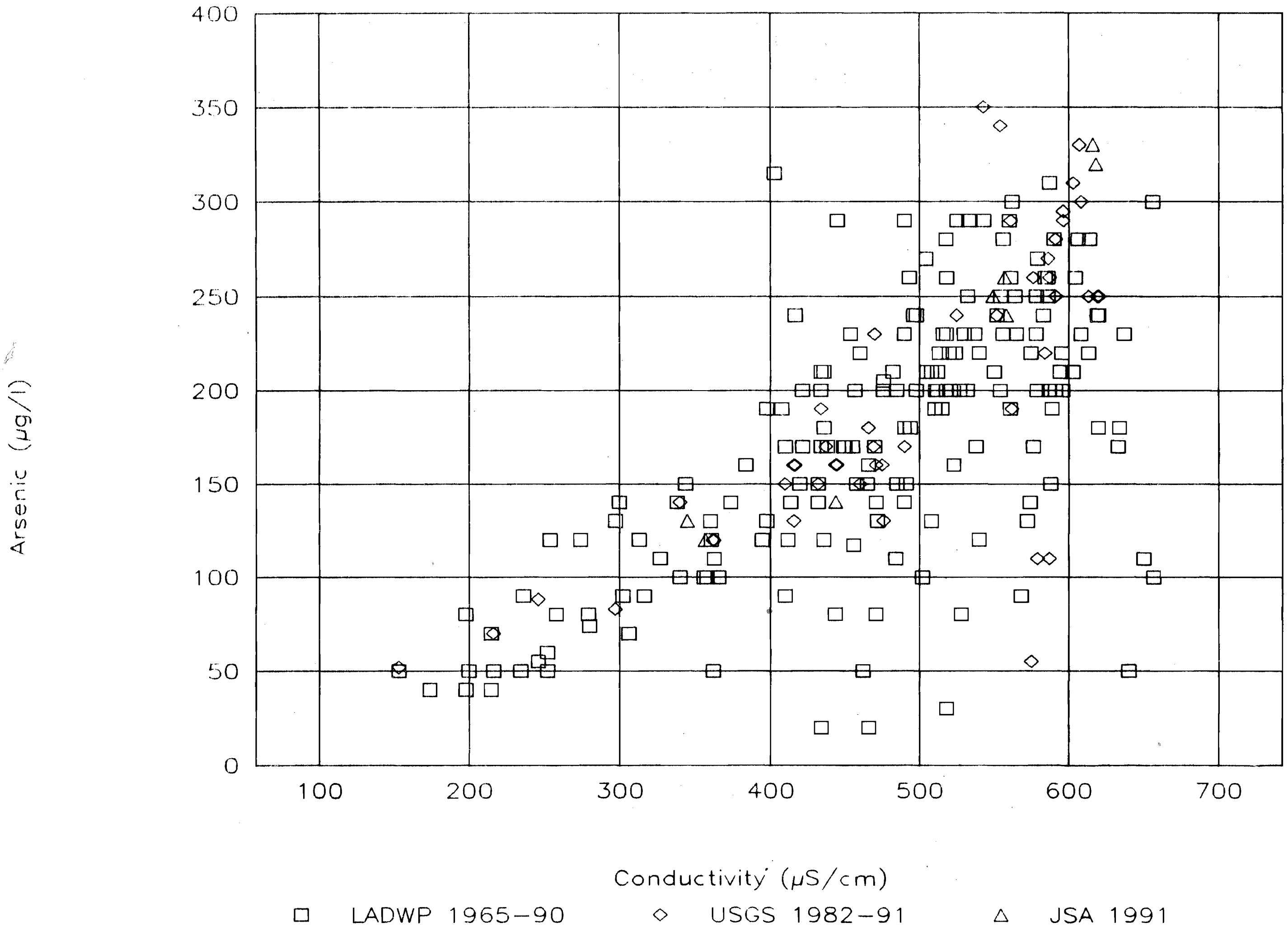


Figure 59. Hot Creek Arsenic as a Function of Conductivity (1965-1991).

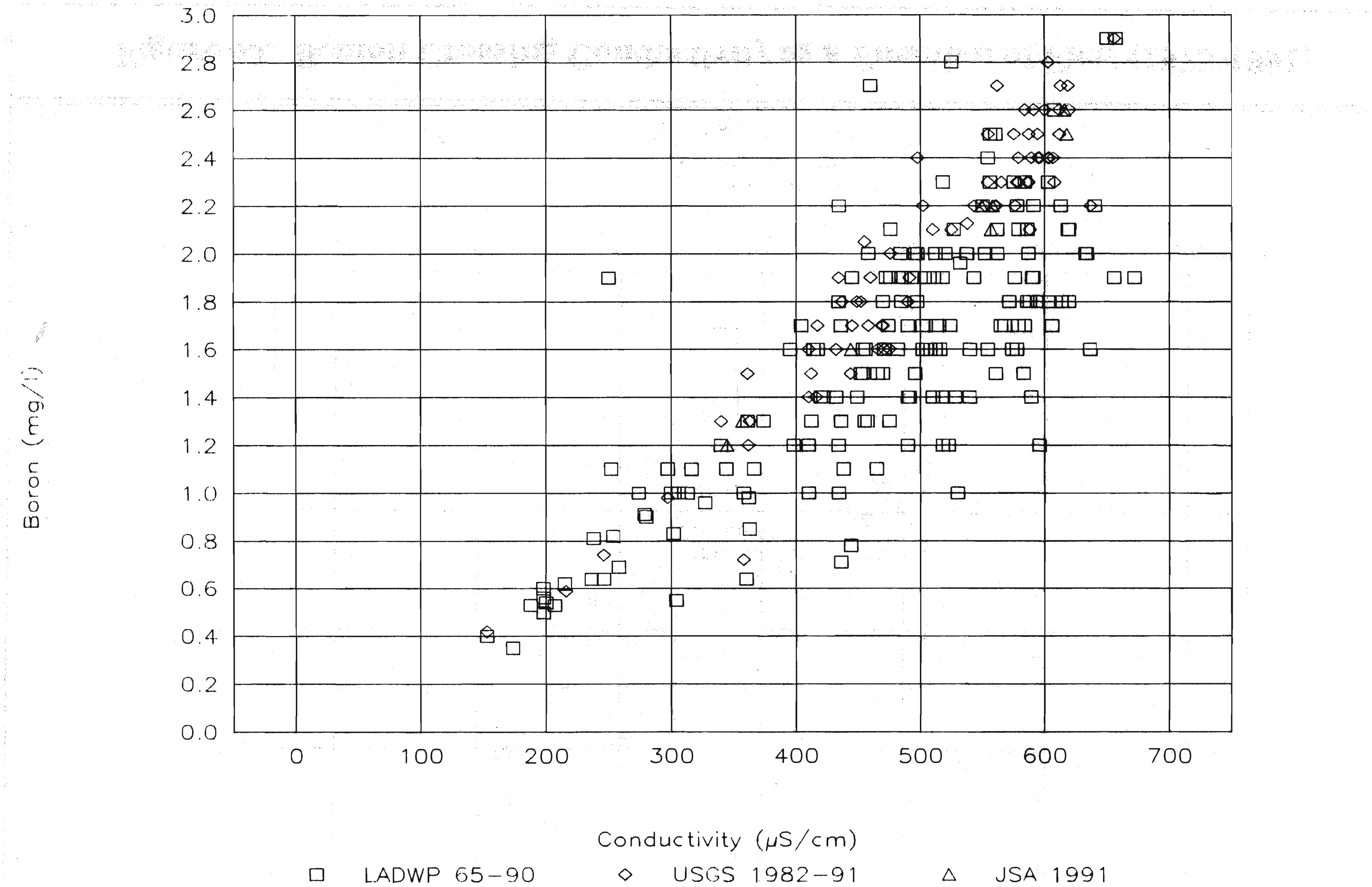


Figure 60. Hot Creek Boron as a Function of Conductivity (1965-1991).

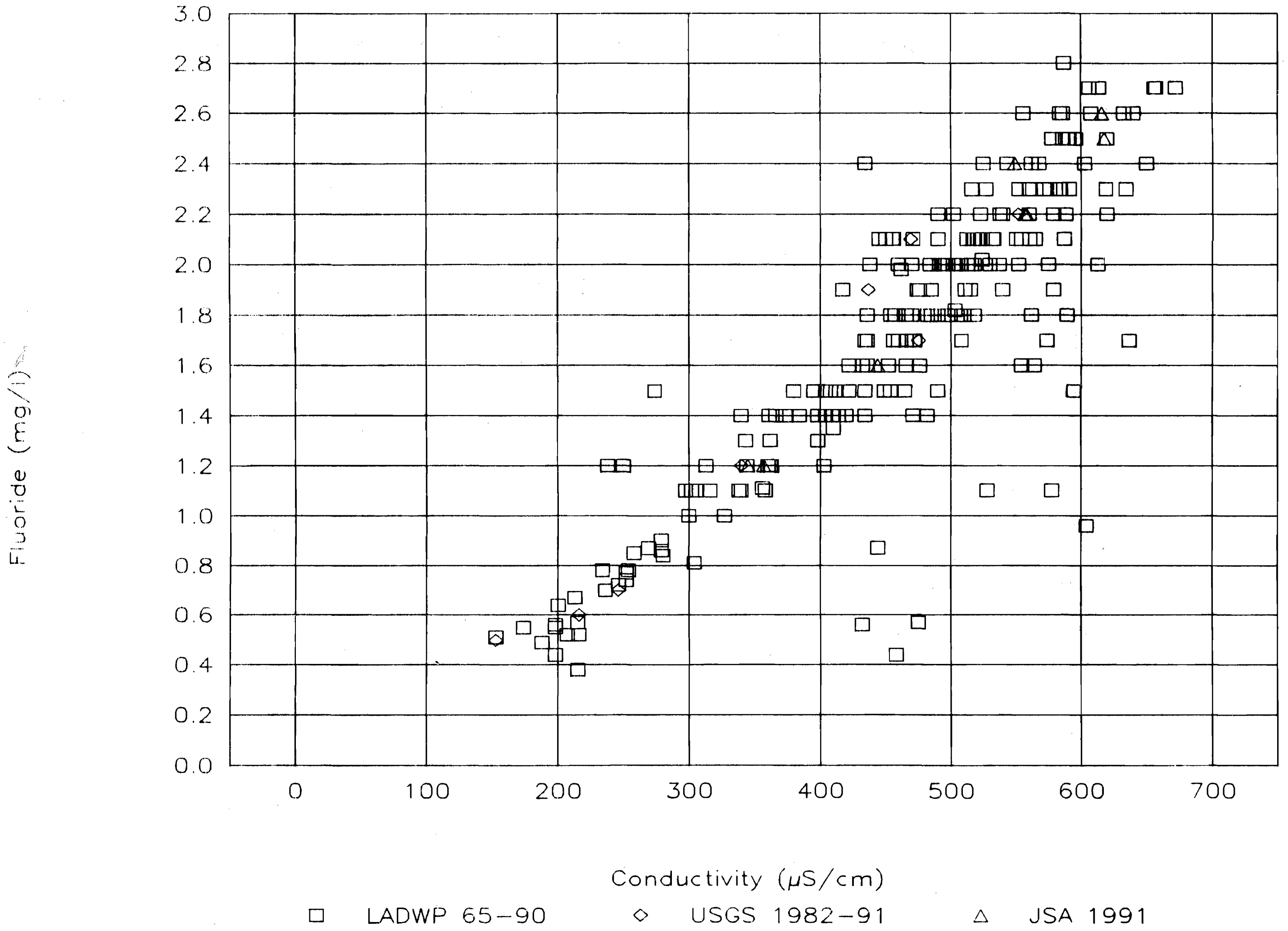


Figure 61. Hot Creek Fluoride as a Function of Conductivity (1965-1991).

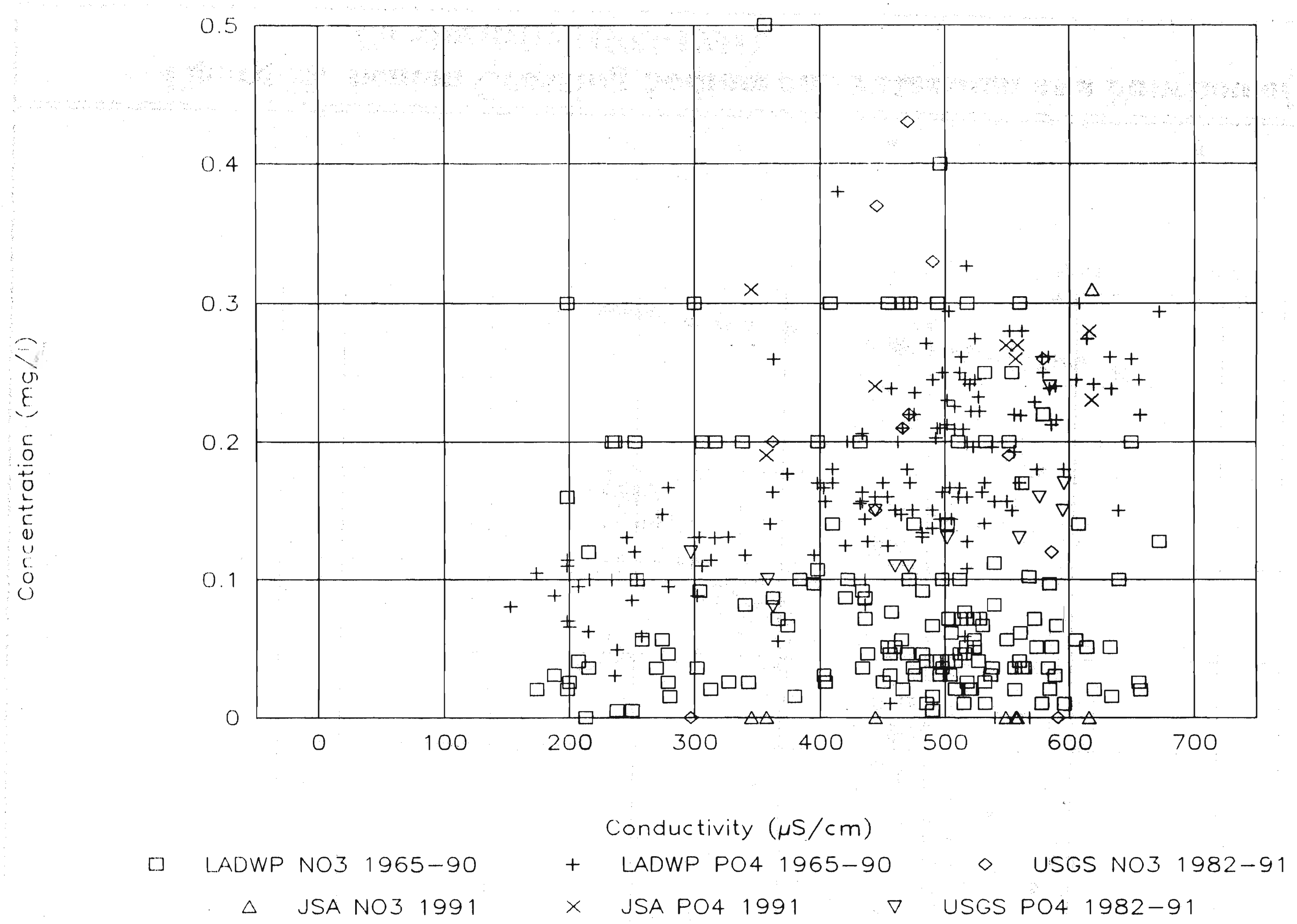


Figure 62. Hot Creek Nitrate and Phosphate as a Function of Conductivity (1965-1991).

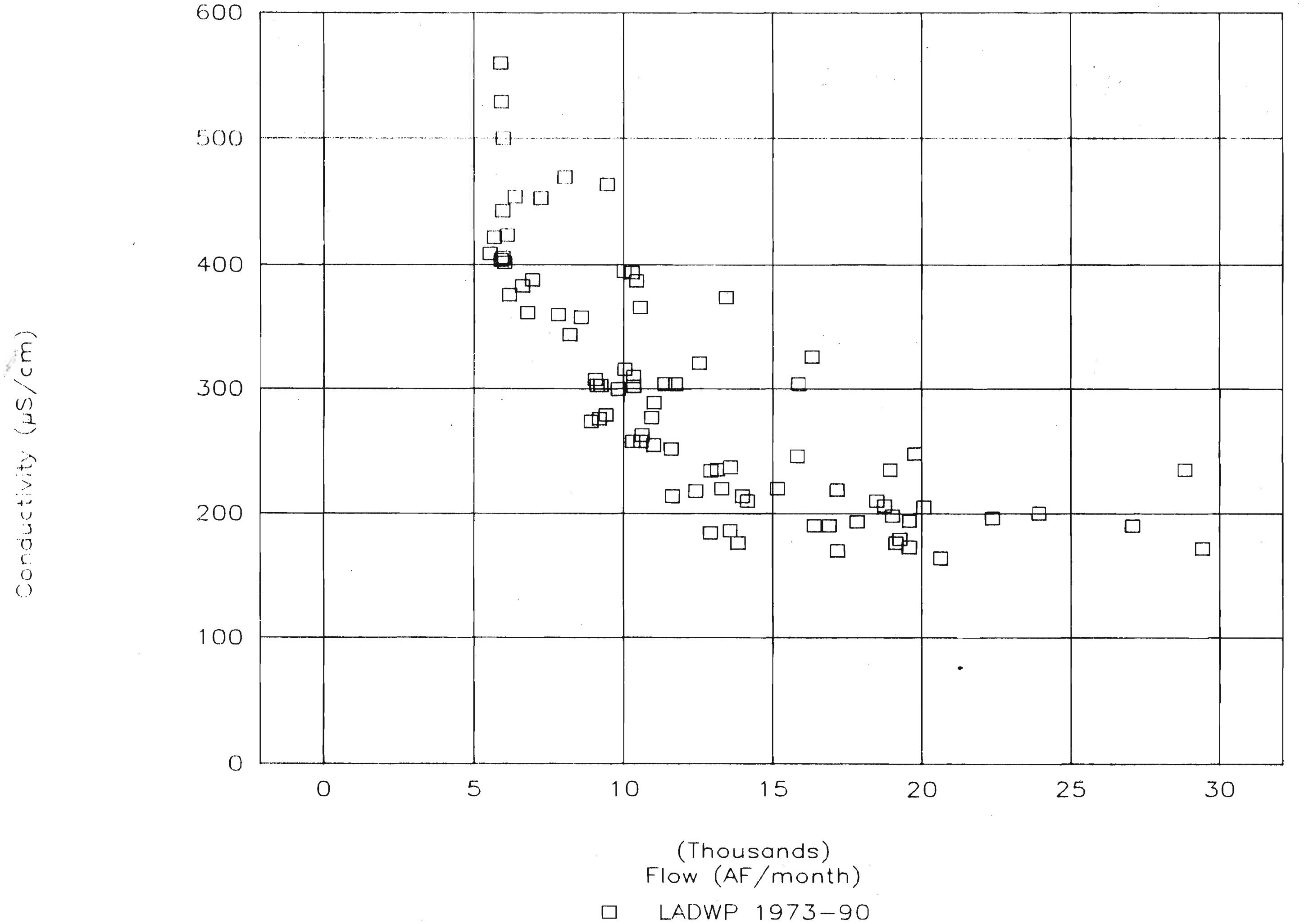


Figure 63. Benton Crossing Conductivity as a Function of Flow (1973-1991).

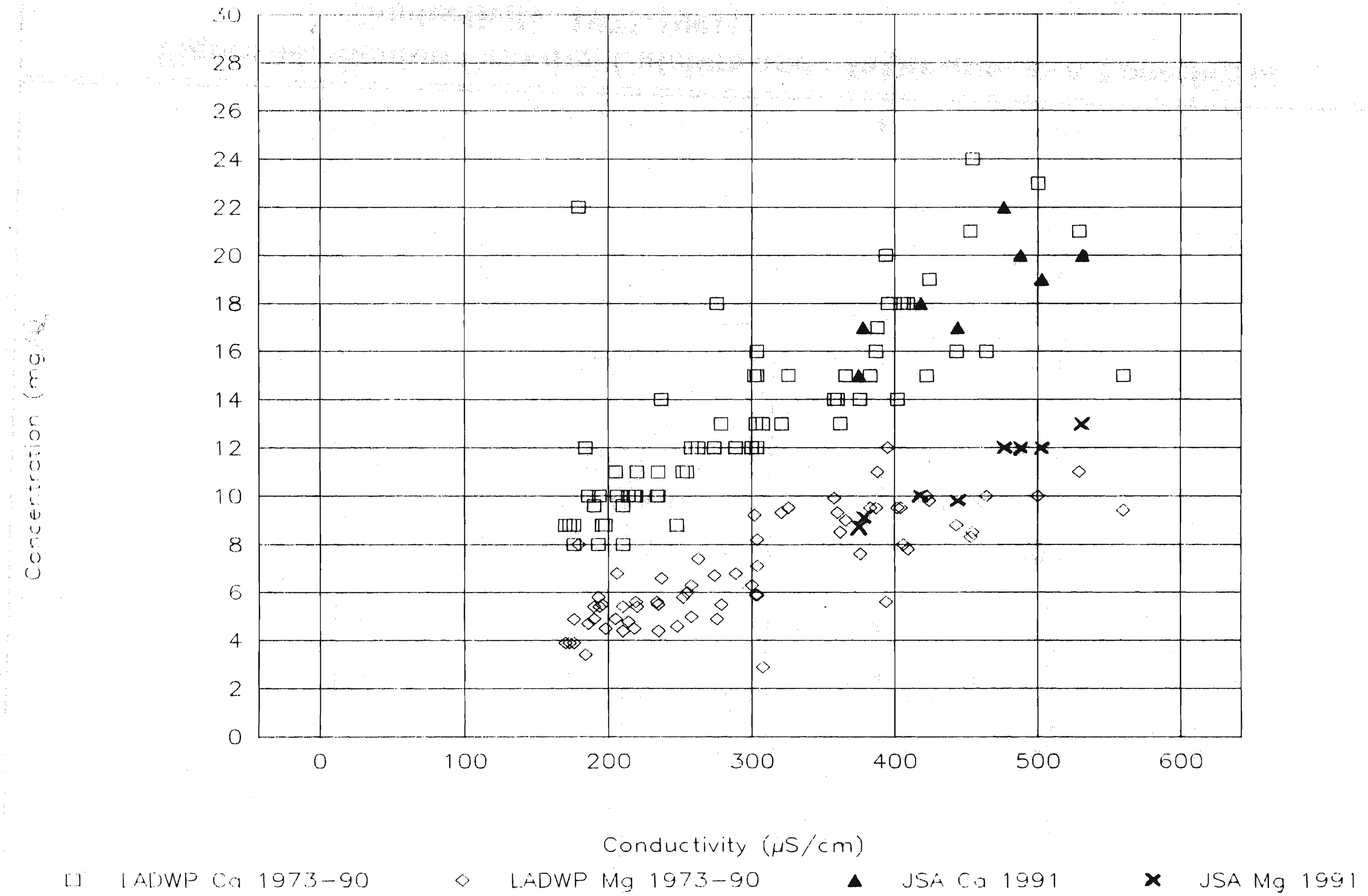


Figure 64. Benton Crossing Calcium and Magnesium as a Function of Conductivity (1973-1991).

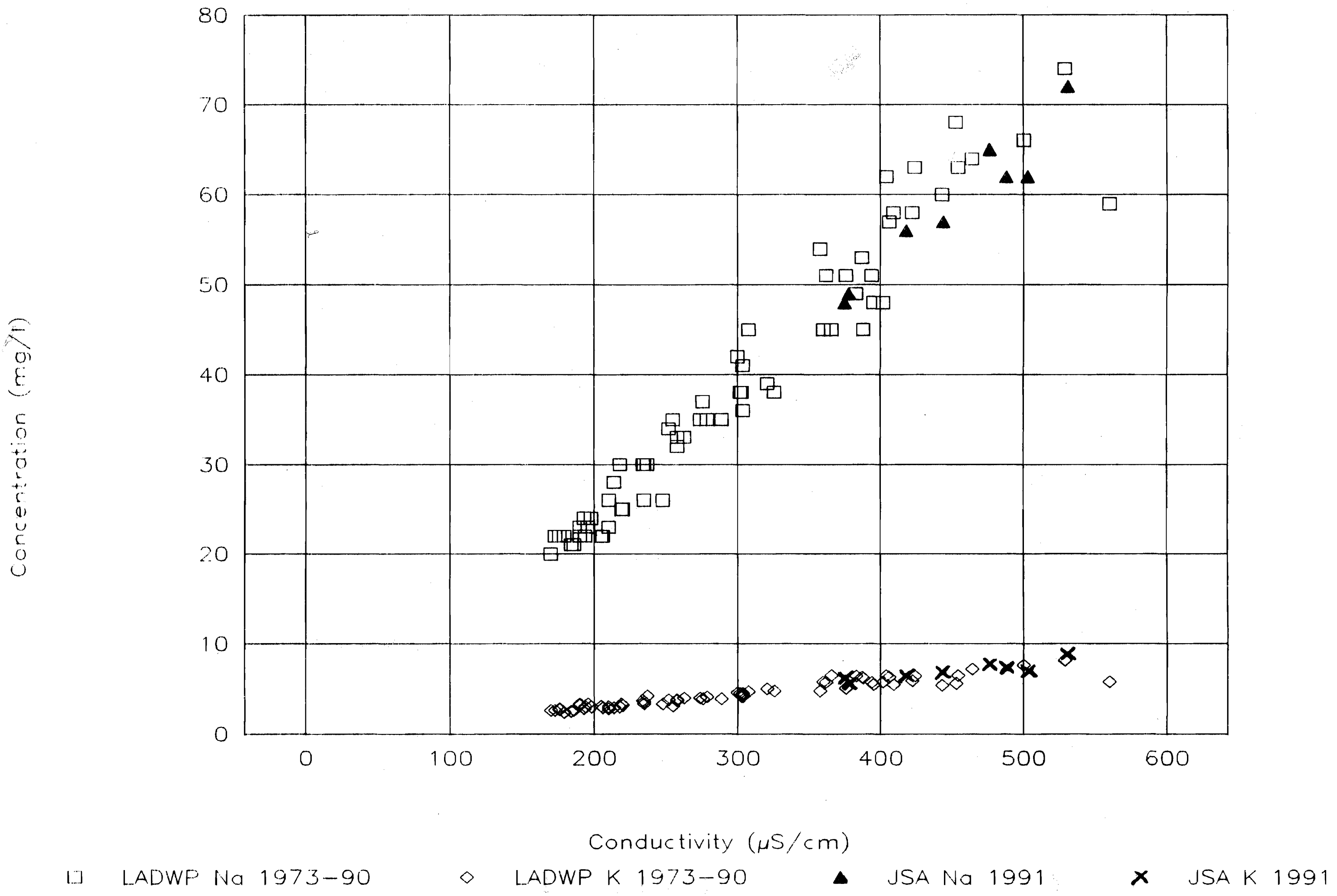


Figure 65. Benton Crossing Sodium and Potassium as a Function of Conductivity (1973-1991).

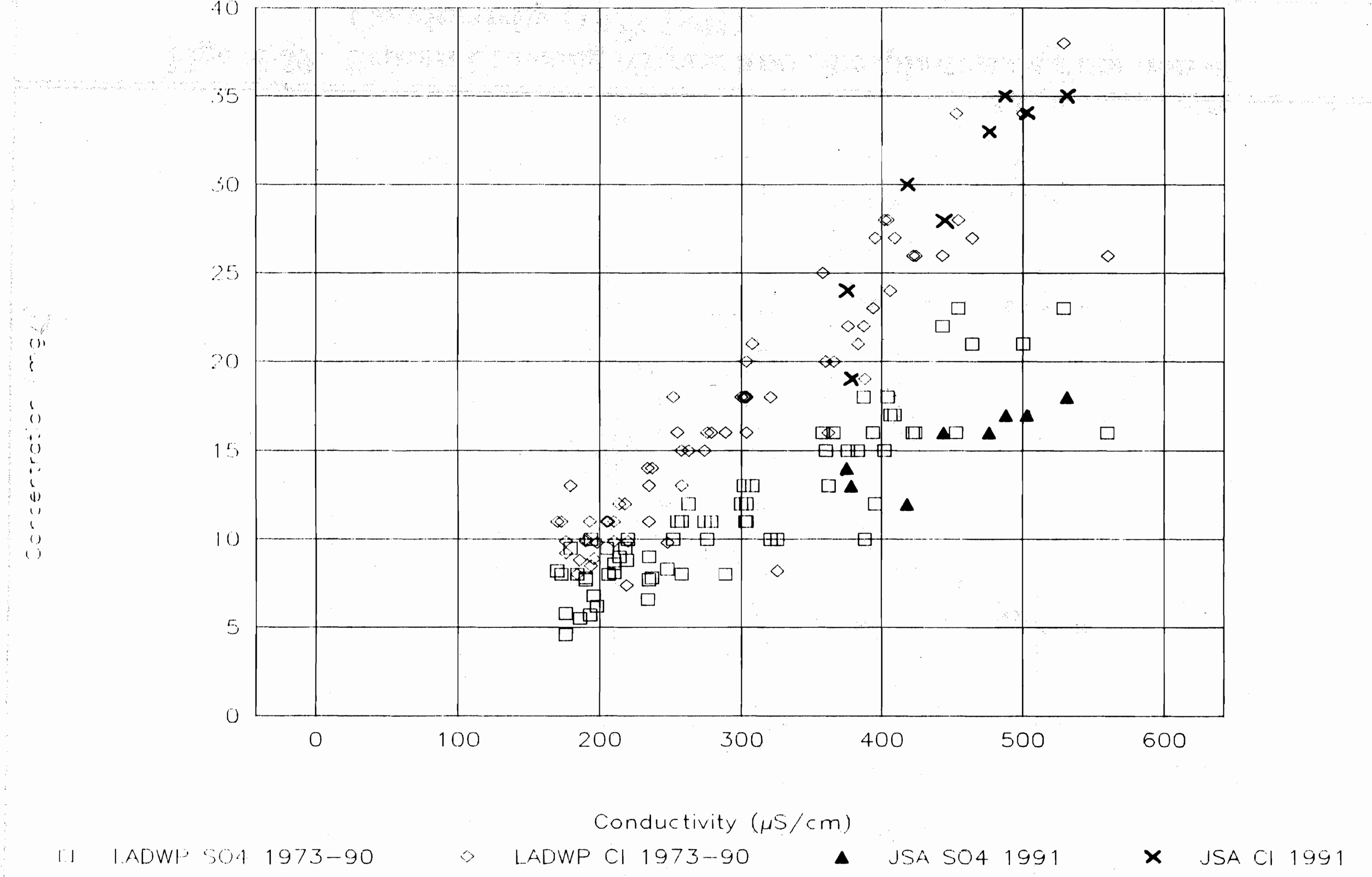


Figure 66. Benton Crossing Sulfate and Chloride as a Function of Conductivity (1973-1991).

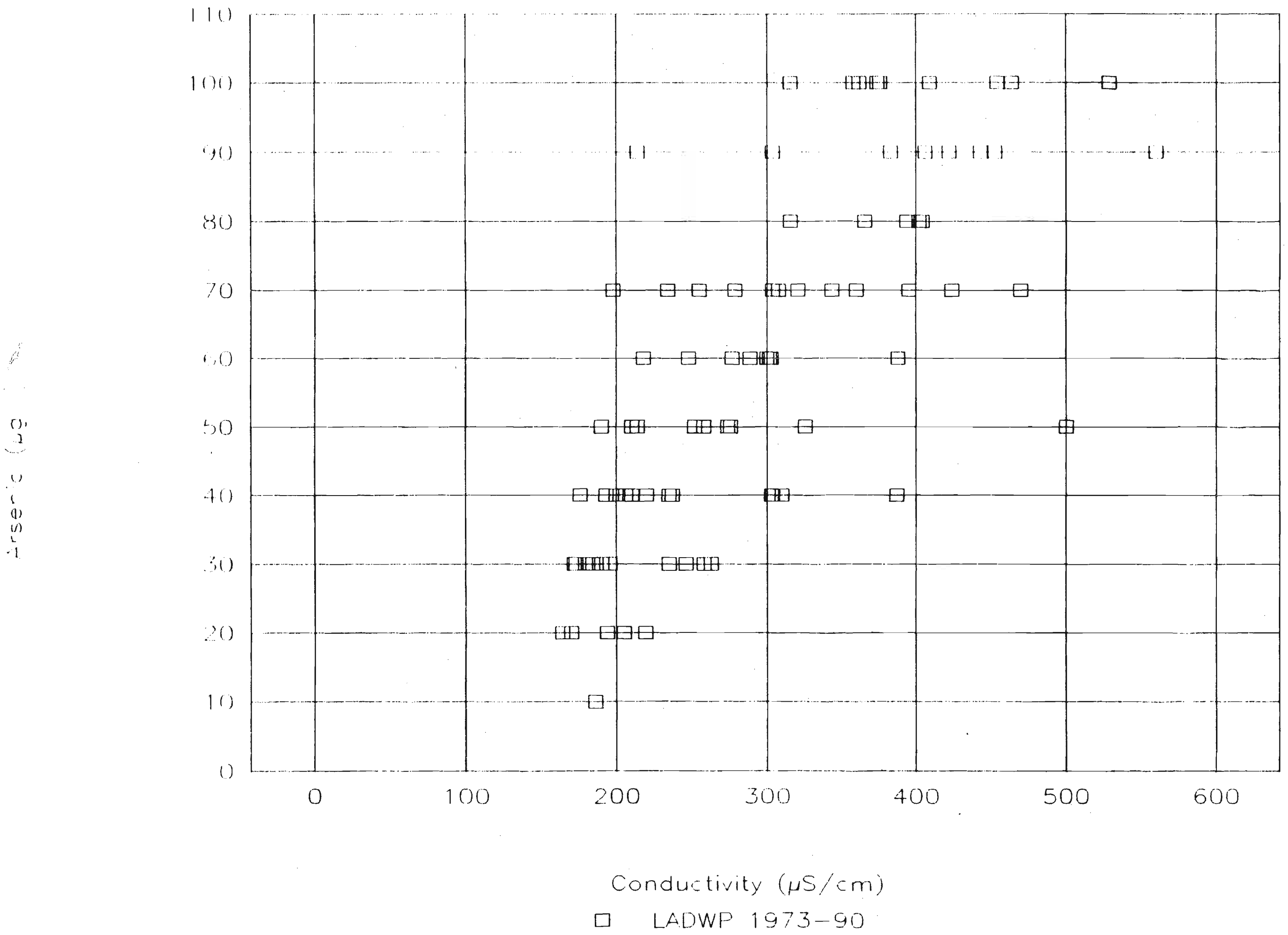


Figure 67. Benton Crossing Arsenic as a Function of Conductivity (1973-1980).

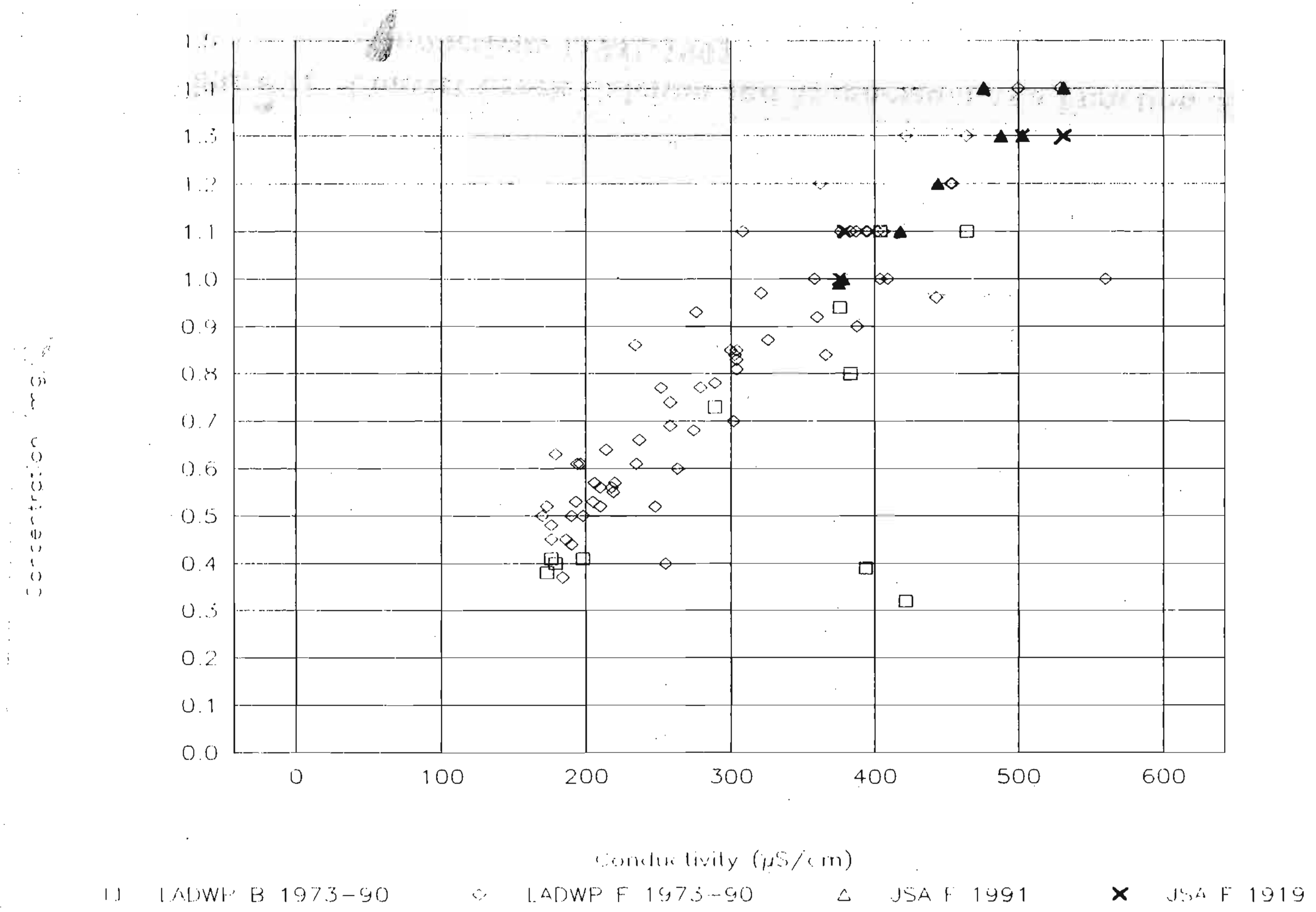


Figure 68. Benton Crossing Boron and Fluoride as a Function of Conductivity (1973-1991).

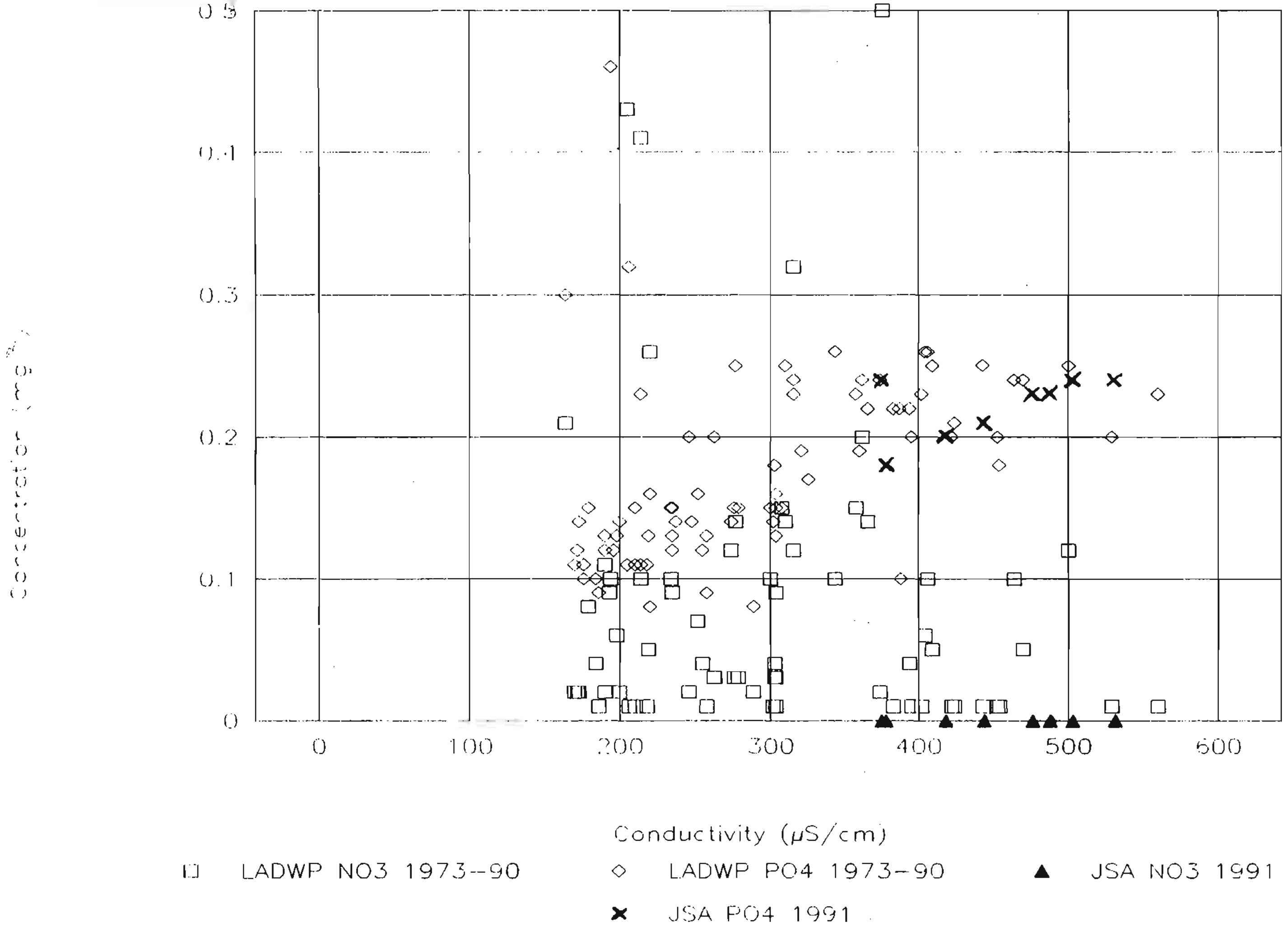


Figure 69. Benton Crossing Nitrate and Phosphate as a Function of Conductivity (1973-1991).

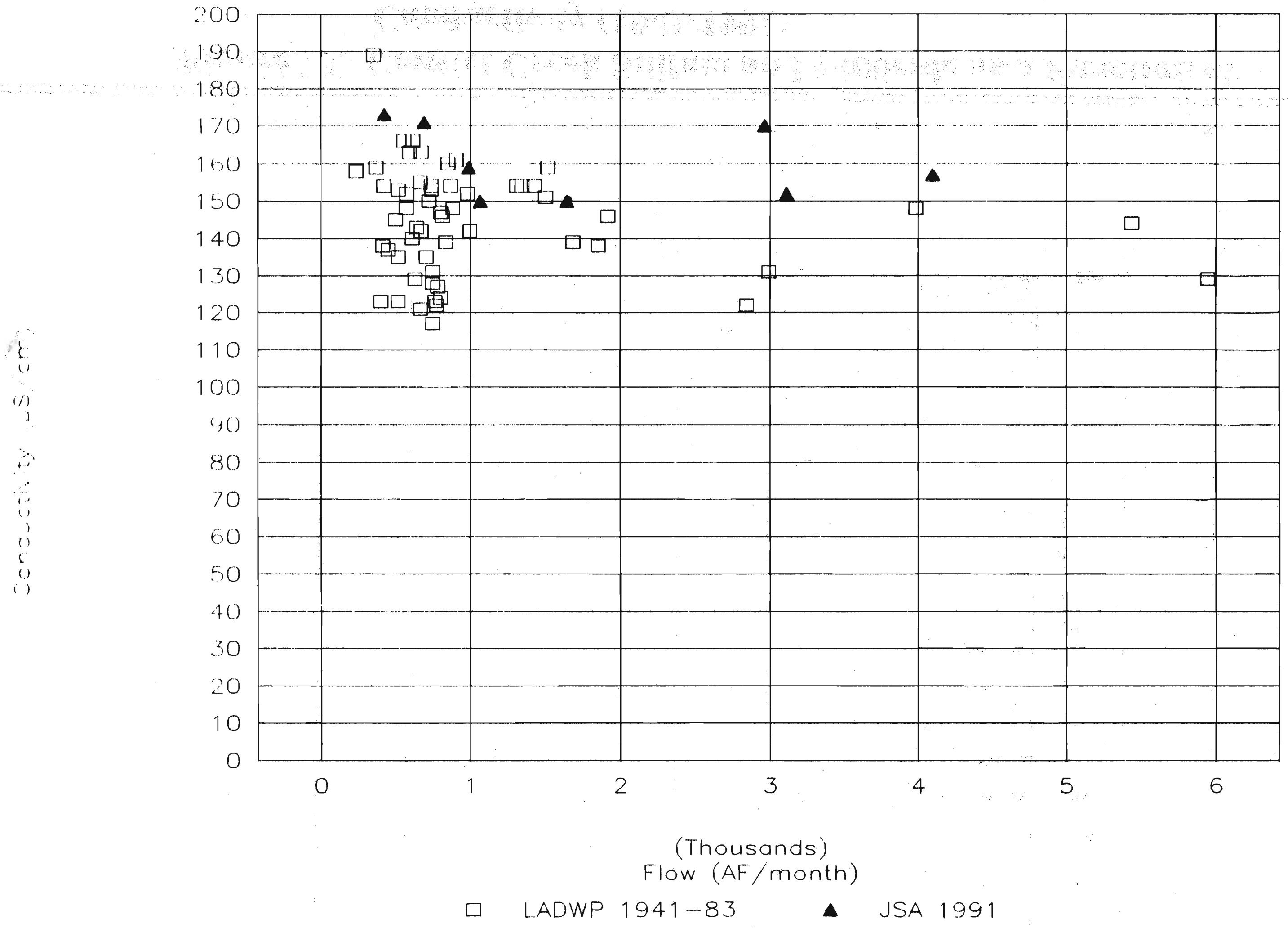


Figure 70. Convict Creek Conductivity as a Function of Flow (1941-1991).

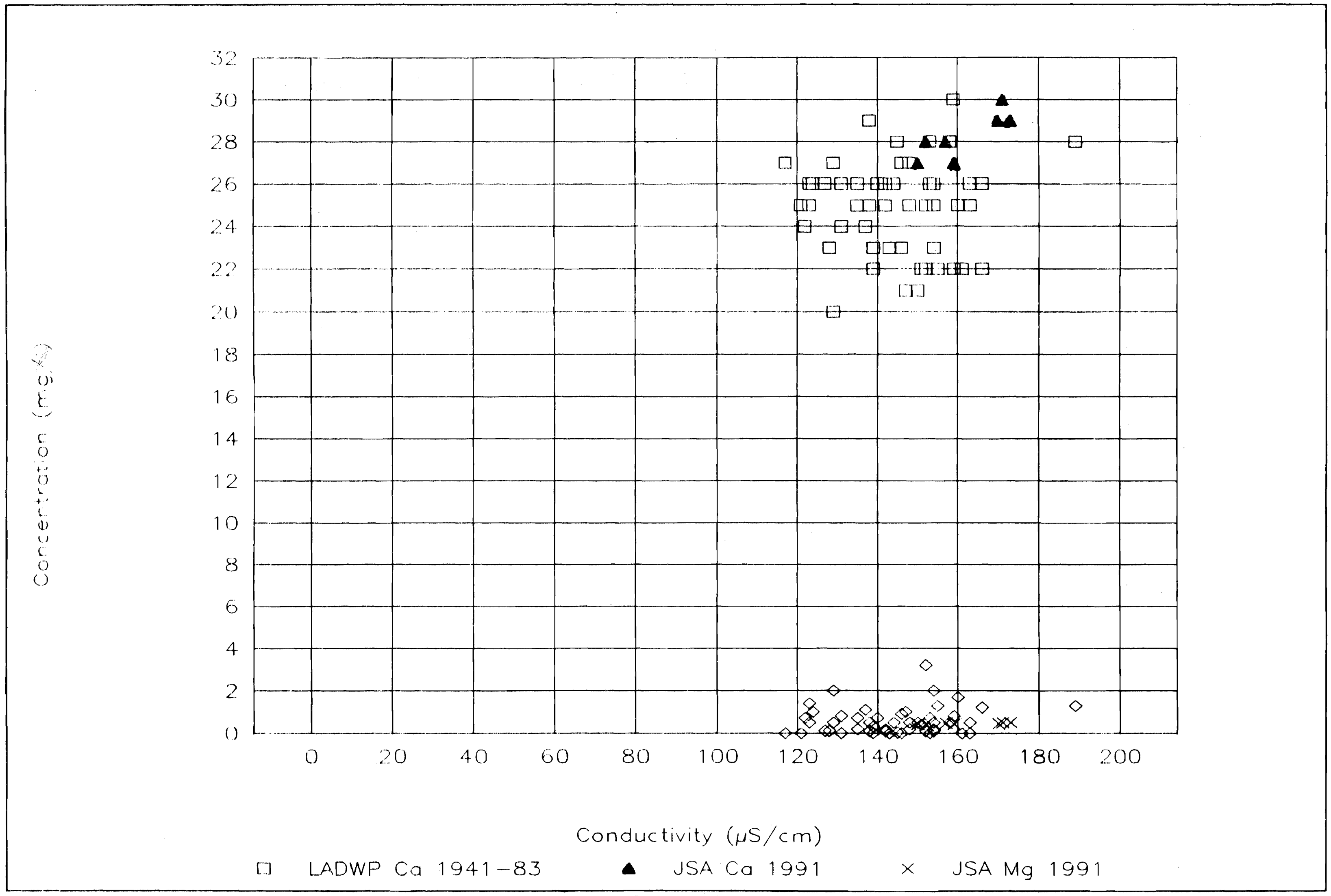


Figure 71. Convict Creek Calcium and Magnesium as a Function of Conductivity (1941-1991).

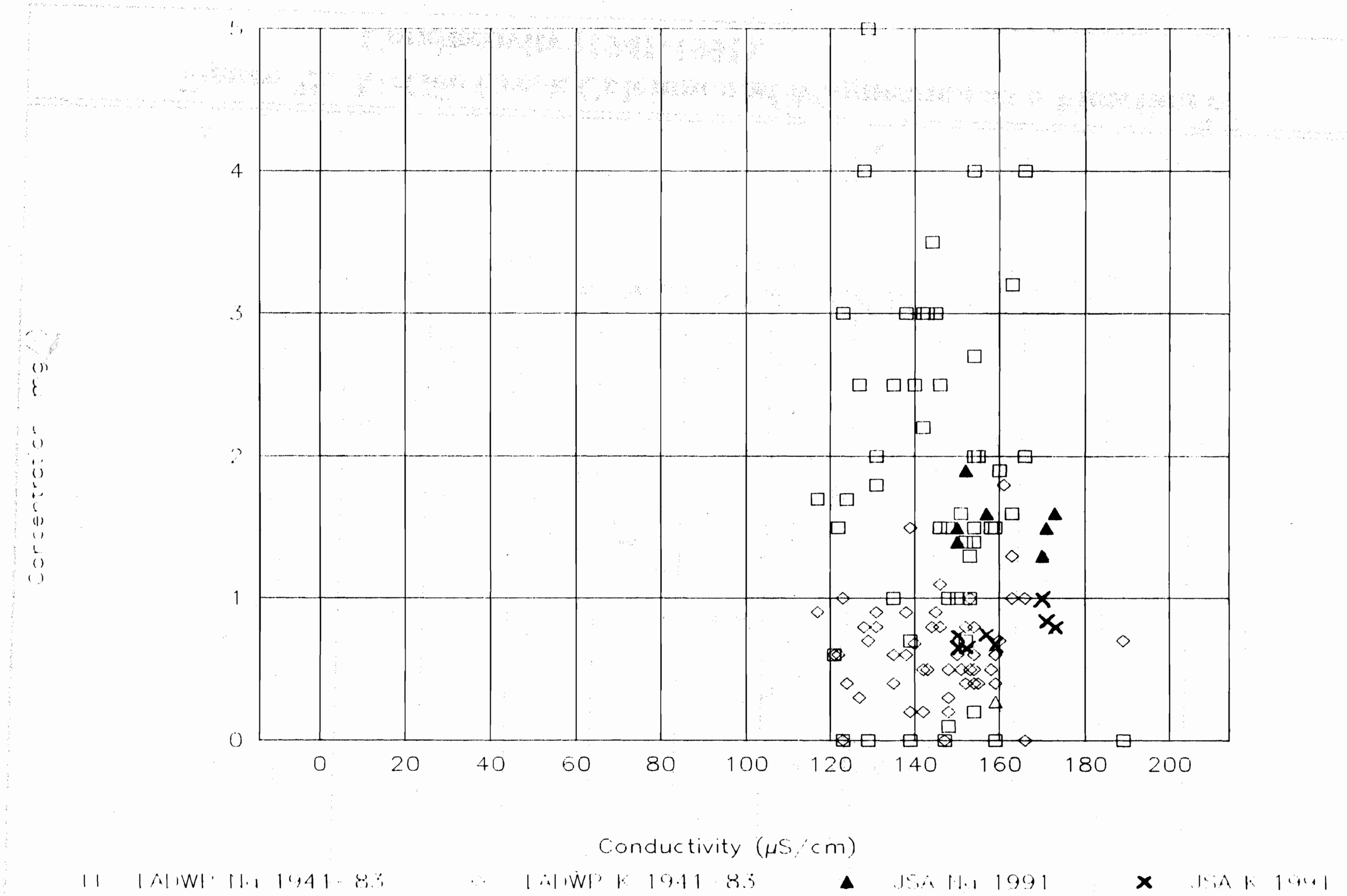


Figure 72. Convict Creek Sodium and Potassium as a Function of Conductivity (1941-1991).

