Quality of Water Conchas Reservoir New Mexico 1939–49

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By JOHN D. HEM

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QUALITY OF WATER OF CONCHAS RESERVOIR, N. MEX., 1939–49

By John D. Hem

ABSTRACT

Conchas Reservoir is formed by Conchas Dam which is located on the Canadian River in San Miguel County in northeastern New Mexico. Storage in the reservoir began in December 1938. At the level of the spillway in the main dam (pool elevation, 4,201 feet), the reservoir has a capacity of 370,000 acre-feet. Water from the reservoir is used on the Tucumcari Project of the Bureau of Reclamation. Construction of canals and laterals on the project, which contains about 45,000 acres, was completed in 1949.

Samples for chemical analysis were collected from Canadian and Conchas Rivers for a time in 1936 during construction of the dam. After storage began, samples of inflow and stored water were collected for chemical analysis from April 1939 to July 1949. During the period of record, the water of Canadian River ranged in dissolved solids concentration from 133 parts per million September 22, 28–29, 1941, to 2,320 parts per million July 10–11, 1943. Water stored in the reservoir ranged in dissolved solids from about 320 to about 800 parts per million after a volume of stored water of 25,000 acre-feet was first attained. In general the predominant anion in the inflow and stored water is sulfate, but of the cations calcium, magnesium, and sodium all are present in significant amounts. At low concentrations the water in Canadian River is of the calcium bicarbonate type. Except during and for some time after periods of excessive inflow, the water in the reservoir is generally well mixed.

The water from Conchas Reservoir is classified as good to permissible in quality for irrigation, based on standards of the United States Department of Agriculture. The water is very hard and rather high in sulfate, but is otherwise satisfactory for domestic use. It is anticipated that with the Tucumcari Project in full operation, greater amounts of water will be used for irrigation in the years following 1949, and a wider range of fluctuation of the quality of stored water than that occurring in the last 6 years of the 1939–49 period, may be experienced.

INTRODUCTION

HISTORY, SCOPE, AND PURPOSE OF THE INVESTIGATION

The studies upon which this report is based were begun in January 1936 near the reservoir site early in the construction period. At that time samples were obtained from Canadian River at several points below its confluence with Conchas River during the first 3 months of the year and also in June and July. No further sampling was done until after storage began in the reservoir at the end of 1938.

Conchas Dam was built as a multiple-purpose project under the control of the Corps of Engineers. The quality-of-water studies were made to determine the suitability of the stored water for irrigation and municipal uses.

Beginning in April 1939, water samples were collected systematically at various locations within the reservoir, and near the end of that year collection of daily samples of inflow from Canadian and Conchas Rivers was begun. Investigations also were begun late in 1939 to determine variations of chemical quality with depth below the water surface within the reservoir. By the middle of 1940, samples were being collected daily from Canadian River at or near the gaging station near Sanchez, and during periods of flow from Conchas River near the gaging station at Variadero. Surface samples were being collected weekly at three points in the reservoir near the dam, and sets of samples were being collected at 2- to 4-month intervals at different depths at these three points and after October 1941 at two other points in the reservoir farther upstream. This program of sampling was continued until the end of the investigation on June 30, 1949.

The quality-of-water studies at Conchas Reservoir provide information on the chemical characteristics of water available from the reservoir and assist in determining the effect of inflowing water at various reservoir stages. This report includes a summary of all previously published analyses and contains all the significant analyses made during the investigation which have not previously been published.

ACKNOWLEDGMENTS

The funds for the quality of water studies were provided by the Corps of Engineers, Department of the Army, and all routine samples were collected by employees of the Corps of Engineers. The investigation was made under the direction of S. K. Love, Chief, Quality of Water Branch, and was under the general supervision of C. S. Howard, Regional Chemist of the Geological Survey. The description of Conchas Dam included in this report is based on an information pamphlet issued by the Albuquerque District, Corps of Engineers, revised in March 1948. The description of the Tucumcari Irrigation Project is based on the Bureau of Reclamation descriptive statement, "The Tucumcari Project, New Mexico, June 1948." The author wishes to express his appreciation to John T. Martin of the Albuquerque District, Corps of Engineers and to Ray J. Lyman, U. S. Bureau of Reclamation, Tucumcari, N. Mex. for making available maps and additional information on Conchas Dam and the Tucumcari Irrigation Project, included in this report. The photograph of Conchas Dam used in preparing plate 6 was furnished by the Corps of Engineers.

Analyses were made in the laboratories of the Geological Survey at Washington, D. C., Roswell, N. Mex., and Albuquerque, N. Mex., by V. E. Arnold, J. P. Bertino, W. W. Brannock, A. W. Carlson, T. Downer, W. I. Ettleman, I. M. Gutierrez, J. L. Hatchett, J. D. Hem, C. S. Howard, L. S. Hughes, R. T. Kiser, M. E. Krausnick, W. L.

Lamar, E. W. Lohr, W. L. Minton, W. M. Noble, C. D. Orcutt, M. D. Reeves, H. R. Simms, S. A. Simpson, G. R. Stewart, N. Talvitie, H. B. Waha, Jr., W. F. White, and E. F. Williams.

DESCRIPTION OF CANADIAN RIVER BASIN

Canadian River rises in northern Colfax County, N. Mex., west of Raton, flows generally south-southeastward to Conchas Dam in southeastern San Miguel County; thence it flows eastward across Quay County into Texas. The river and its tributaries drain an area of 7,327 square miles above Conchas Dam. Except for a few square miles in Colorado near Raton, all the drainage area above the dam is in New Mexico. The entire basin of Canadian River above the New Mexico-Texas line is shown on the base map, figure 11.

The principal tributaries of the river above Conchas Dam rise in the Sangre de Cristo Mountains and in smaller ranges along the western edge of the basin. Among the more important tributaries from the west are Vermejo, Cimarron, and Mora Rivers, and Ocate Creek, all of which are perennial streams. Conchas River enters the reservoir from the west but rises in an area of comparatively low elevation and is intermittent. All tributaries of Canadian River from the east above the reservoir are small ephemeral or intermittent streams.

The maximum altitudes reached in the Sangre de Cristo range are more than 13,000 feet, but only a few peaks within the basin rise above 12,000 feet. Most of the area of the basin above Conchas Dam comprises plains and remnants of plains at various levels. The altitude of most of this part of the basin is from 4,200 to 7,000 feet. The altitude of the river bed at the dam is 4,050 feet.

The climate of the basin is characterized by abundant sunshine, low humidity, and considerable wind movement. Climatic conditions within the basin are influenced considerably by differences in altitude, with short cool summers and long periods of winter cold at the highest elevations, and long warm summers with only short periods of cold weather in winter in the lower plains area. In much of the mountain area annual precipitation averages more than 20 inches, a large part of which is received in the form of snow. The major tributaries of Canadian River receive much of their runoff from the slopes of the high mountains. Most of the precipitation on the plains area is received in the form of local summer thundershowers, some of which are violent and cause flash floods in normally dry stream channels. The mean annual precipitation at Tucumcari is 16.42 inches, which probably represents about the normal amount for the plains area of the basin. Evaporation from a Weather Bureau type of land pan at Conchas Dam averaged 98.29 inches annually for a 12-year period ending in 1949.