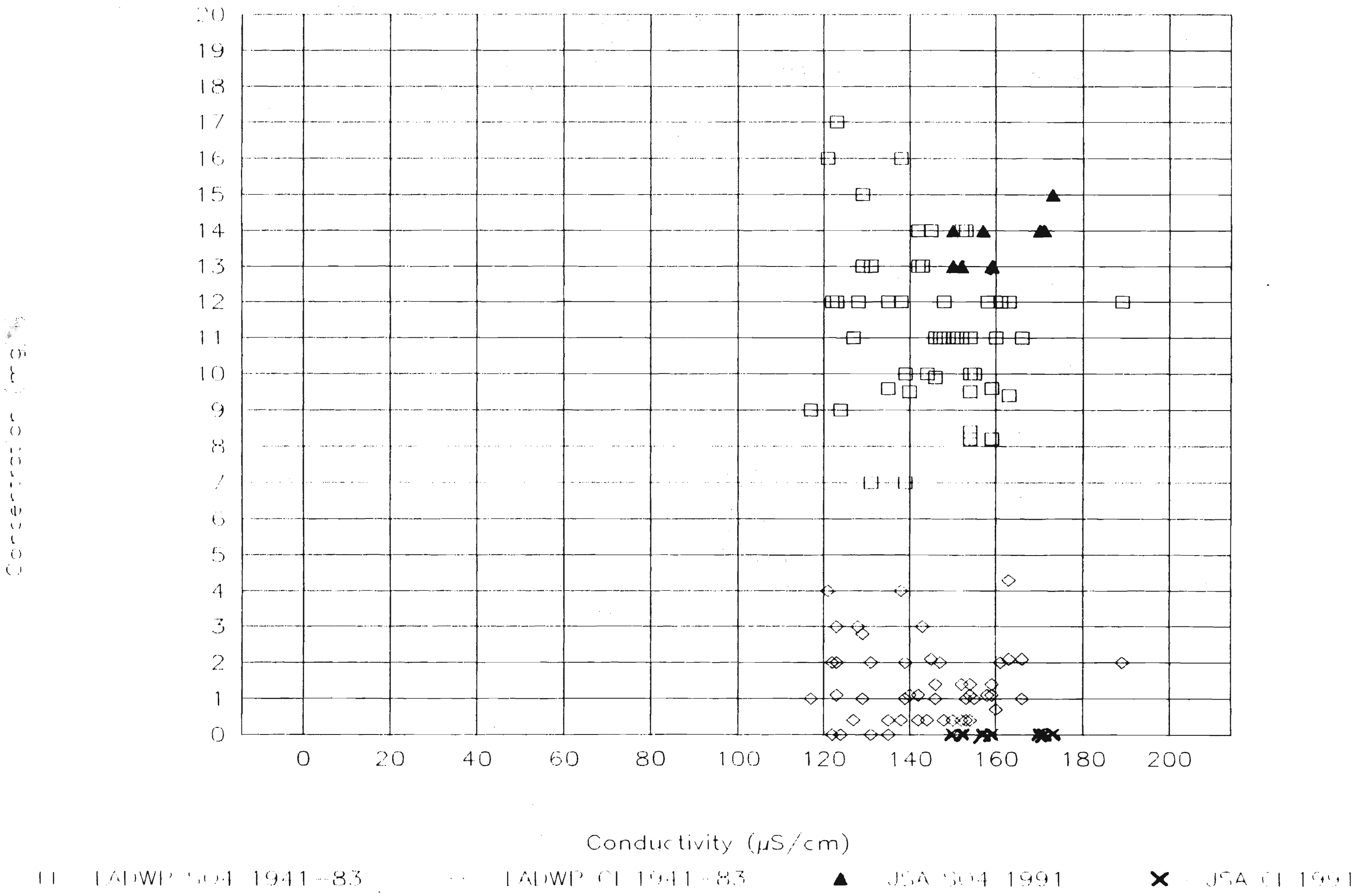


Figure 73. Convict Creek Sulfate and Chloride as a Function of Conductivity (1941-1991).

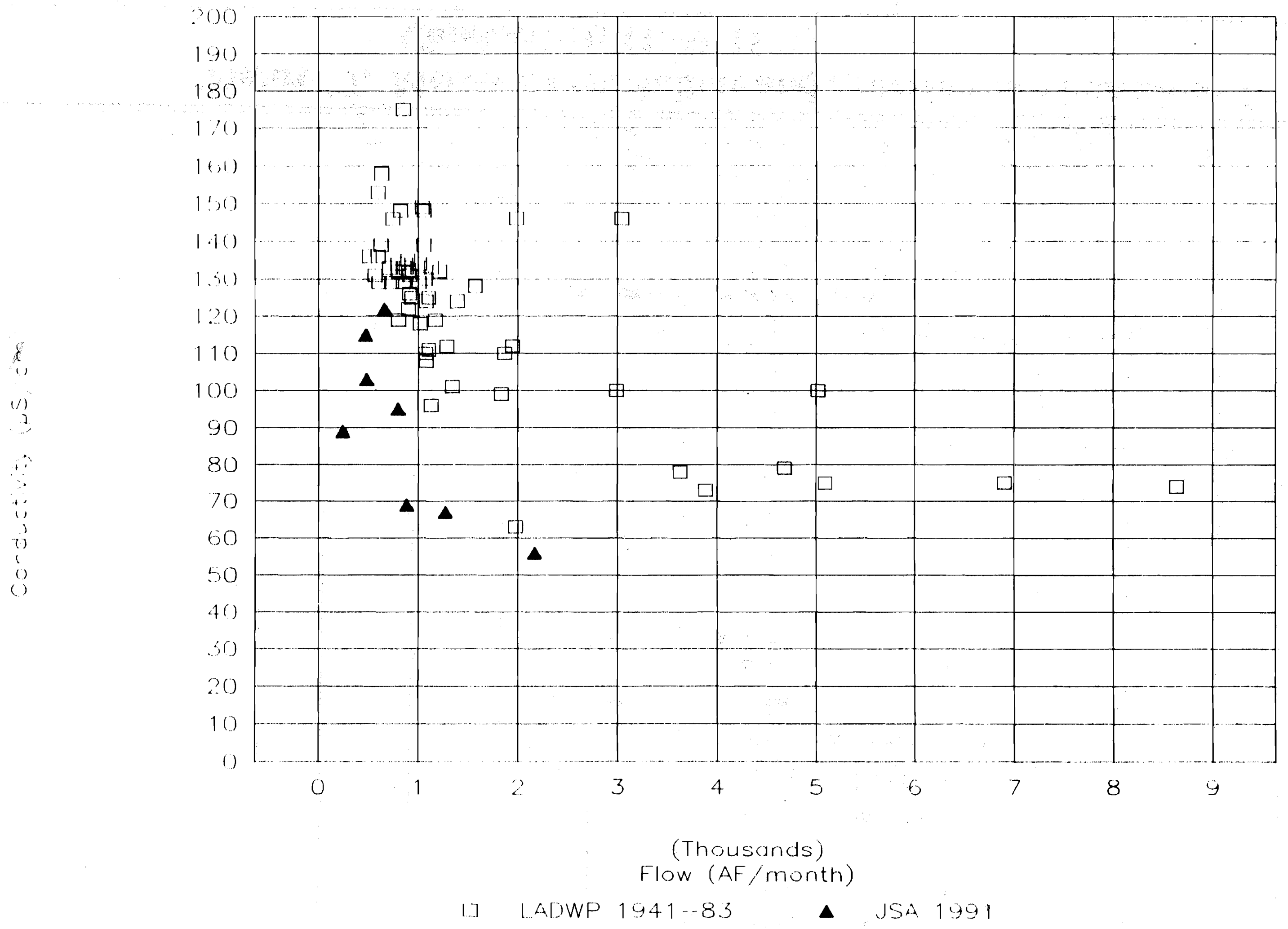


Figure 74. McGee Creek Conductivity as a Function of Flow (1941-1991).

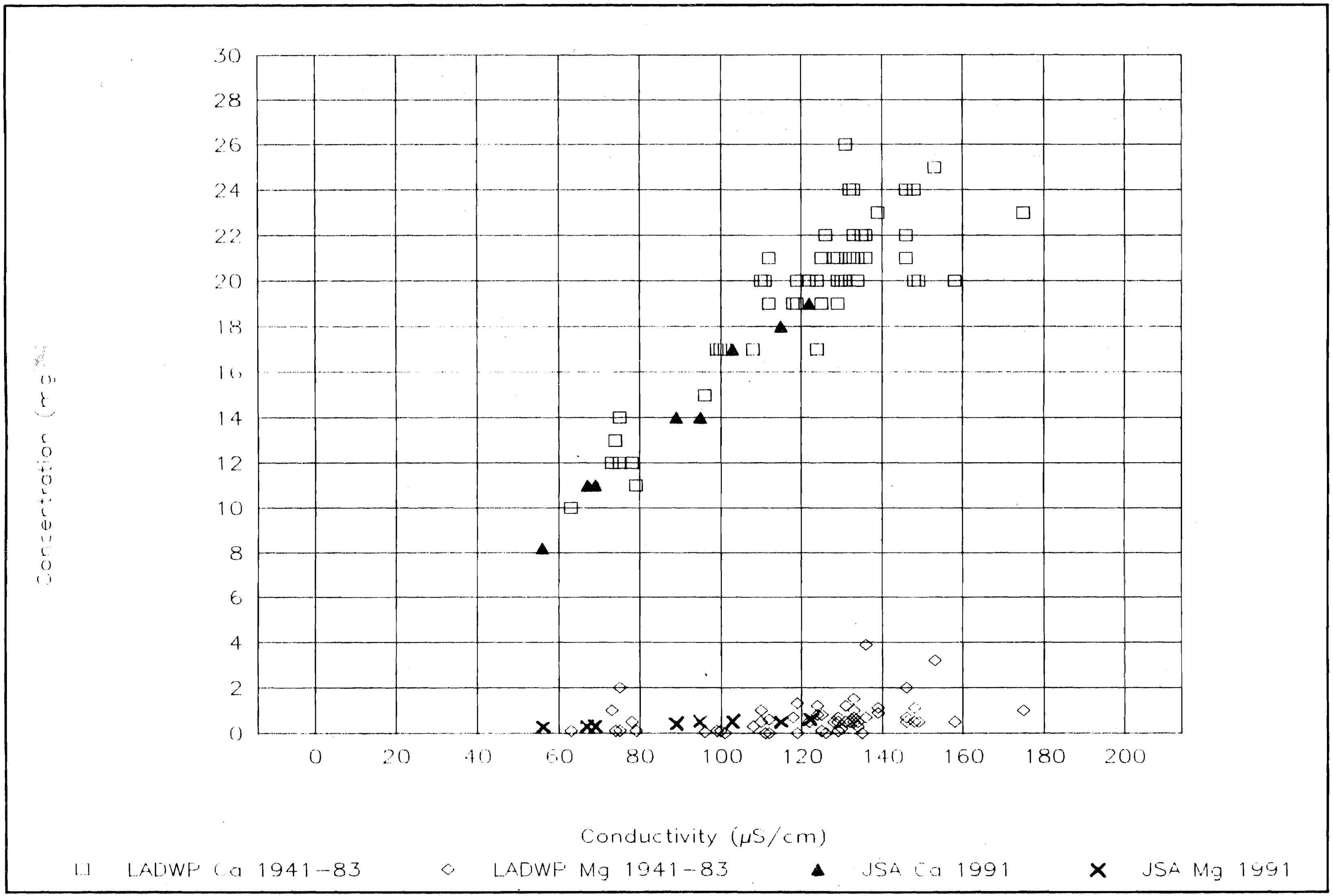


Figure 75. McGee Creek Calcium and Magnesium as a Function of Conductivity (1941-1991).

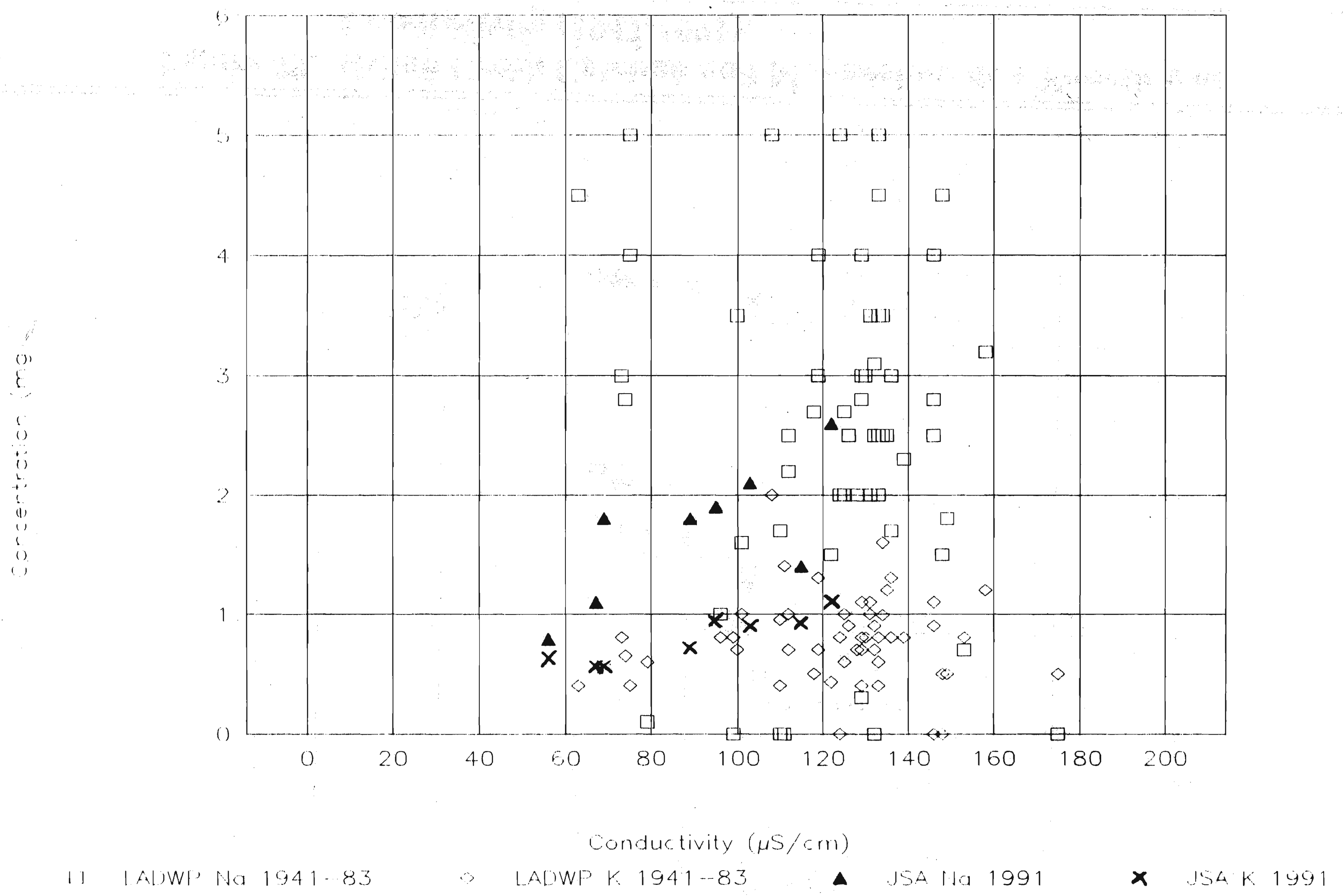


Figure 76. McGee Creek Sodium and Potassium as a Function of Conductivity (1941-1991).

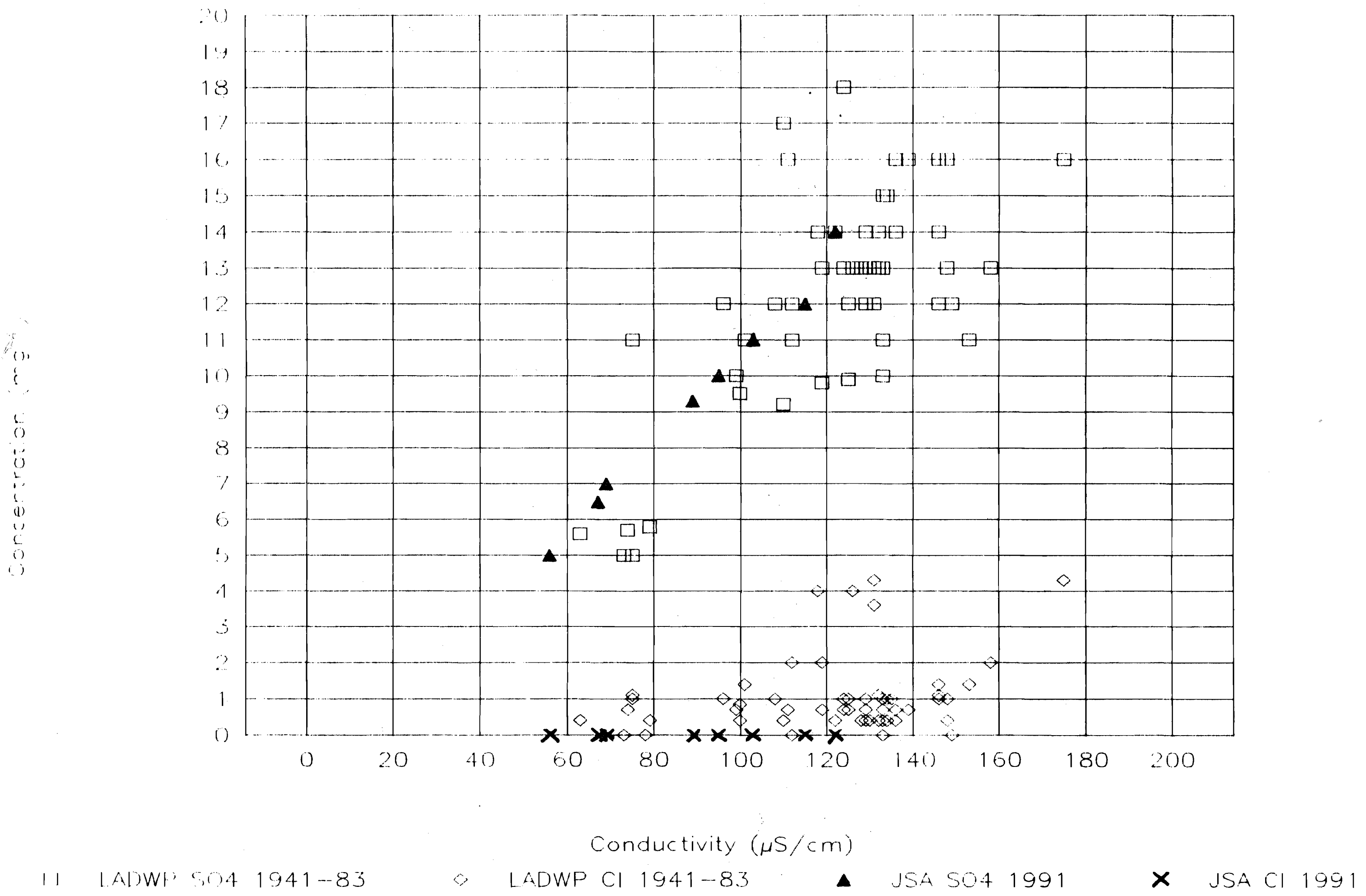


Figure 77. McGee Creek Sulfate and Chloride as a Function of Conductivity (1941-1991).

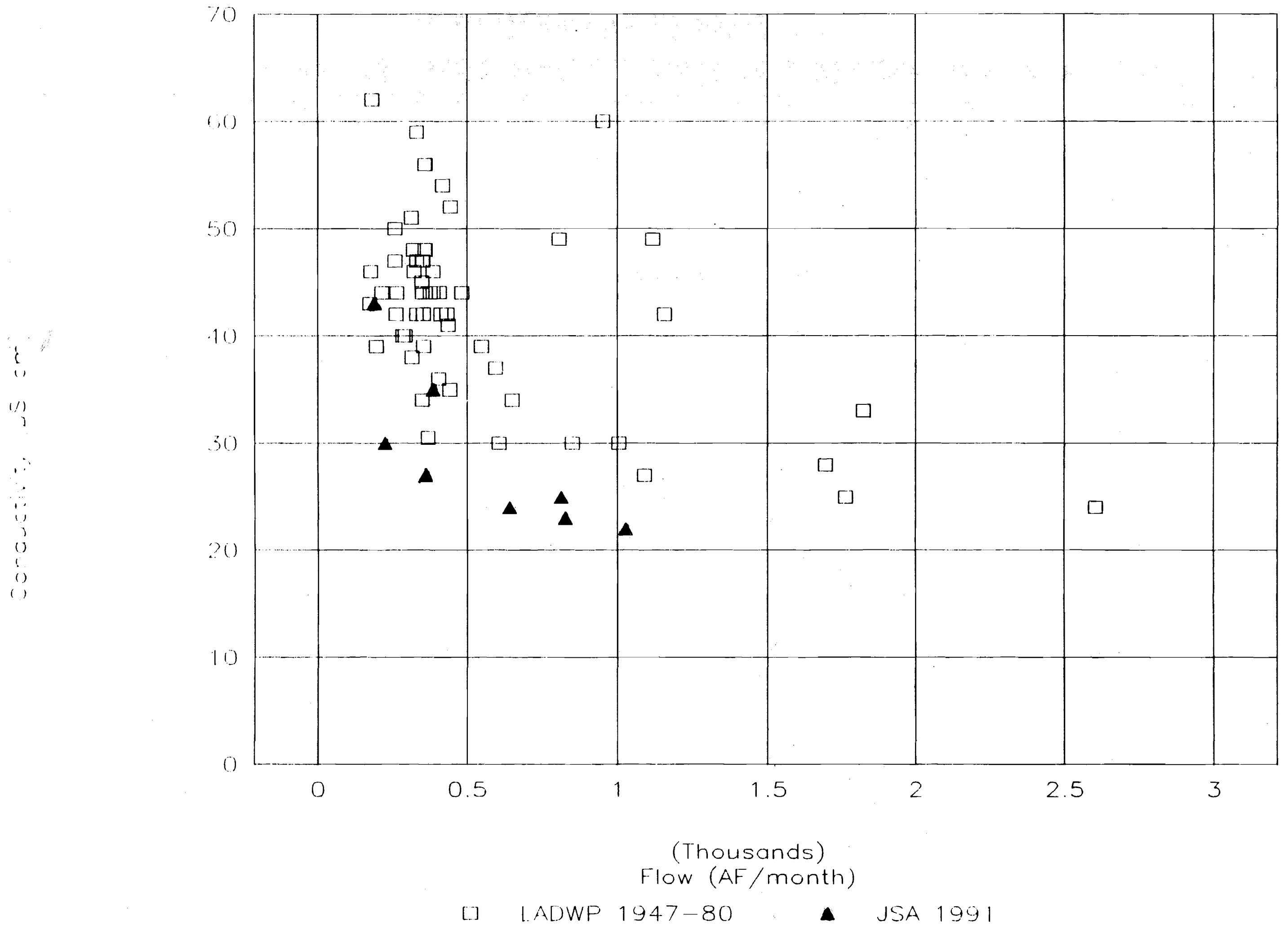


Figure 78. Hilton Creek Conductivity as a Function of Flow (1974-1991).

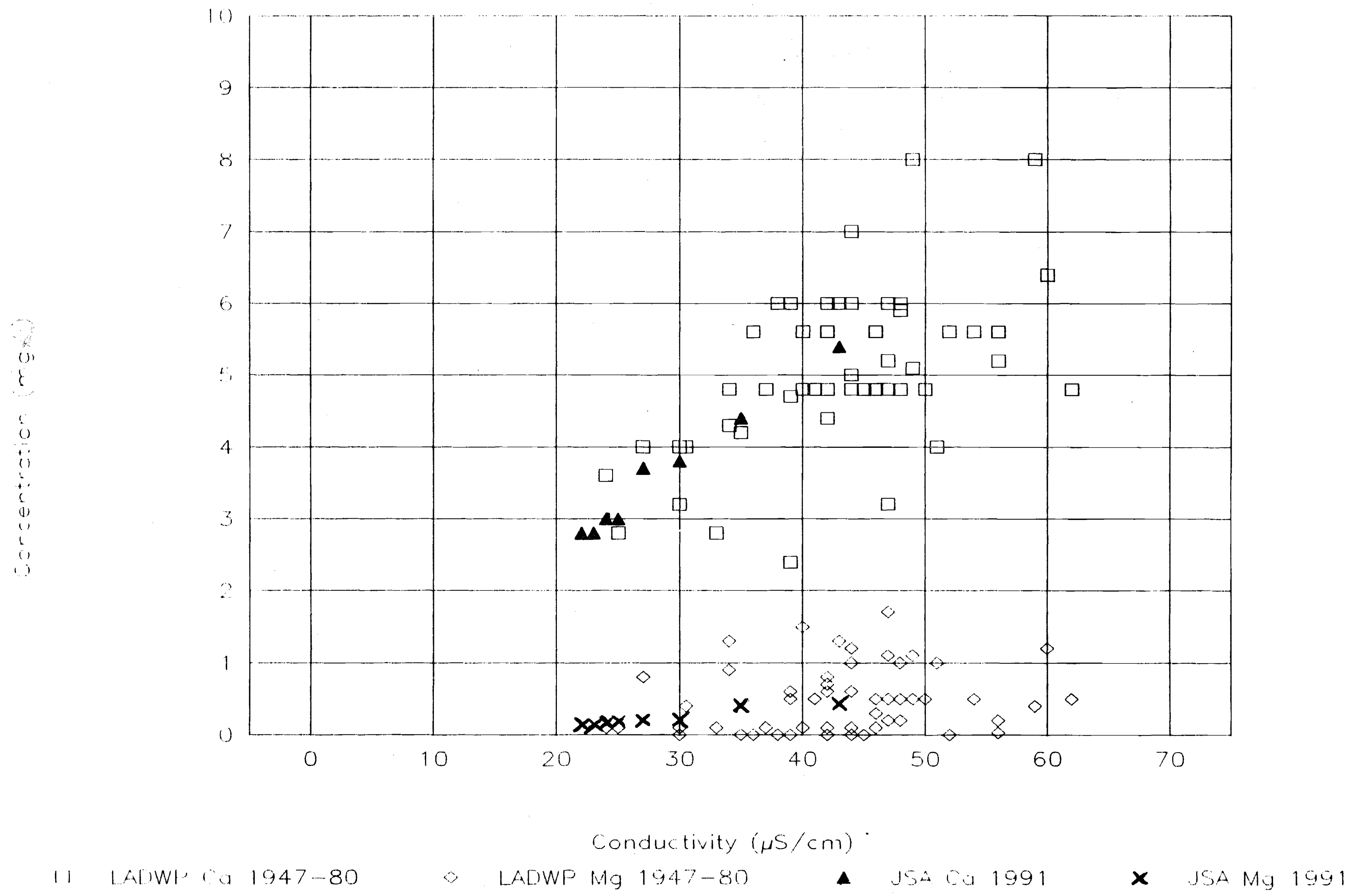


Figure 79. Hilton Creek Calcium and Magnesium as a Function of Conductivity (1947-1991).

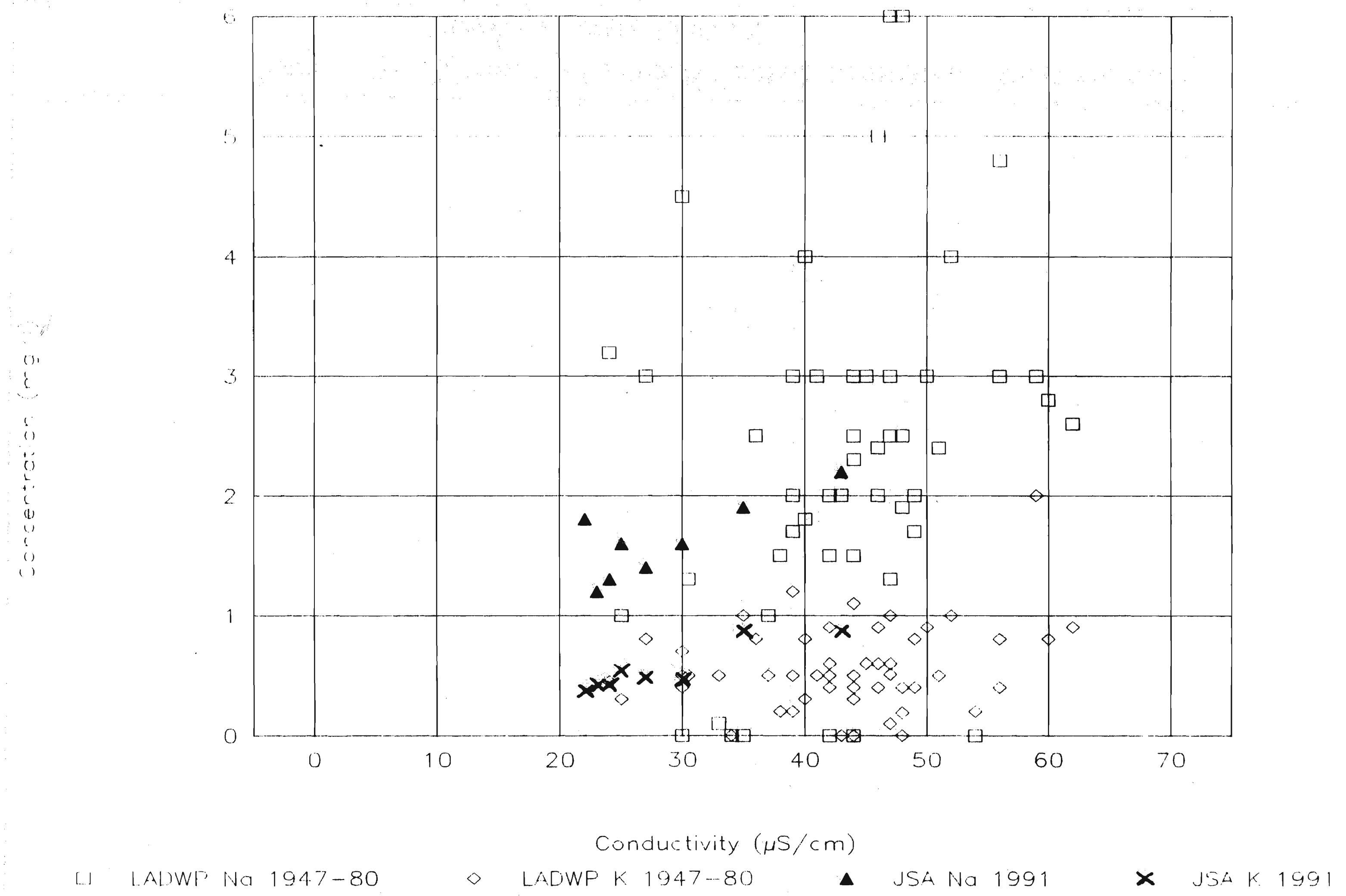


Figure 80. Hilton Creek Sodium and Potassium as a Function of Conductivity (1947-1991).

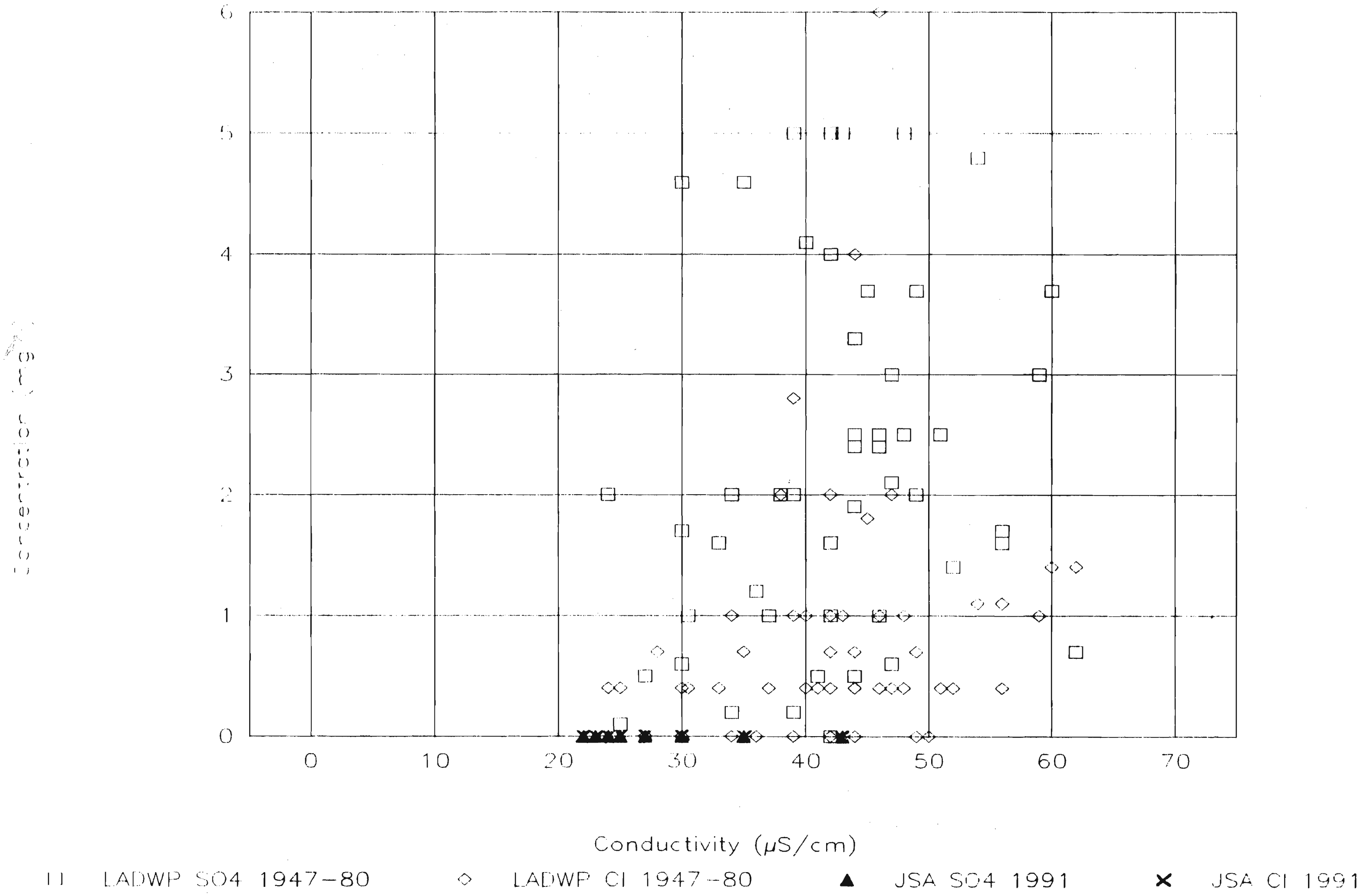


Figure 81. Hilton Creek Sulfate and Chloride as a Function of Conductivity (1947-1991).

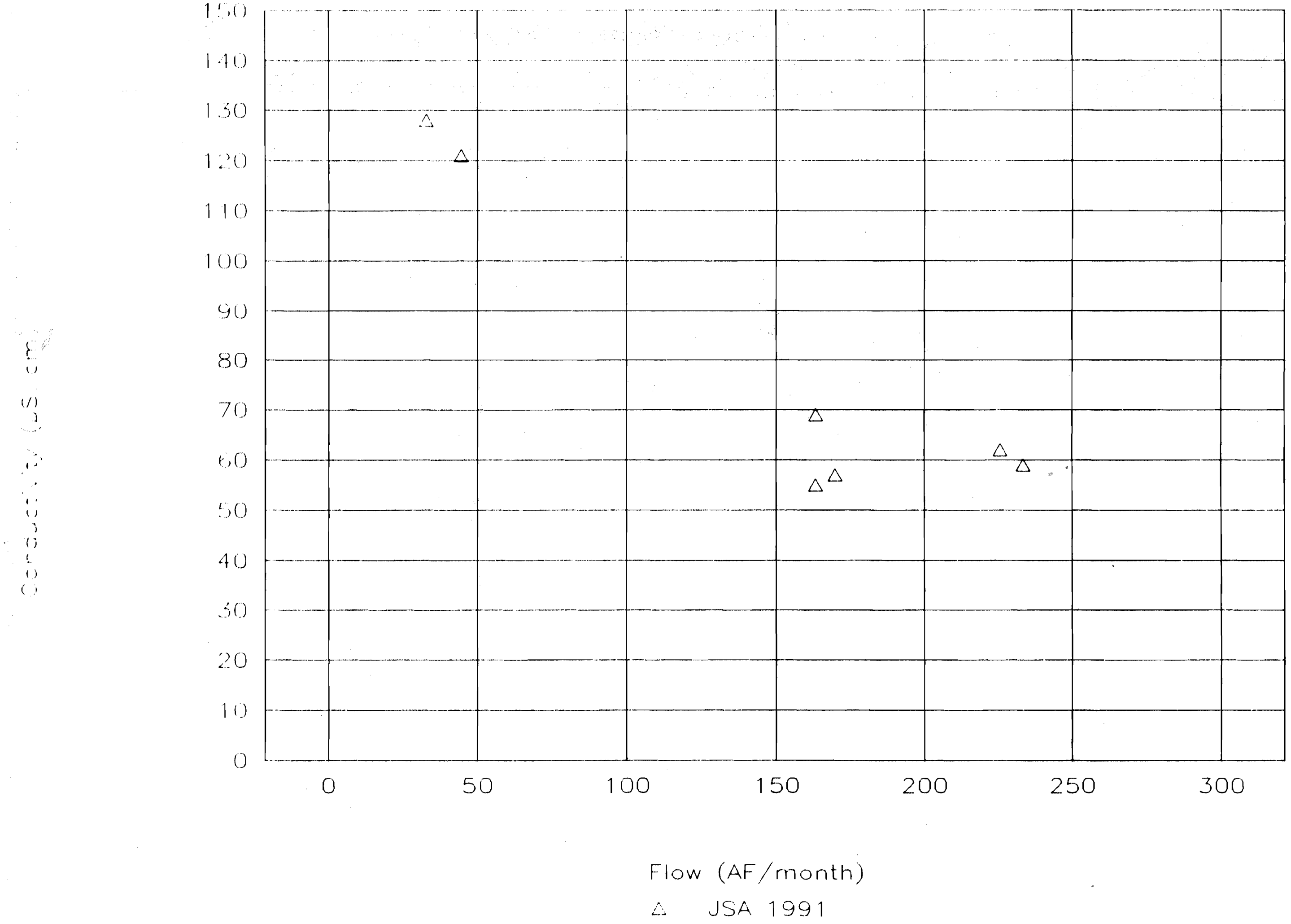


Figure 82. Crooked Creek Conductivity as a Function of Flow (1991).

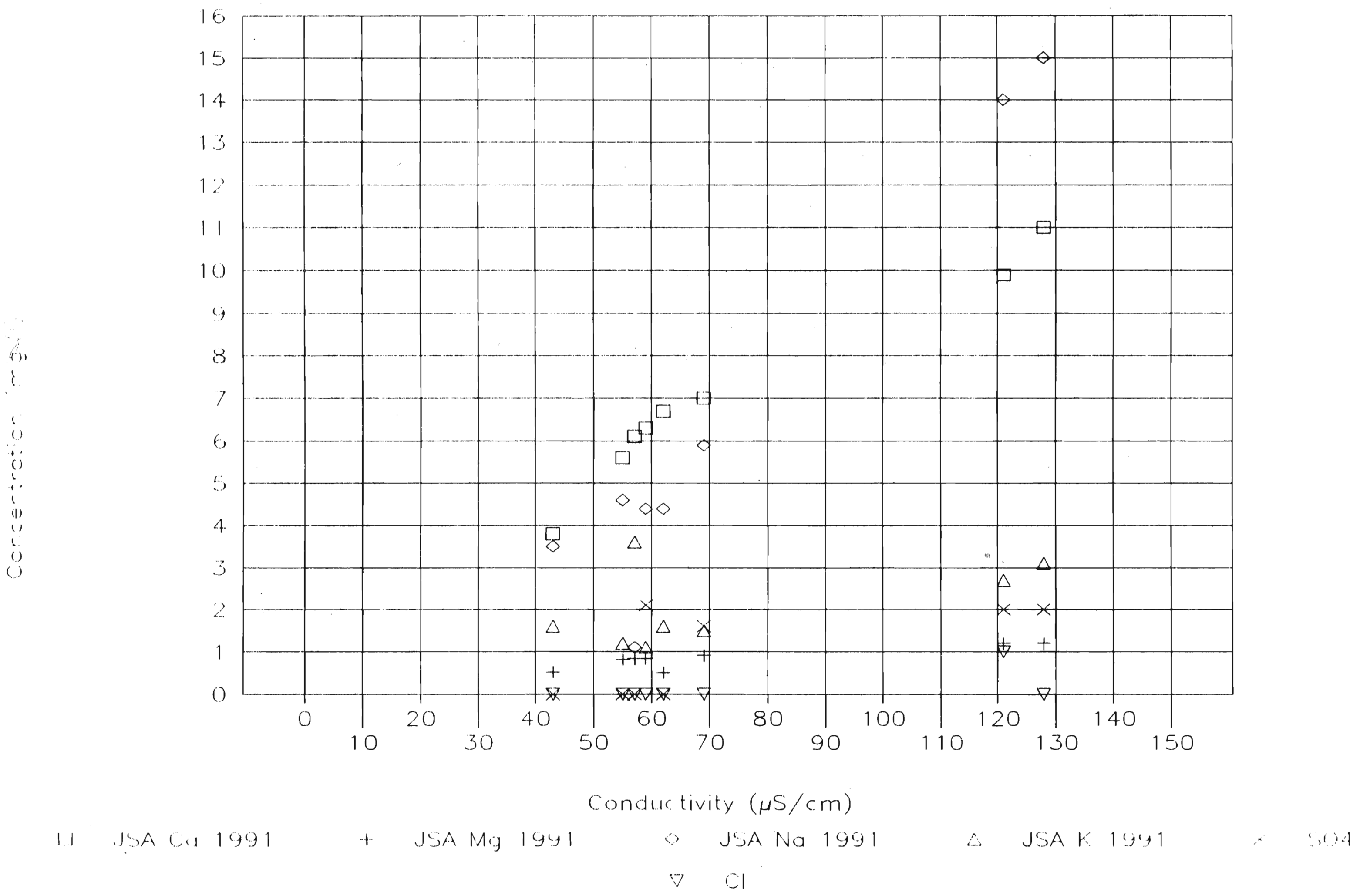


Figure 83. Crooked Creek Selected Ions as a Function of Conductivity (1991).

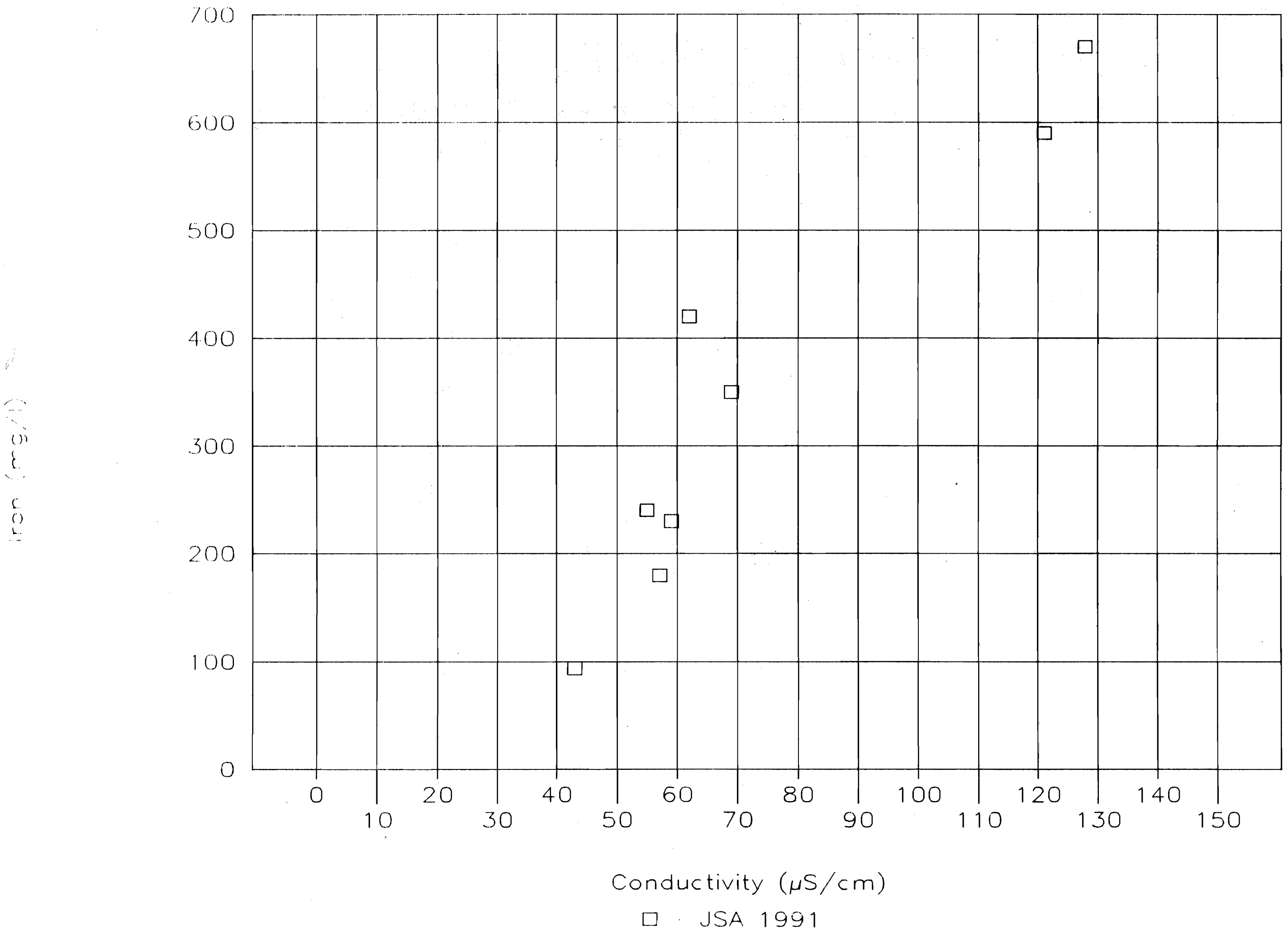


Figure 84. Crooked Creek Iron as a Function of Conductivity (1991).

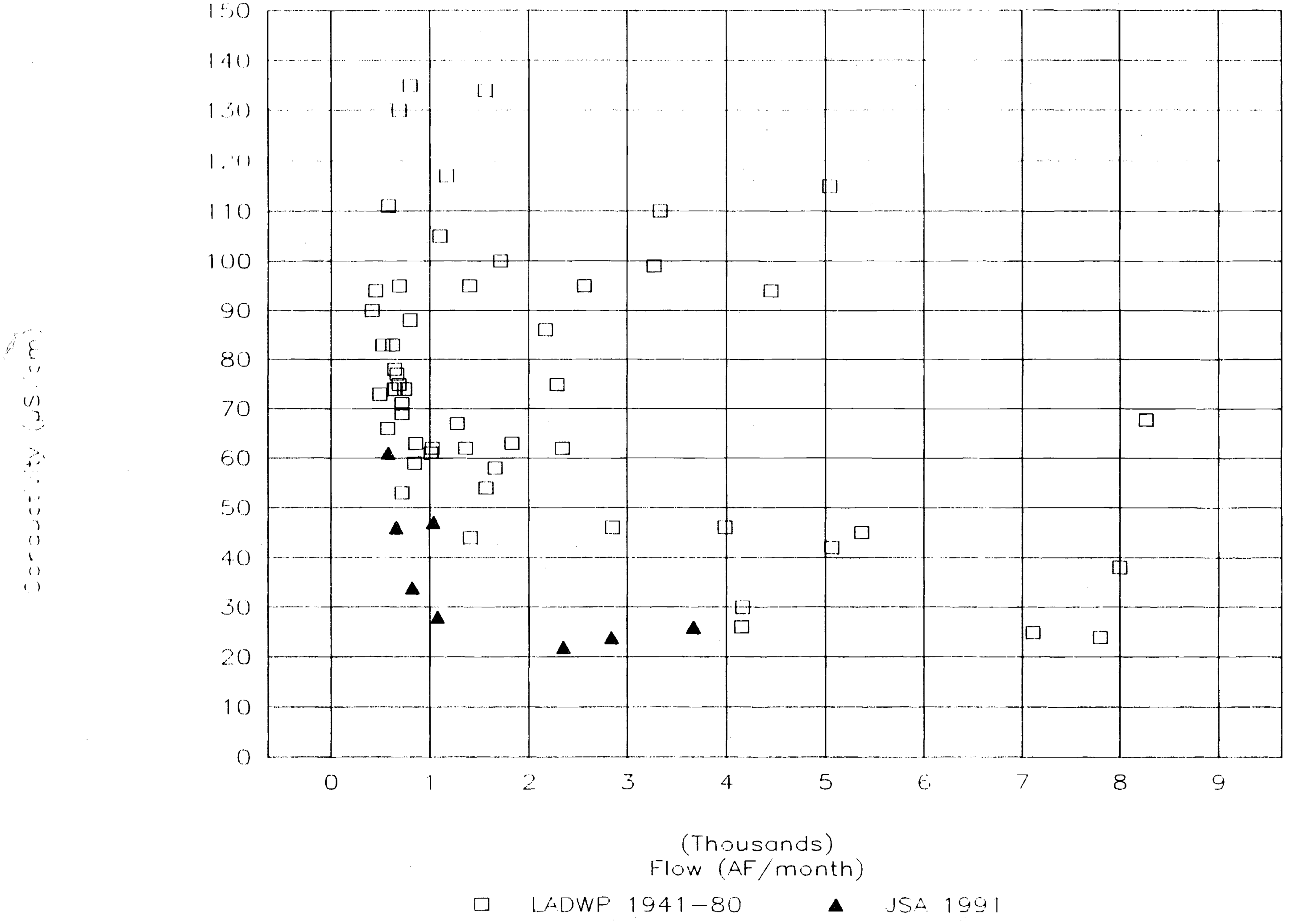


Figure 85. Rock Creek Conductivity as a Function of Flow (1941-1991).

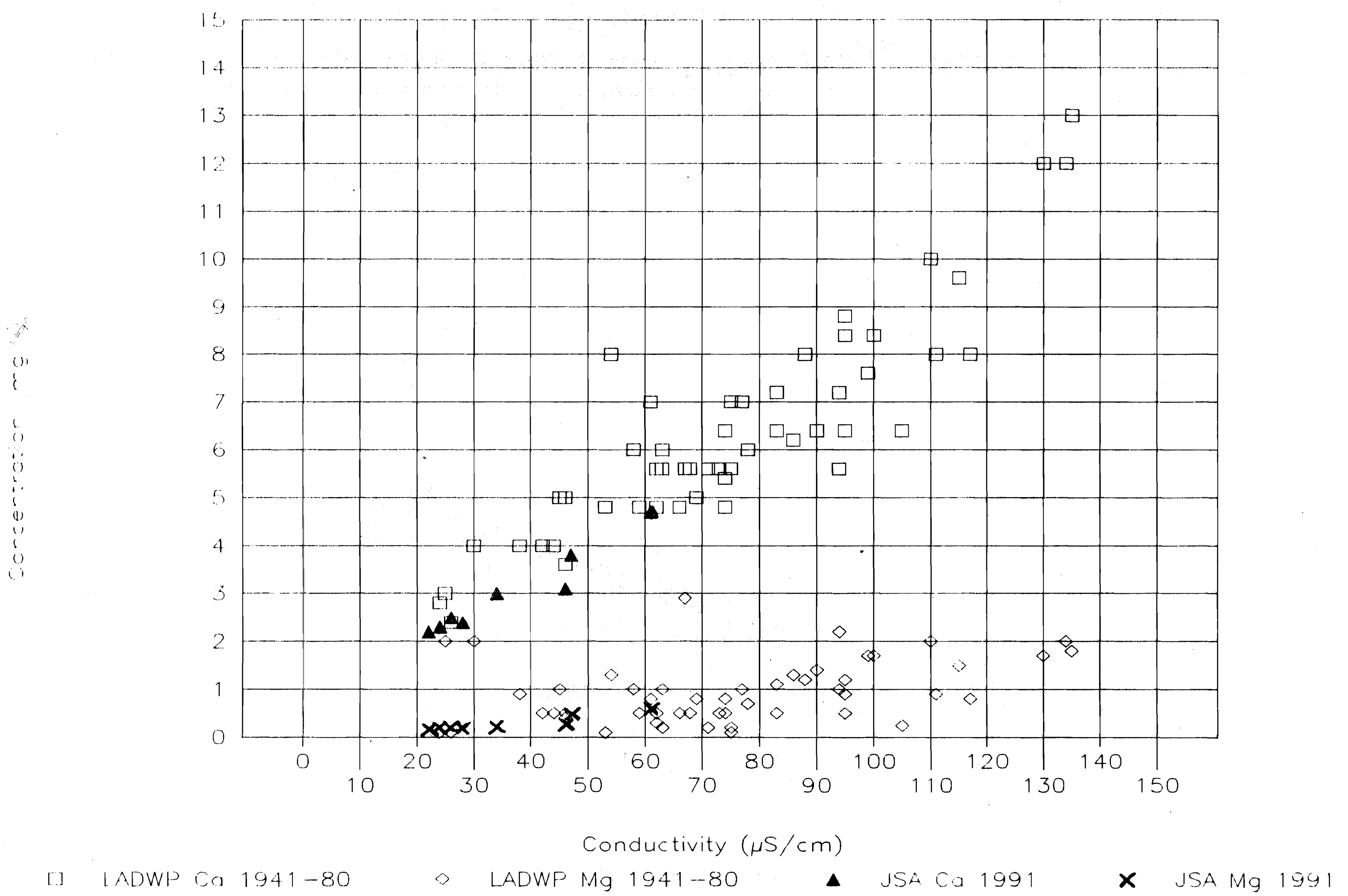


Figure 86. Rock Creek Calcium and Magnesium as a Function of Conductivity (1941-1991).

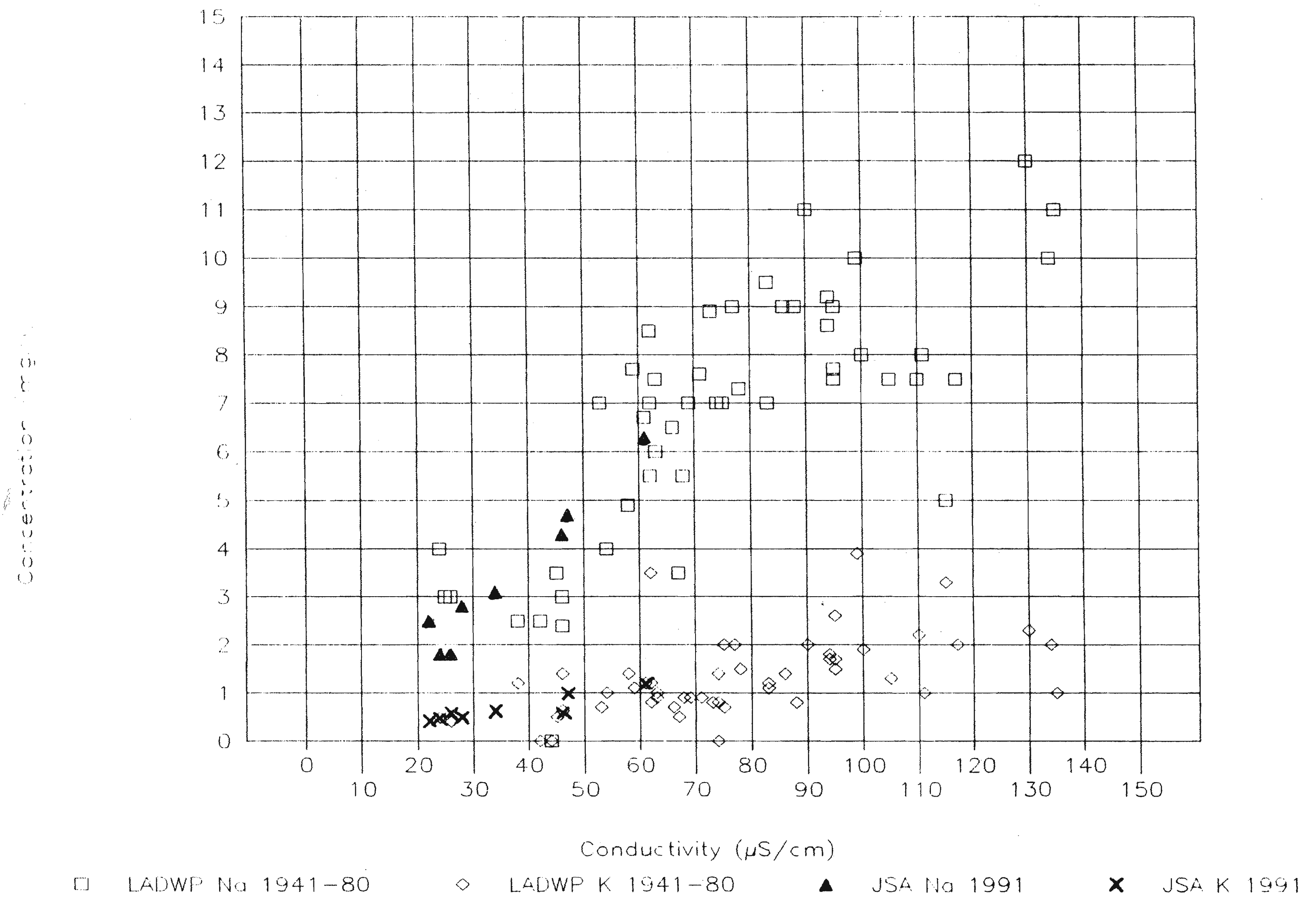


Figure 87. Rock Creek Sodium and Potassium as a Function of Conductivity (1941-1991).

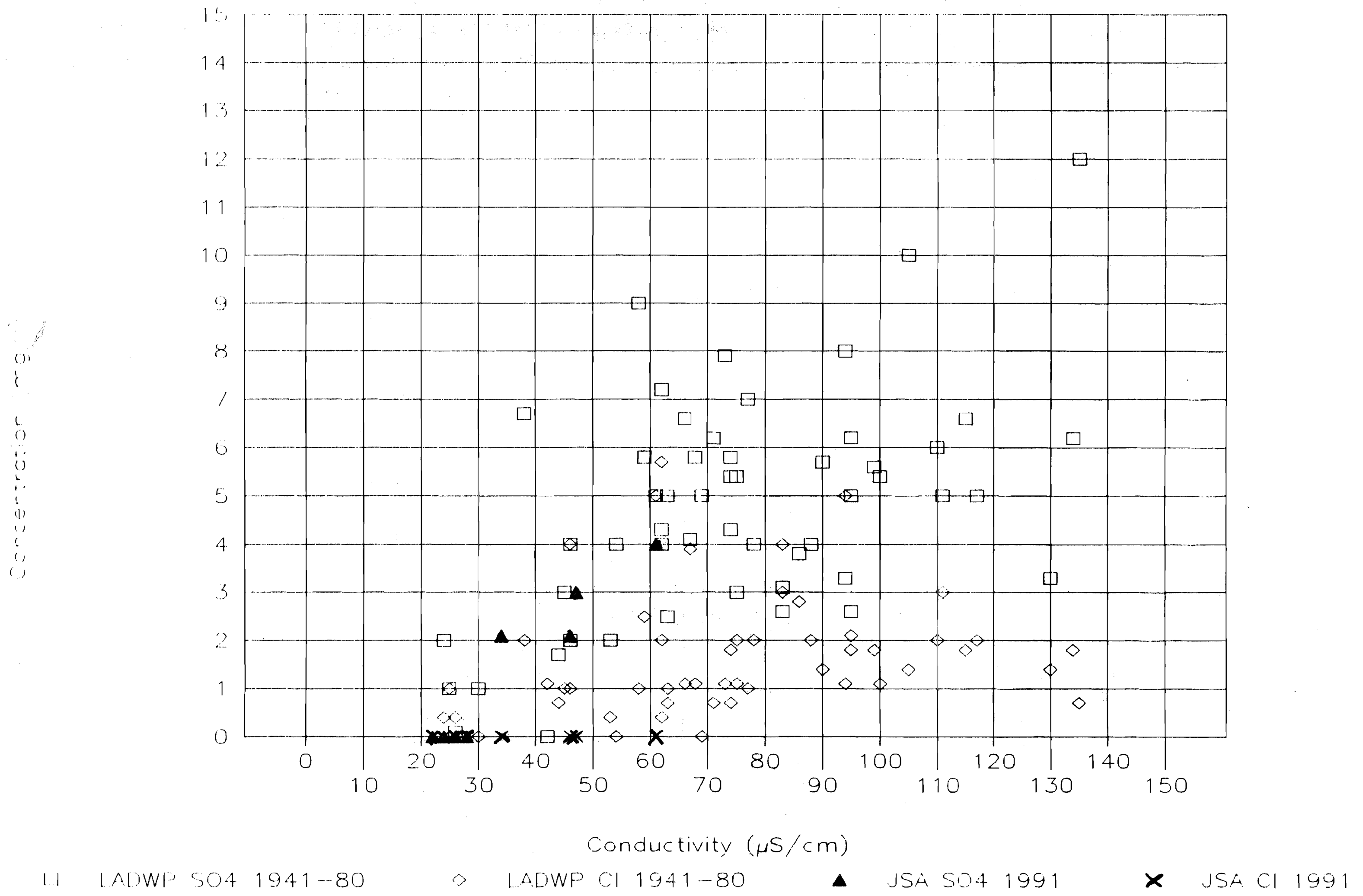


Figure 88. Rock Creek Sulfate and Chloride as a Function of Conductivity (1941-1991).

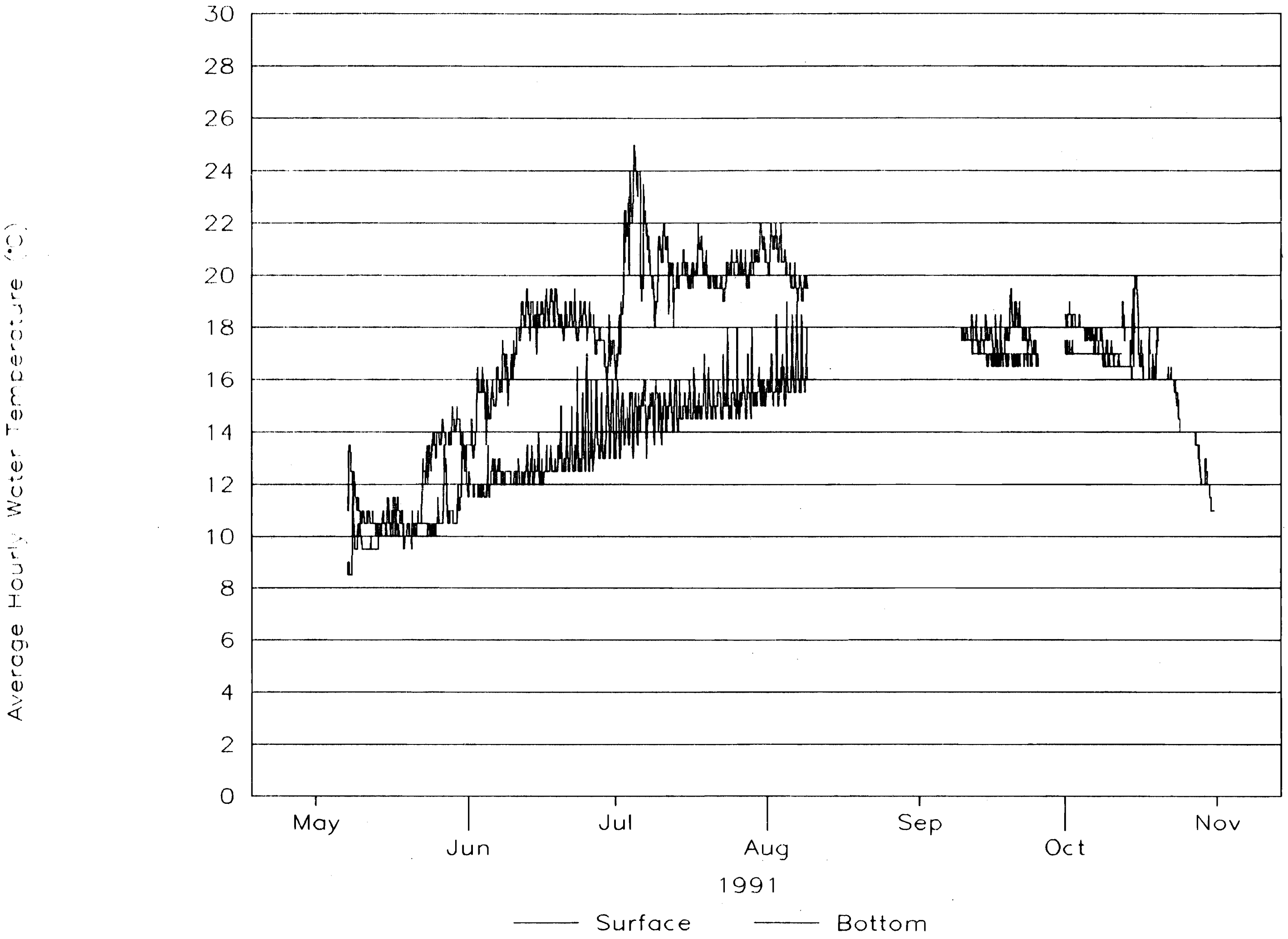


Figure 89. Crowley Lake Surface and Bottom Temperatures 1991 (Hourly LADWP Data from Datapods).

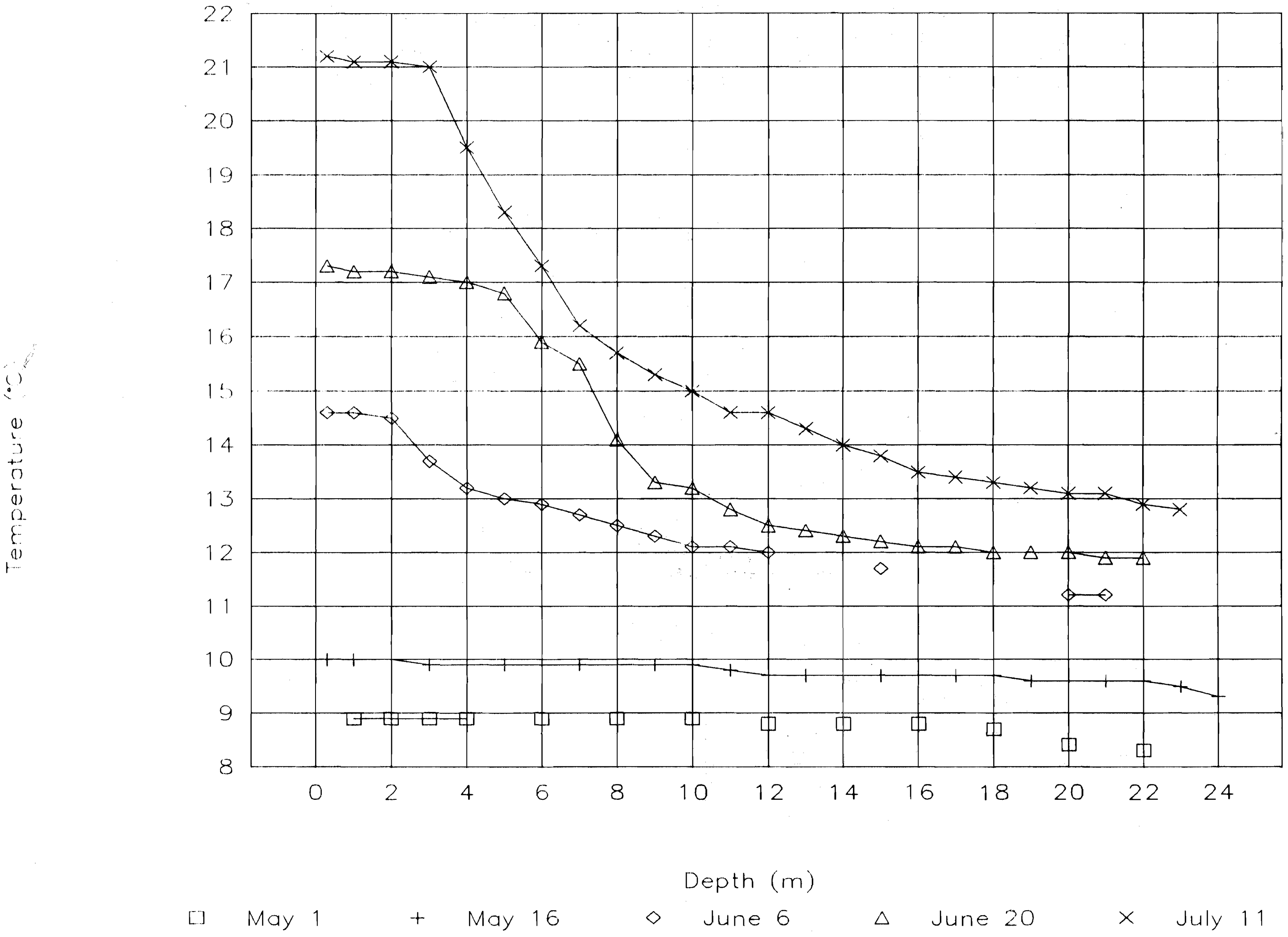


Figure 90A. Crowley Lake Temperature Profiles 1991 (JSA Data Sampled from May 1 to July 11 at the Dam Arm).

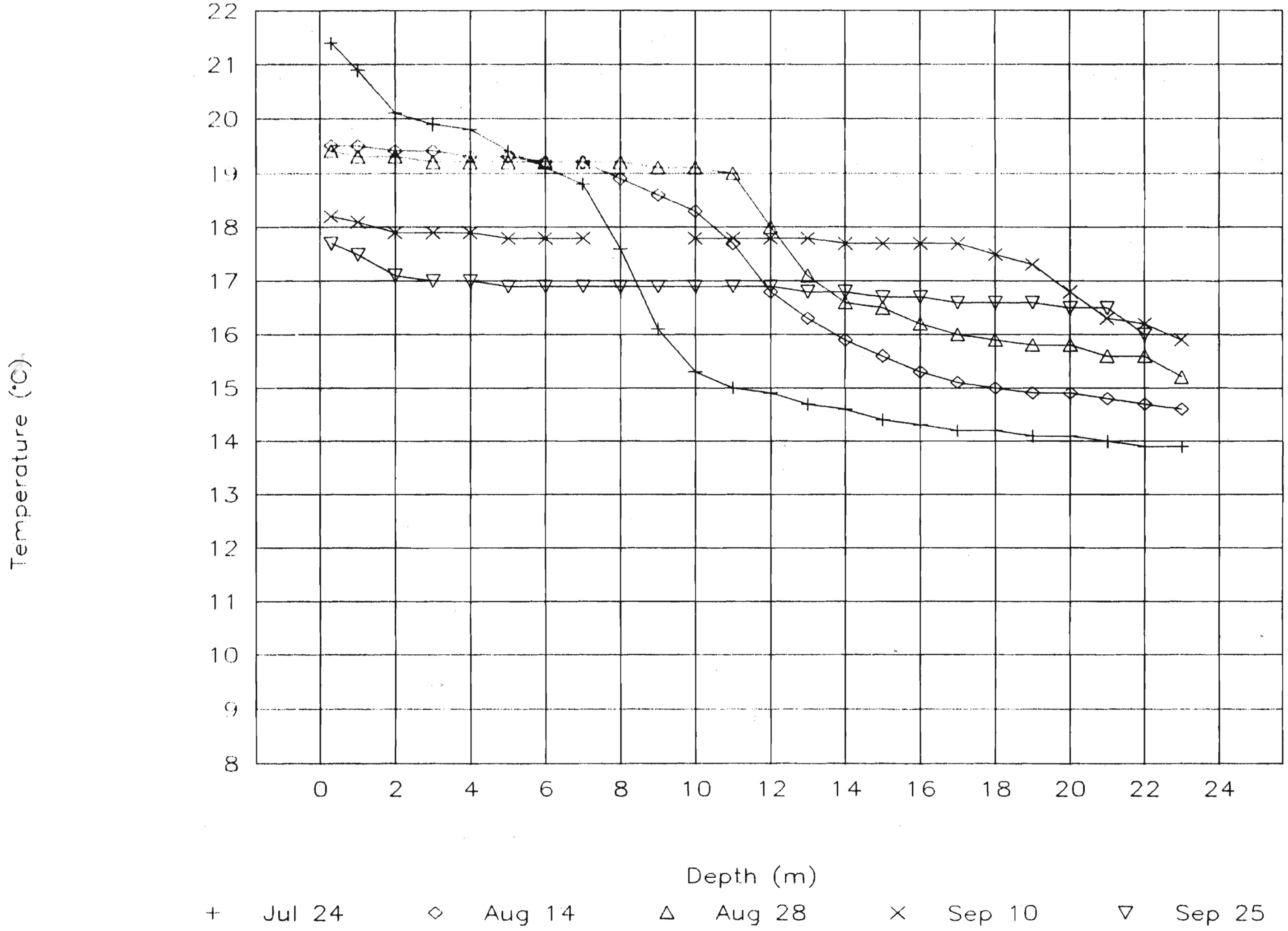


Figure 90B. Crowley Lake Temperatue Profiles 1991 (JSA Data Sampled from July 24 to September 25 at the Dam Arm).

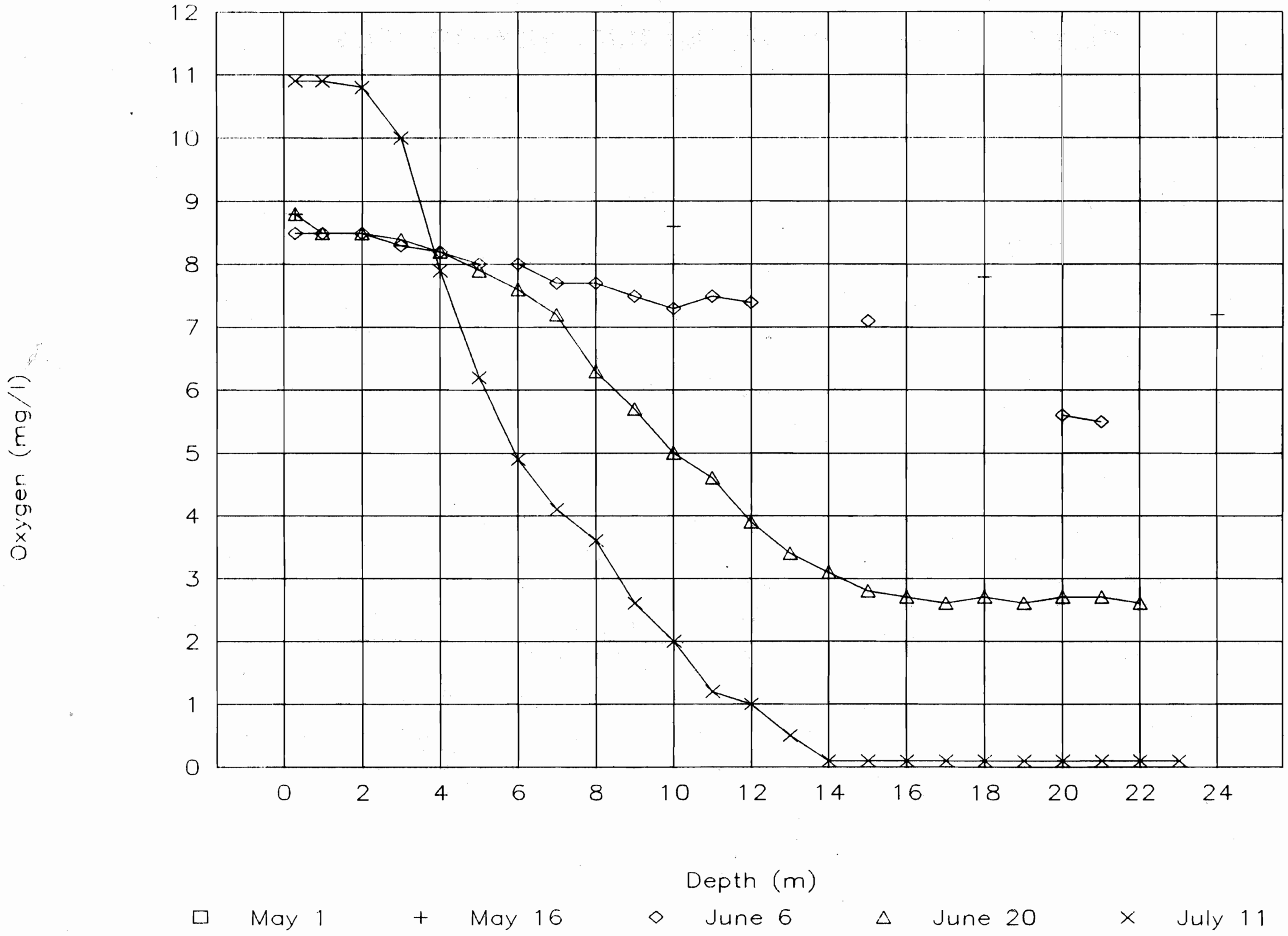


Figure 91A. Crowley Lake Oxygen Profiles 1991 (JSA Data Sampled from May 1 to July 11 at the Dam Arm.)

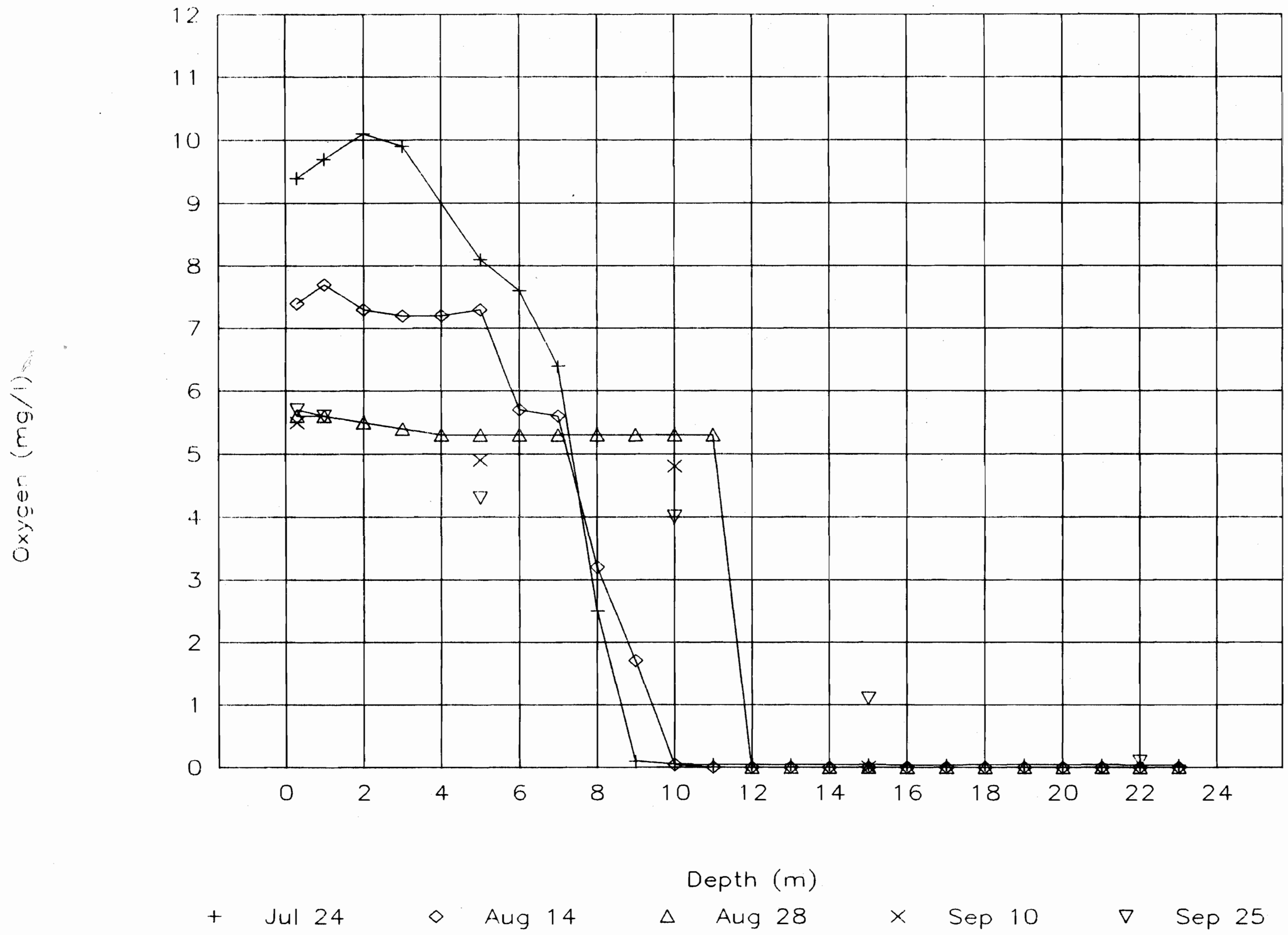


Figure 91B. Crowley Lake Oxygen Profiles 1991 (JSA Data Sampled from July 24 to September 25 at the Dam Arm.)

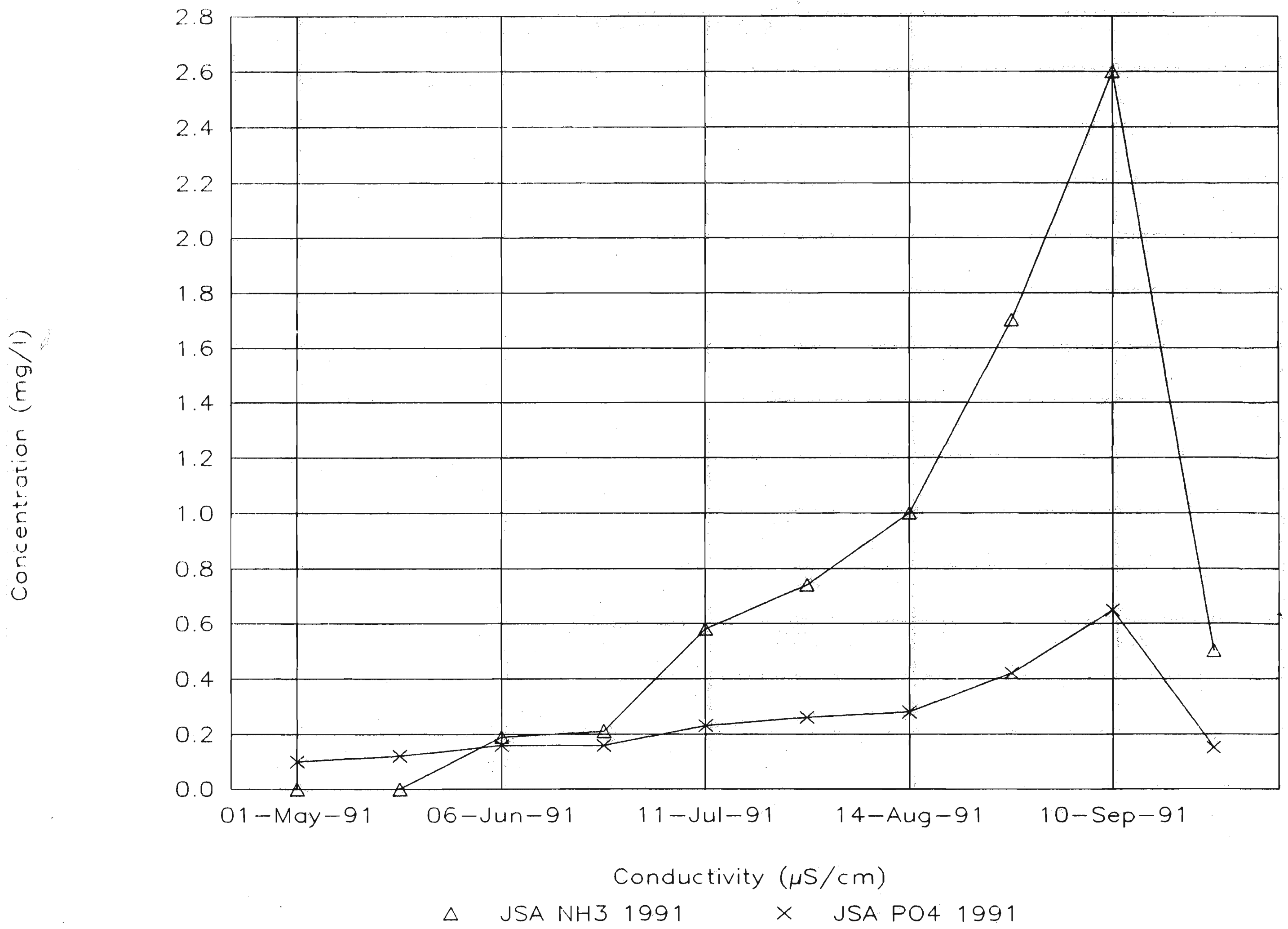


Figure 92. Crowley Lake Bottom Ammonia and Phosphate 1991. (JSA Data Sampled from May 1 to September 25 at the Dam Arm).

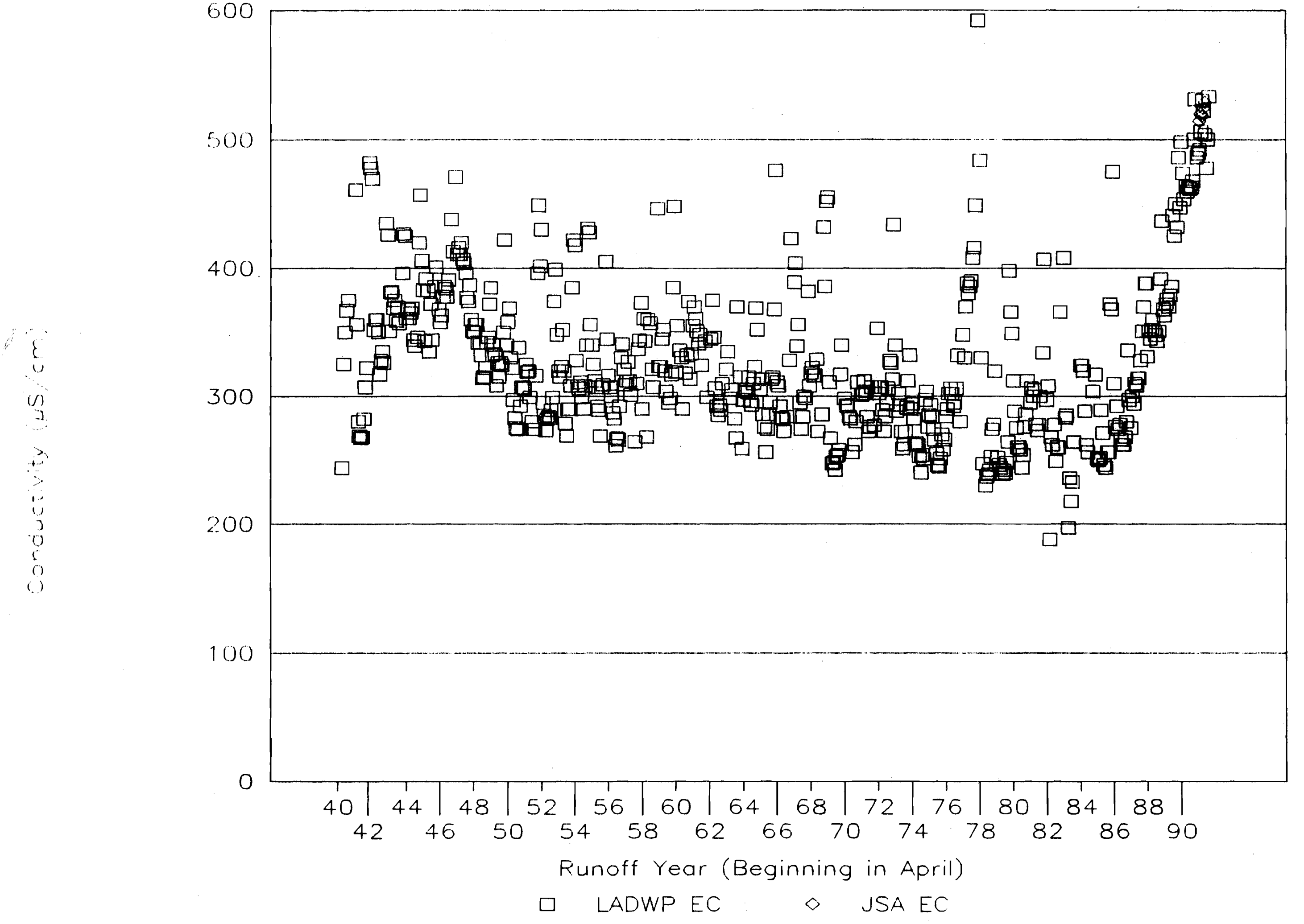


Figure 93. Crowley Lake Outlet Conductivity (1940-1991).

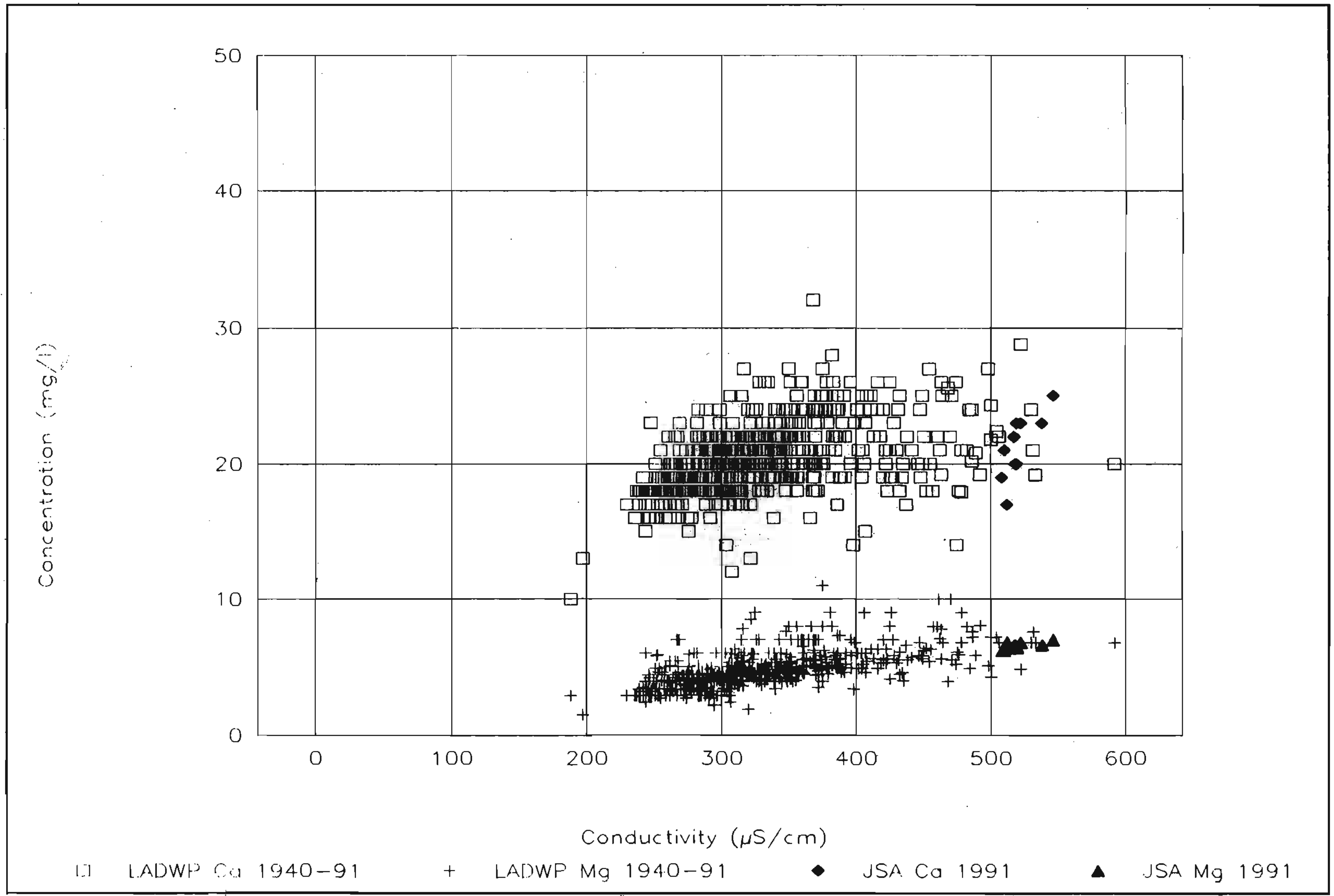


Figure 94. Crowley Lake Outlet Calcium and Magnesium as a Function of Conductivity (1940-1991).

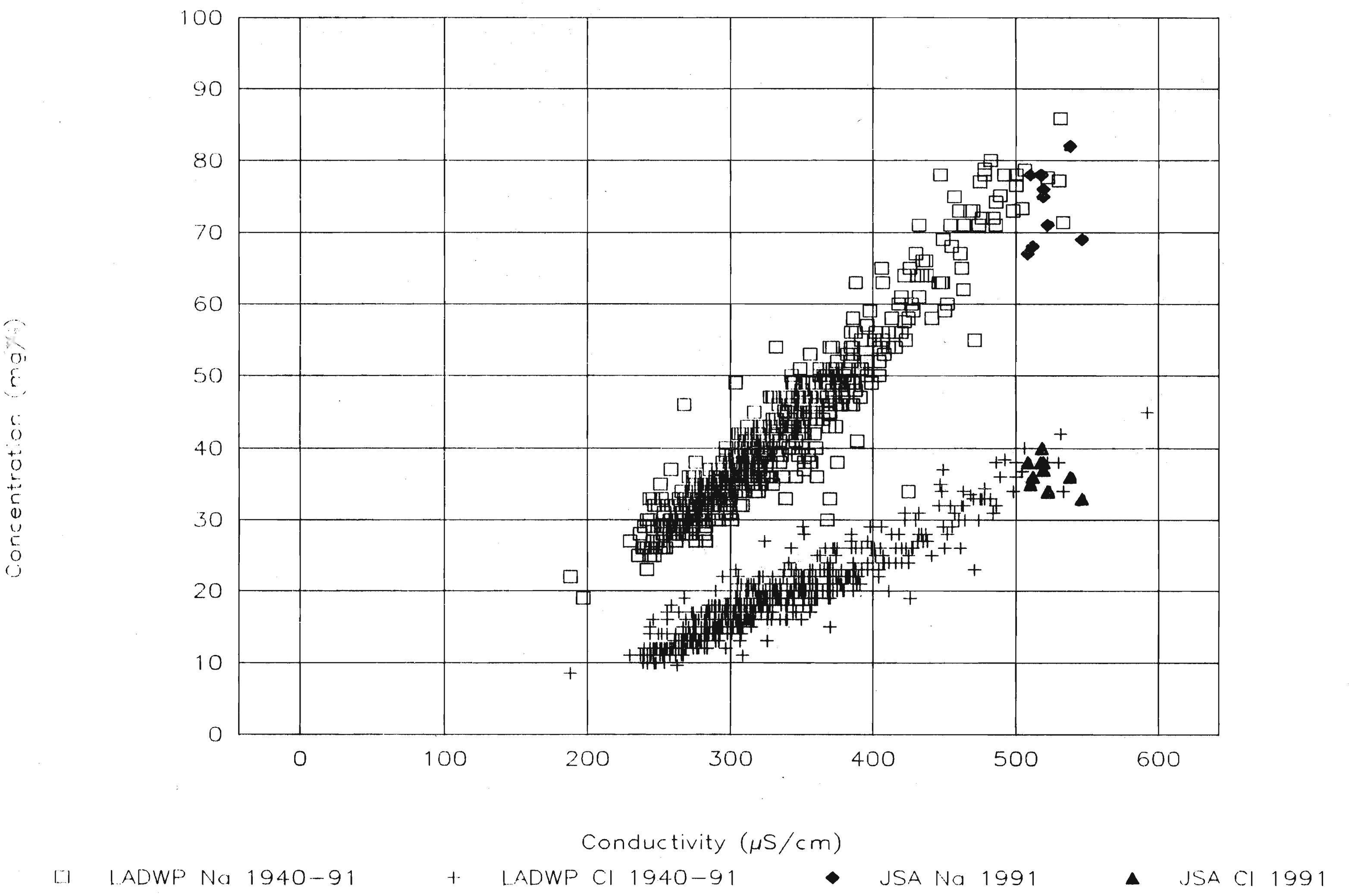


Figure 95. Crowley Lake Outlet Sodium and Chloride as a Function of Conductivity (1940-1991).

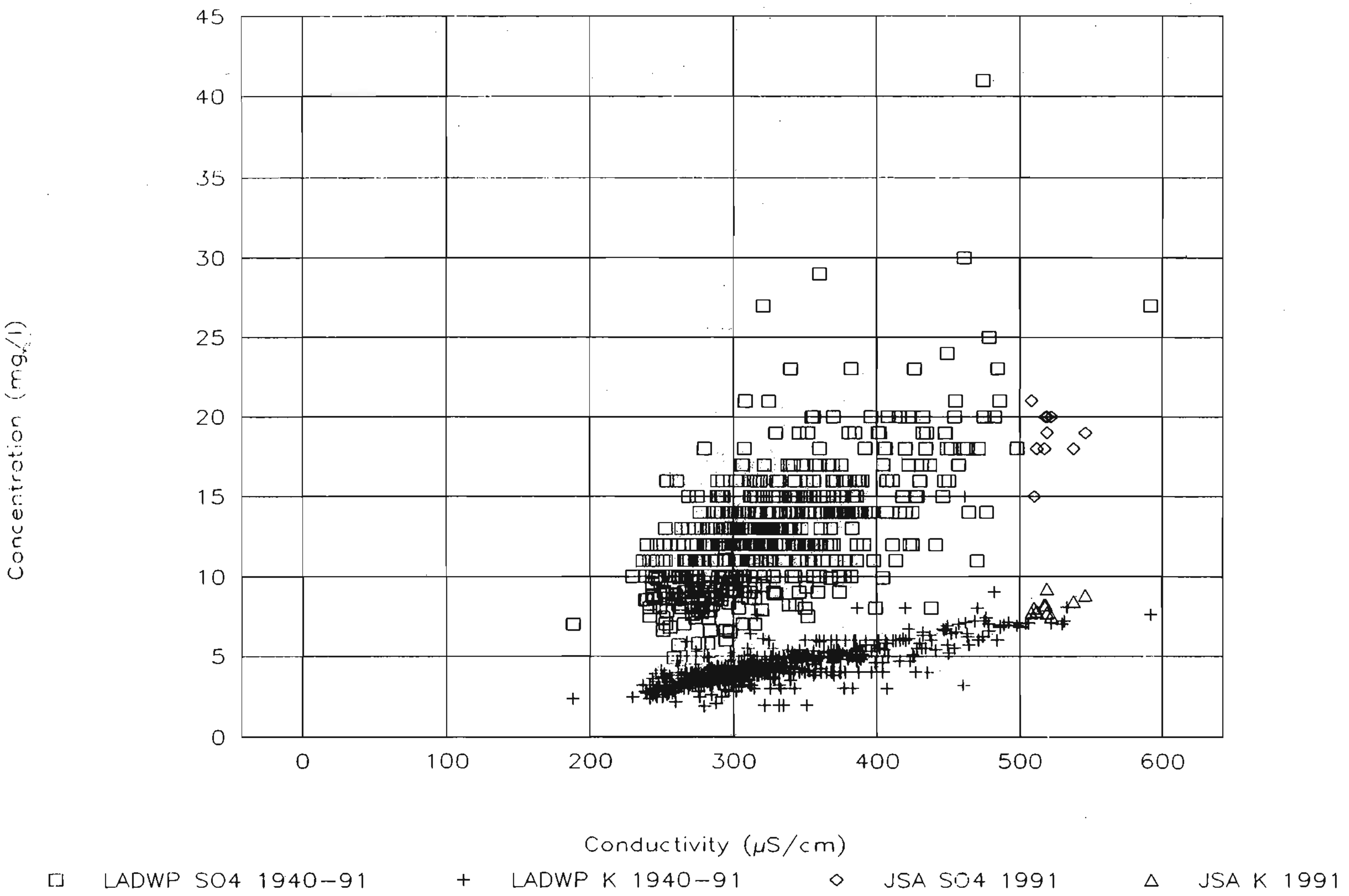


Figure 96. Crowley Lake Outlet Sulfate and Potassium as a Function of Conductivity (1940-1991).

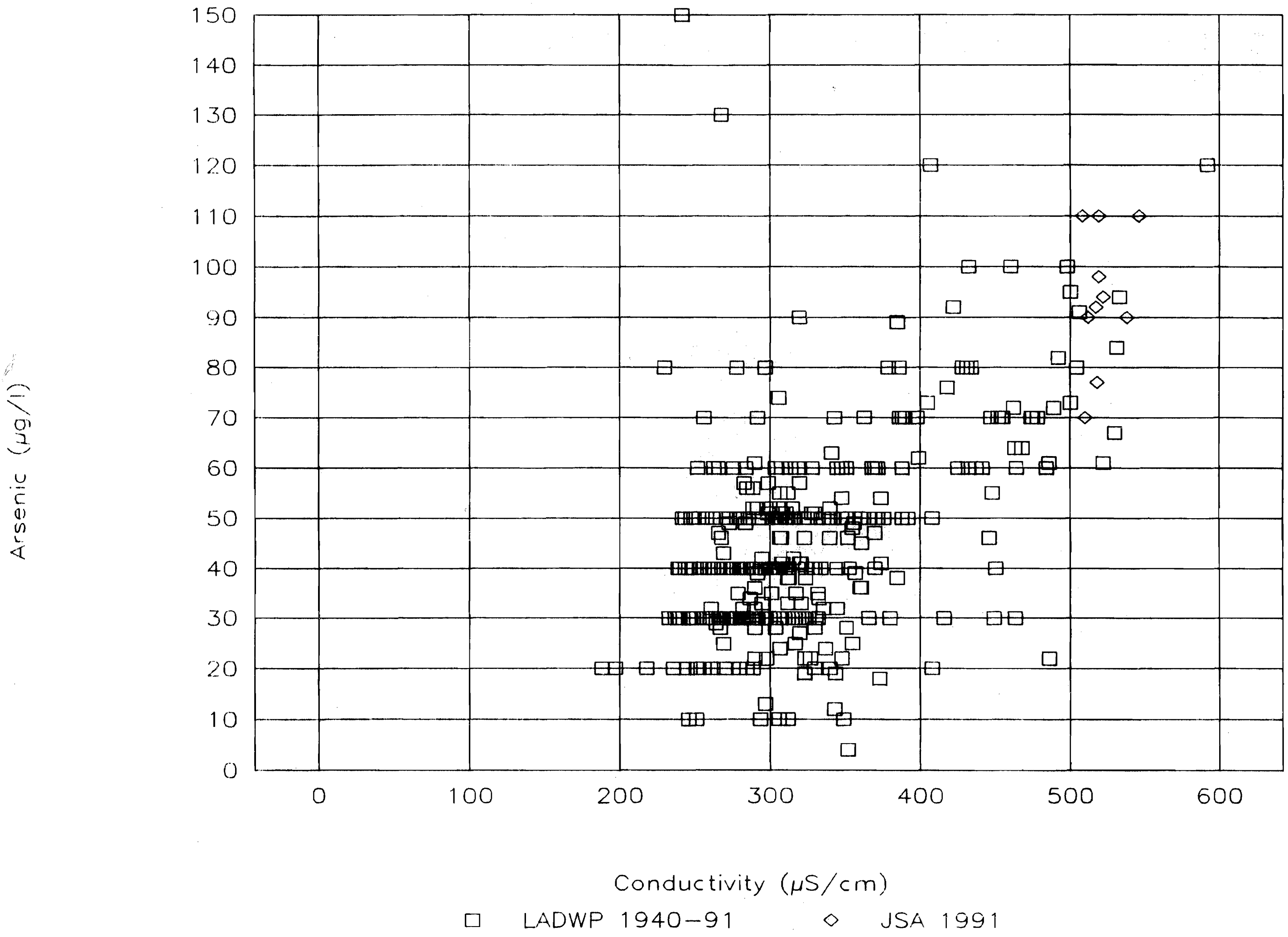


Figure 97. Crowley Lake Outlet Arsenic as a Function of Conductivity (1940-1991).

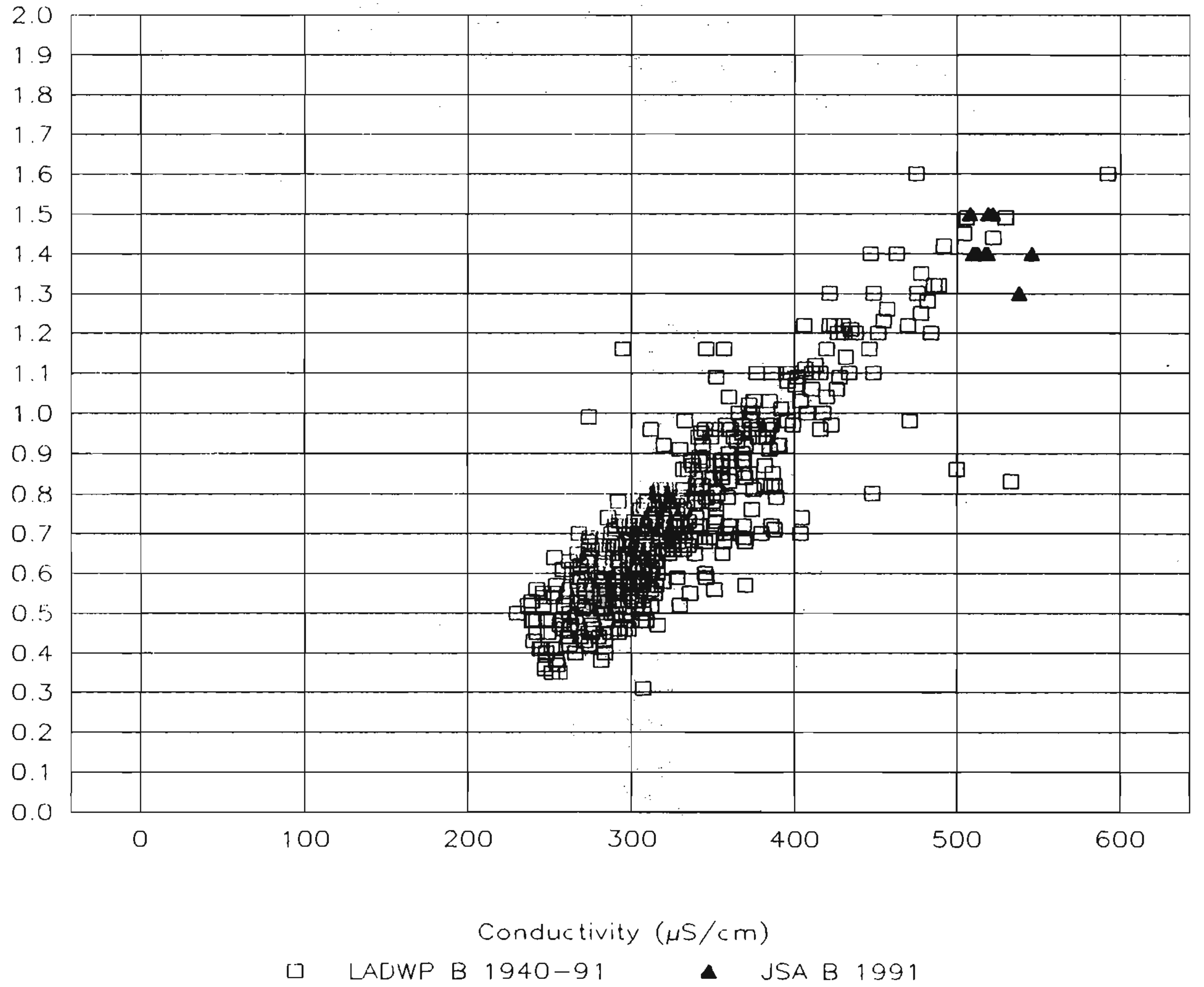


Figure 98. Crowley Lake Outlet Boron as a Function of Conductivity (1940-1991).

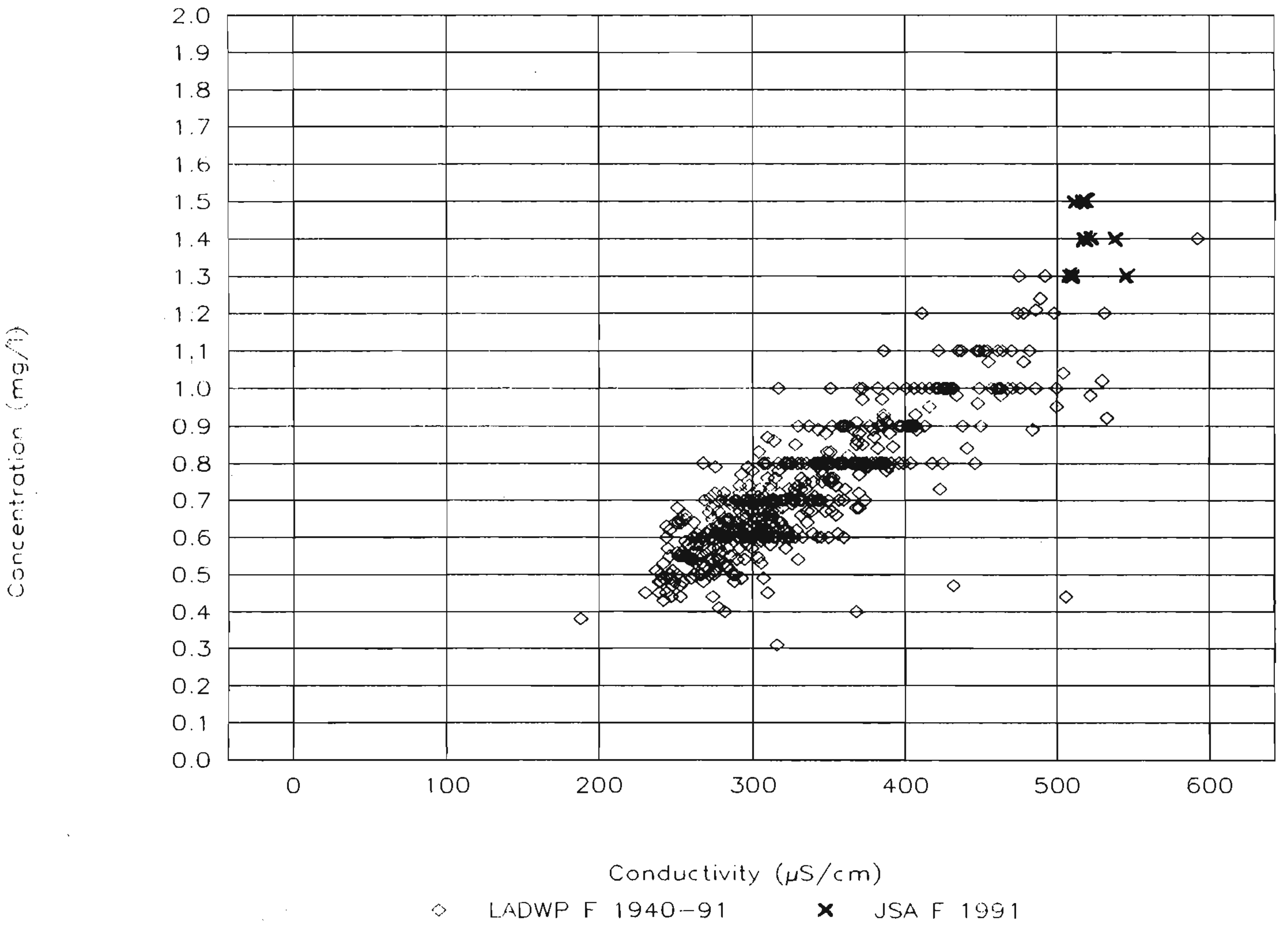


Figure 99. Crowley Lake Outlet Fluoride as a Function of Conductivity (1940-1991).

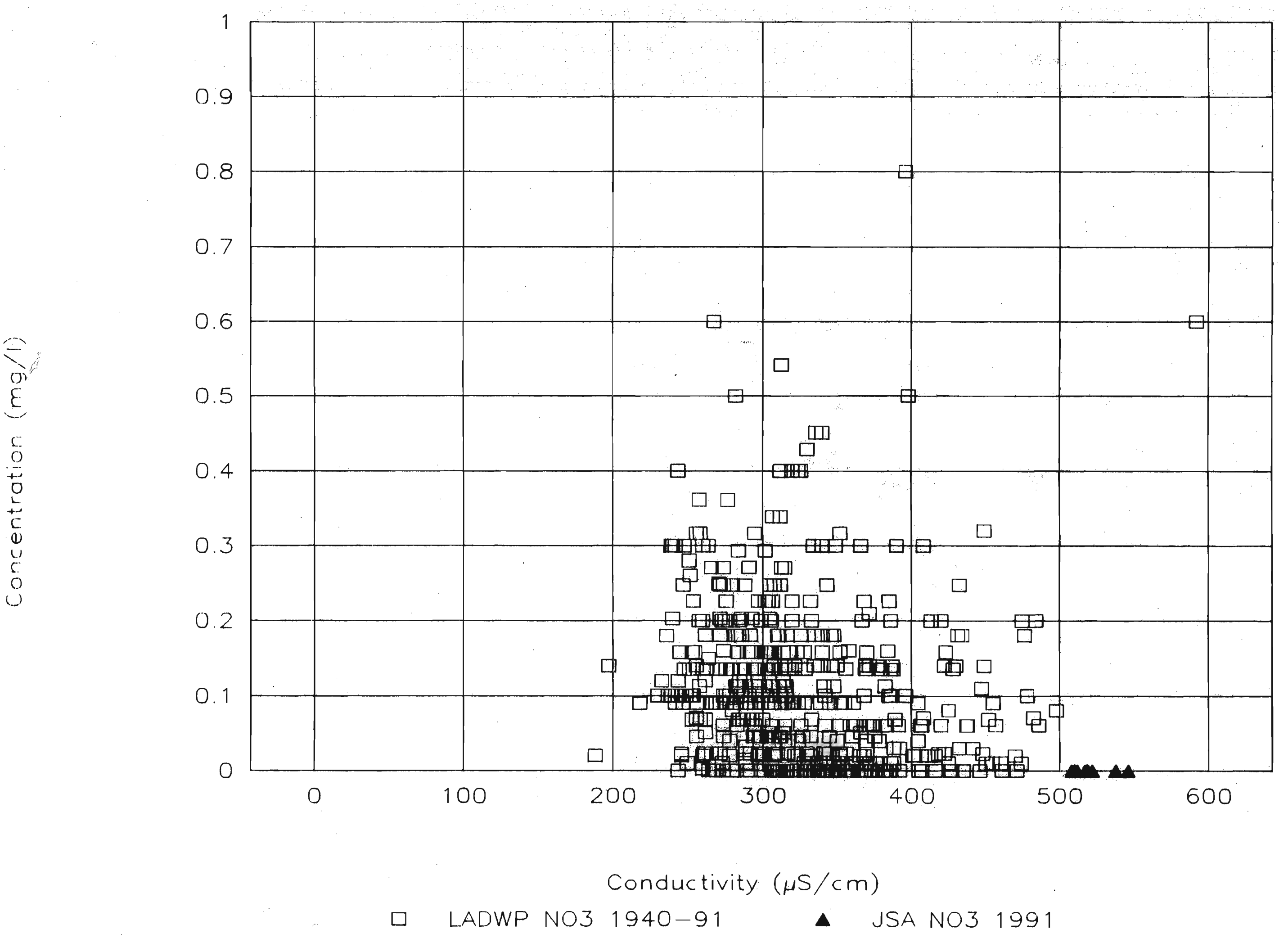


Figure 100. Crowley Lake Outlet Nitrate as a Function of Conductivity (1940-1991).

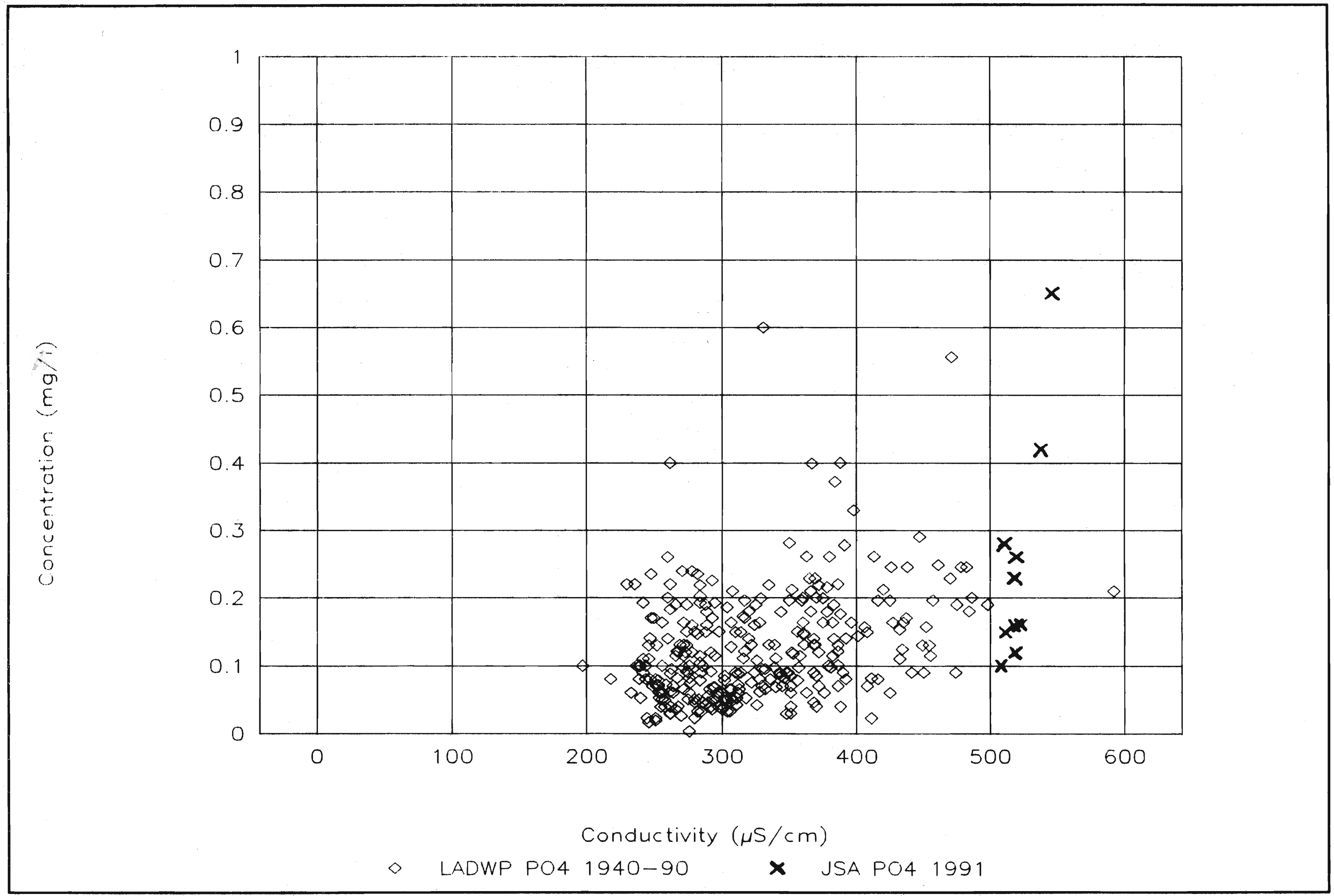


Figure 101. Crowley Lake Outlet Phosphate as a Function of Conductivity (1940-1991).

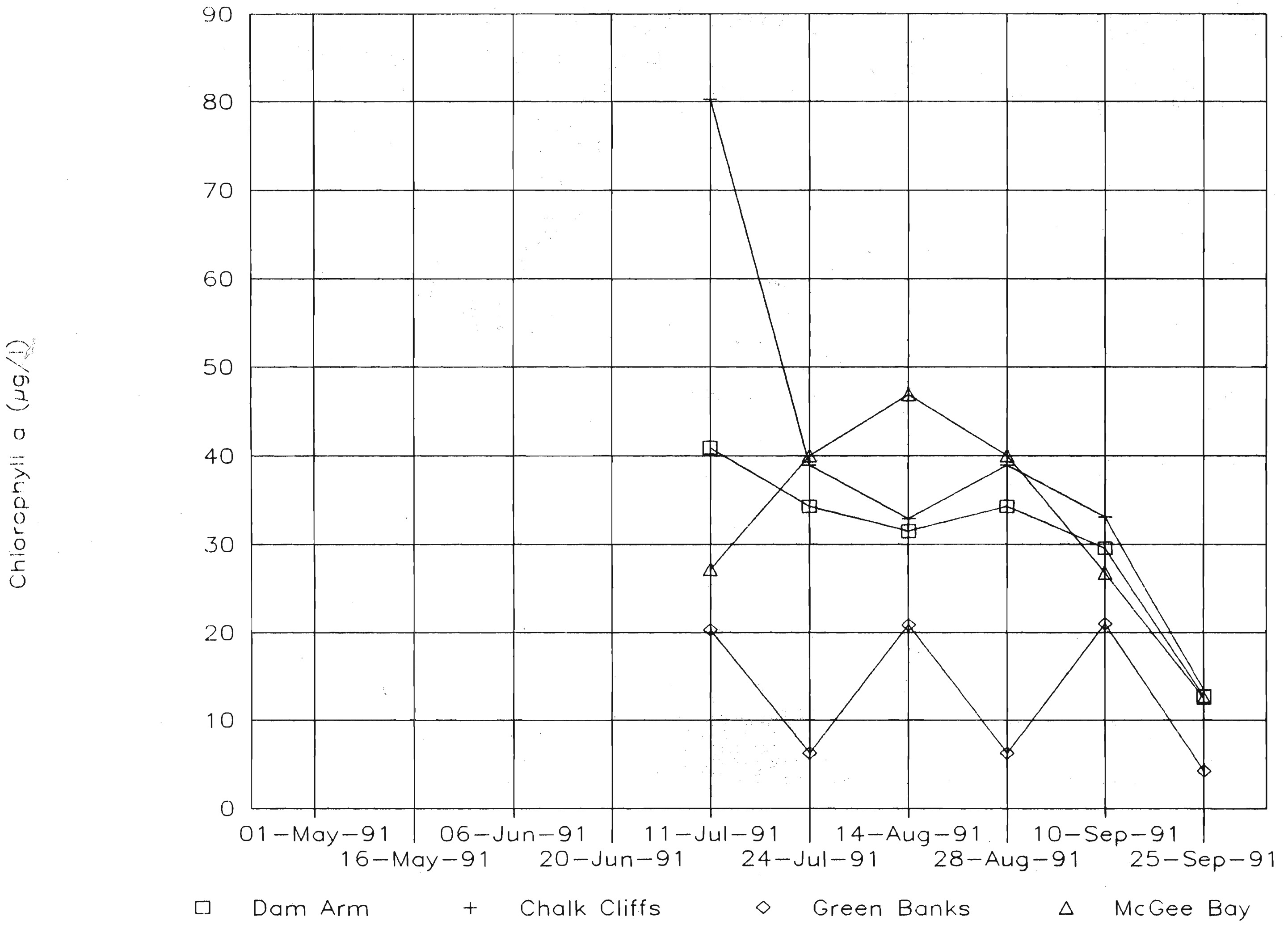


Figure 102A. Crowley Lake Chlorophyll a. (JSA Data Sampled from May 1 to September 25).

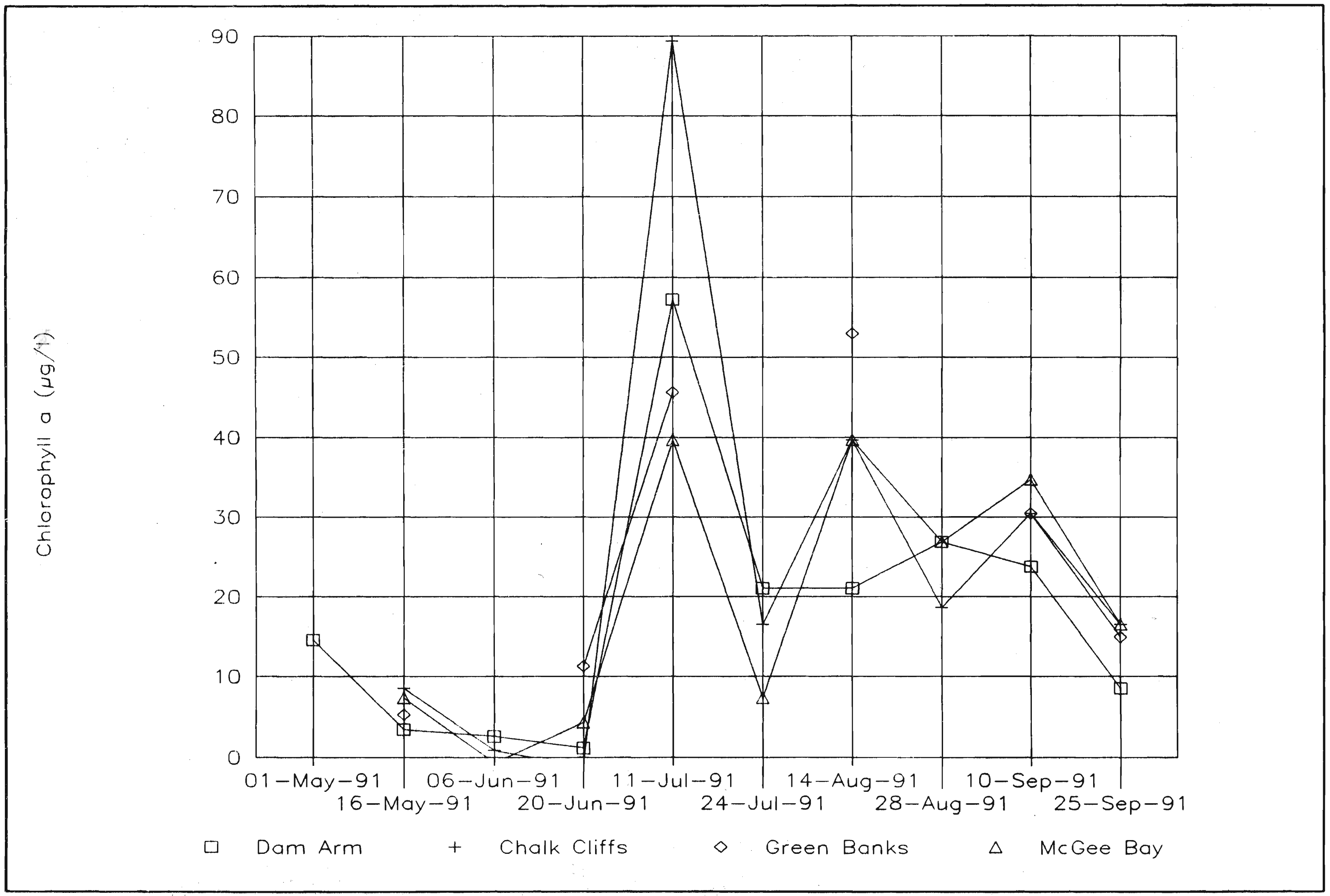


Figure 102B. Crowley Lake Chlorophyll a. (Calculated Chlorophyll a Values Based on Secchi Depths Measured from May 1 to September 25).

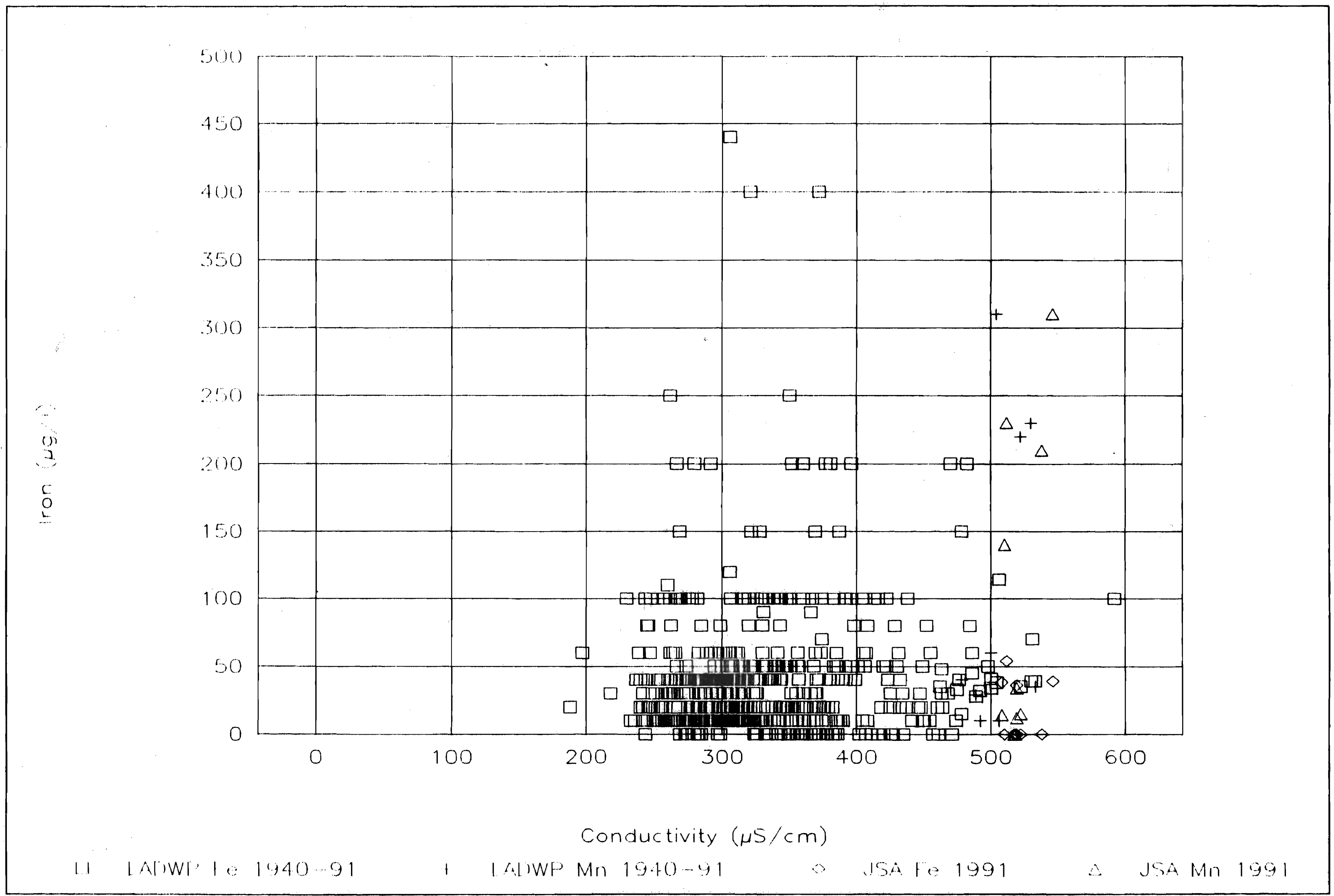
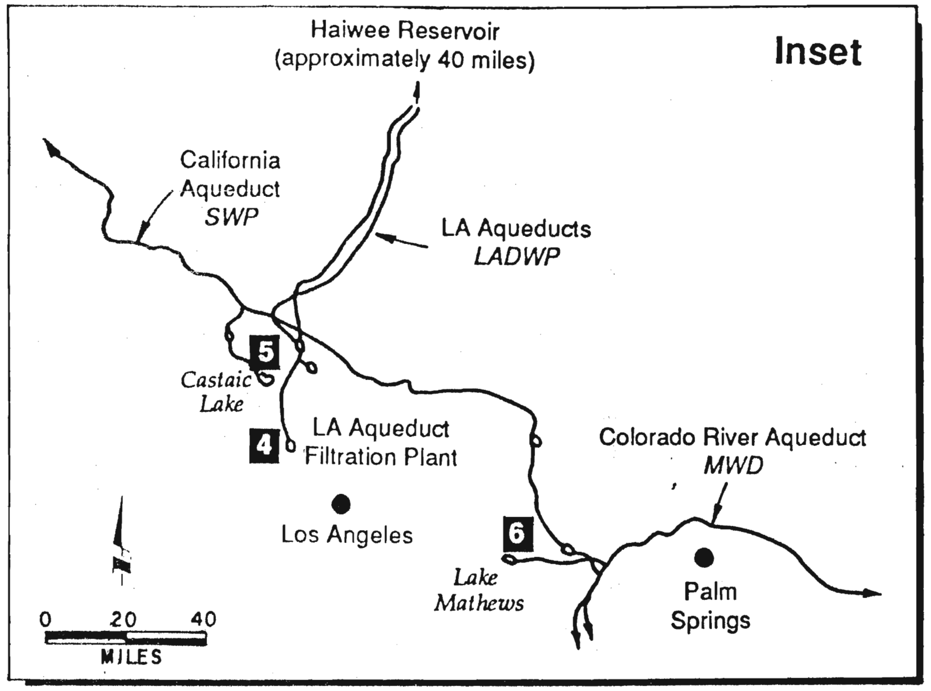


Figure 103. Crowley Lake Outlet Iron and Manganese as a Function of Conductivity (1940-1991).

Figure 104.
Location of Monitoring Sites in the Los Angeles Aqueduct System.

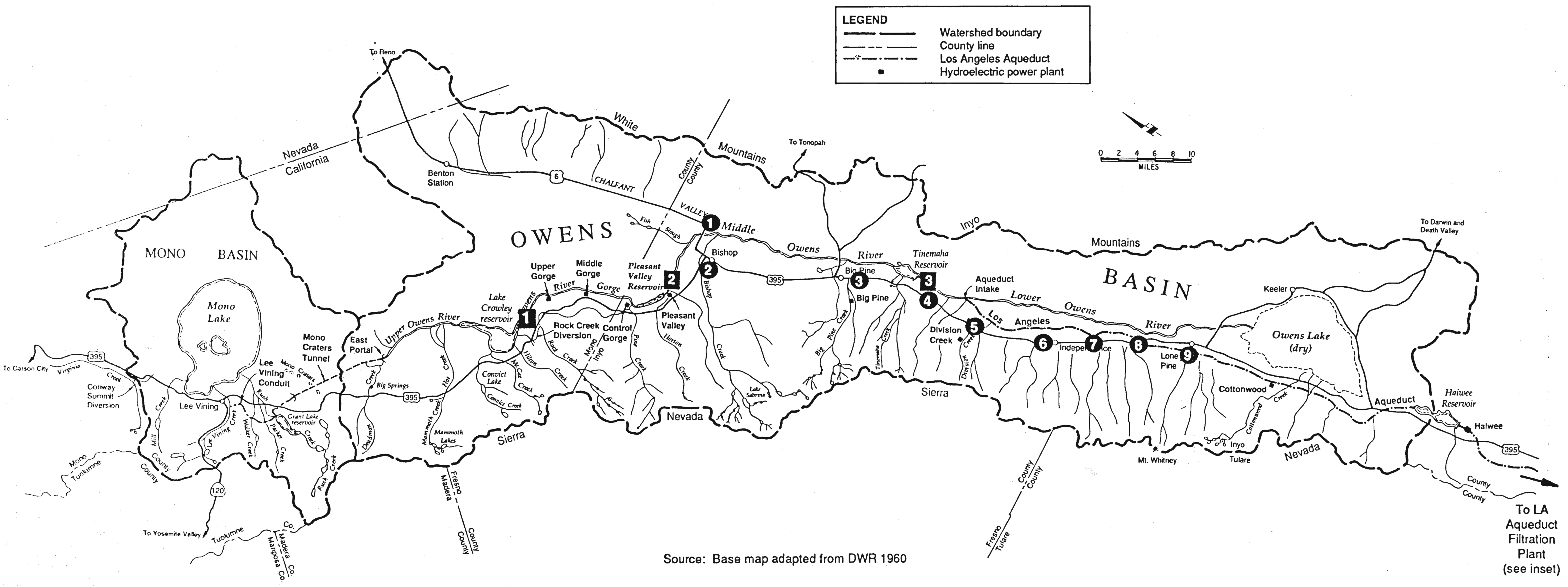


● = **Groundwater Monitoring Sites**

1 Laws
2 Bishop - Warm Springs
3 Big Pine - Crater Mountain
4 Taboose - Aberdeen
5 Thibaut - Sawmill Creek
6 Independence - Oak Creek
7 Symmes - Shepherd Creek
8 Bairs - George Creek
9 Lone Pine

■ = **Surface Water Monitoring Sites**

1 Below Lake Crowley reservoir
2 Below Pleasant Valley Reservoir
3 Below Tinemaha Reservoir
4 LA Aqueduct Filtration Plant
5 Castaic Lake (State Water Project)
6 Lake Mathews (Metropolitan Water District)



Source: Base map adapted from DWR 1960

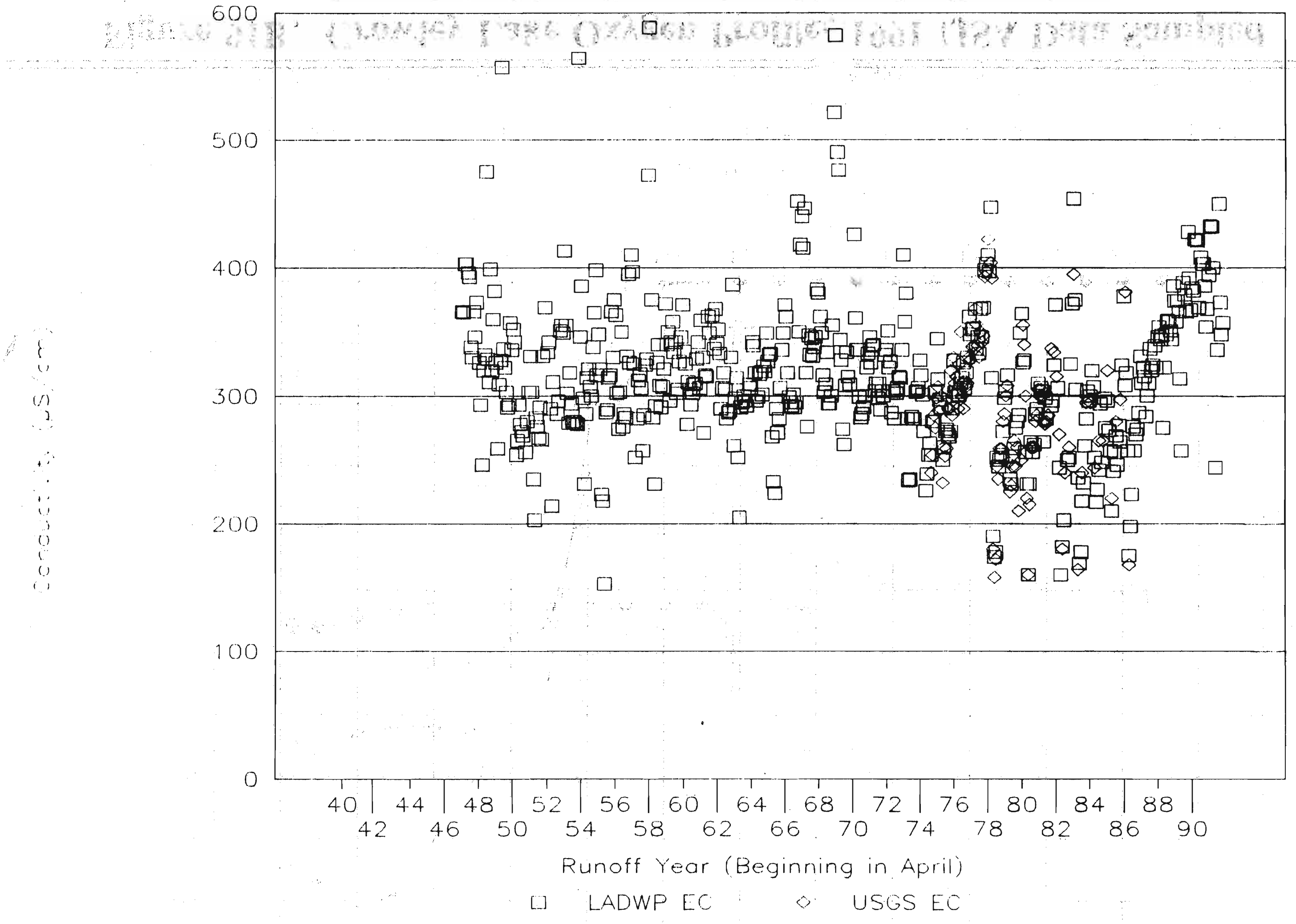


Figure 105. Tinemaha Reservoir Outlet Conductivity (1940-1991). (Monthly Data).

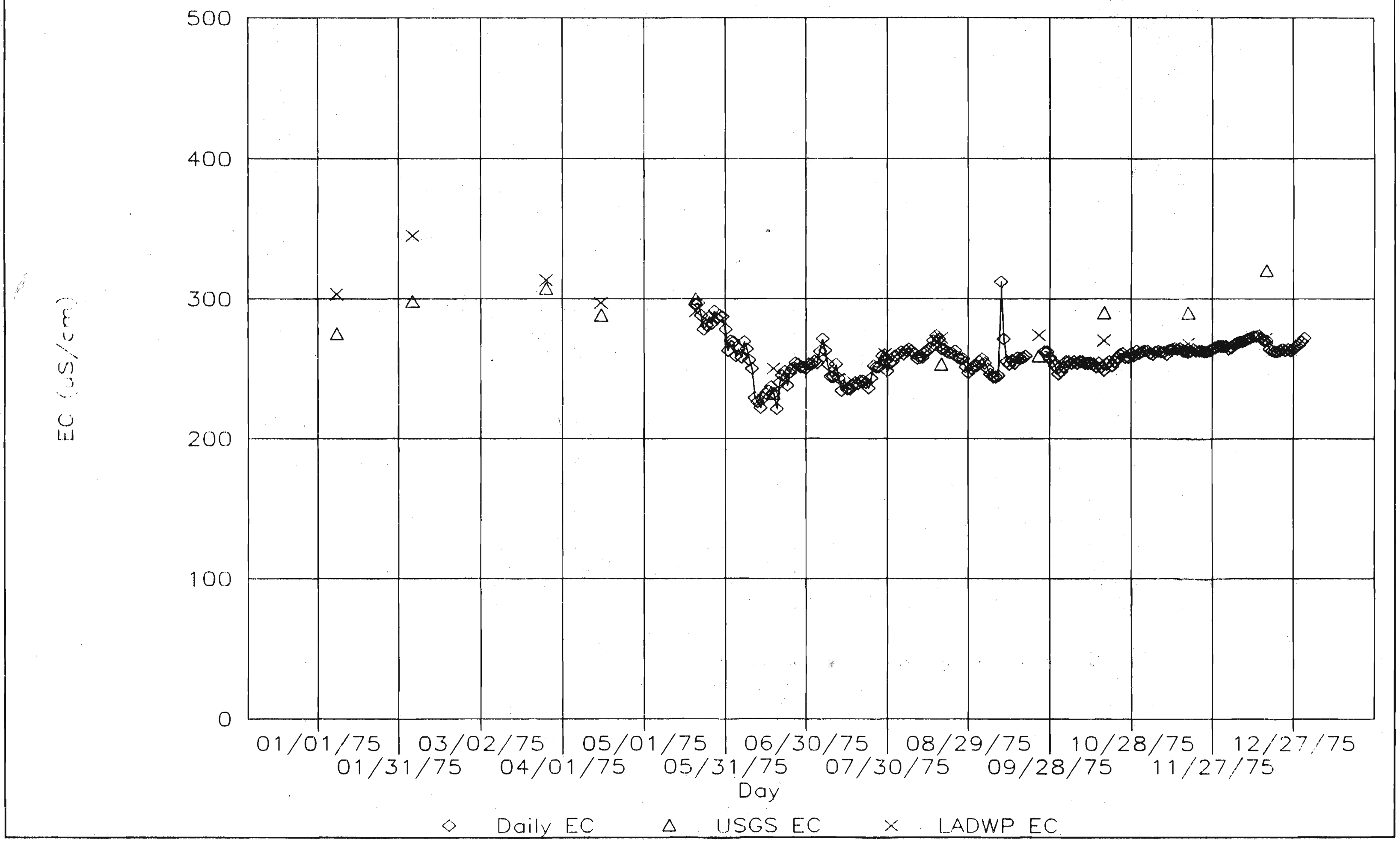


Figure 106A. Tinemaha Reservoir Outlet Conductivity (1975) (Daily Data Compared to Monthly Data).

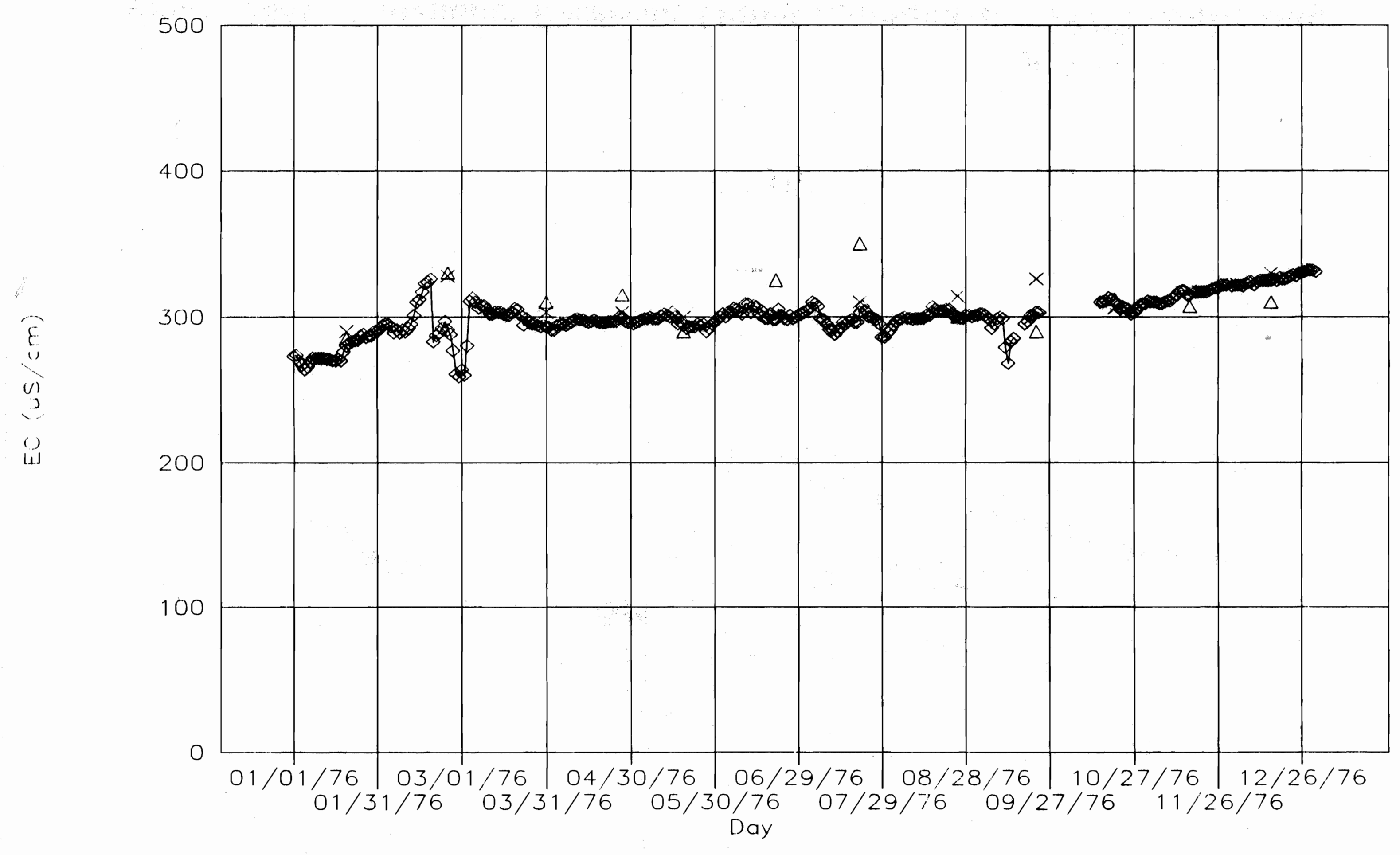


Figure 106B. Tinemaha Reservoir Outlet Conductivity (1976) (Daily Data Compared to Monthly Data).

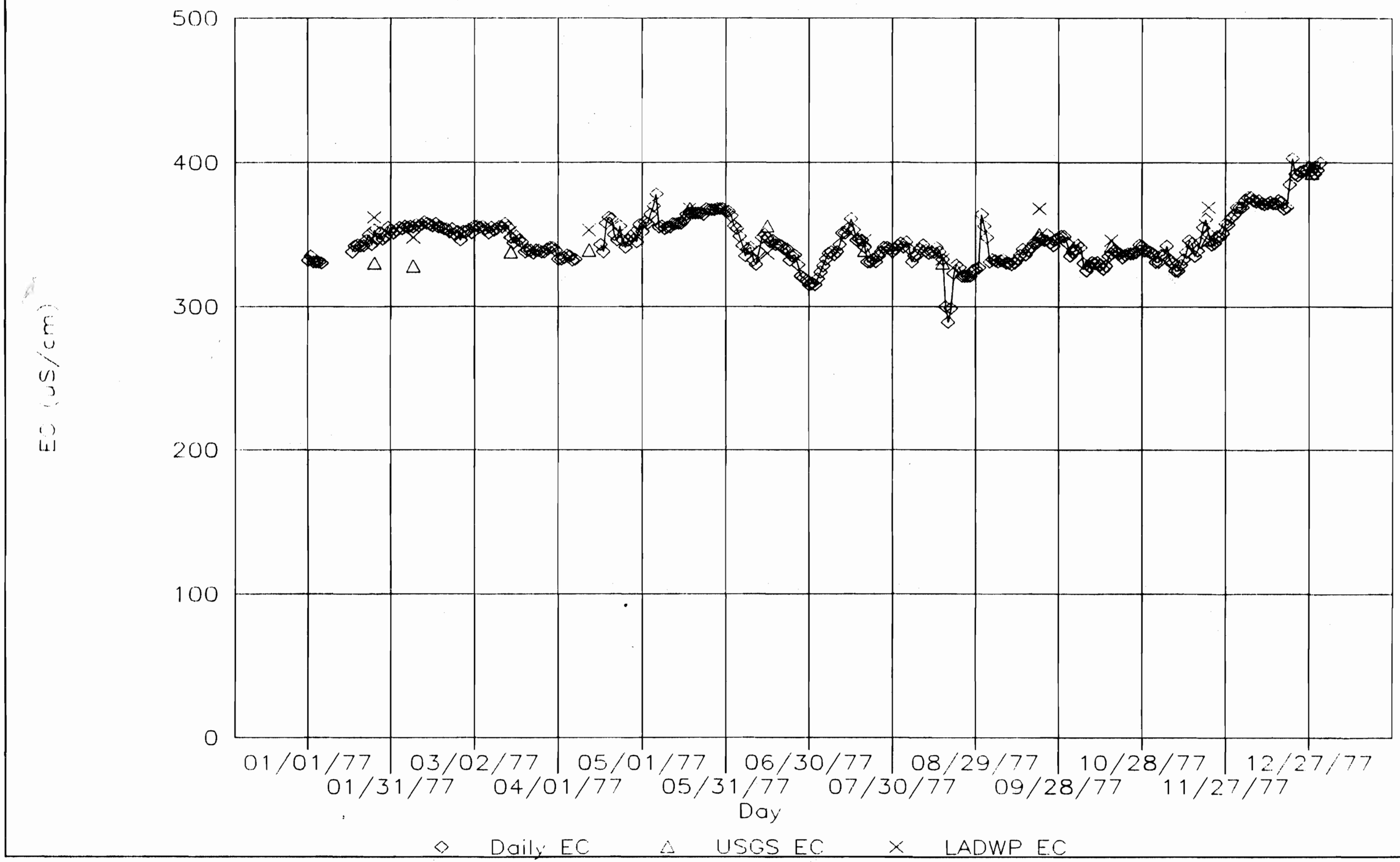


Figure 106C. Tinemaha Reservoir Outlet Conductivity (1977) (Daily Data Compared to Monthly Data).

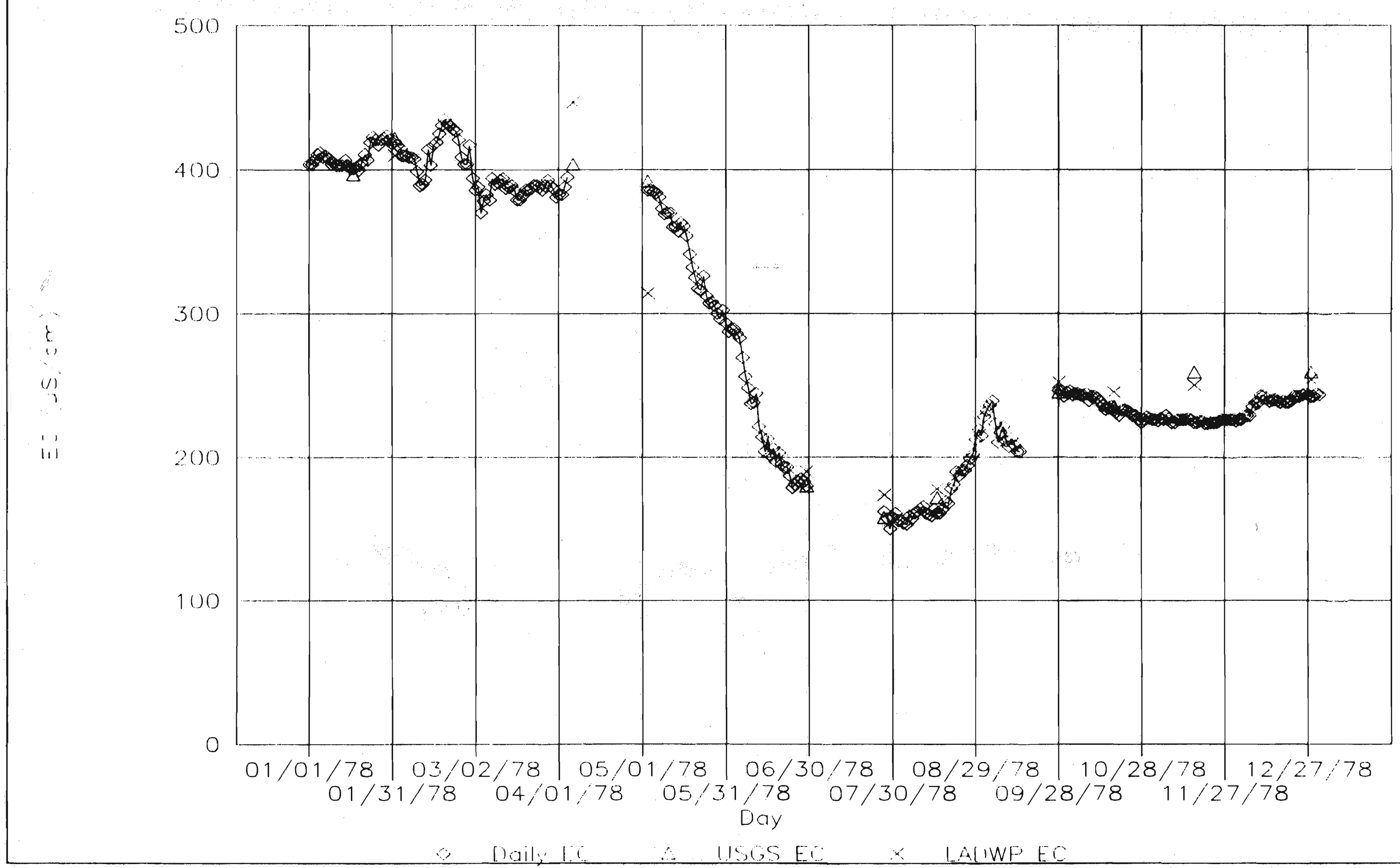


Figure 106D. Tinemaha Reservoir Outlet Conductivity (1978) (Daily Data Compared to Monthly Data).

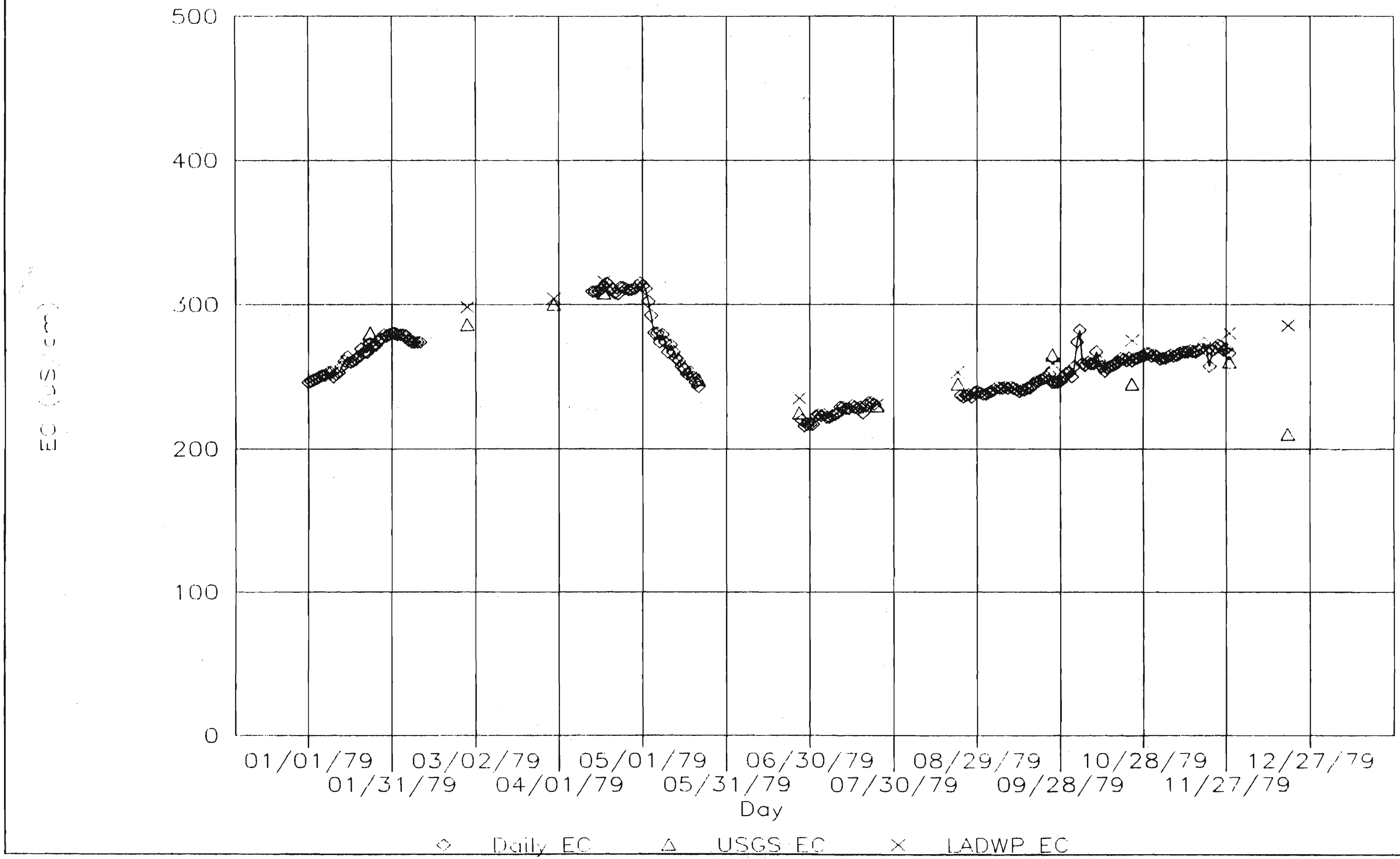


Figure 106E. Tinemaha Reservoir Outlet Conductivity (1979) (Daily Data Compared to Monthly Data).

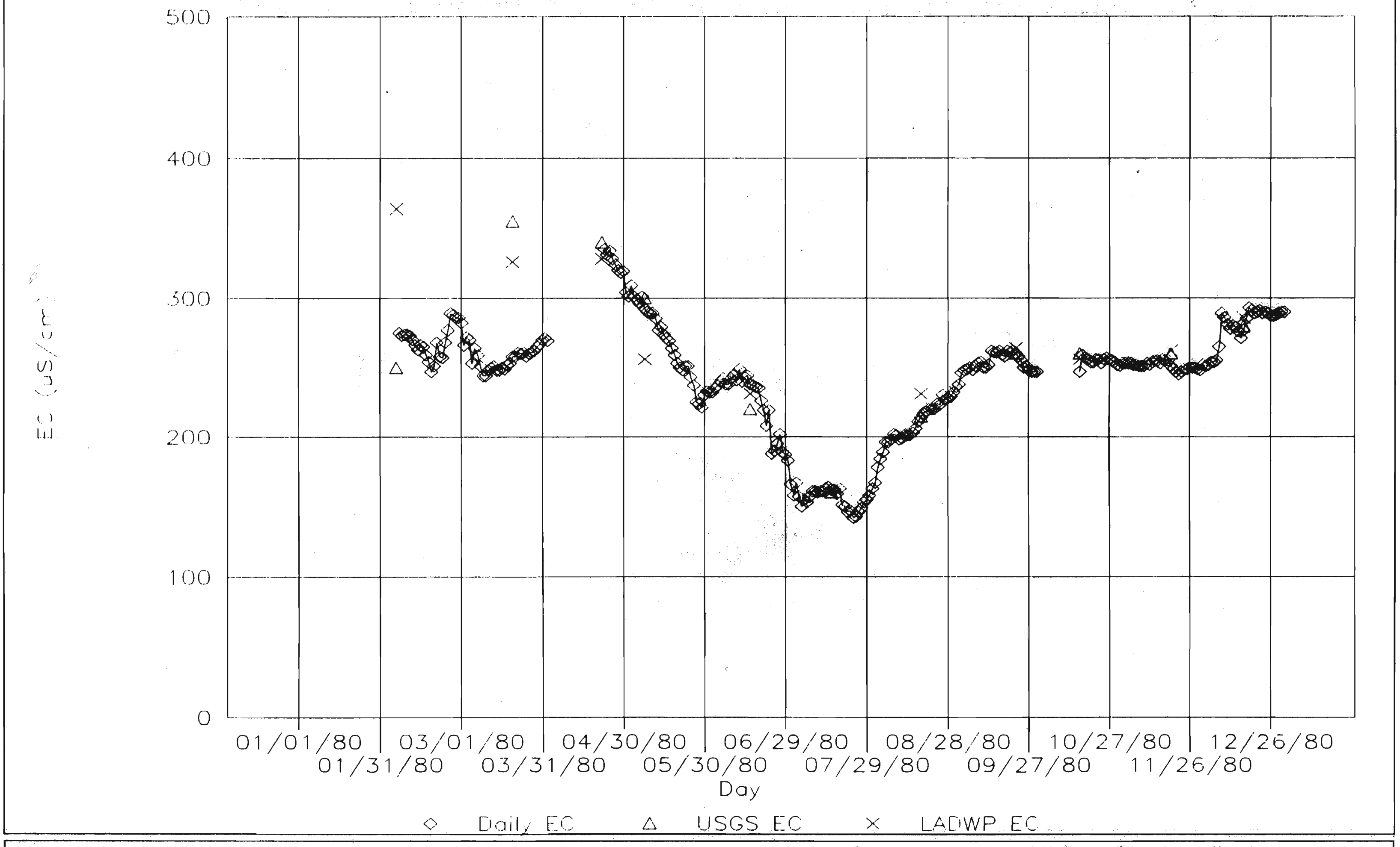


Figure 106F. Tinemaha Reservoir Outlet Conductivity (1980) (Daily Data Compared to Monthly Data).

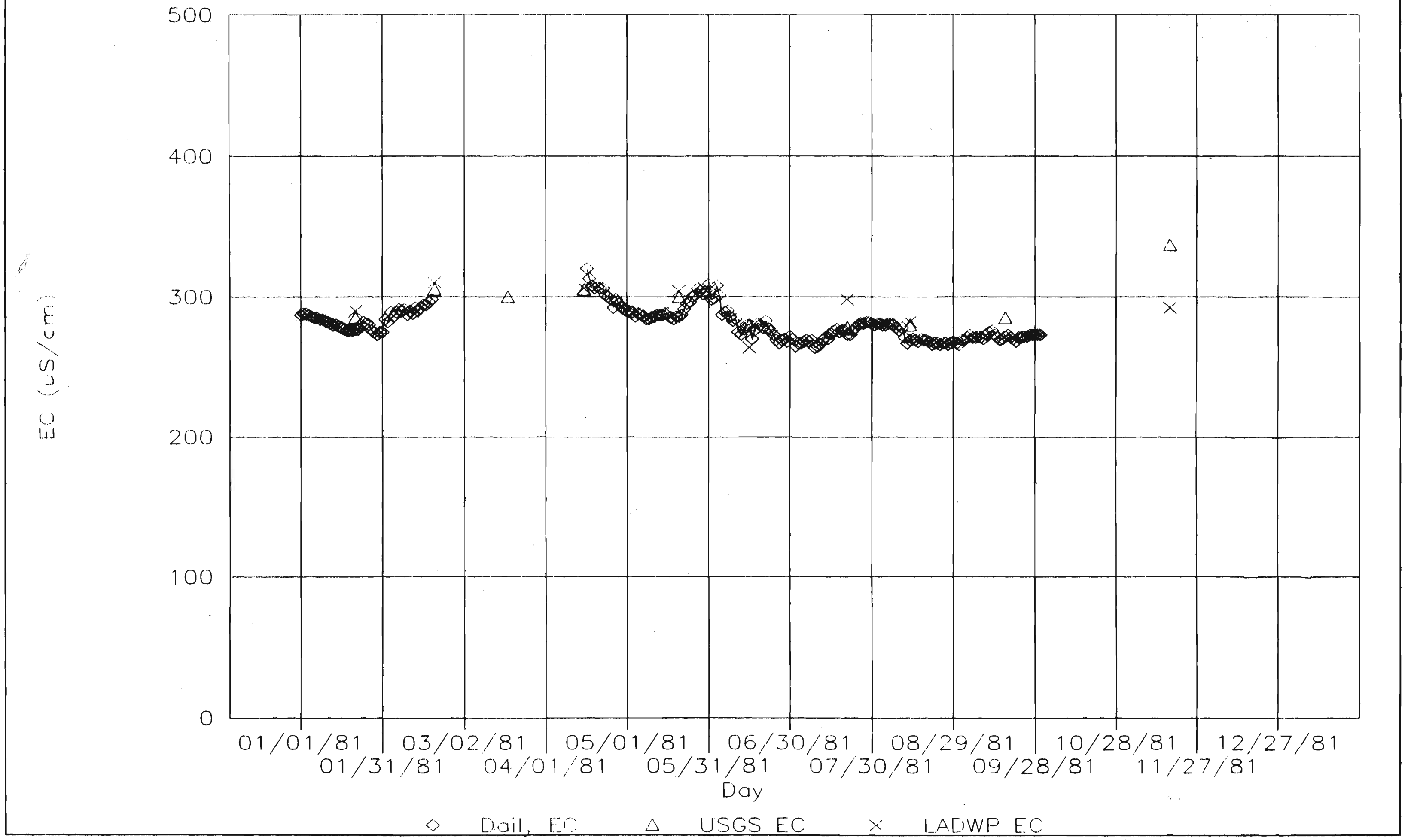


Figure 106G. Tinemaha Reservoir Outlet Conductivity (1981) (Daily Data Compared to Monthly Data).

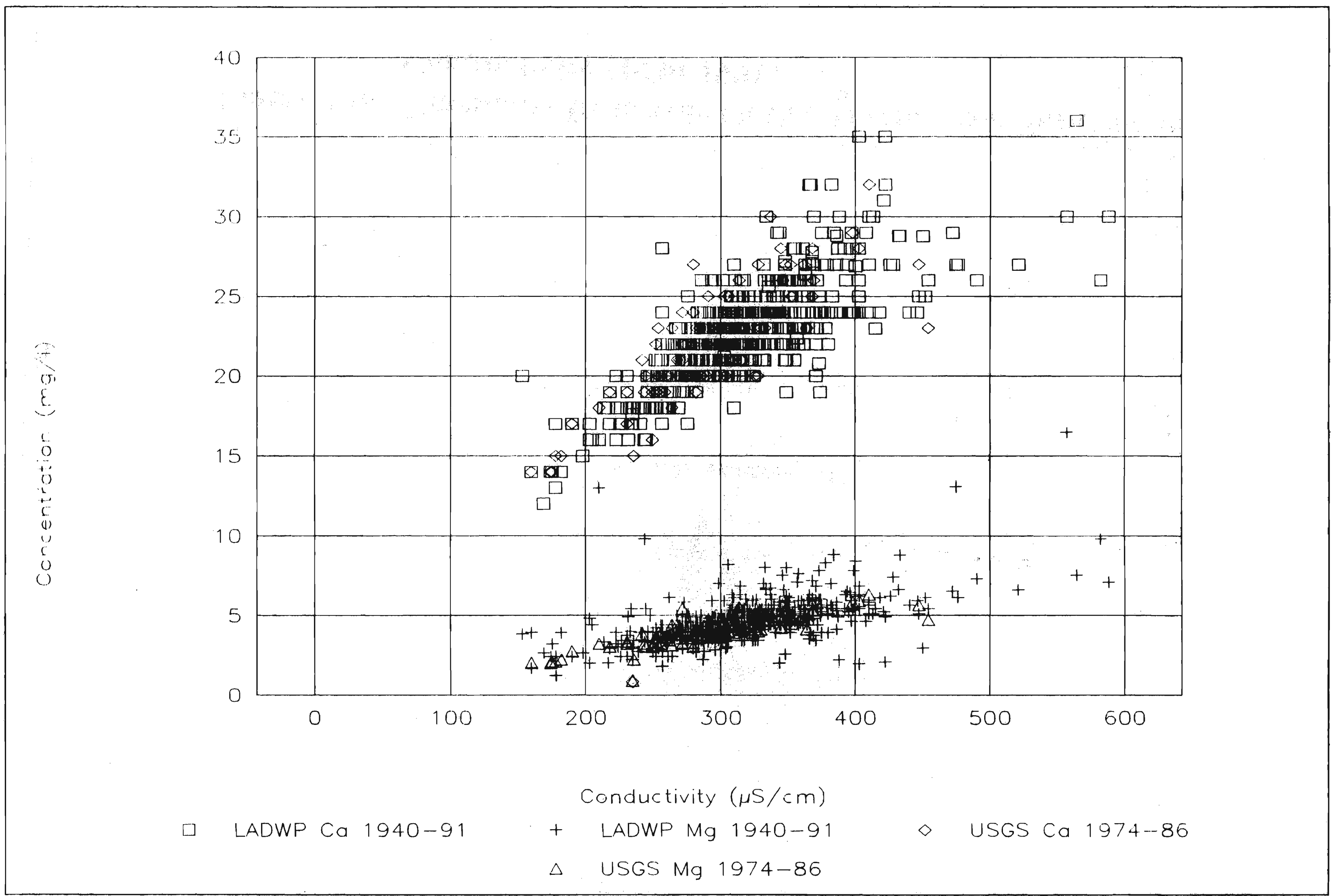


Figure 107. Tinemaha Reservoir Outlet Calcium and Magnesium as a Function of Conductivity (1940-1991).

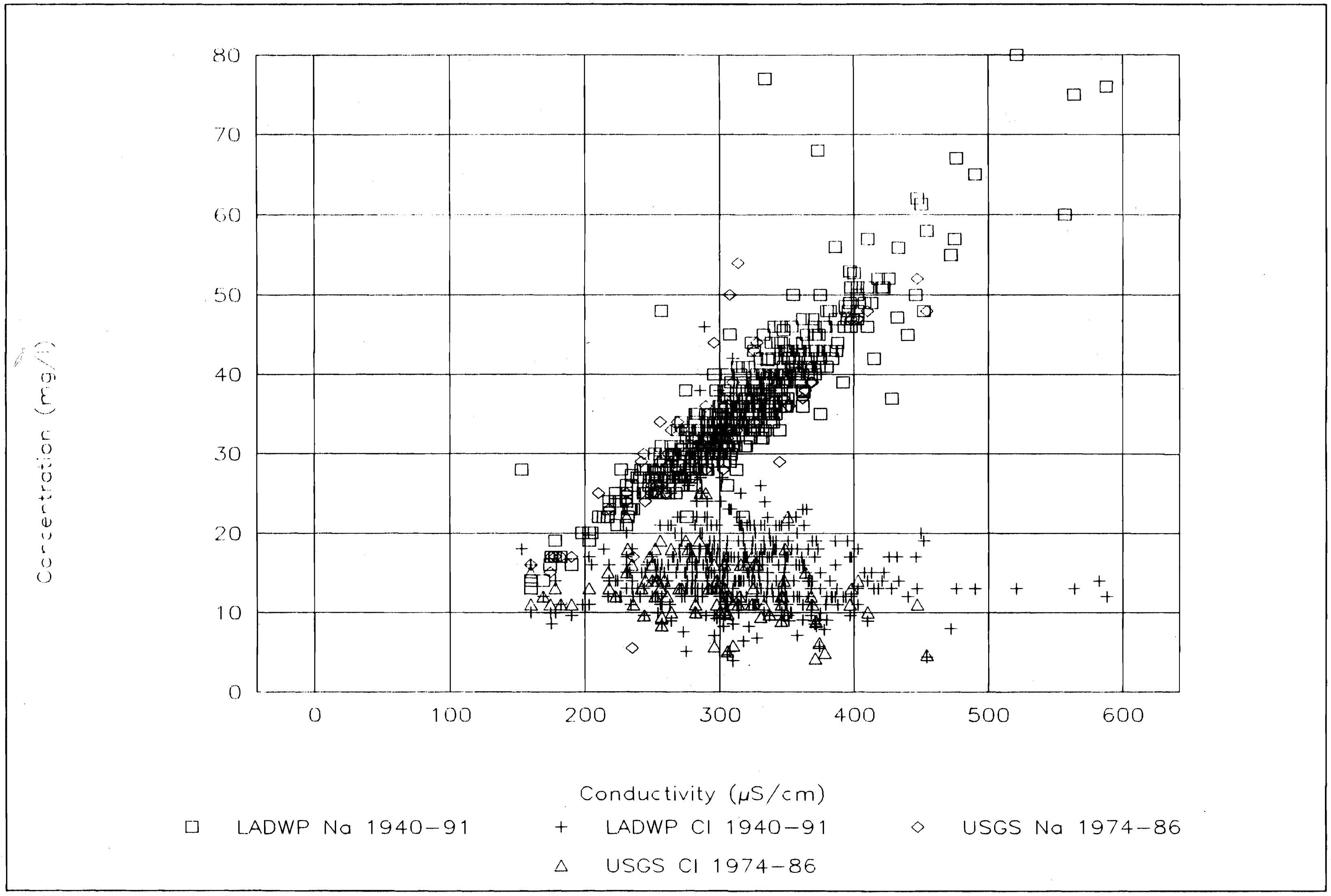


Figure 108. Tinemaha Reservoir Outlet Sodium and Chloride as a Function of Conductivity (1940-1991).

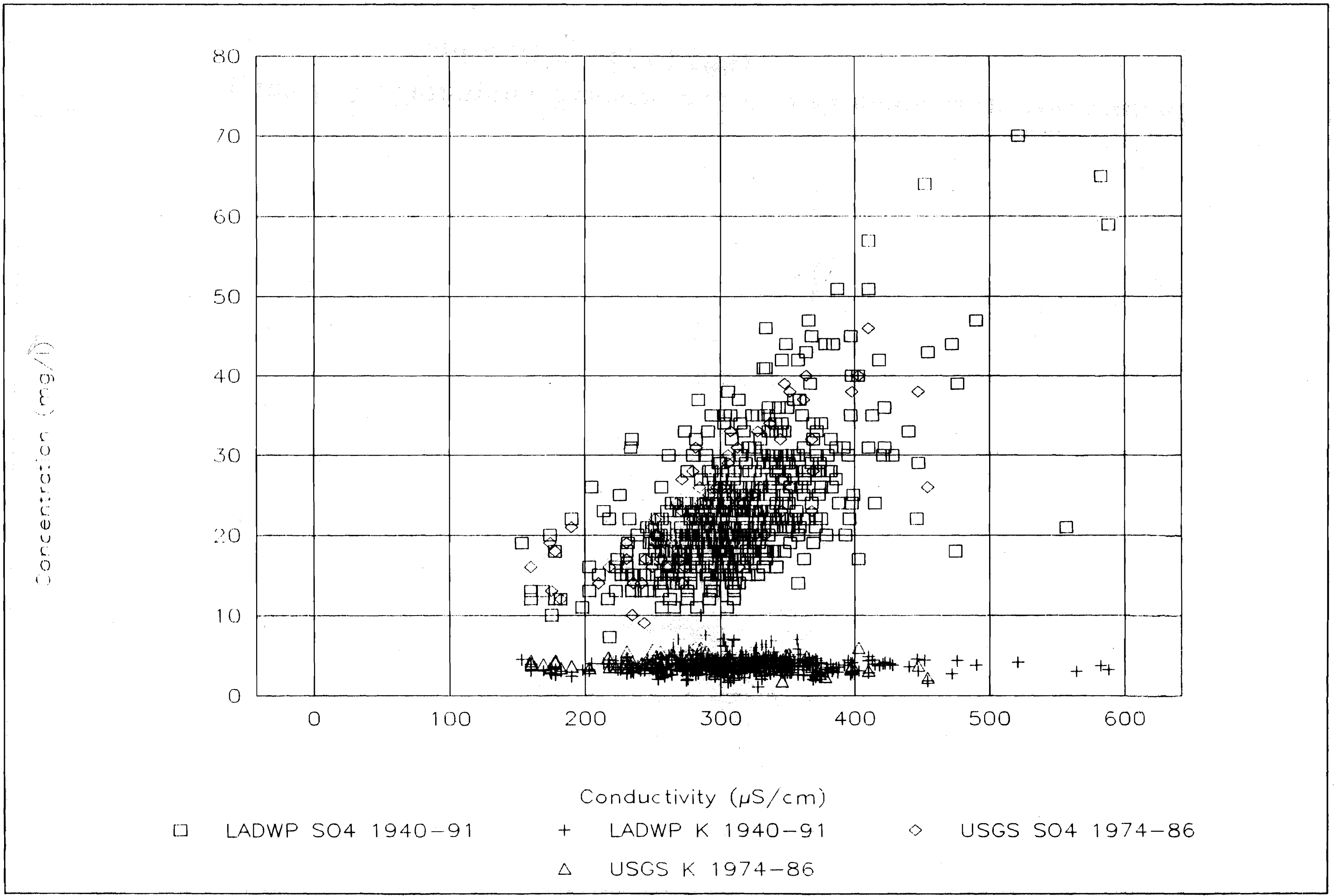


Figure 109. Tinemaha Reservoir Outlet Sulfate and Potassium as a Function of Conductivity (1940-1991).

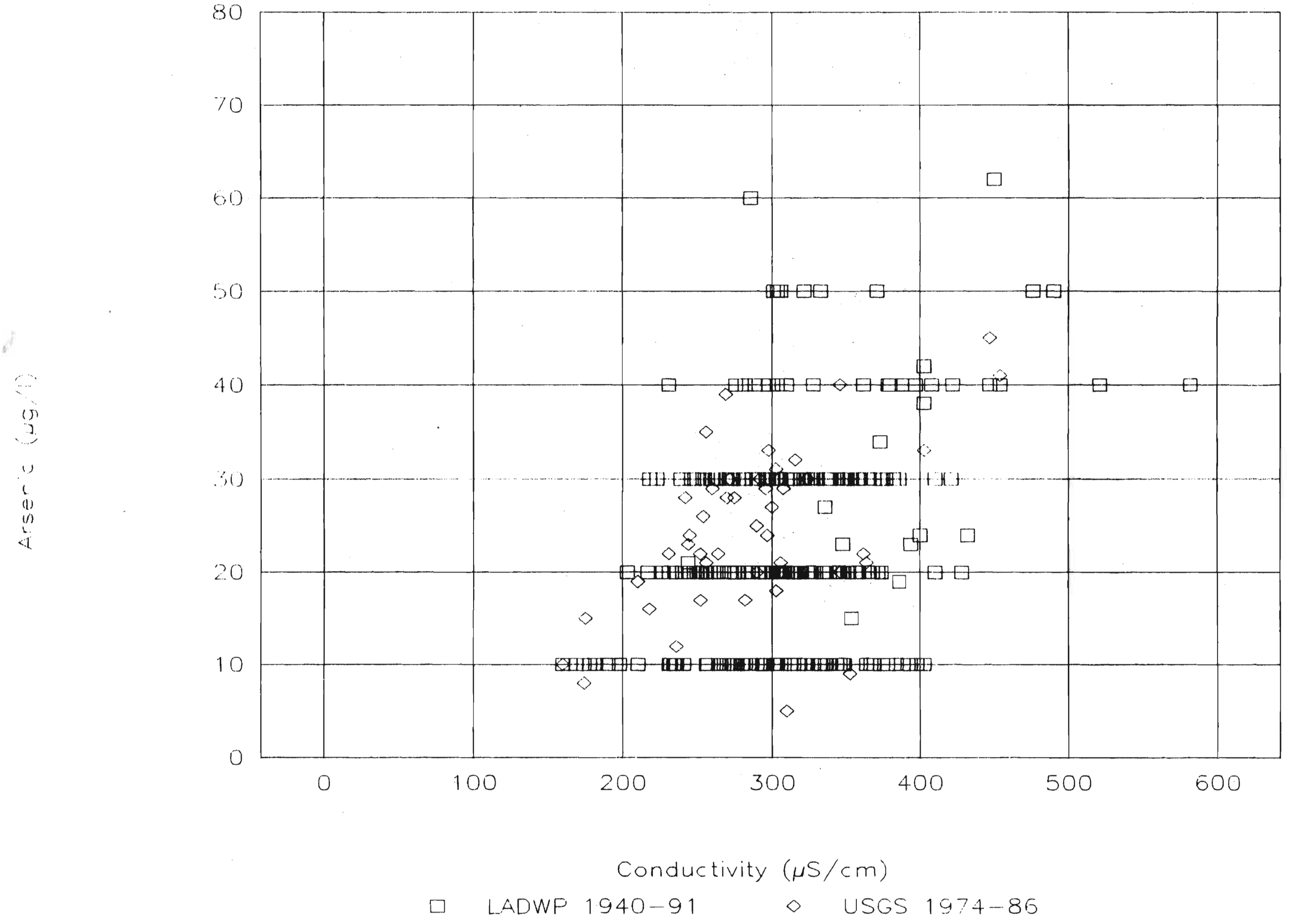


Figure 110. Tinemaha Reservoir Outlet Arsenic as a Function of Conductivity (1940-1991).

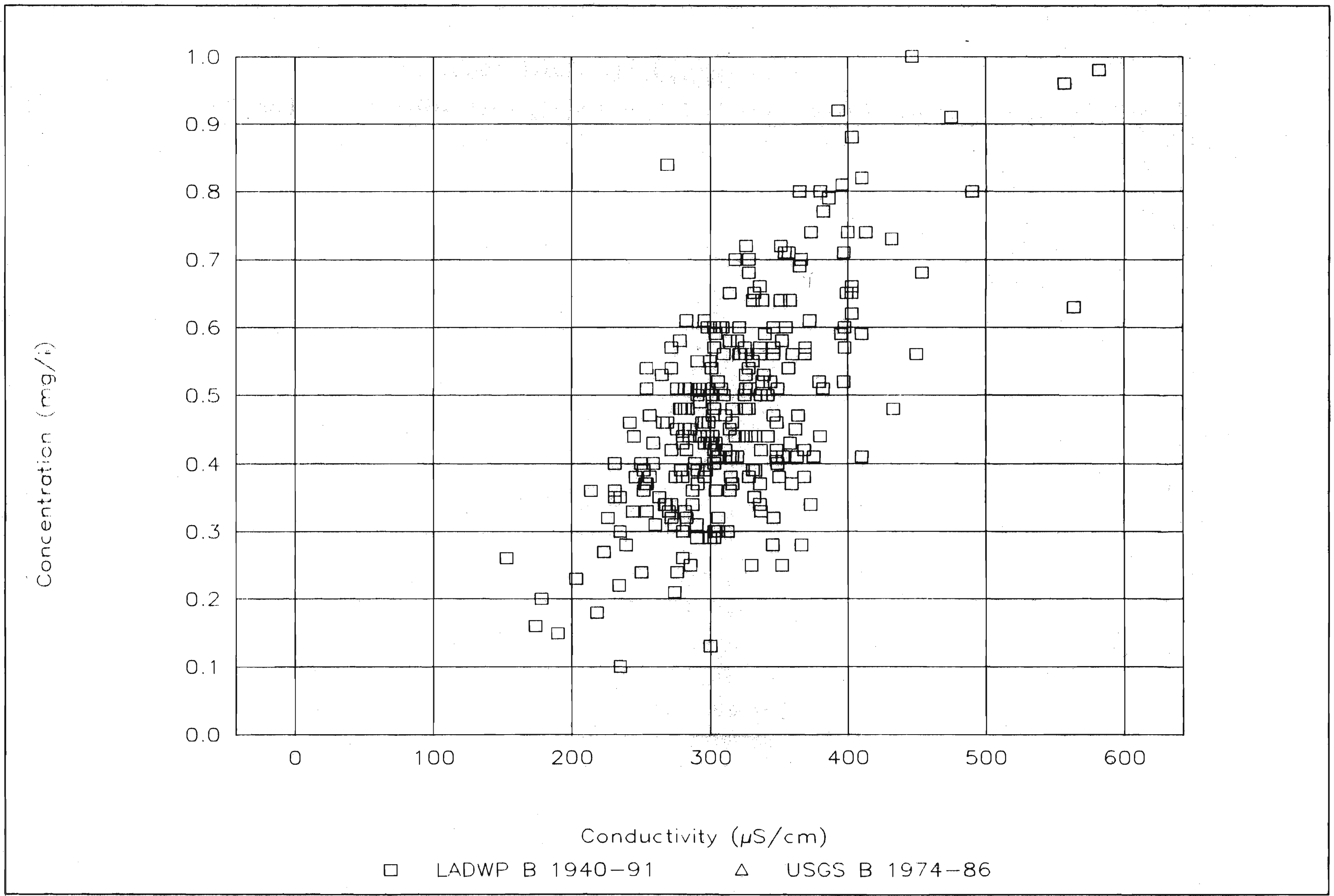


Figure 111. Tinemaha Reservoir Outlet Boron as a Function of Conductivity (1940-1991).

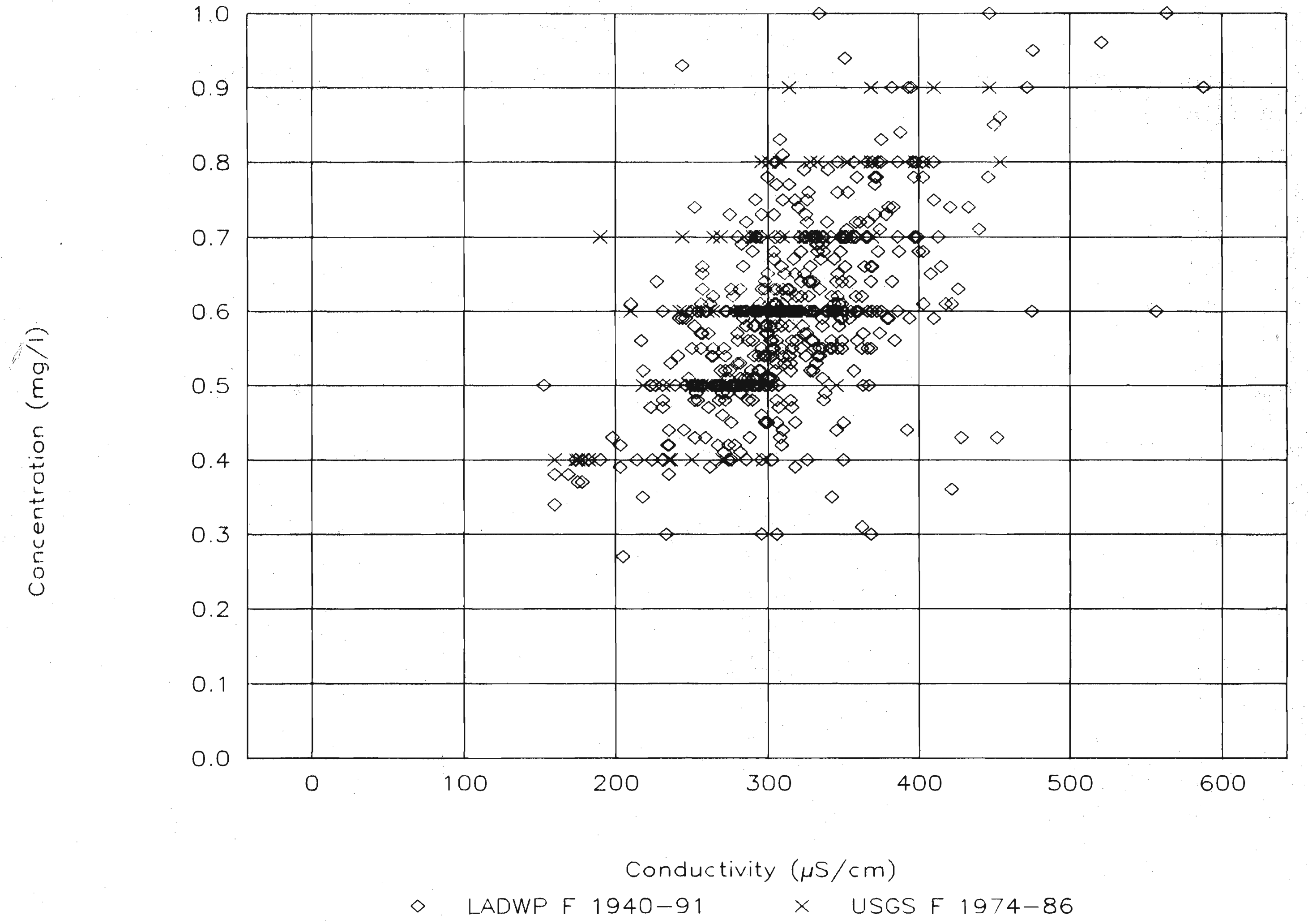


Figure 112. Tinemaha Reservoir Outlet Fluoride as a Function of Conductivity (1940-1991).

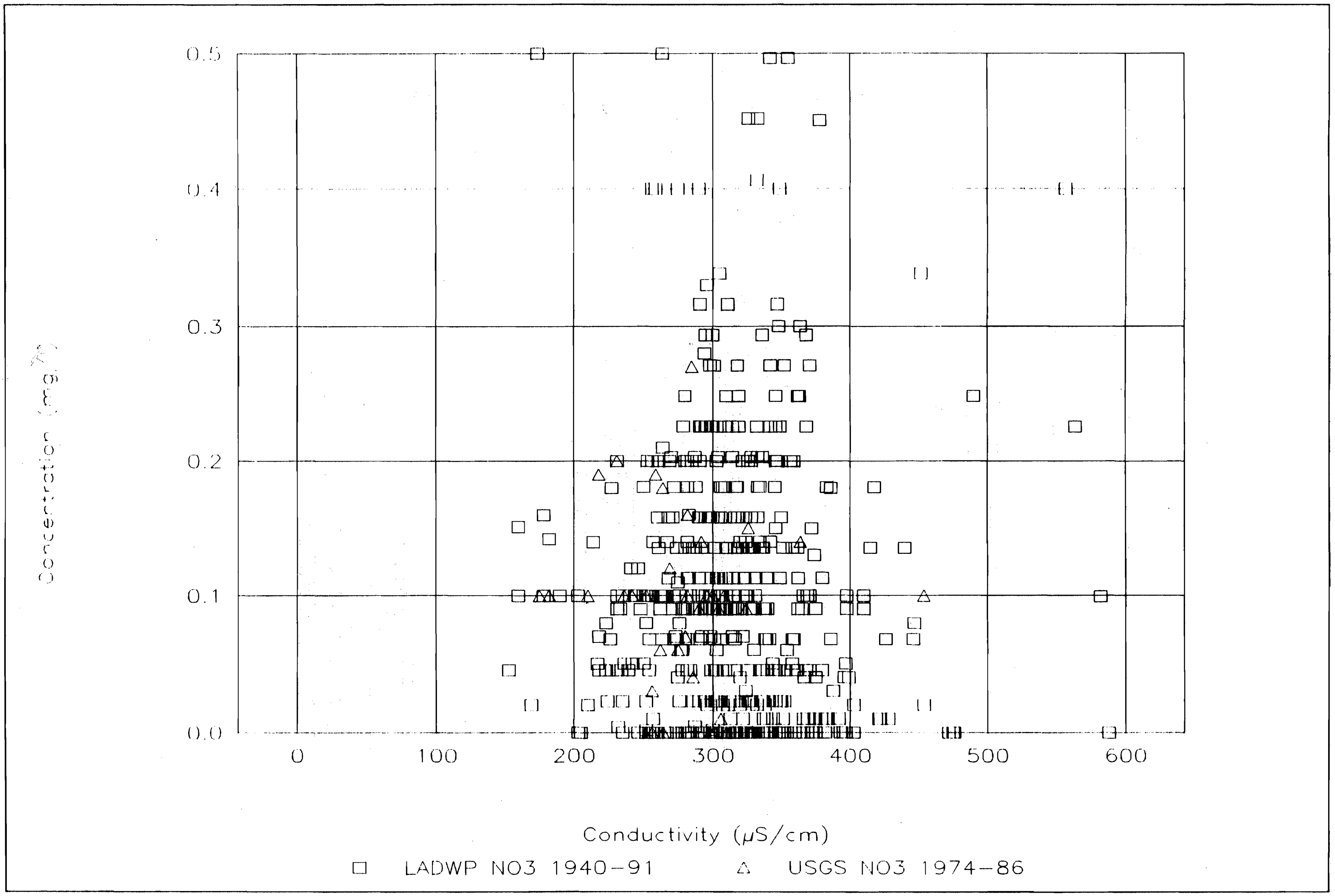


Figure 113. Tinemaha Reservoir Outlet Nitrate as a Function of Conductivity (1940-1991).

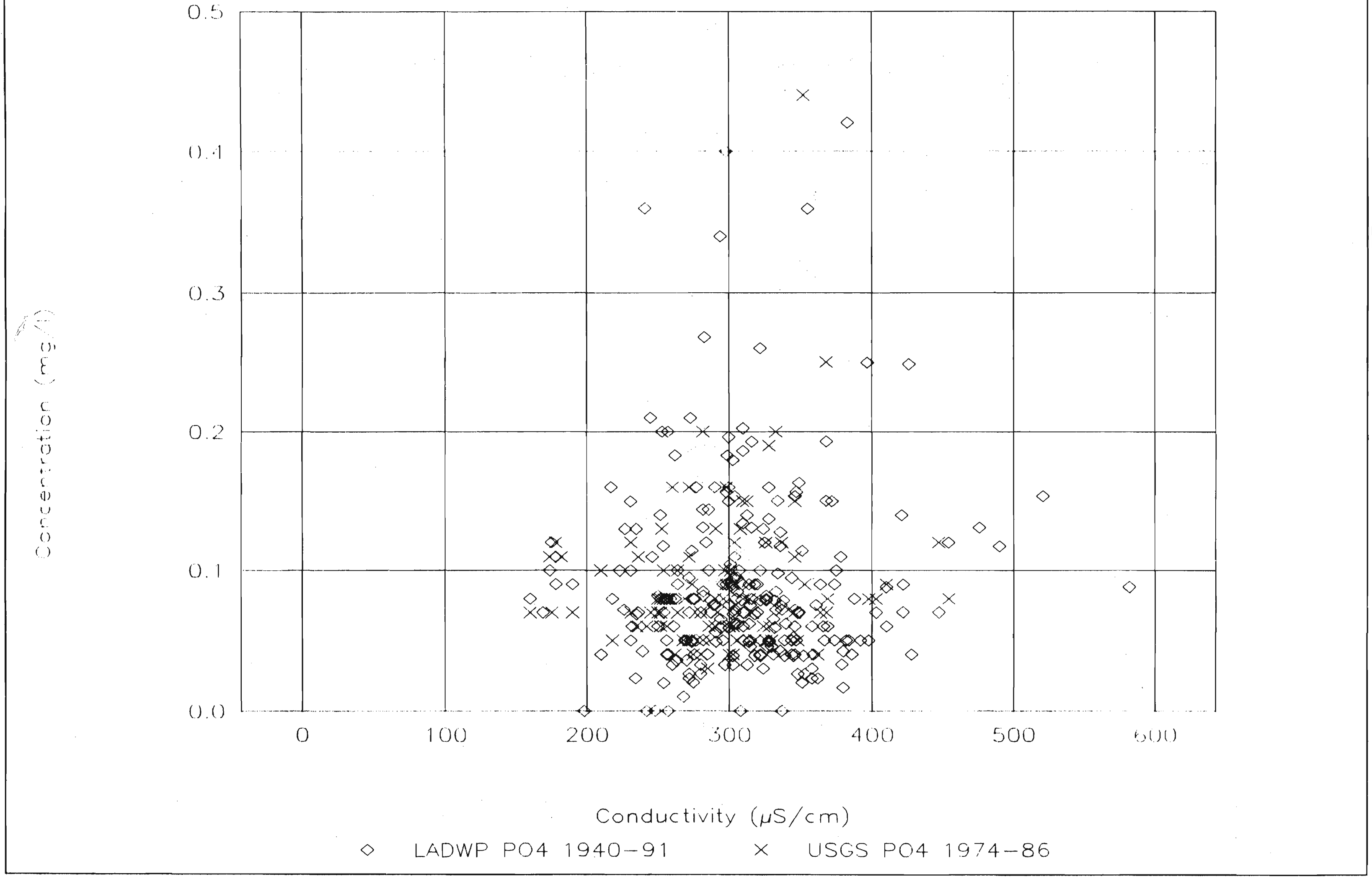


Figure 114. Tinemaha Reservoir Outlet Phosphate as a Function of Conductivity (1940-1991).

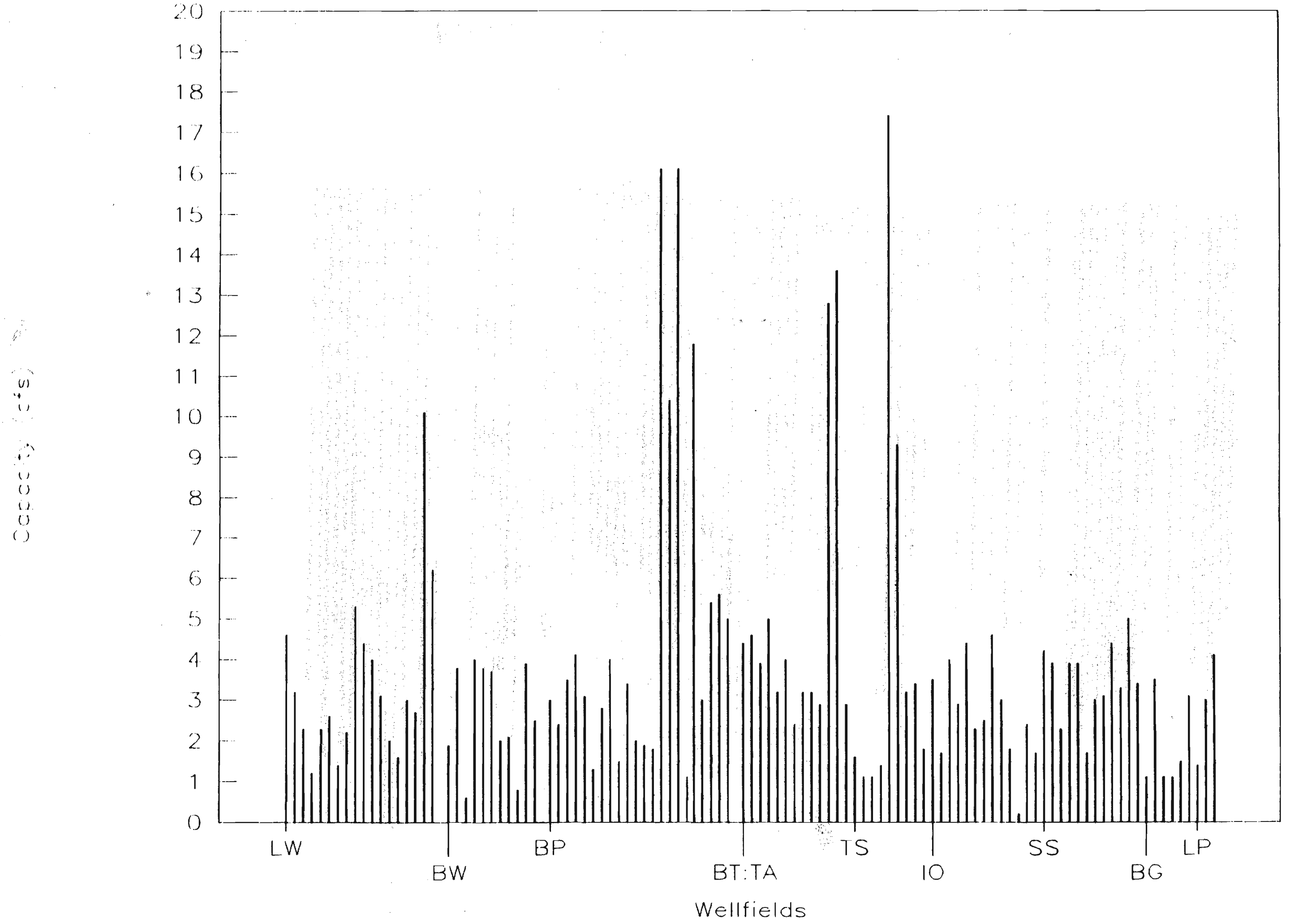


Figure 115. Well Capacity.

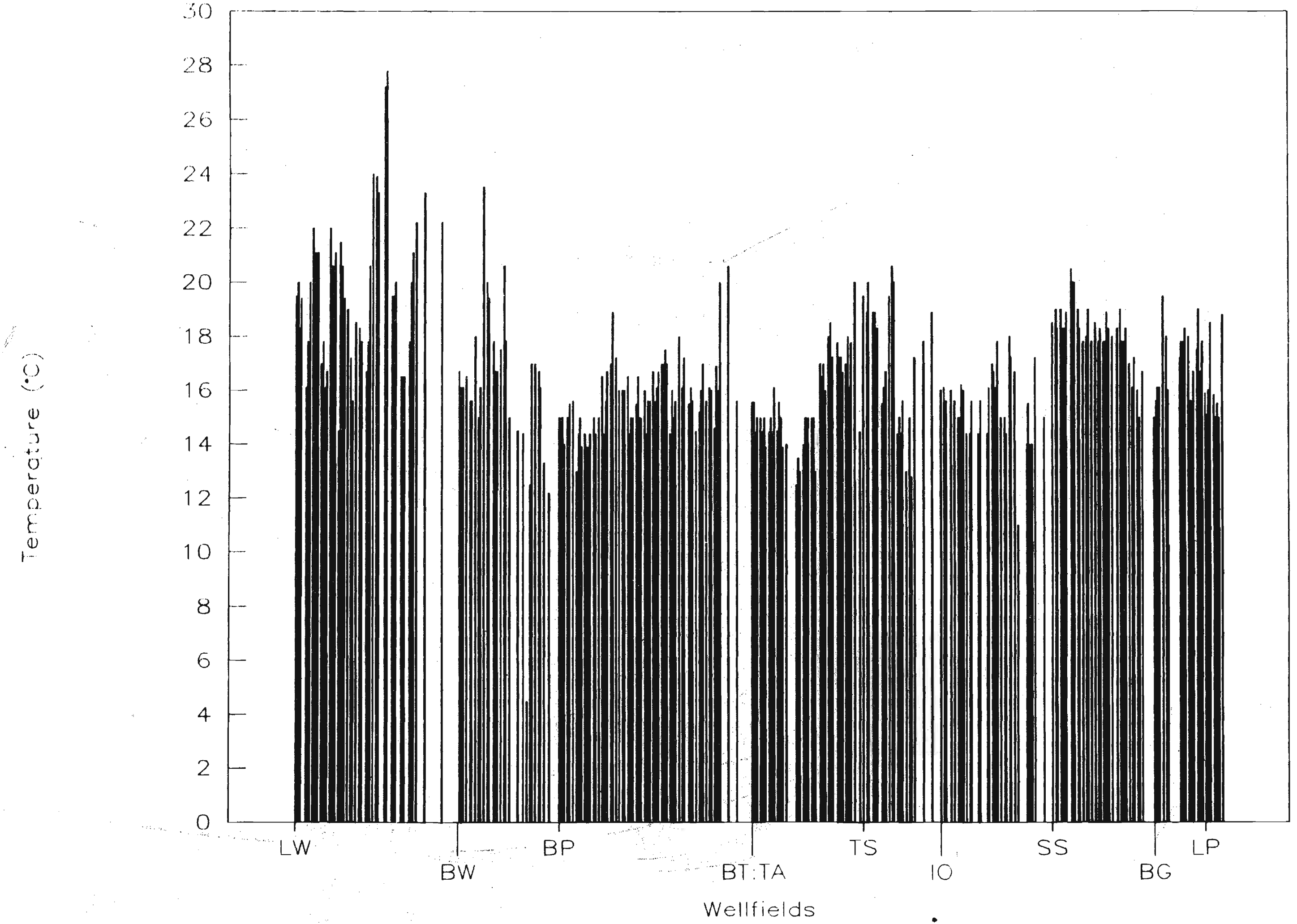


Figure 116. Well Temperatures.

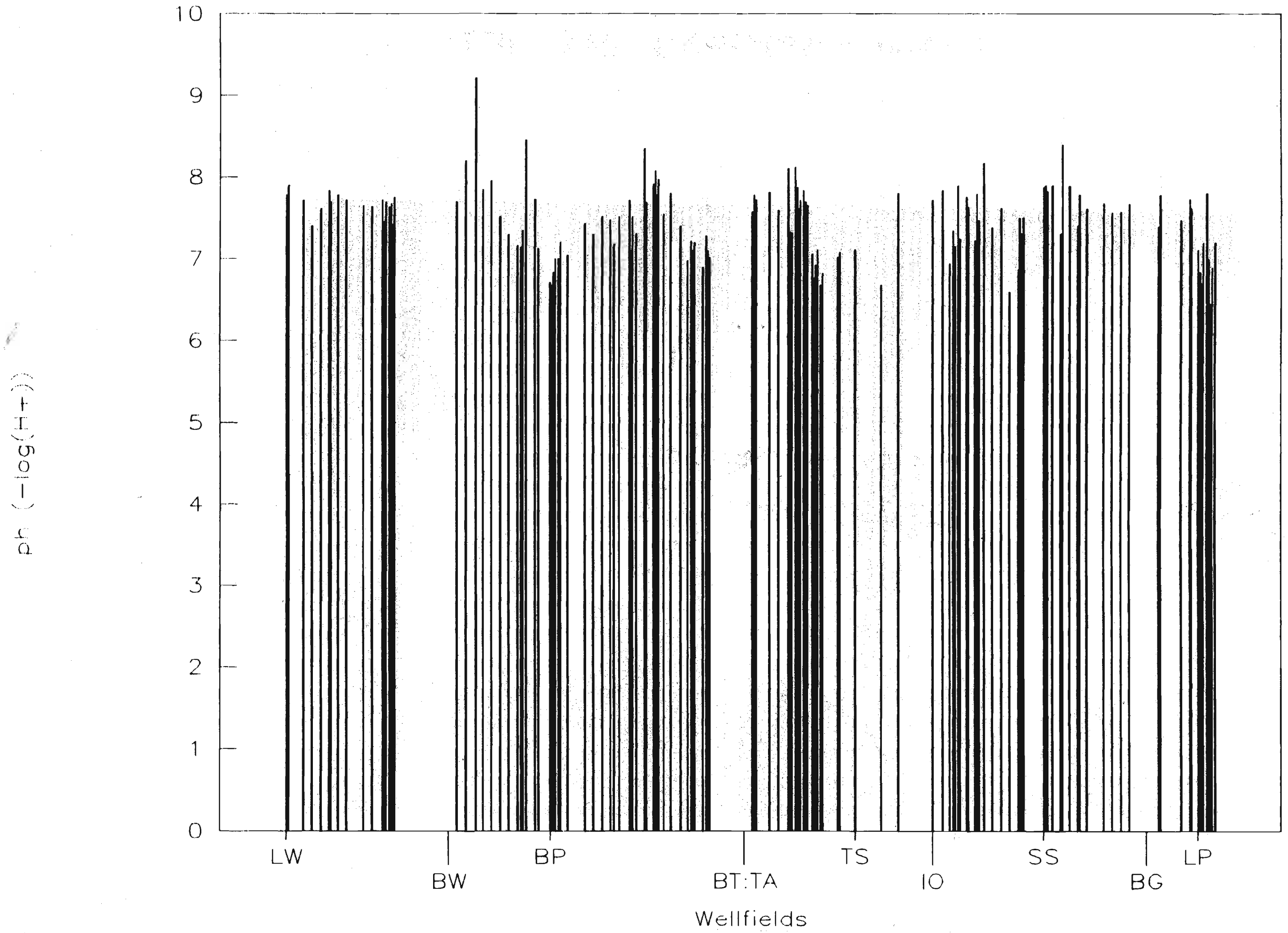


Figure 117. Well pH.

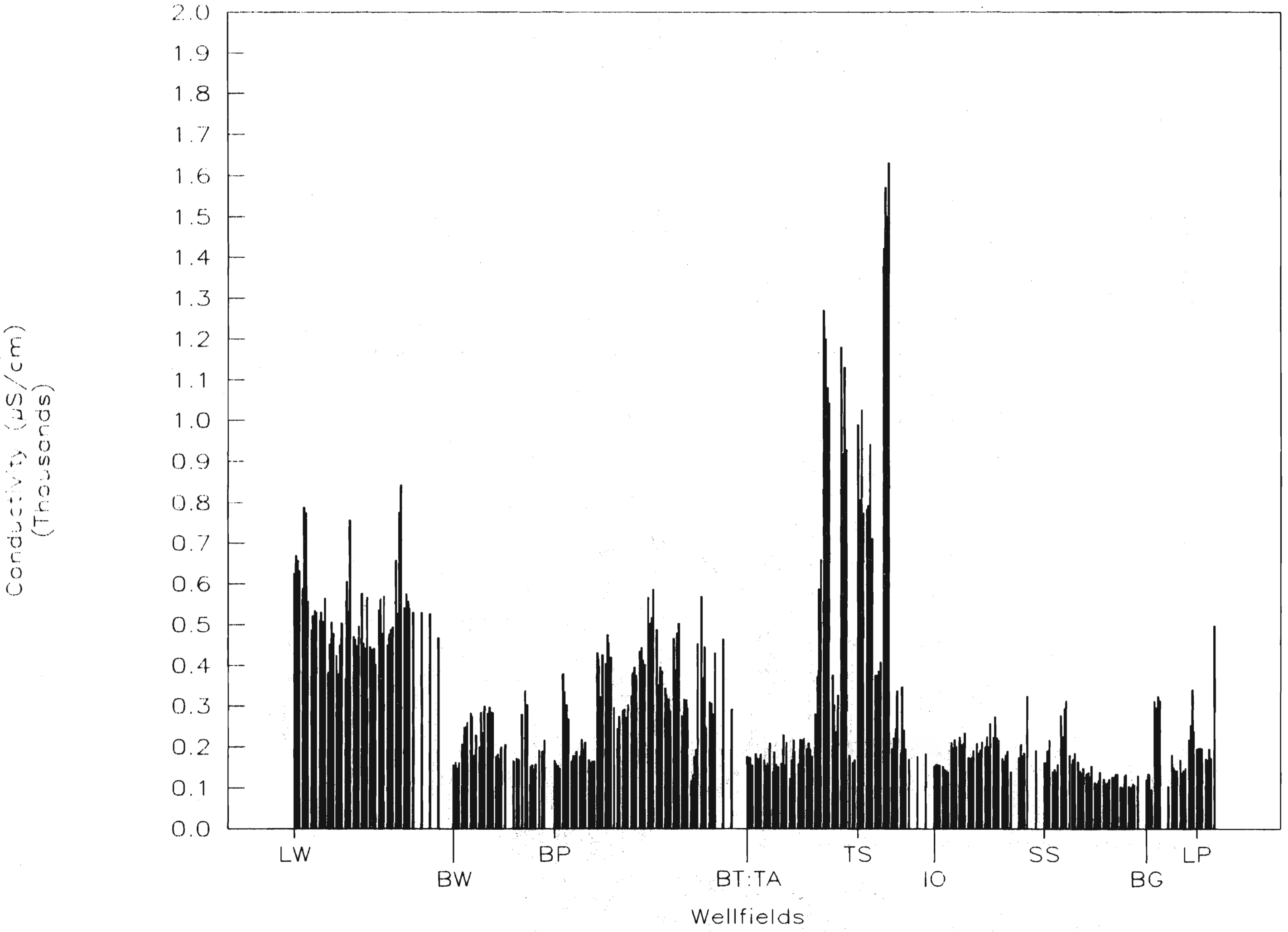


Figure 118. Well Conductivity.

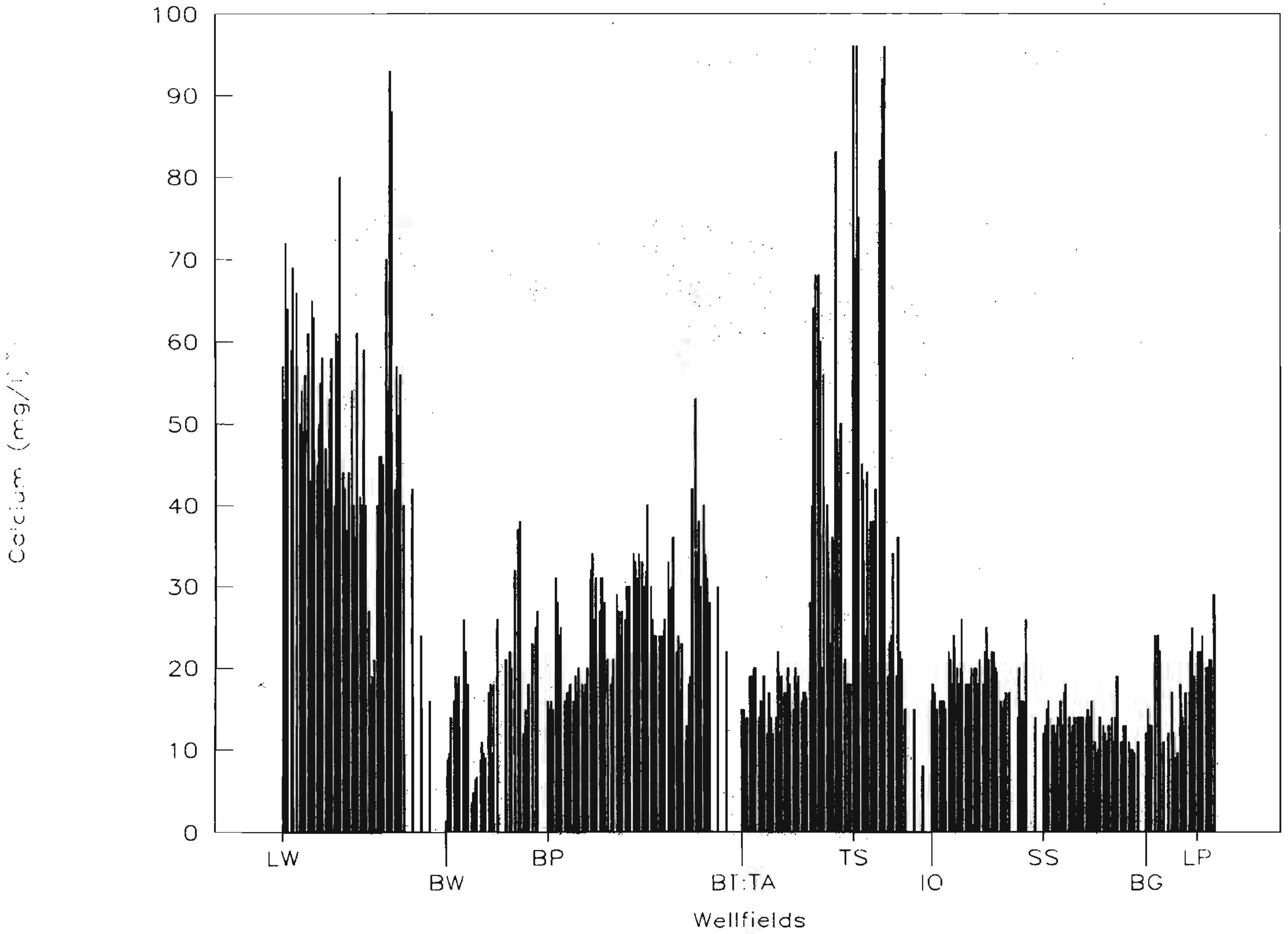


Figure 119. Well Calcium Concentrations.

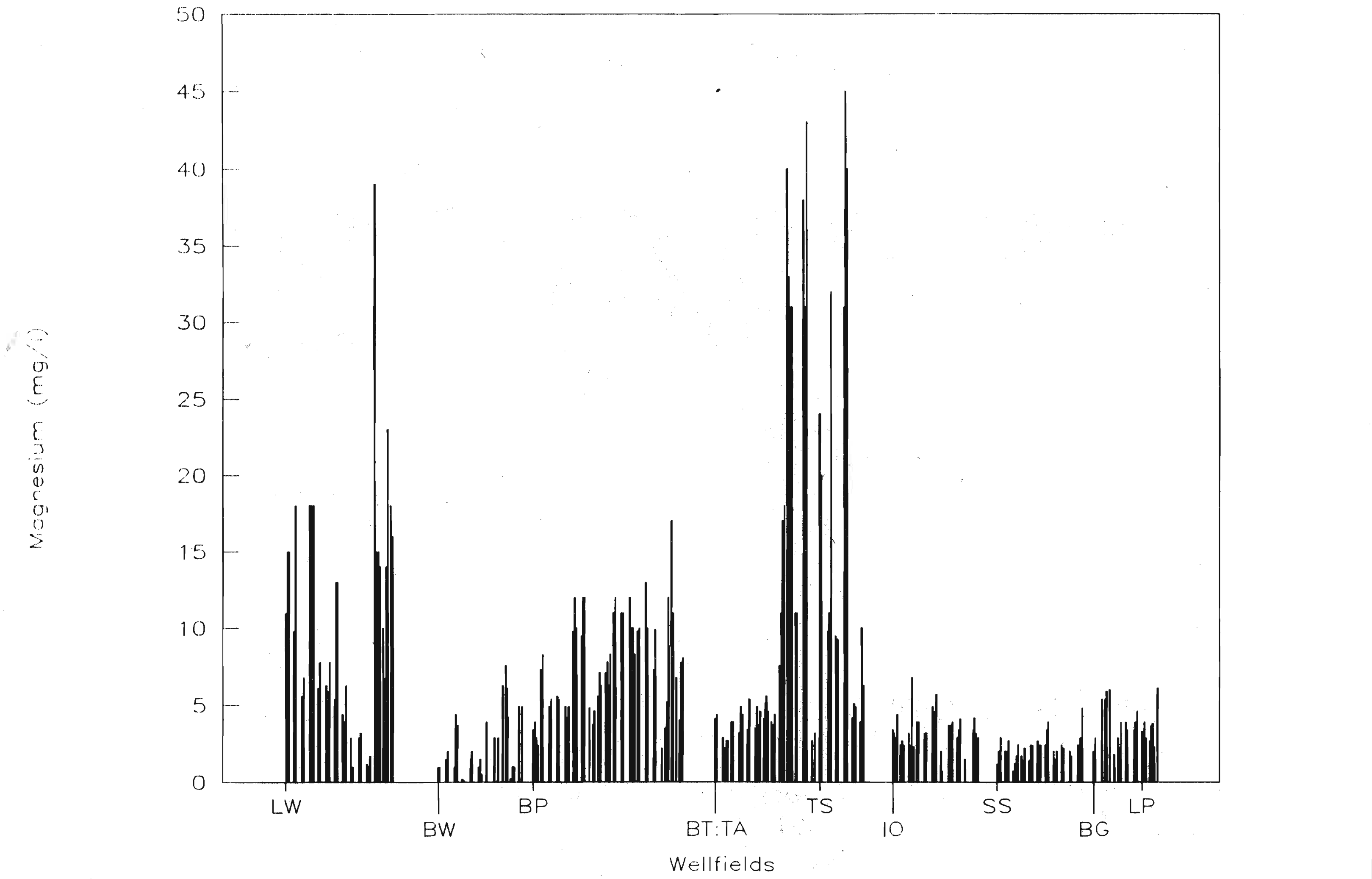


Figure 120. Well Magnesium Concentrations.

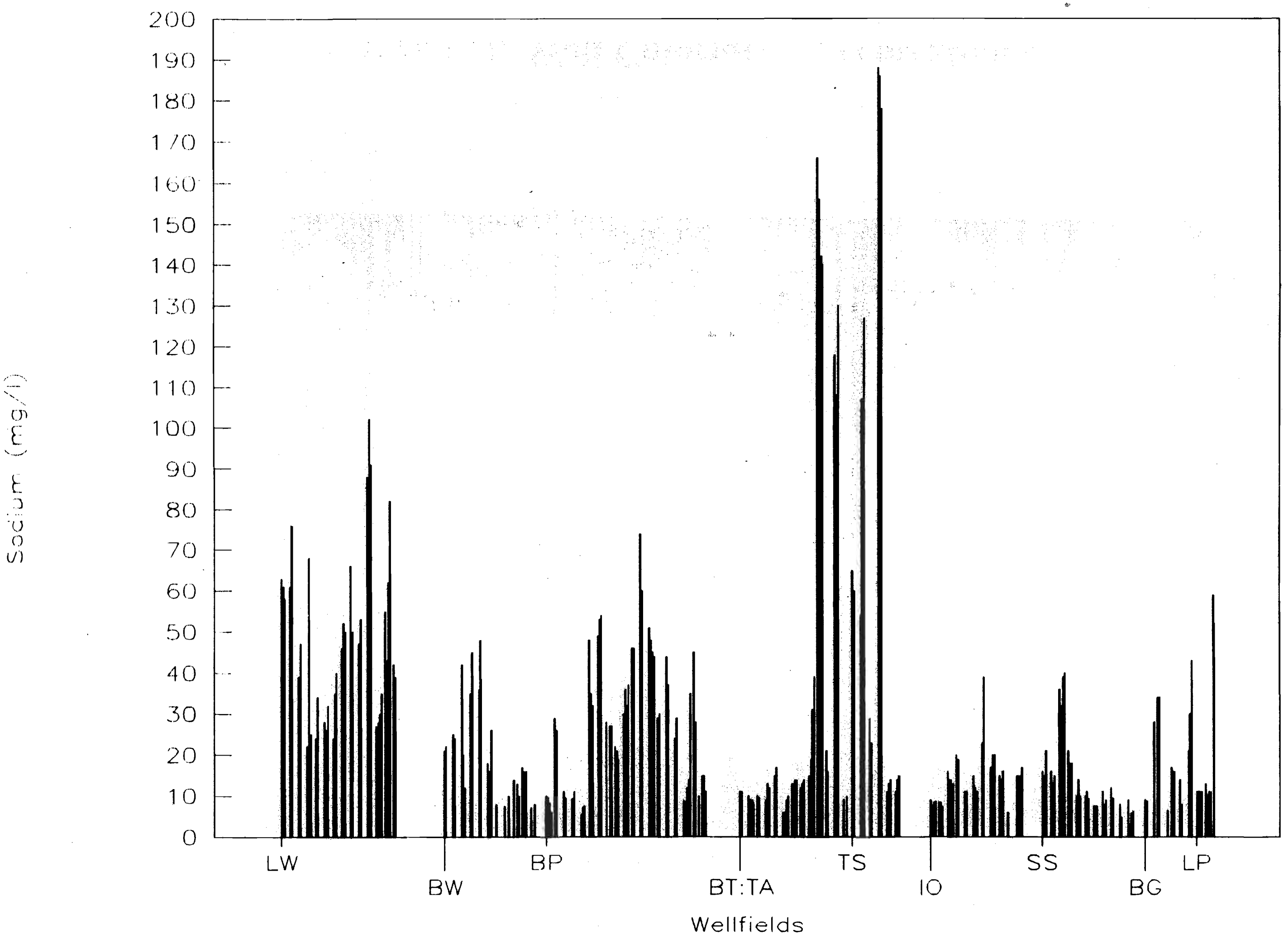


Figure 121. Well Sodium Concentrations.

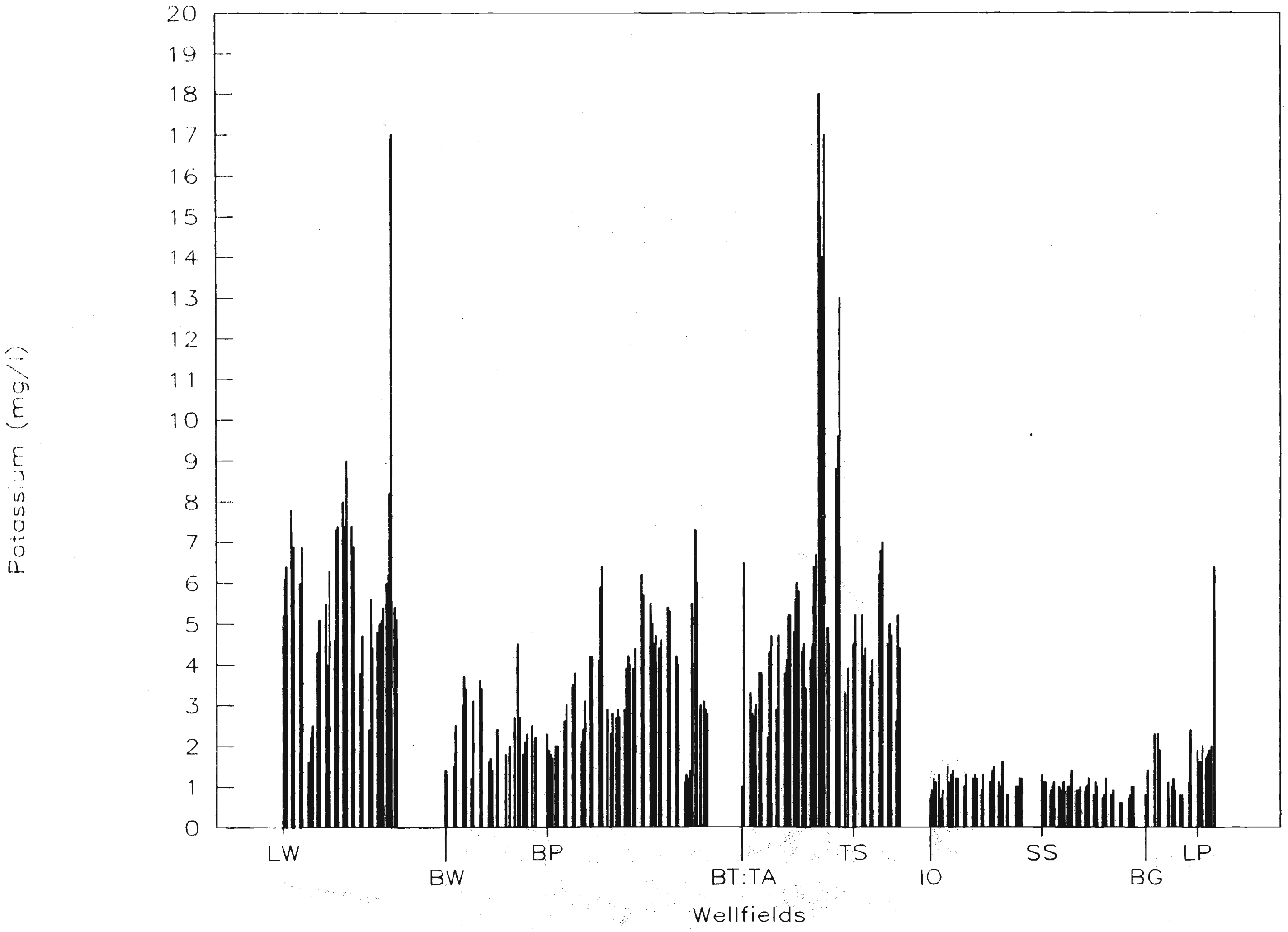


Figure 122. Well Potassium Concentrations.

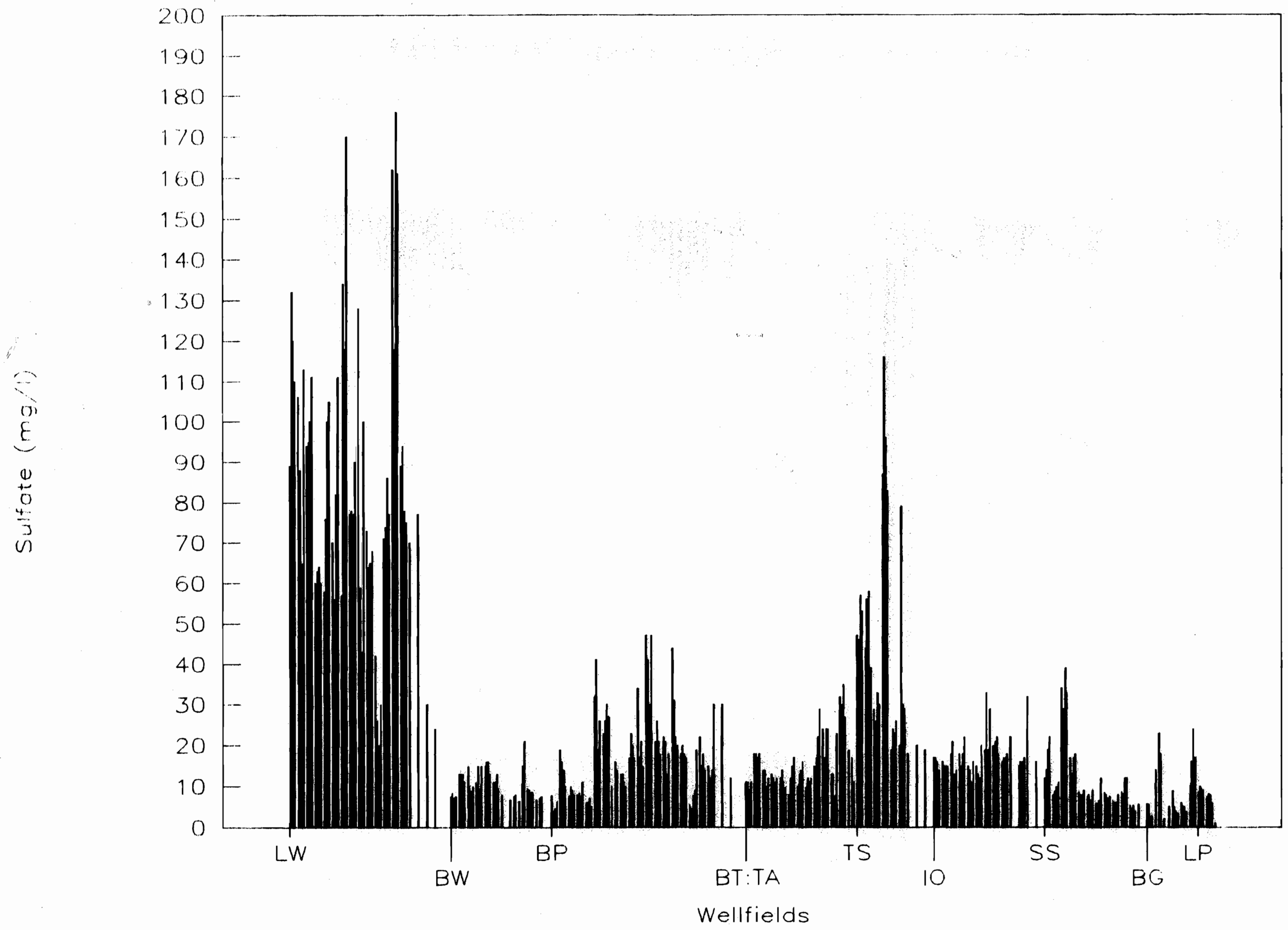


Figure 123. Well Sulfate Concentrations.

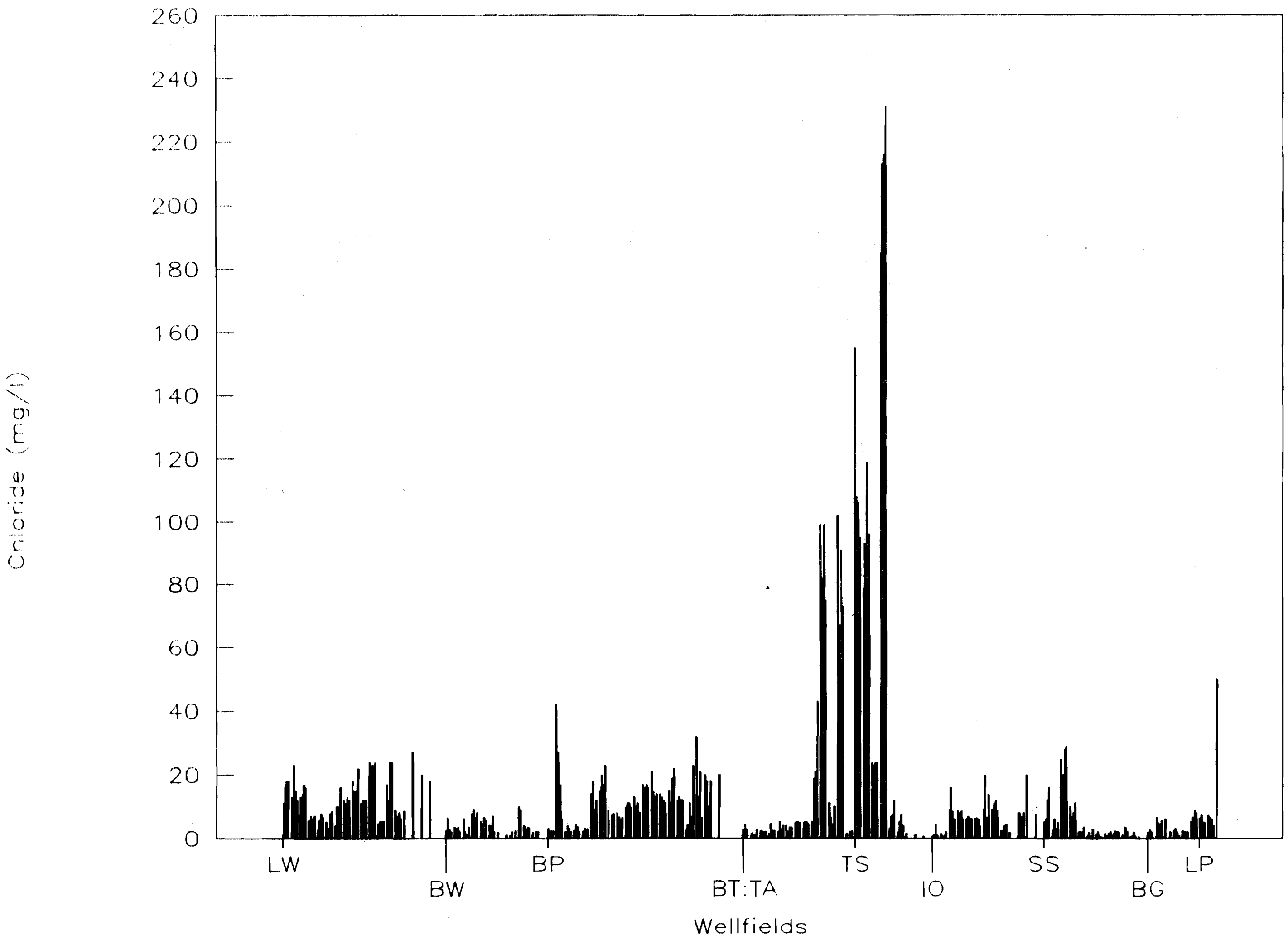


Figure 124. Well Chloride Concentrations.

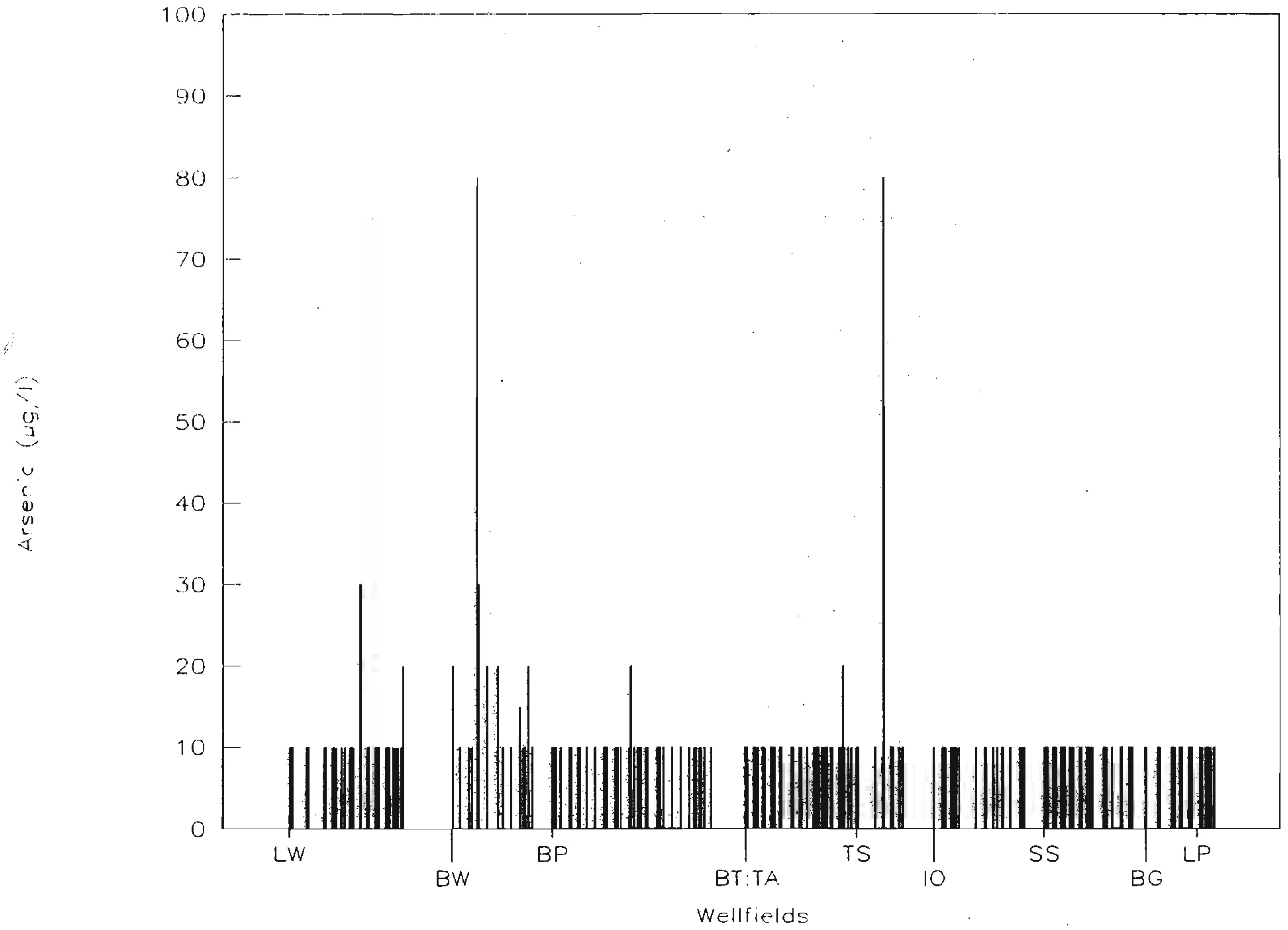


Figure 125. Well Arsenic Concentrations.

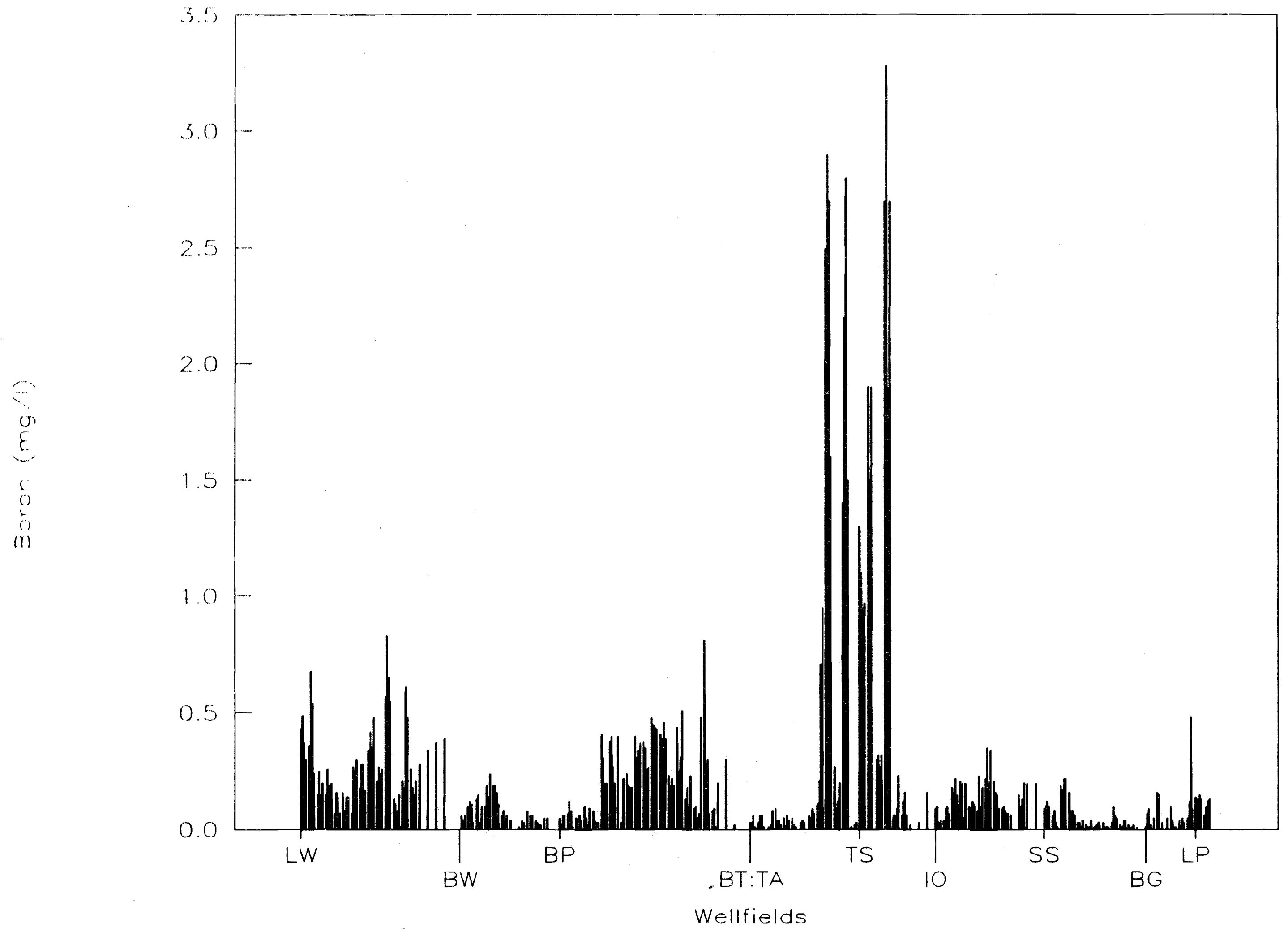


Figure 126. Well Boron Concentrations.

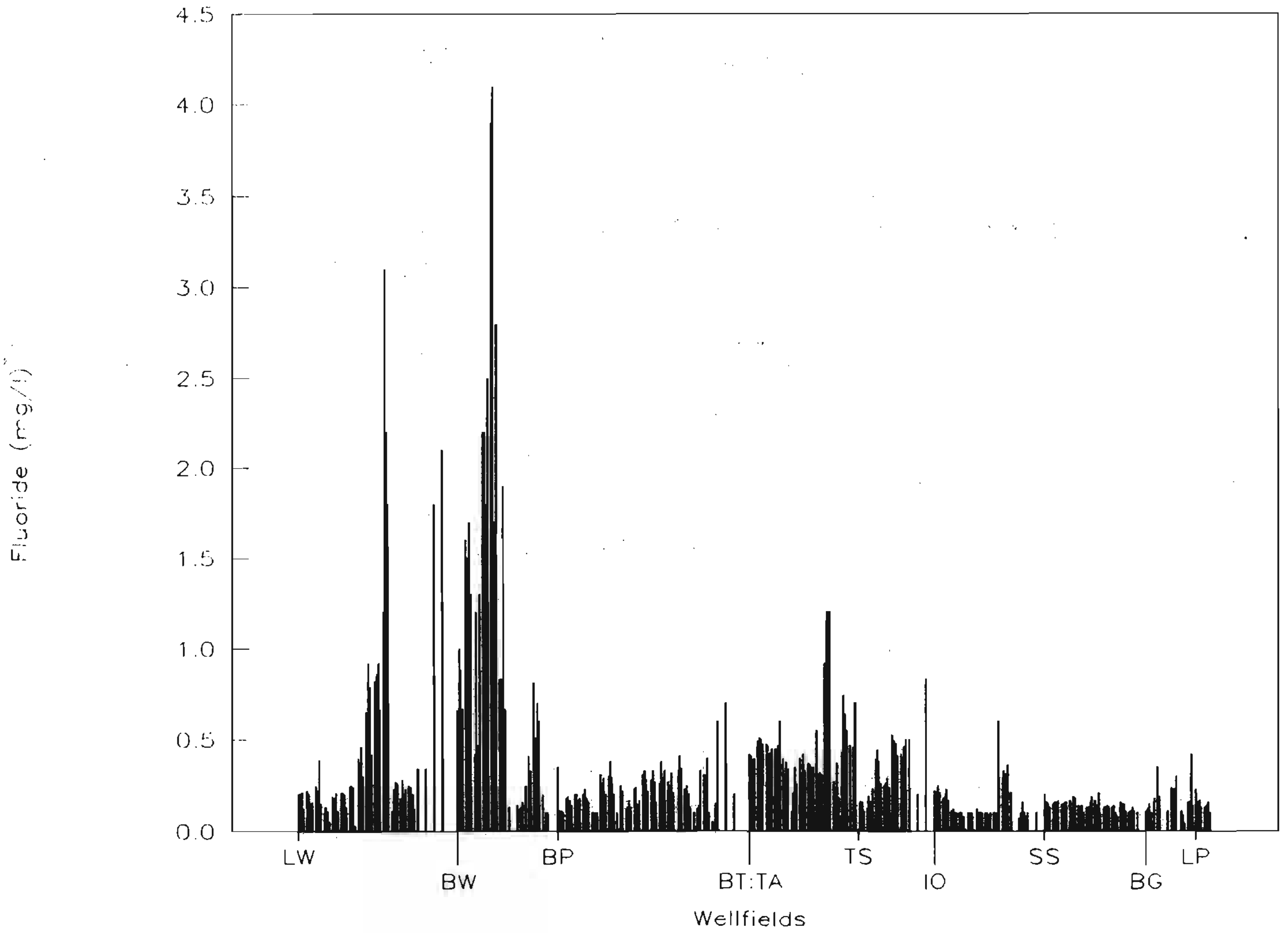


Figure 127. Well Fluoride Concentrations.

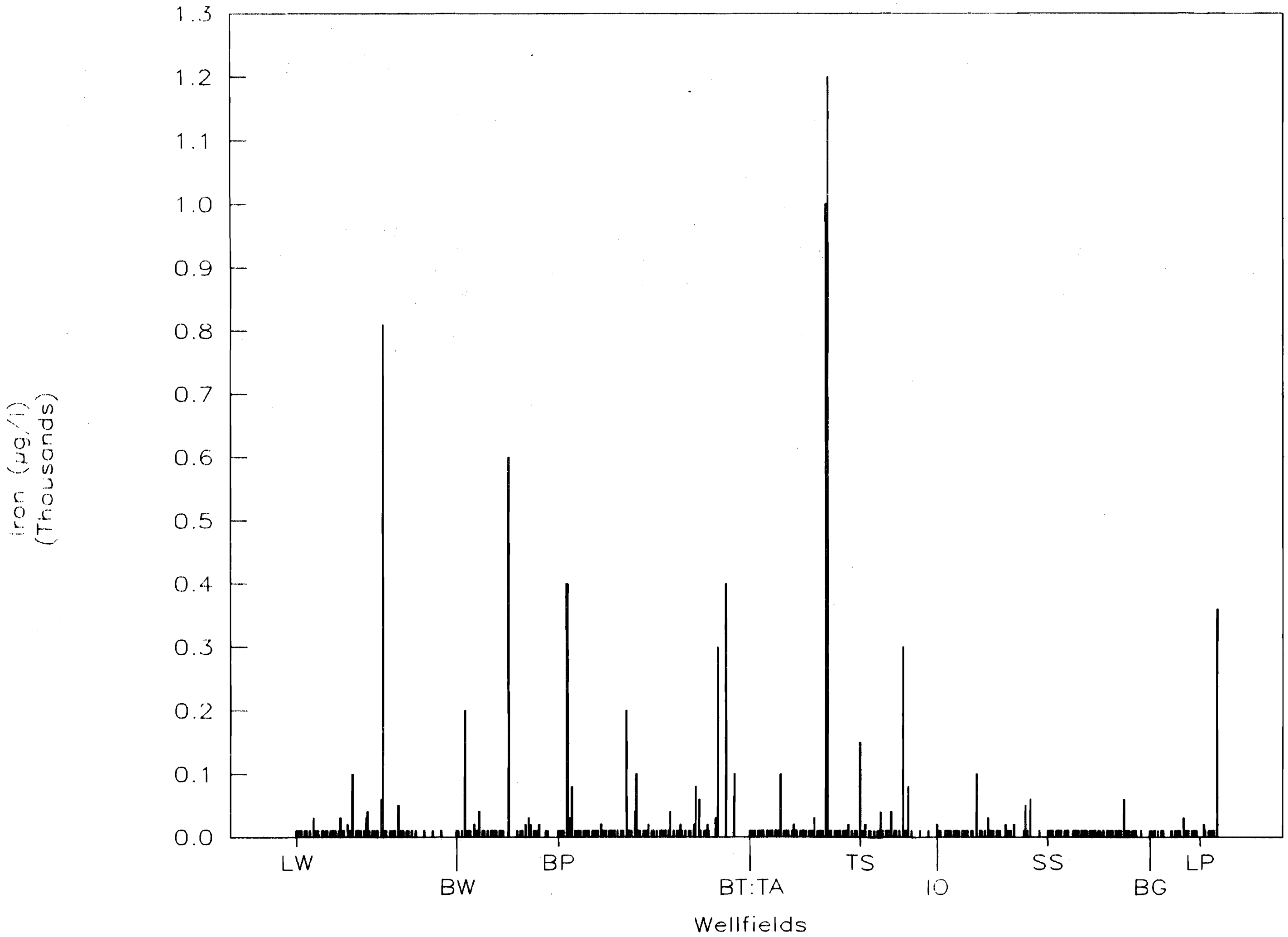


Figure 128. Well Iron Concentrations.

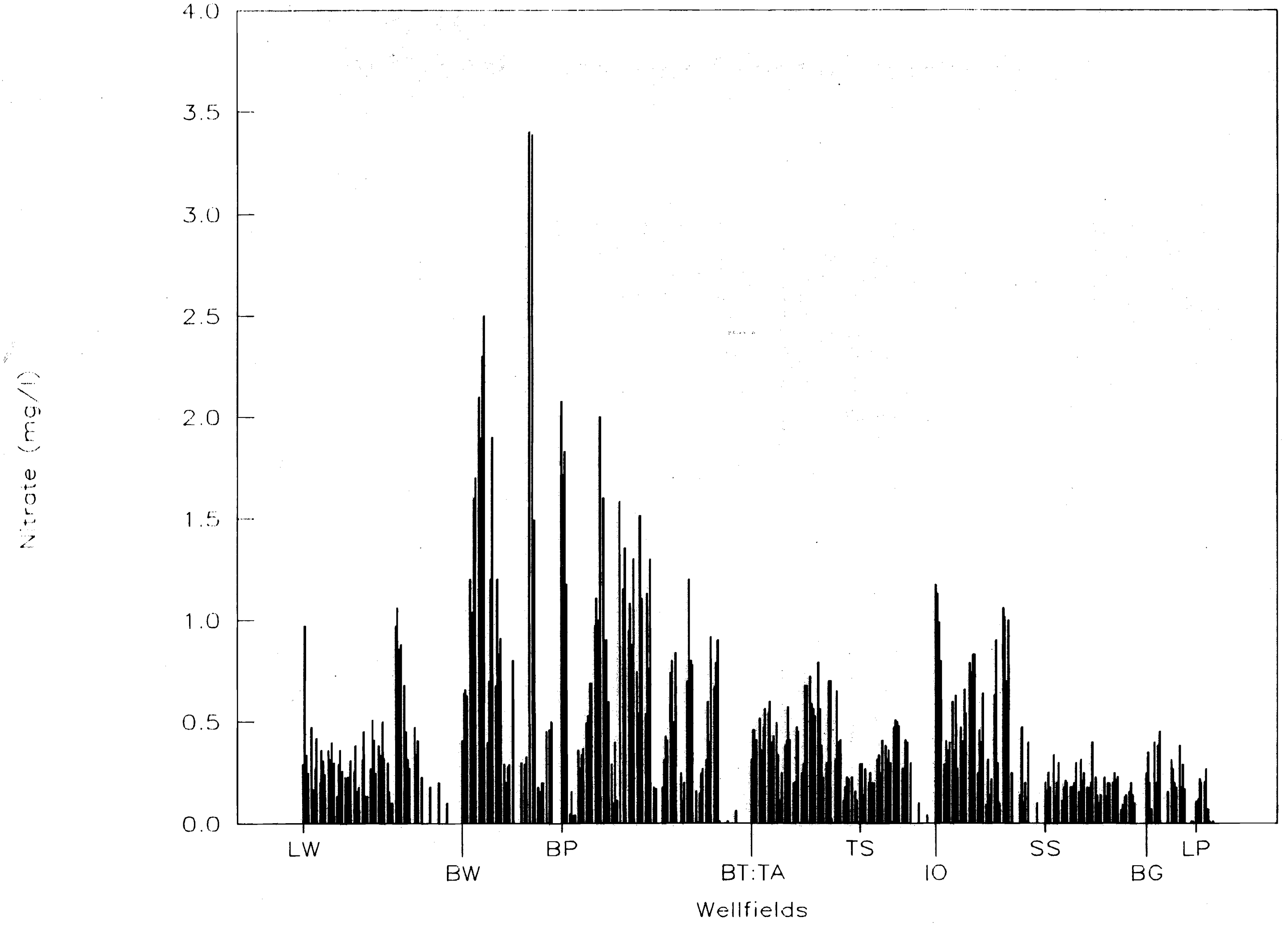


Figure 129. Well Nitrate Concentrations.

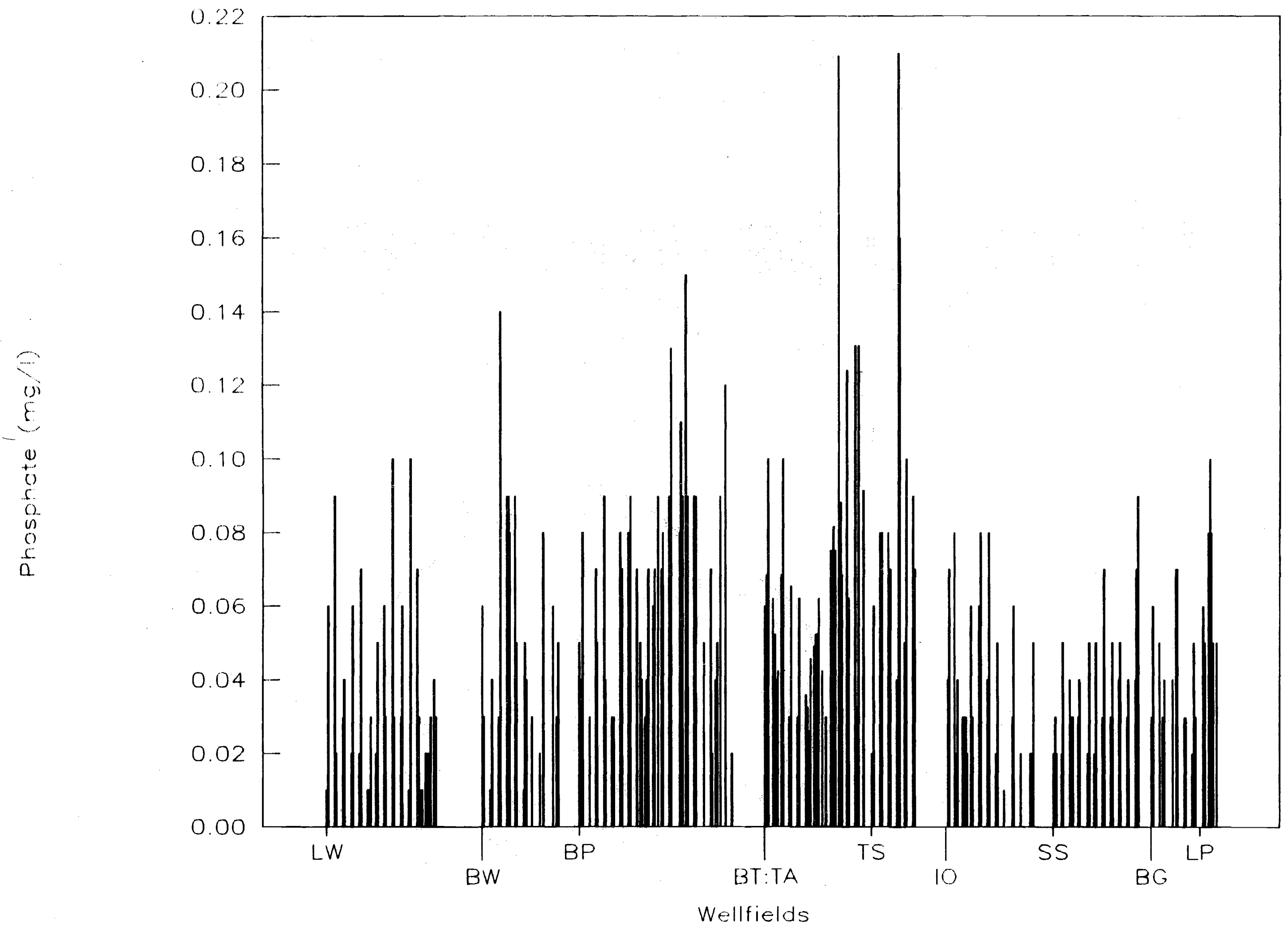


Figure 130. Well Phosphate Concentrations.

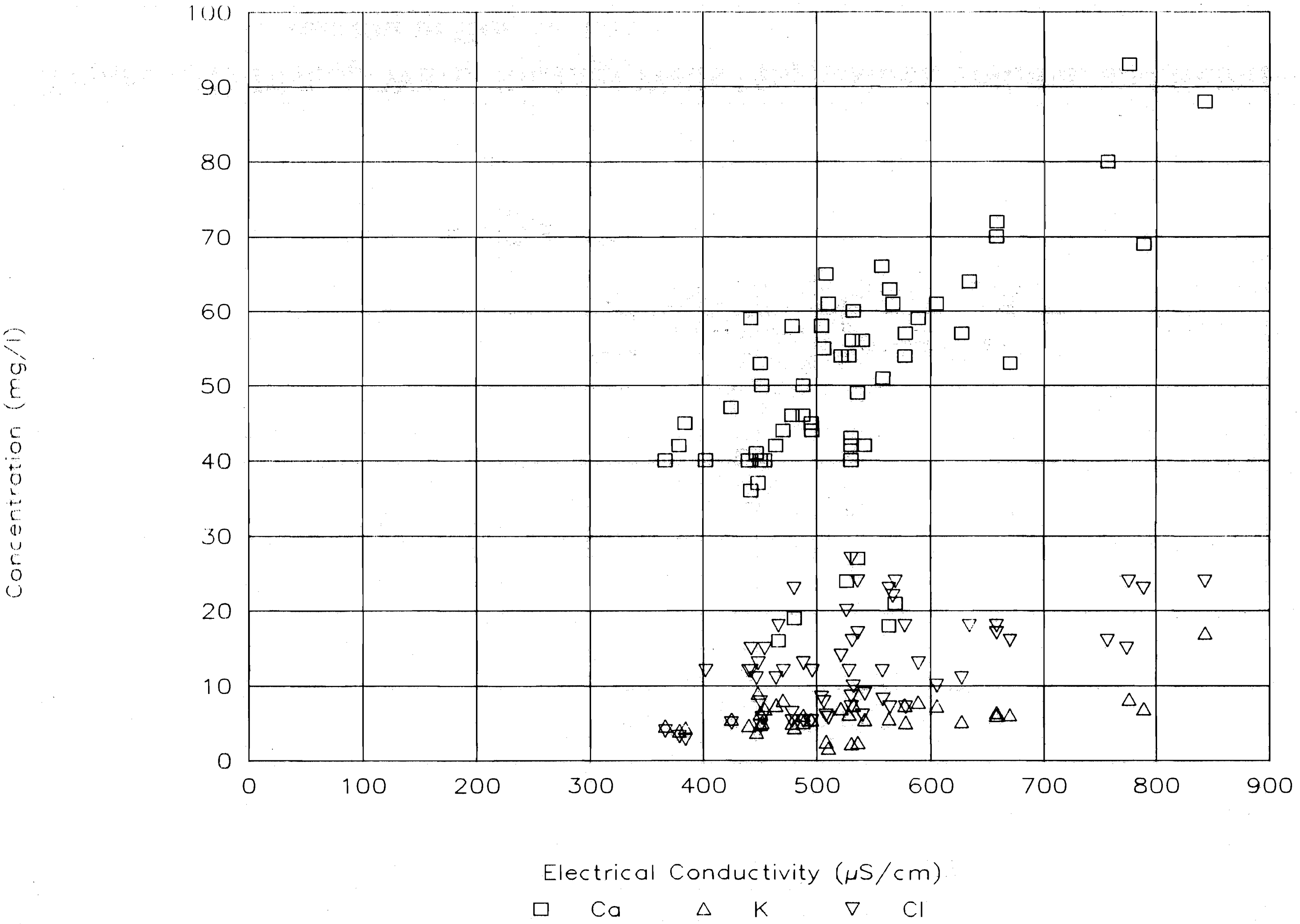


Figure 131. Laws Wells Calcium, Potassium, and Chloride as a Function of Conductivity.

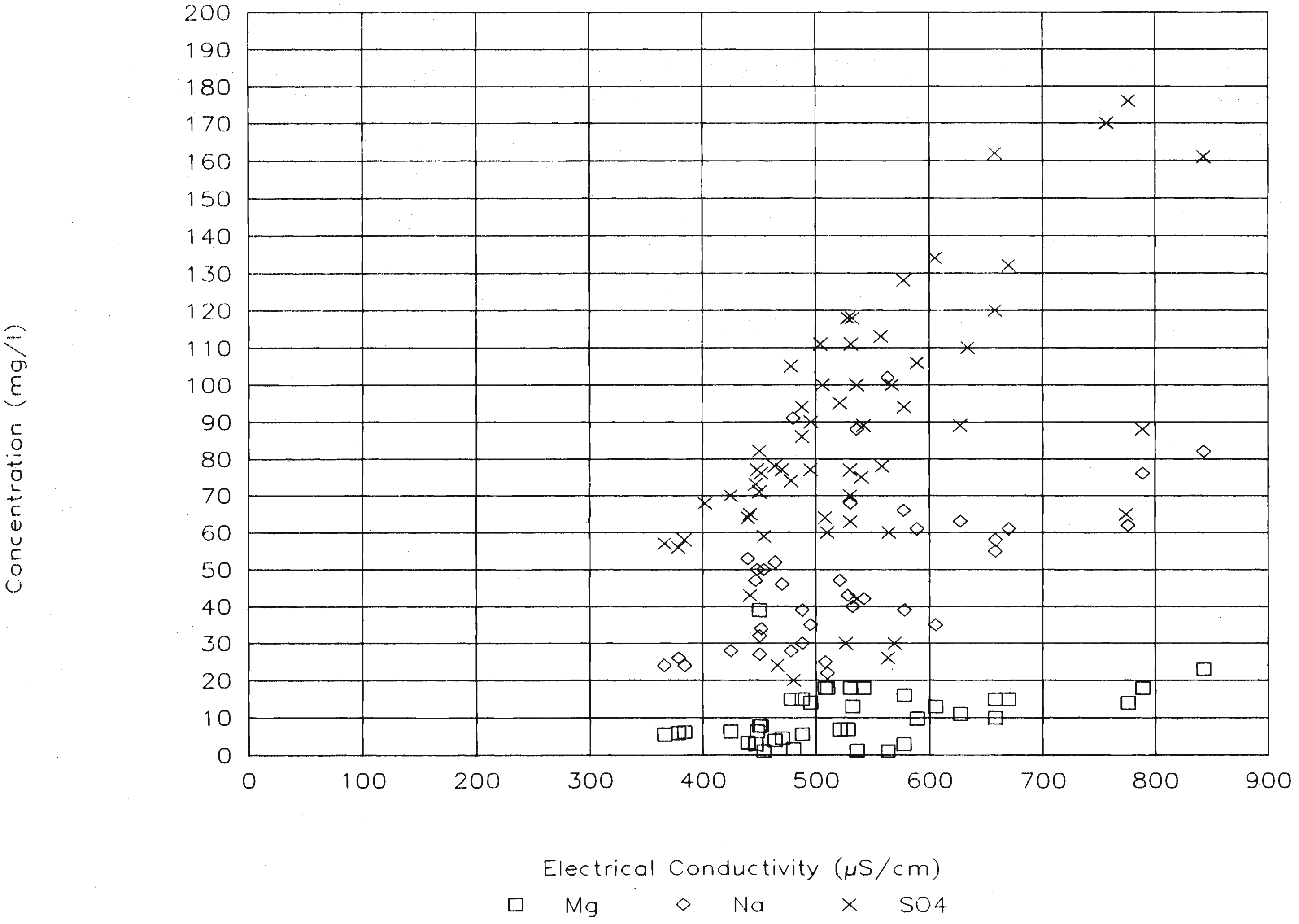


Figure 132. Laws Wells Magnesium, Sodium, and Sulfate as a Function of Conductivity.

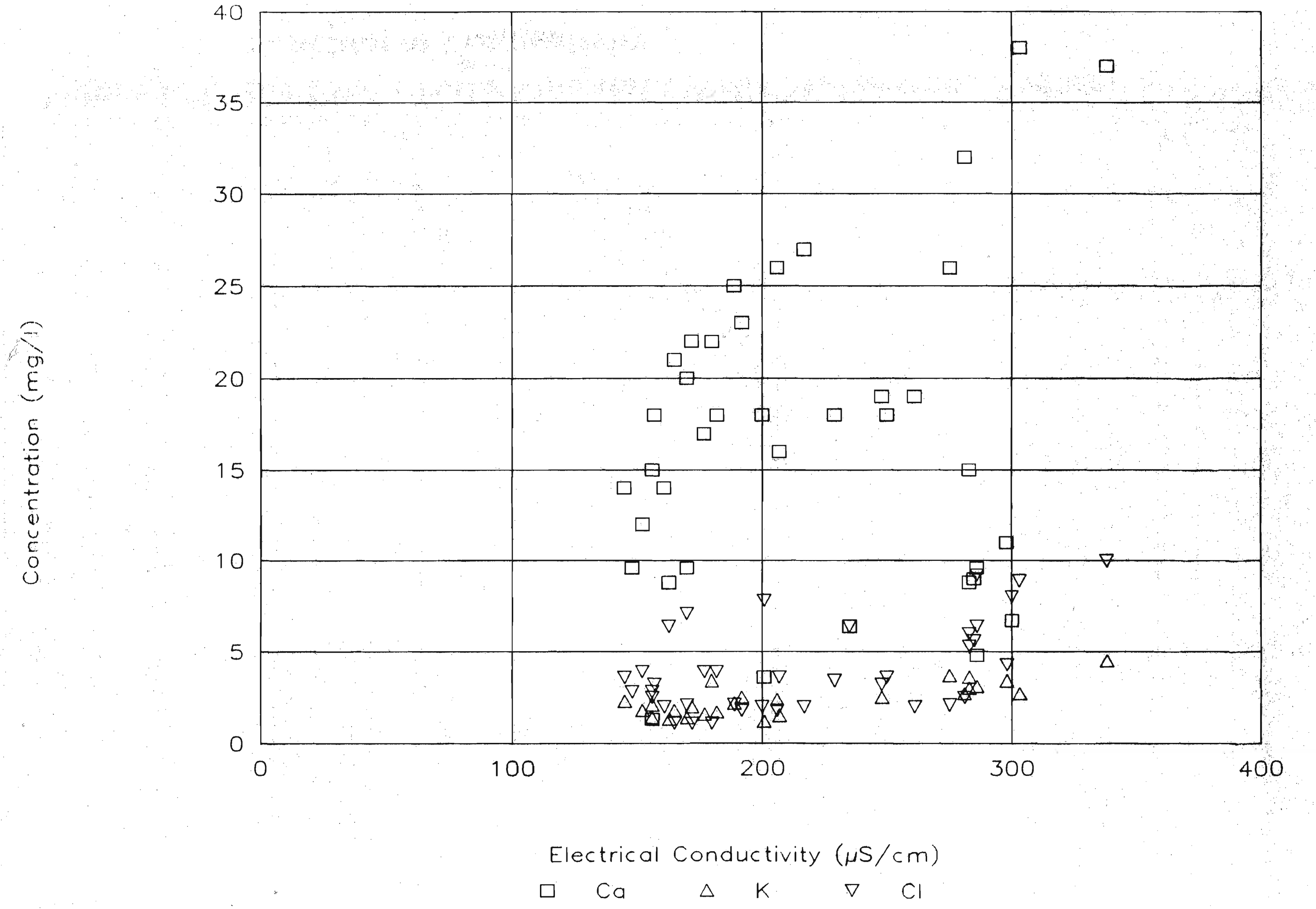


Figure 133. Bishop-Warm Springs Wells Calcium, Potassium, and Chloride as a Function of Conductivity.

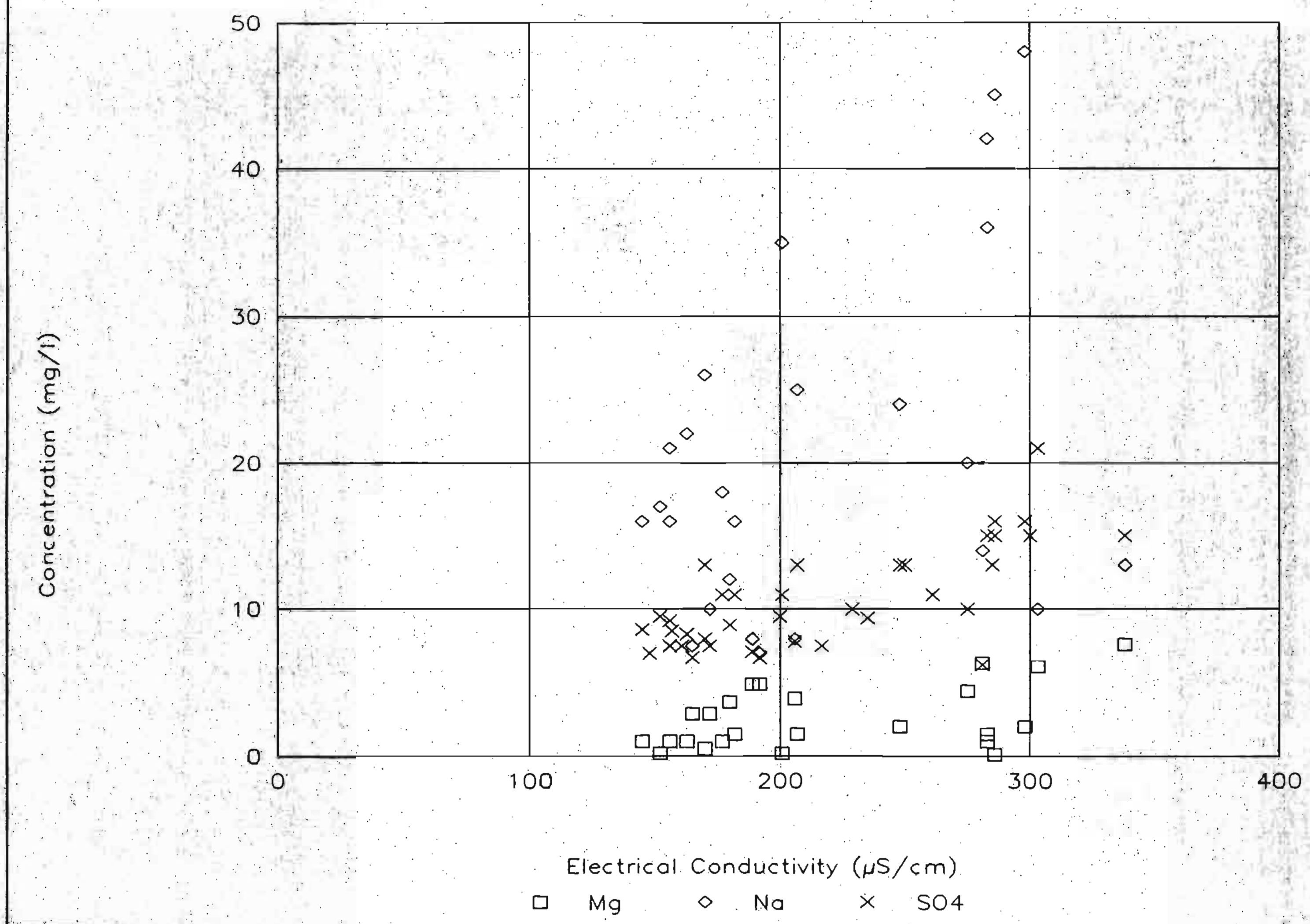


Figure 134. Bishop-Warm Springs Wells Magnesium, Sodium, and Sulfate as a Function of Conductivity.

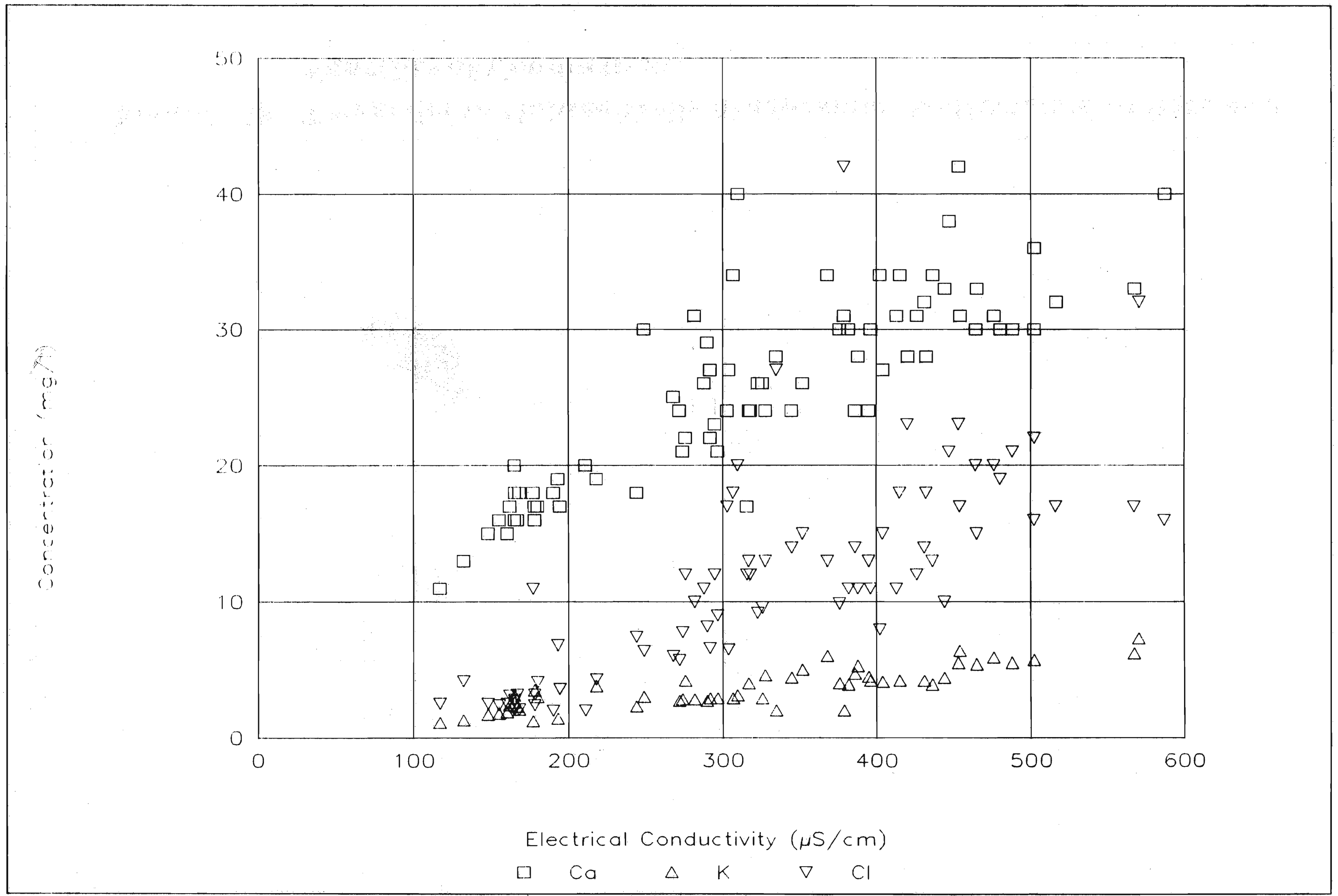


Figure 135. Big Pine-Crater Mountain Wells Calcium, Potassium, and Chloride as a Function of Conductivity.

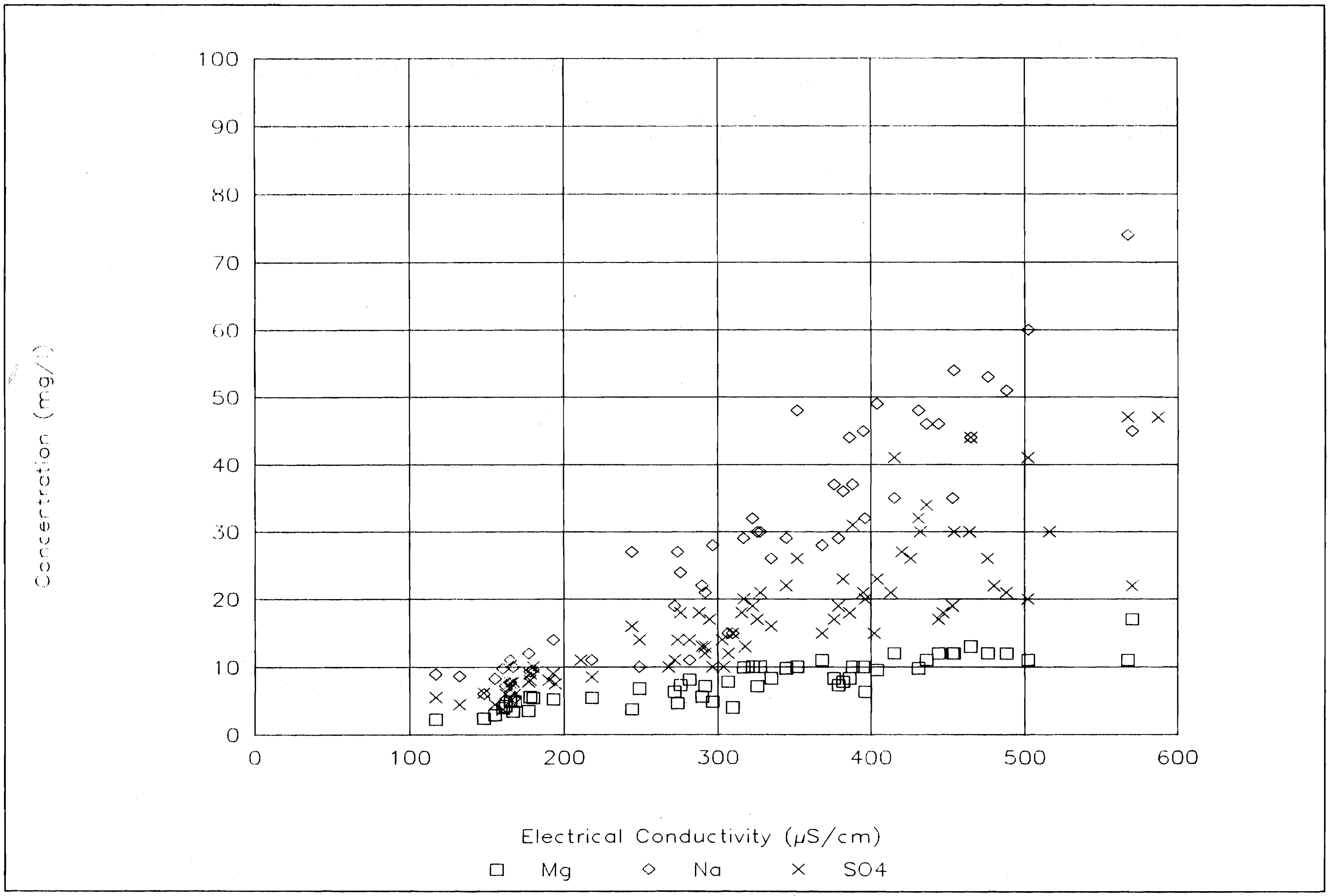


Figure 136. Big Pine-Crater Mountain Wells Magnesium, Sodium, and Sulfate as a Function of Conductivity.

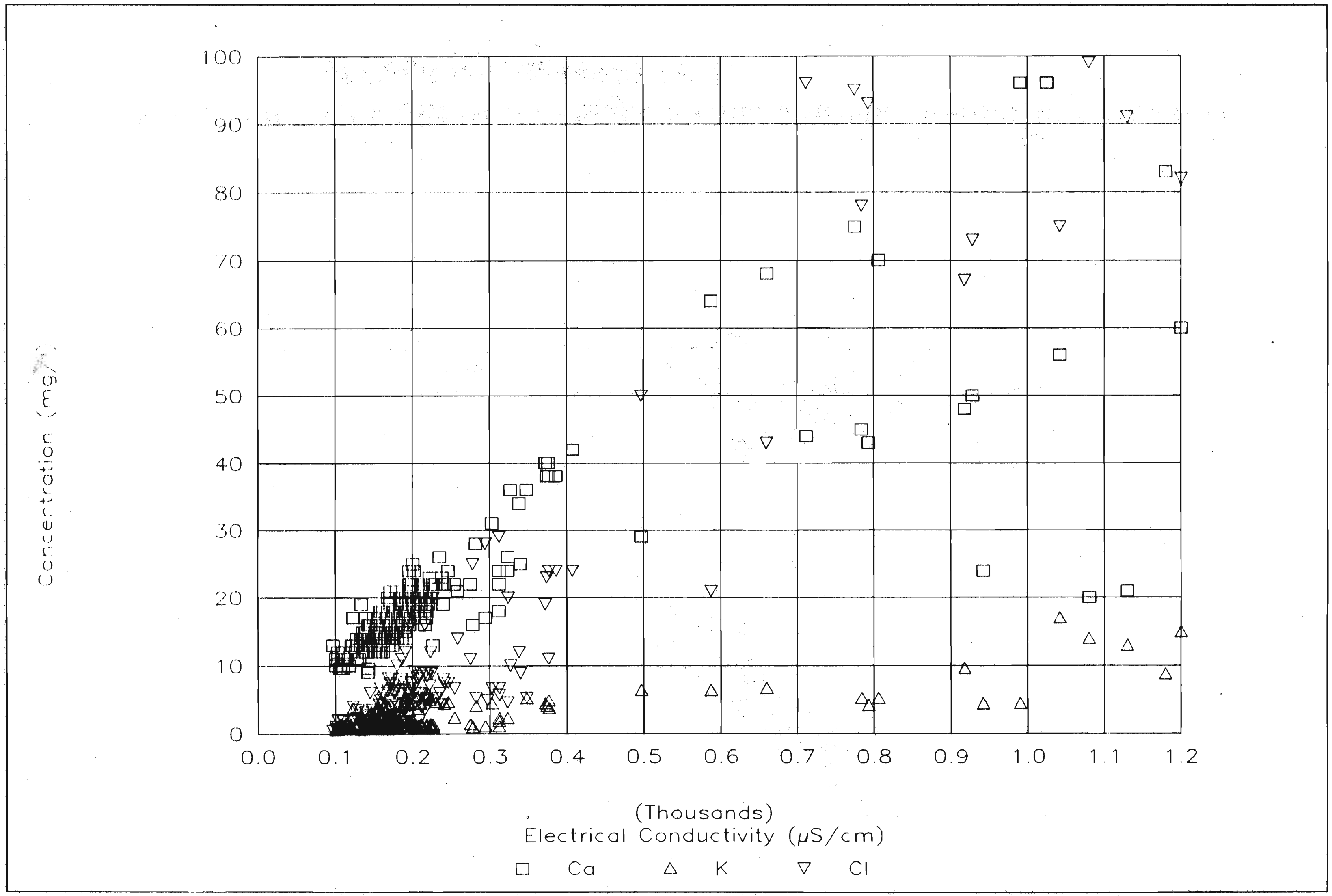


Figure 137. Tinemaha to Haiwee Wells Calcium, Potassium, and Chloride as a Function of Conductivity.

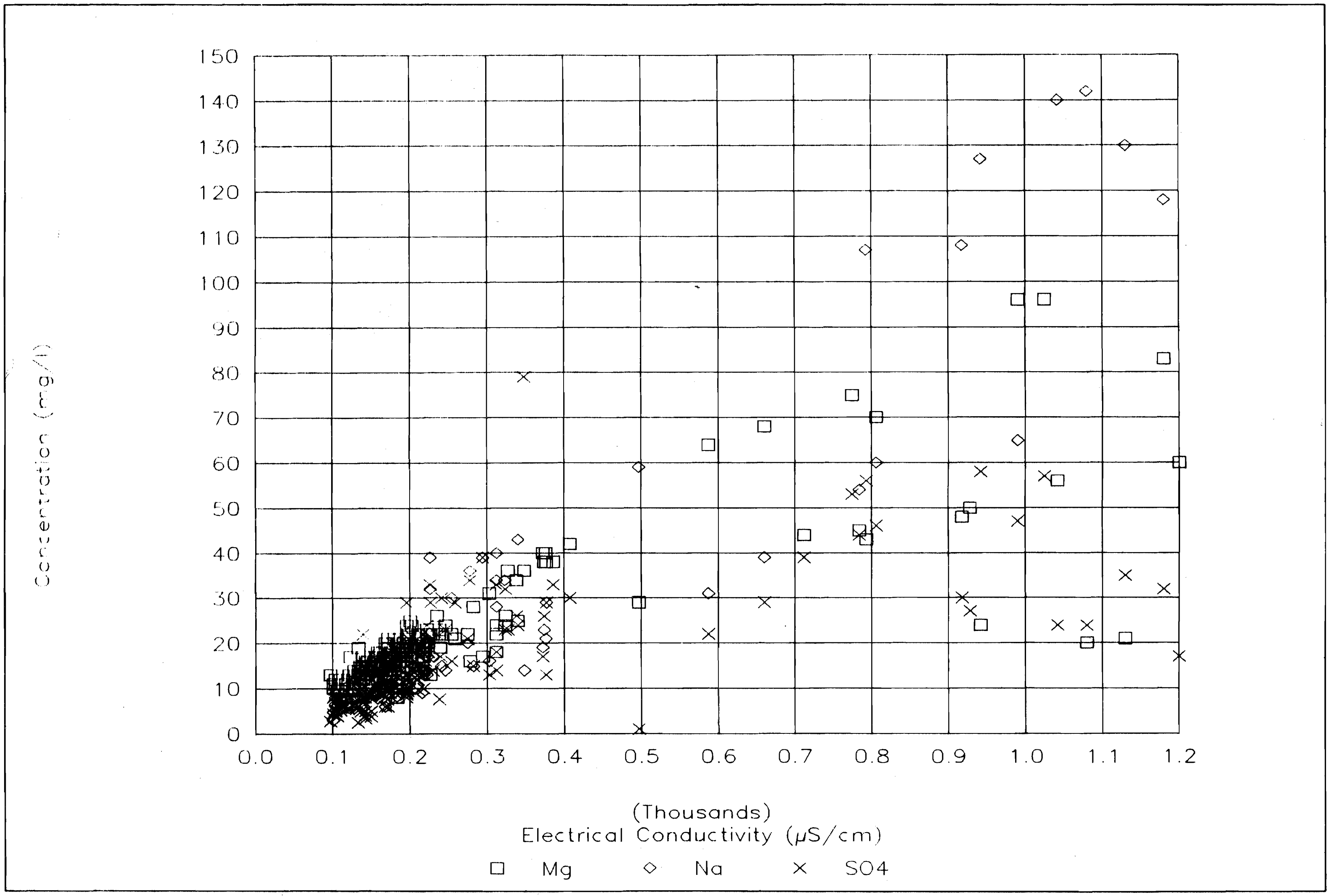


Figure 138. Tinemaha to Haiwee Wells Magnesium, Sodium, and Sulfate as a Function of Conductivity.

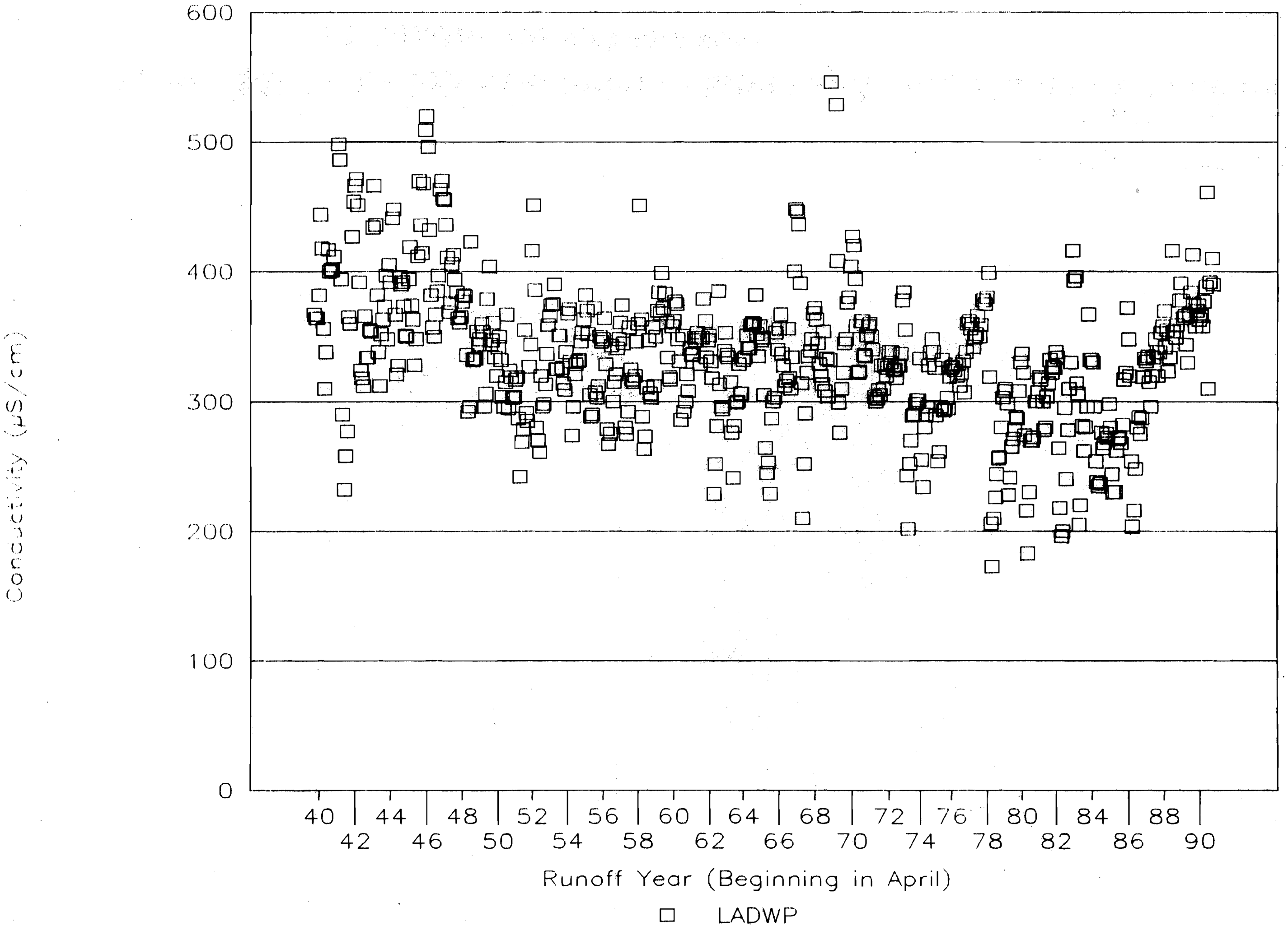


Figure 139. LAA Filtration Plant Conductivity (1940-1991).

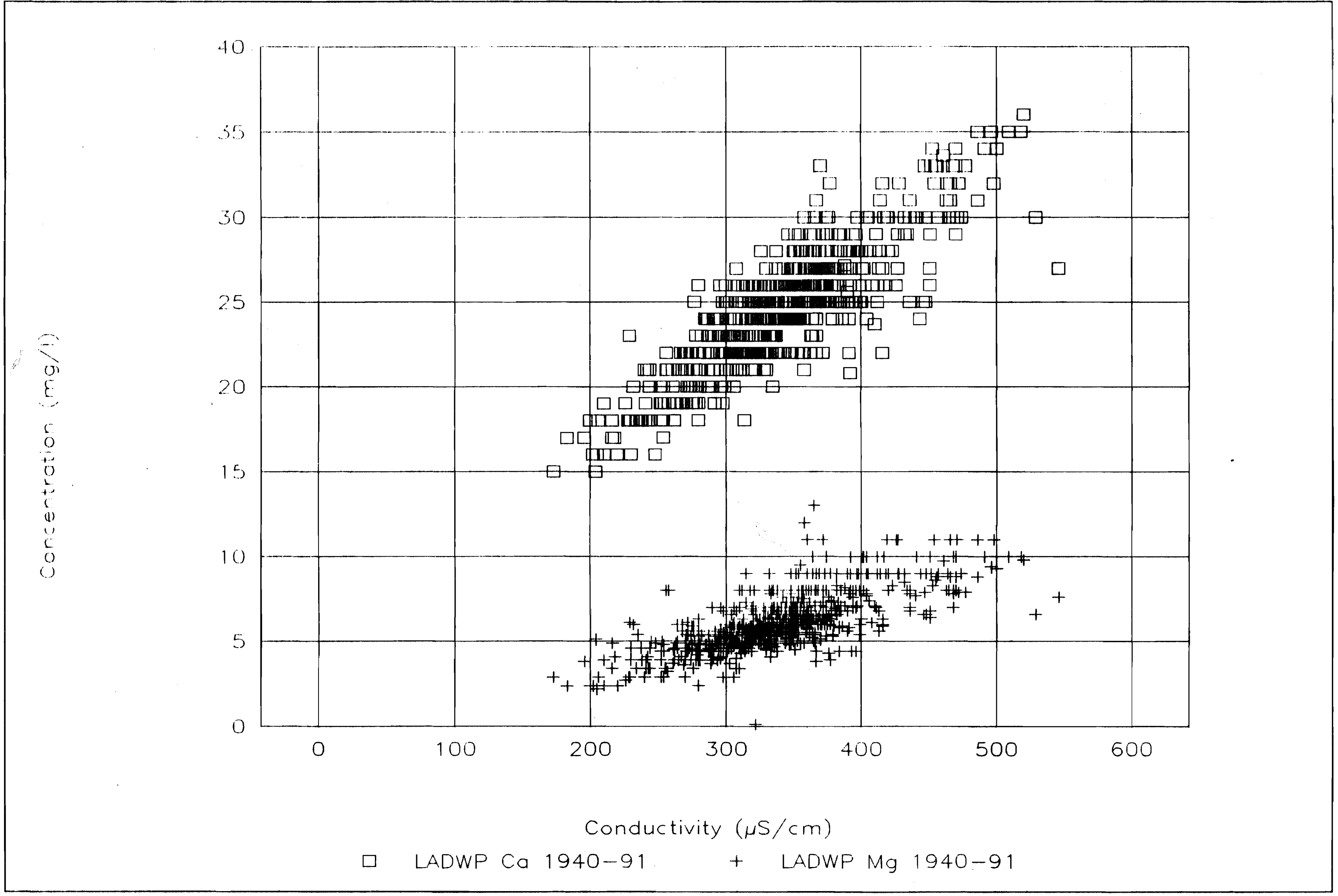


Figure 140. LAA Filtration Plant Calcium and Magnesium as a Function of Conductivity (1940-1991).

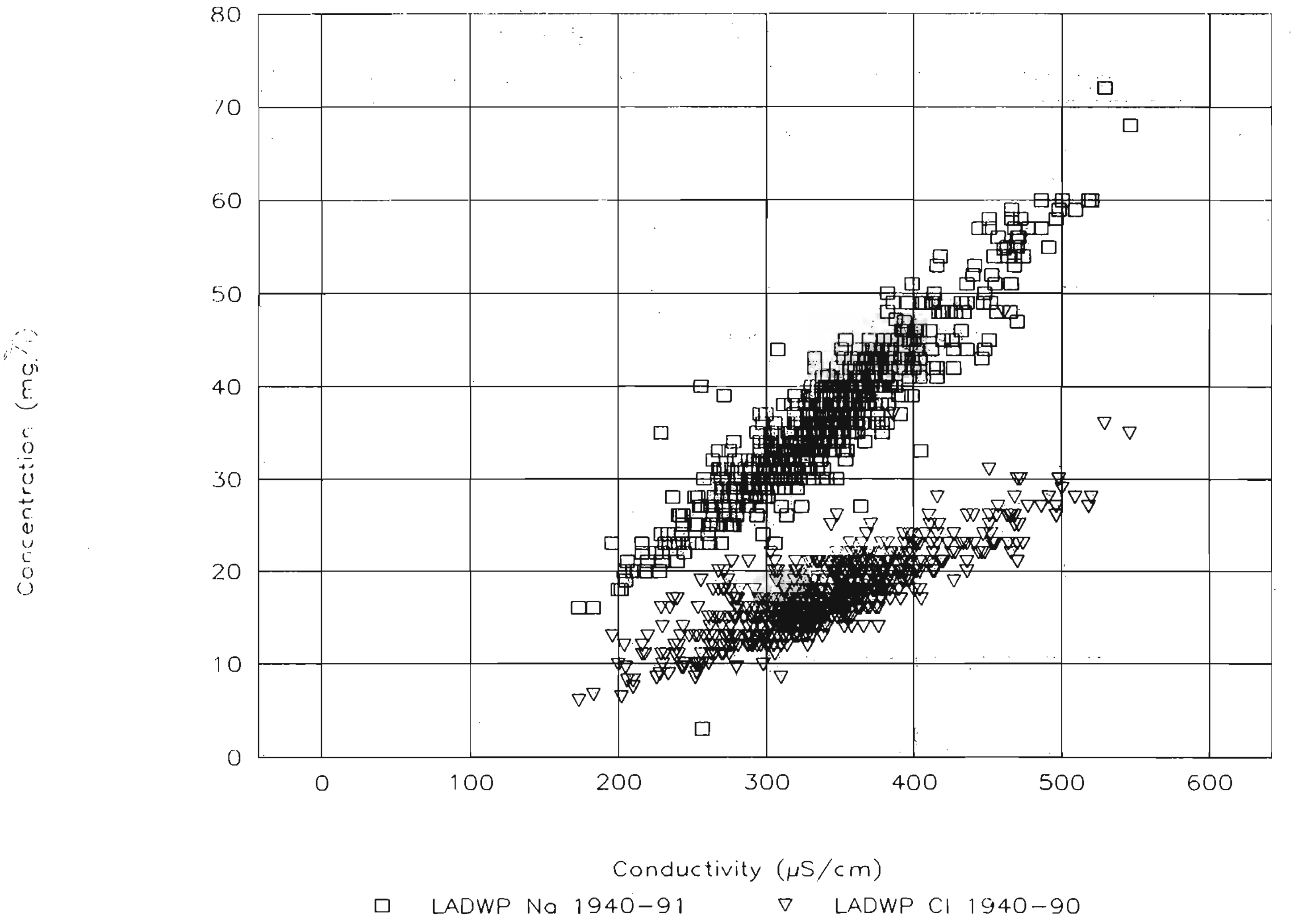


Figure 141. LAA Filtration Plant Sodium and Chloride as a Function of Conductivity (1940-1991).

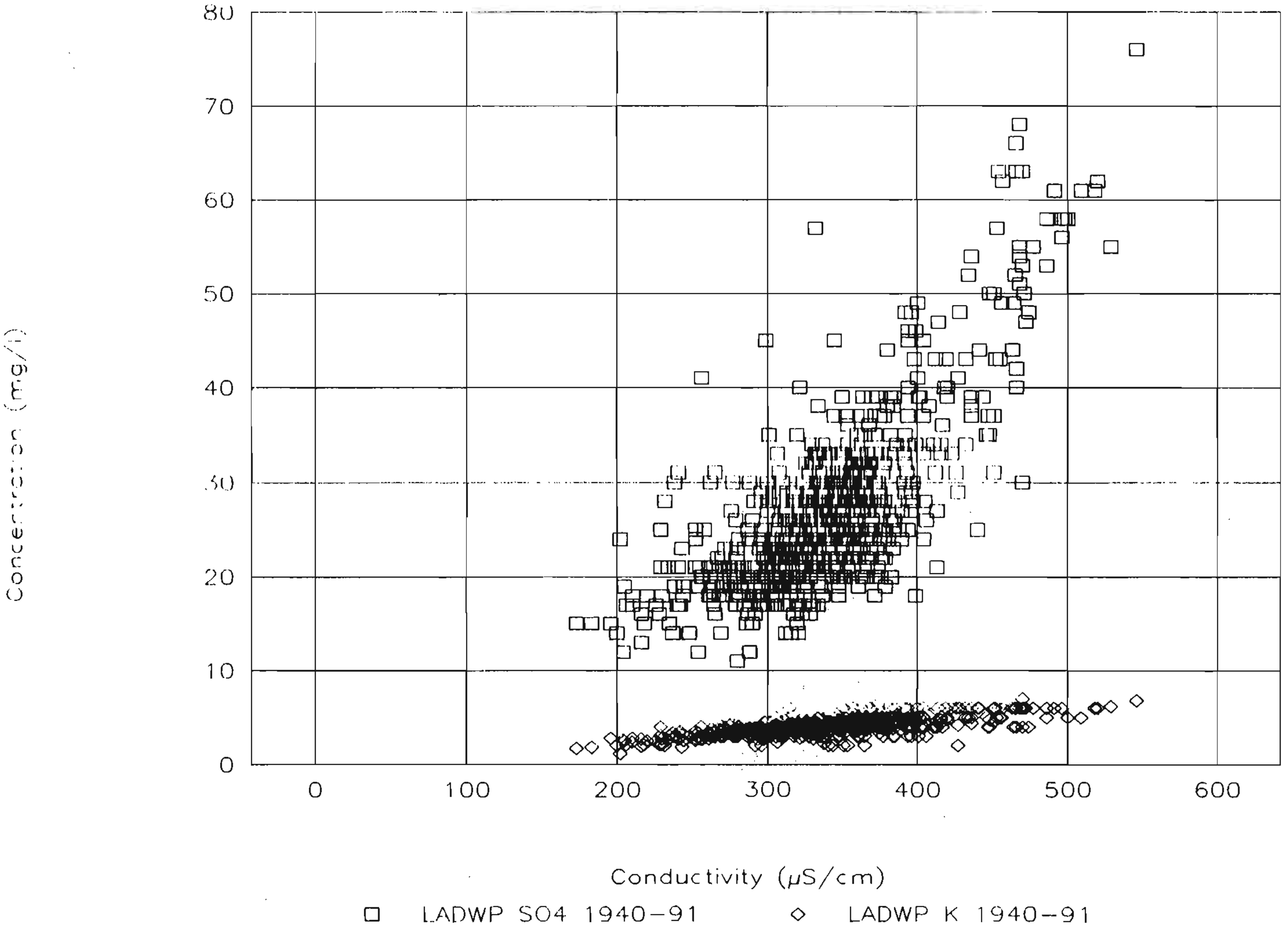


Figure 142. LAA Filtration Plant Sulfate and Potassium as a Function of Conductivity (1940-1991).

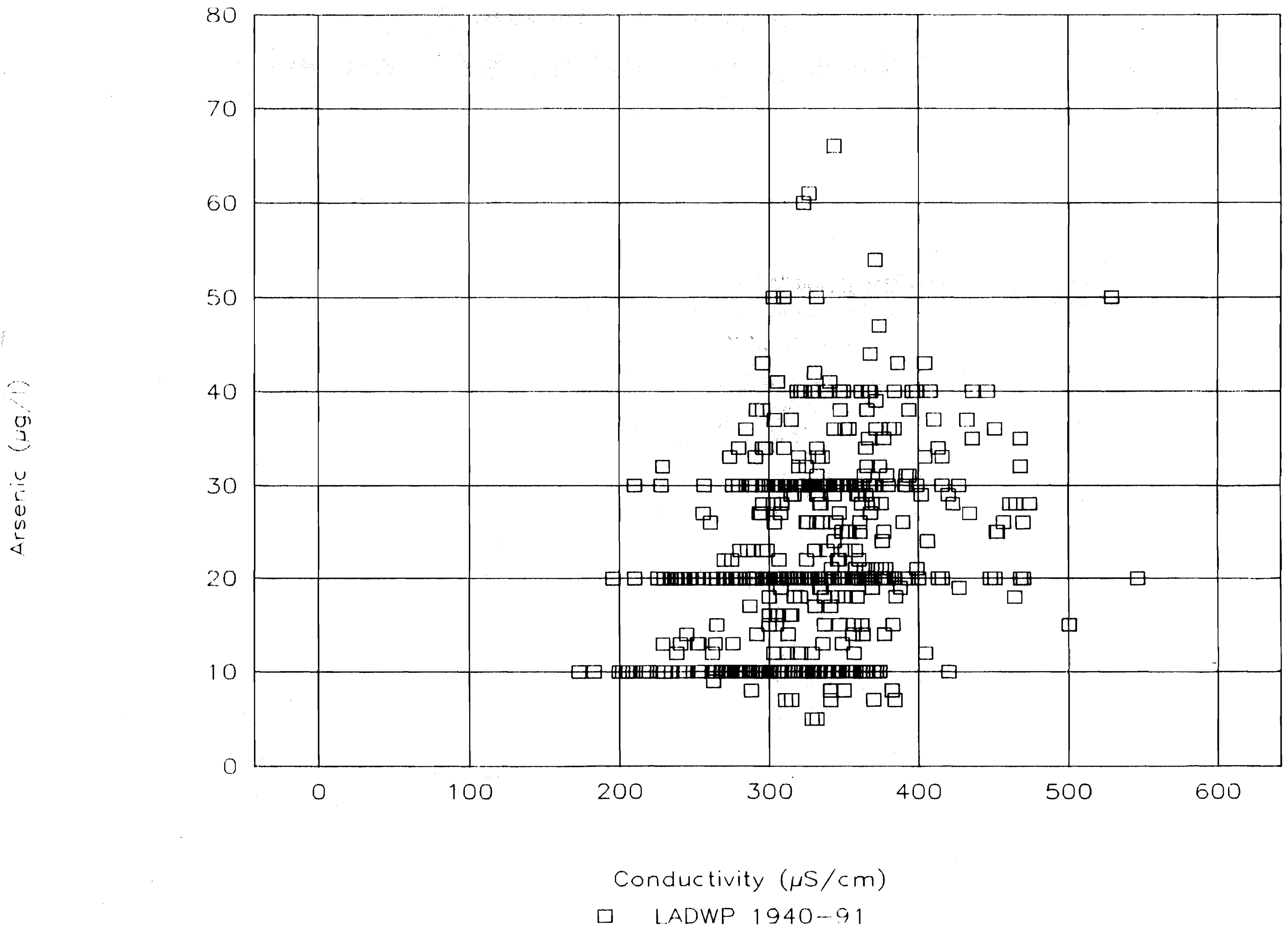


Figure 143. LAA Filtration Plant Arsenic as a Function of Conductivity (1940-1991).

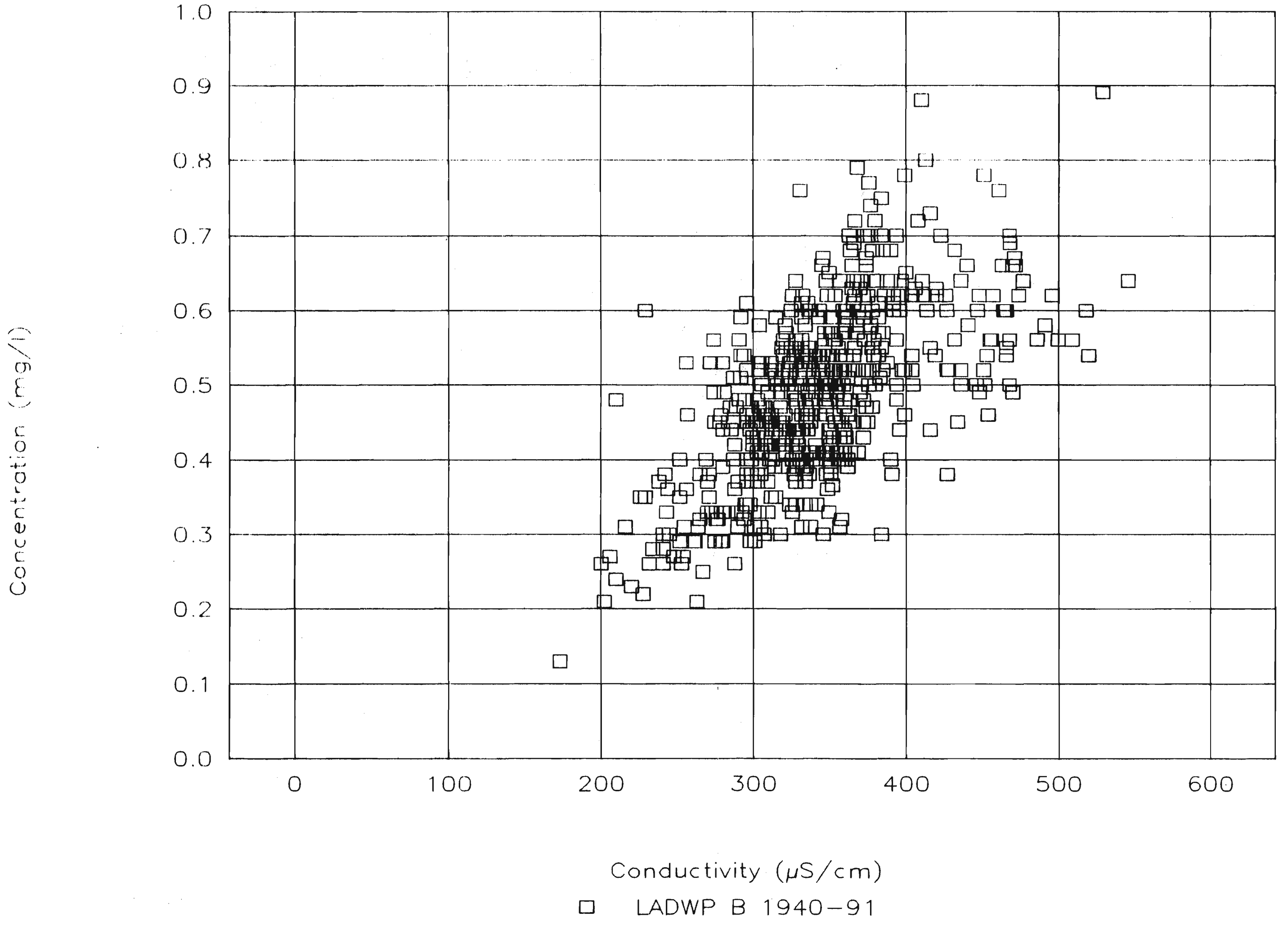


Figure 144. LAA Filtration Plant Boron as a Function of Conductivity (1940-1991).

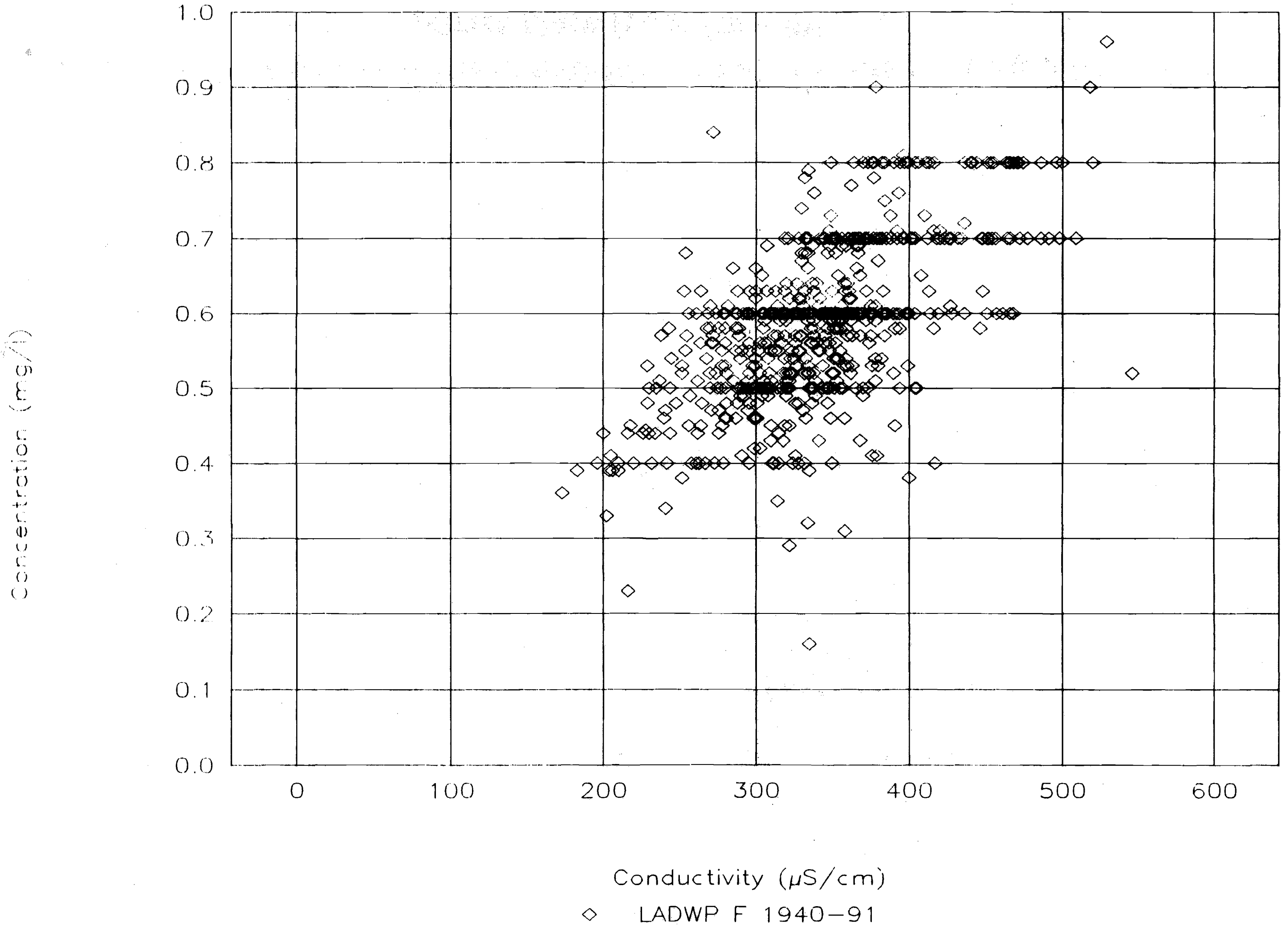


Figure 145. LAA Filtration Plant Fluoride as a Function of Conductivity (1940-1991).

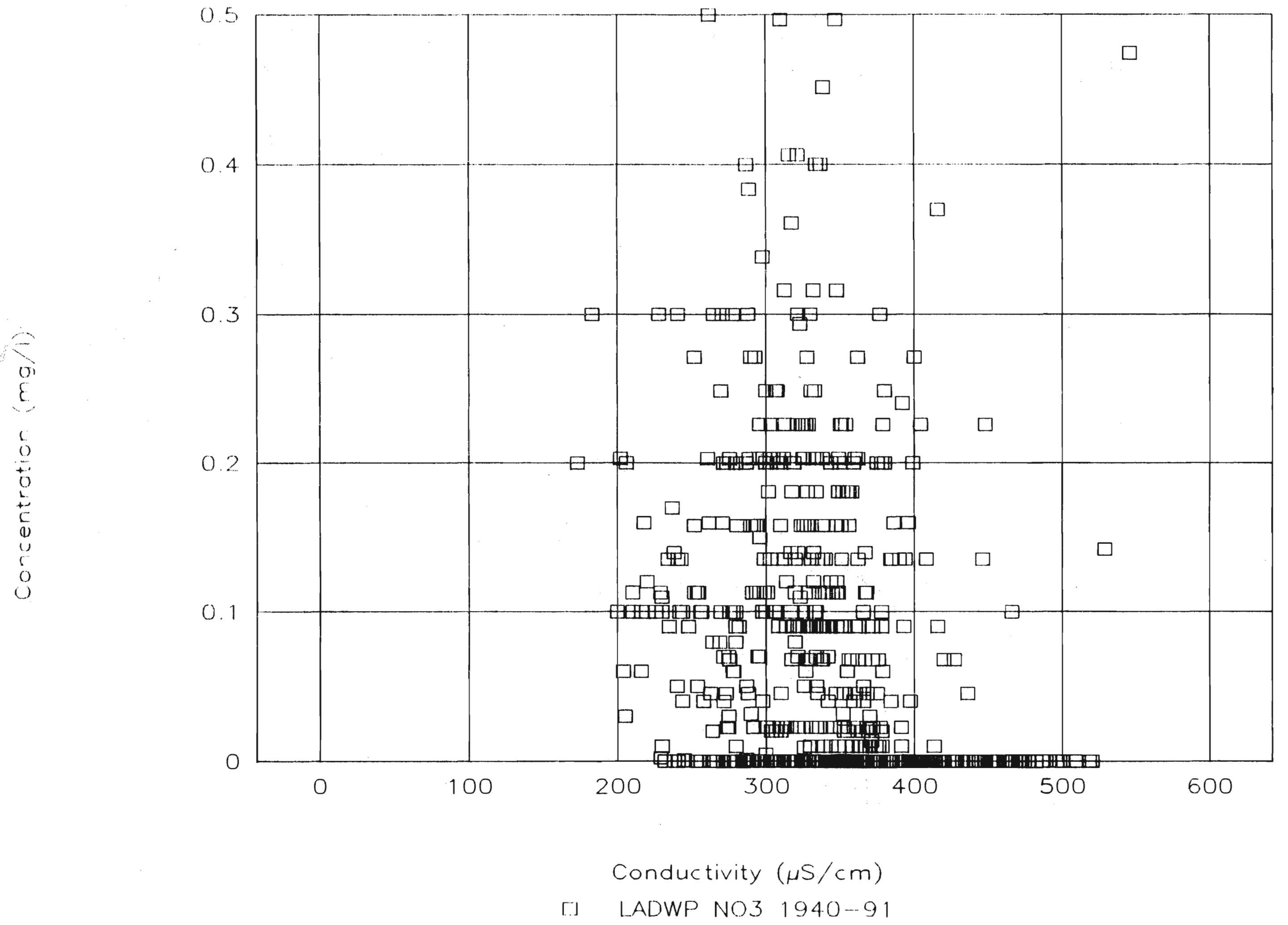


Figure 146. LAA Filtration Plant Nitrate as a Function of Conductivity (1940-1991).

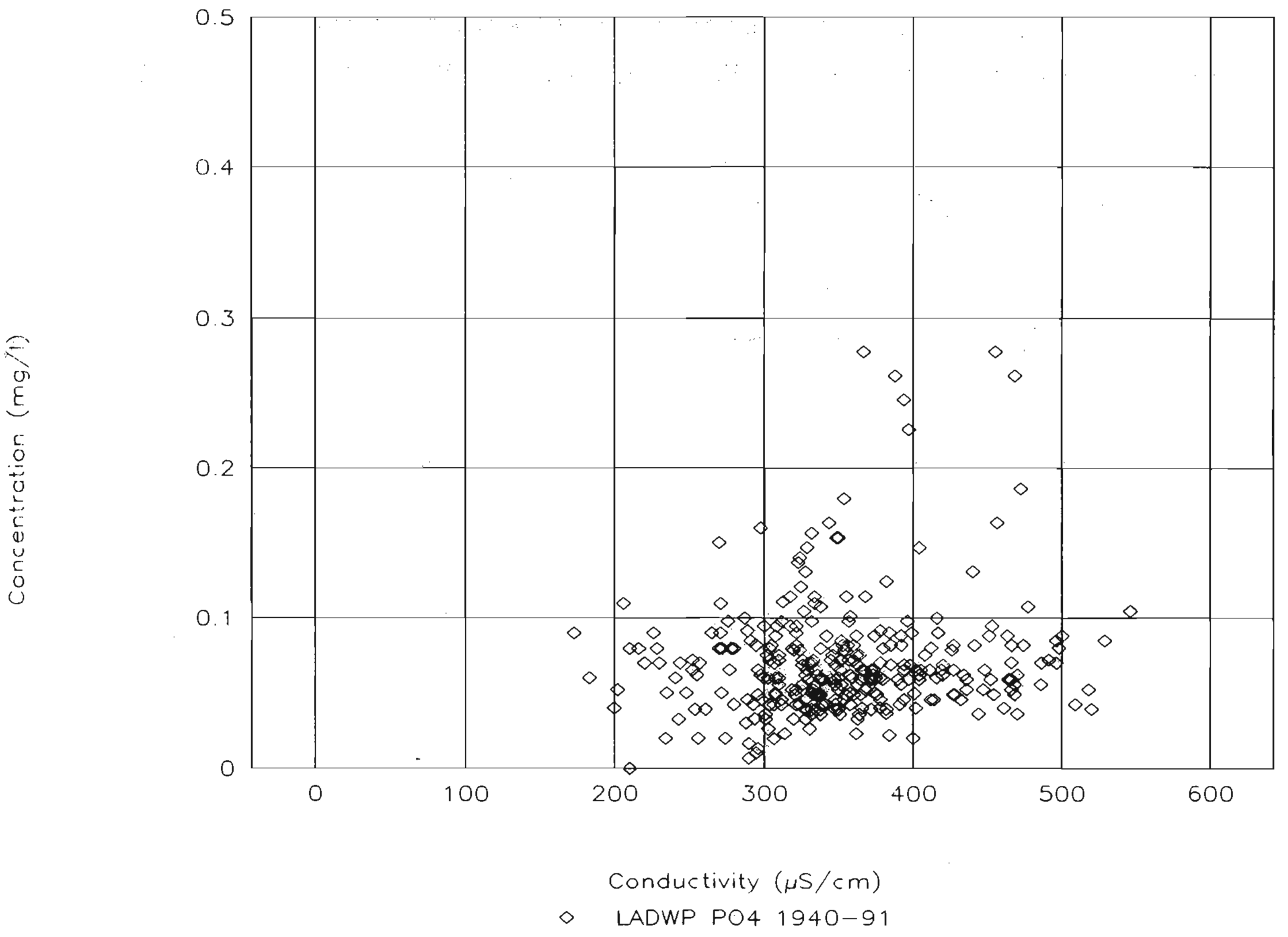


Figure 147. LAA Filtration Plant Phosphate as a Function of Conductivity (1940-1991).

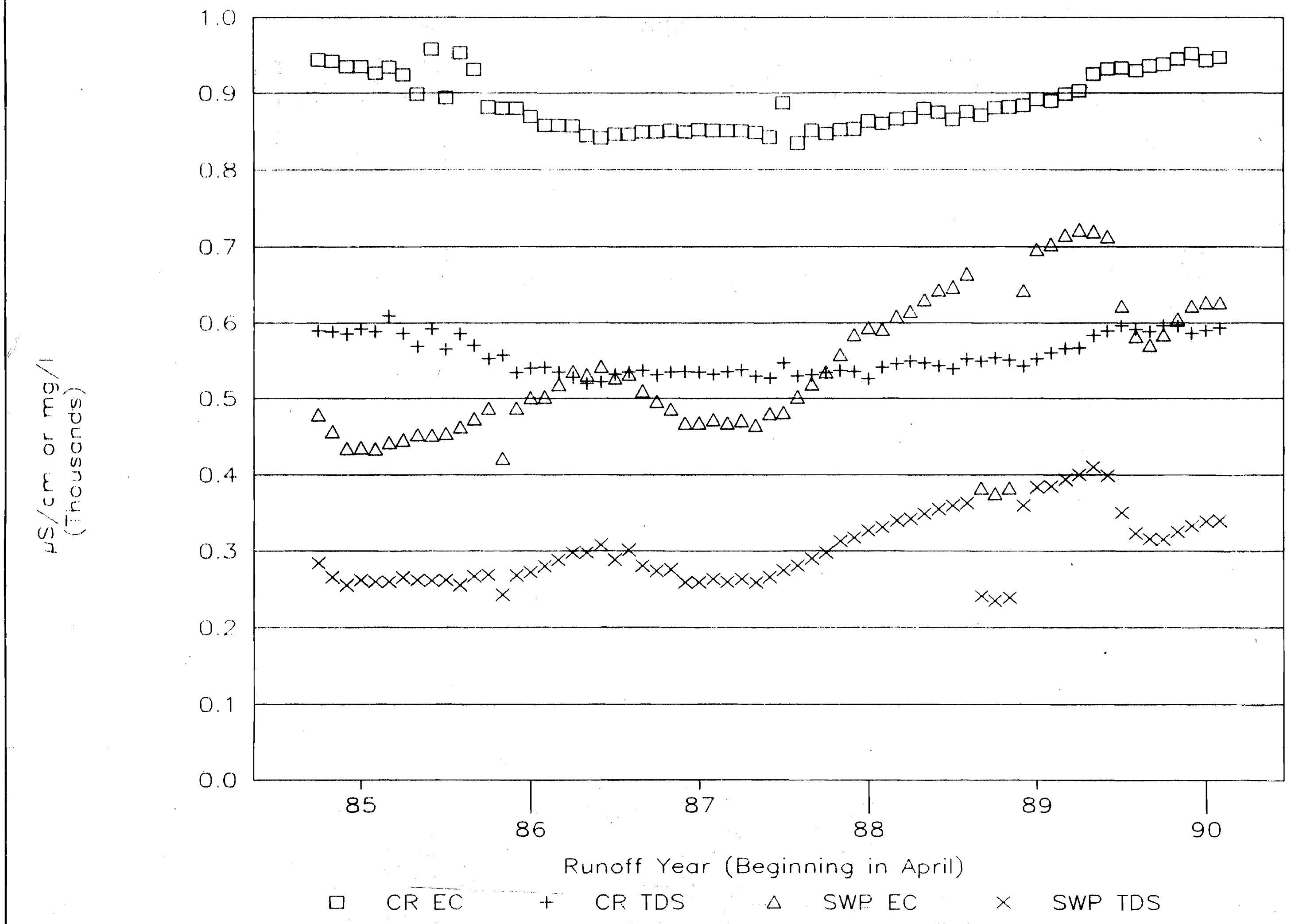


Figure 148. Colorado River and State Water Project Conductivity (Metropolitan Water District Data from Runoff Years 1985-1990).

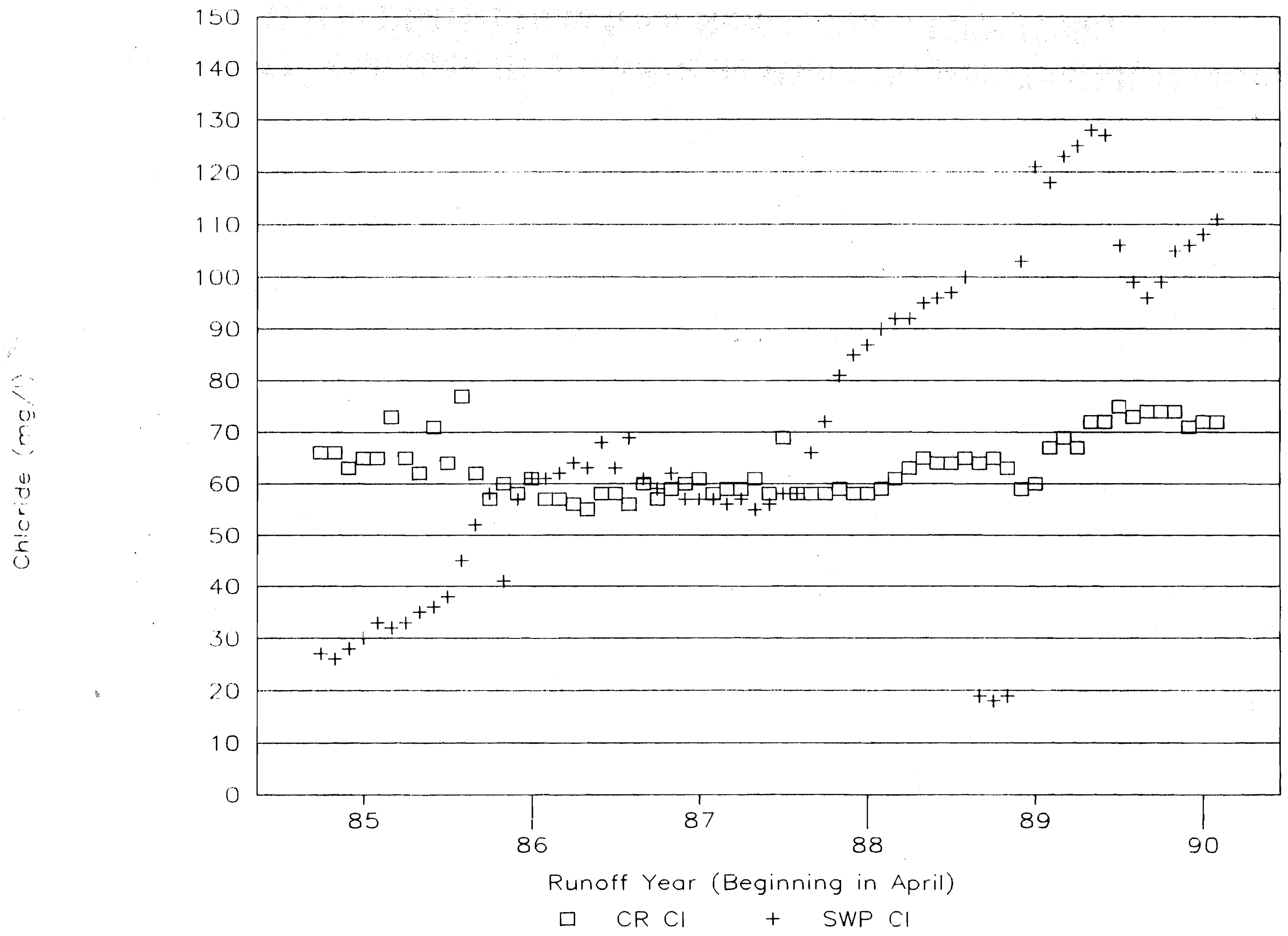


Figure 149. Colorado River and State Water Project Chloride (Metropolitan Water District Data from Runoff Years 1985-1990).

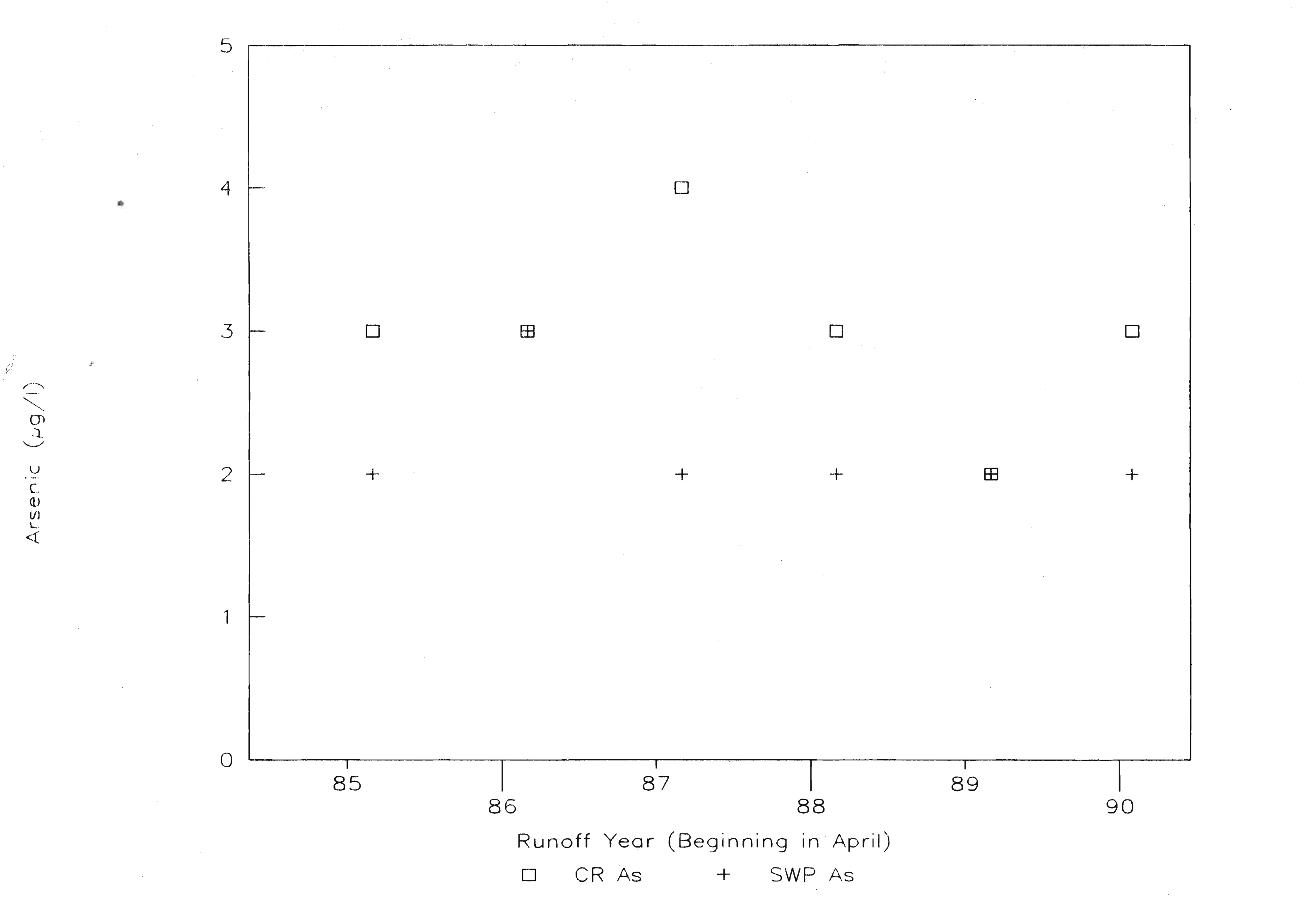


Figure 150. Colorado River and State Water Project Arsenic (Metropolitan Water District Data from Runoff Years 1985-1990).

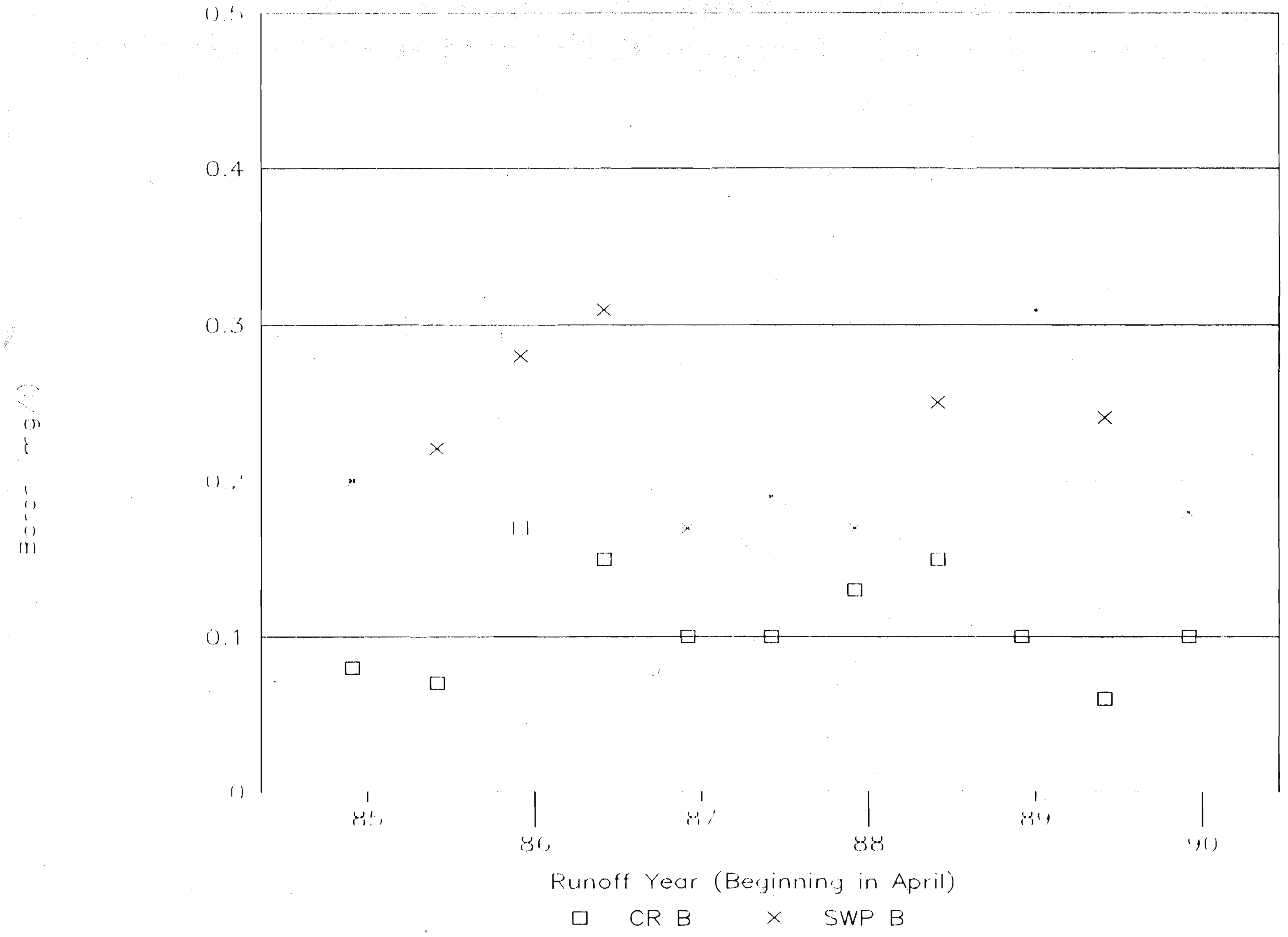


Figure 151. Colorado River and State Water Project Boron (Metropolitan Water District Data from Runoff Years 1985-1990).

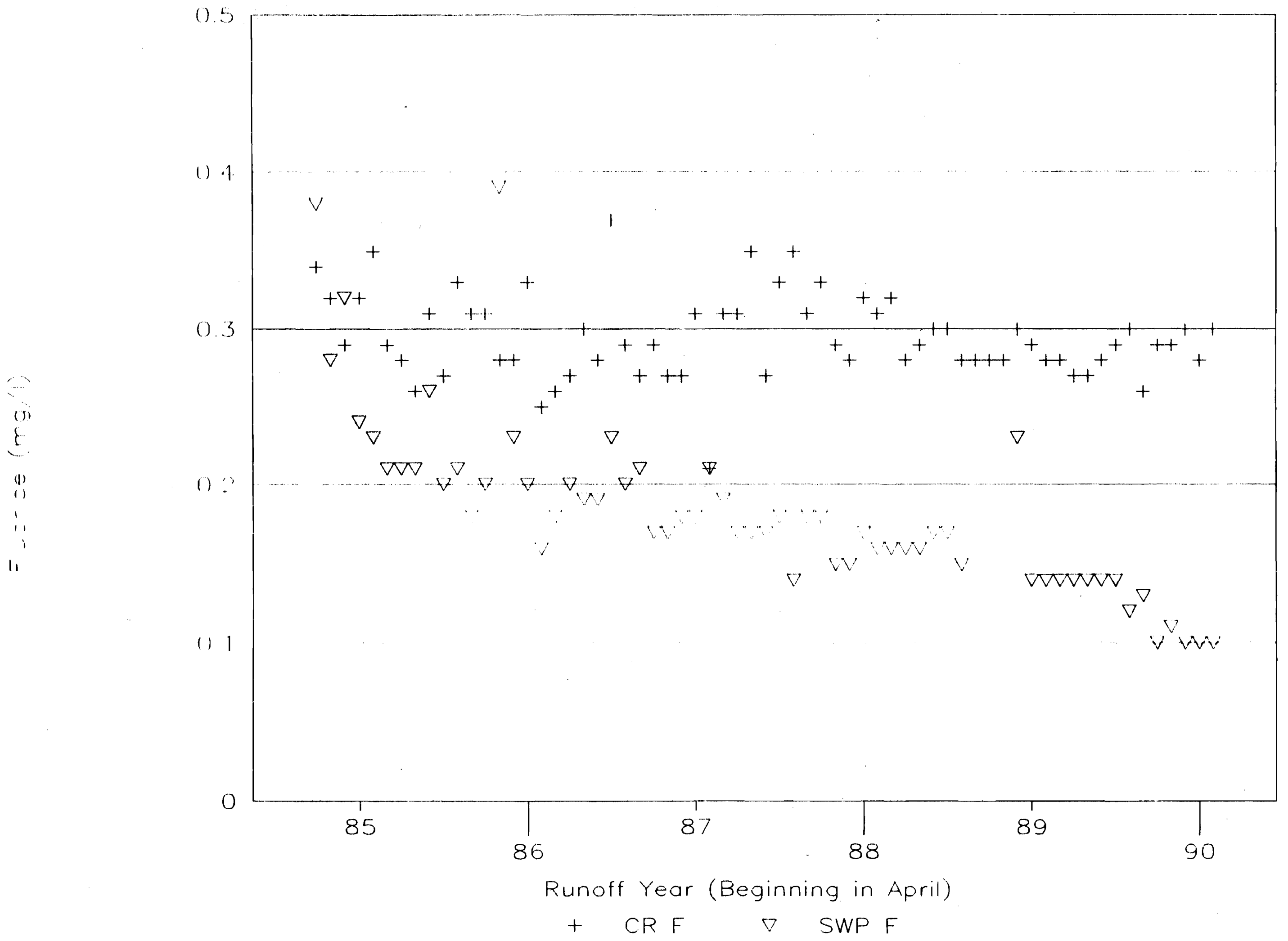


Figure 152. Colorado River and State Water Project Fluoride (Metropolitan Water District Data from Runoff Years 1985-1990).

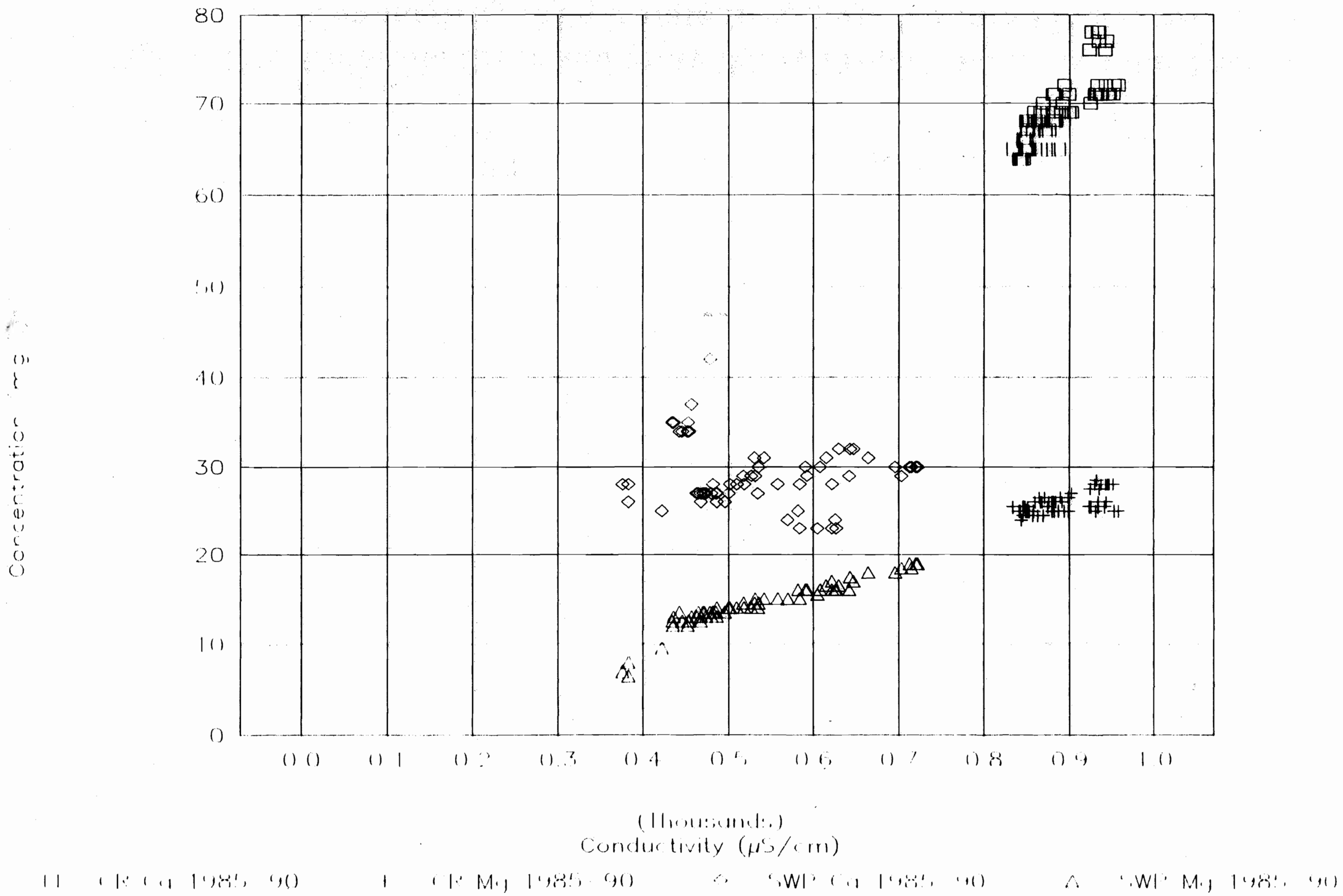


Figure 153. Colorado River and State Water Project Calcium and Magnesium as a Function of Conductivity (MWD Data from Runoff Years 1985-1990).

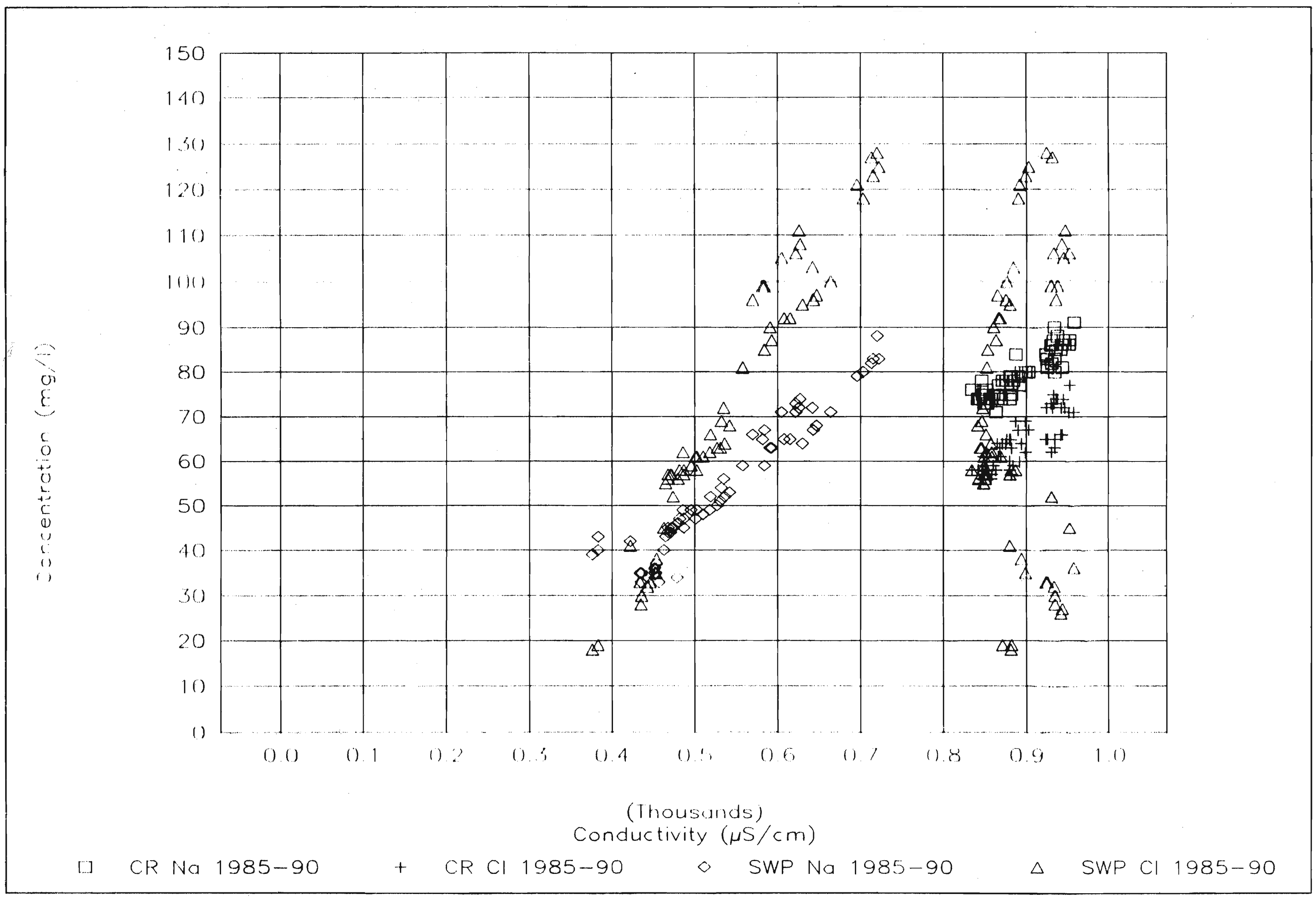


Figure 154. Colorado River and State Water Project Sodium and Chloride as a Function of Conductivity (MWD Data from Runoff Years 1985-1990).

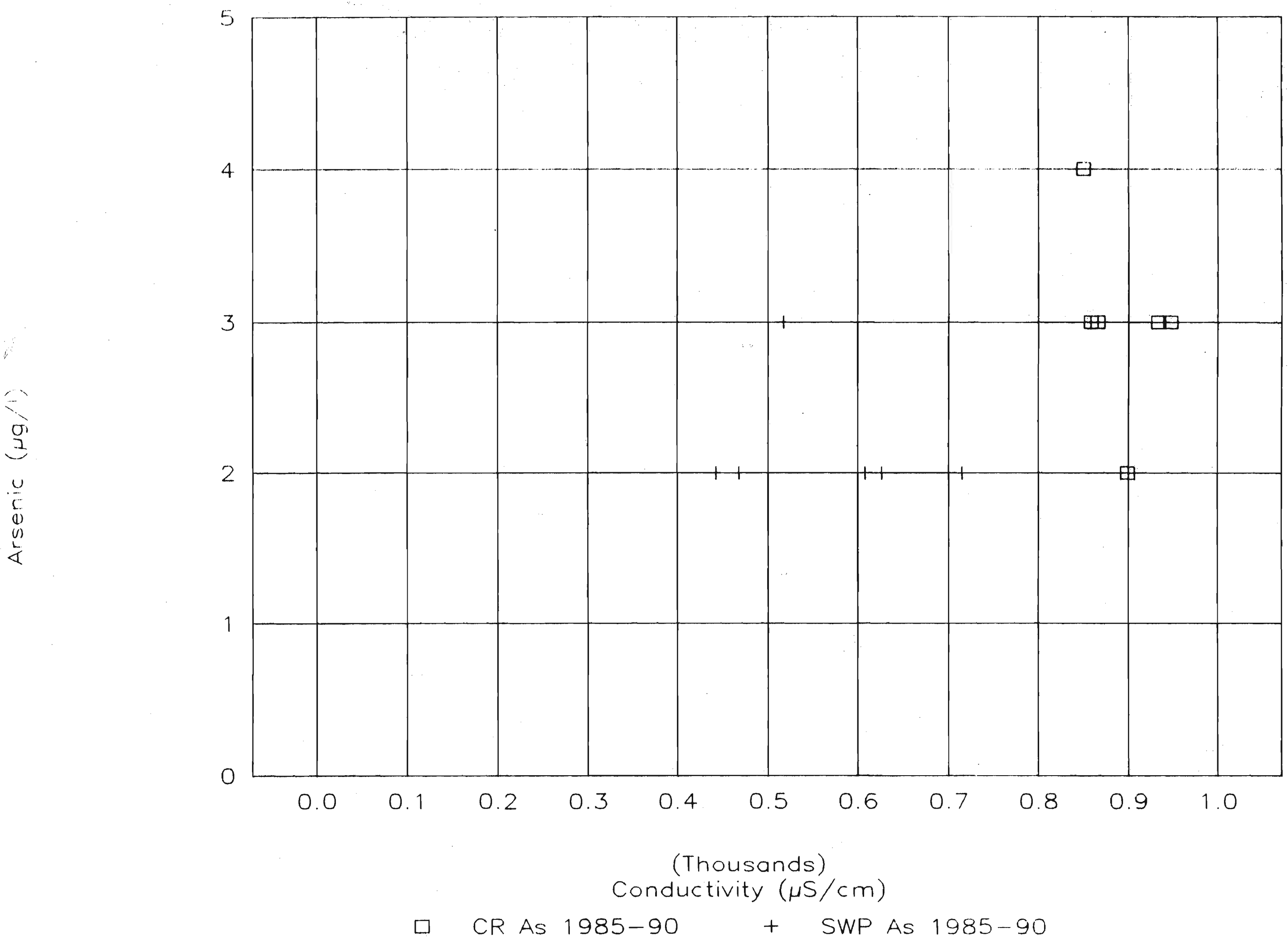


Figure 155. Colorado River and State Water Project Arsenic as a Function of Conductivity (MWD Data from Runoff Years 1985-1990).

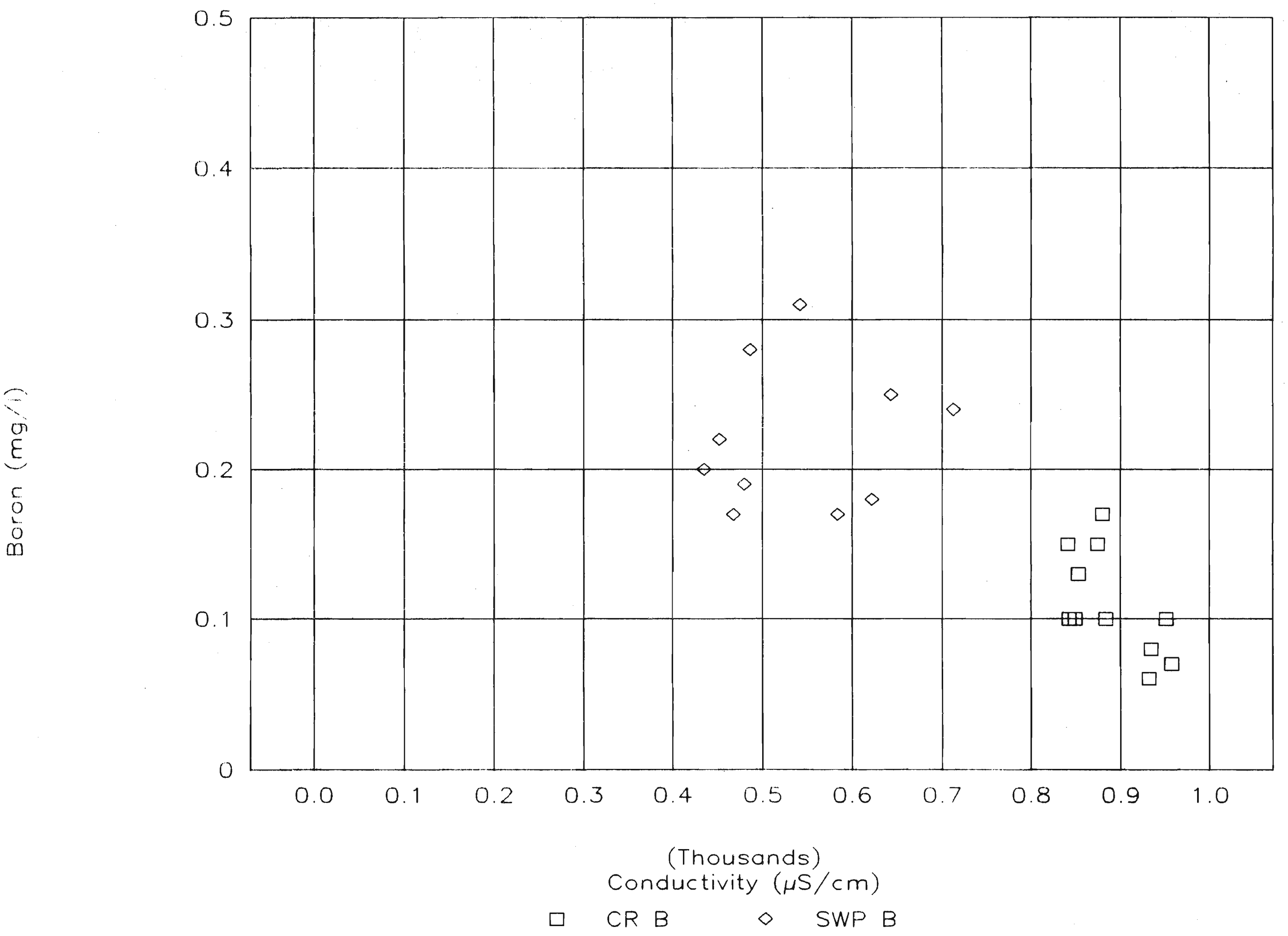


Figure 156. Colorado River and State Water Project Boron as a Function of Conductivity (MWD Data from Runoff Years 1985-1990).

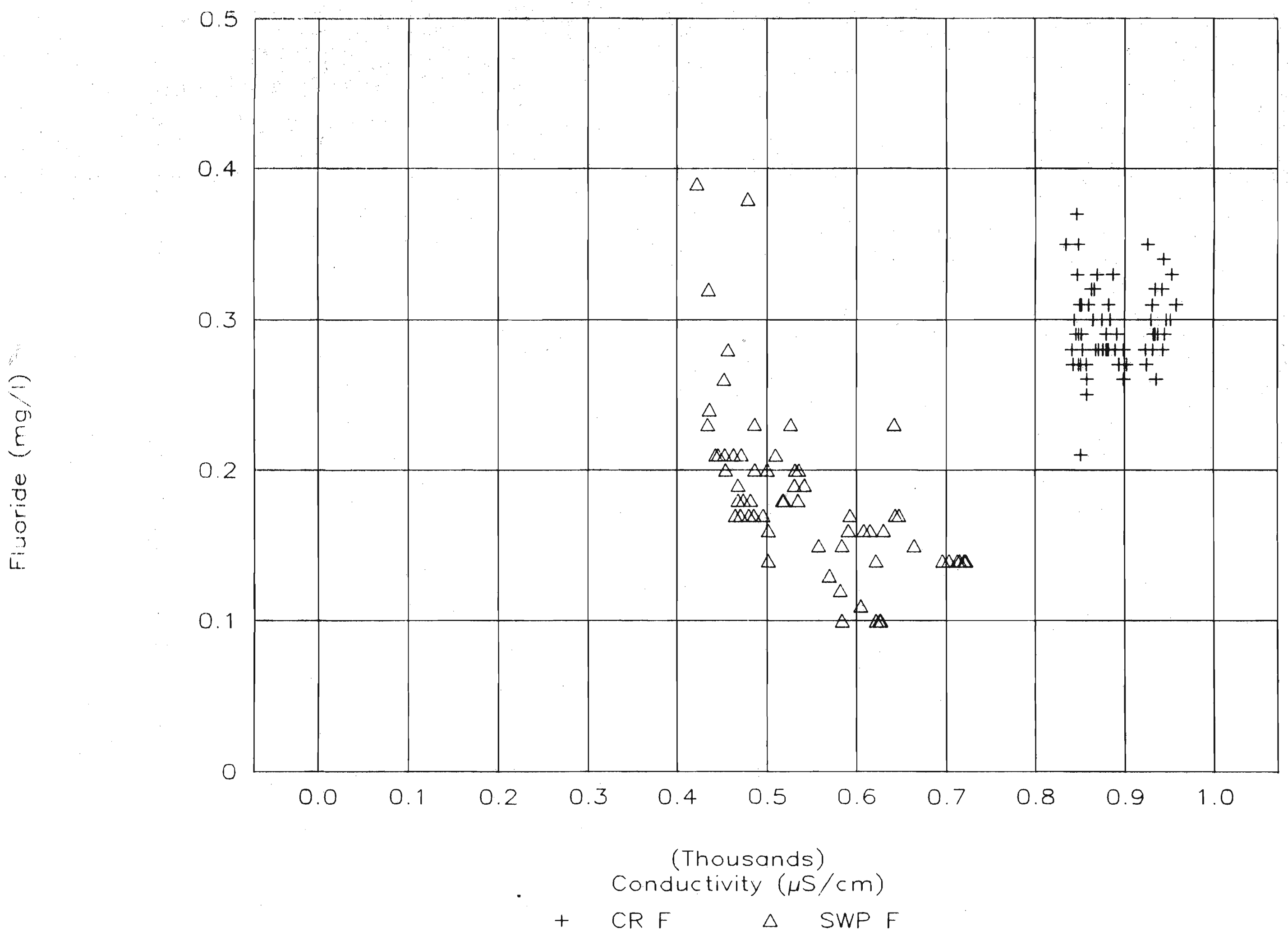


Figure 157. Colorado River and State Water Project Fluoride as a Function of Conductivity (MWD Data from Runoff Years 1985-1990).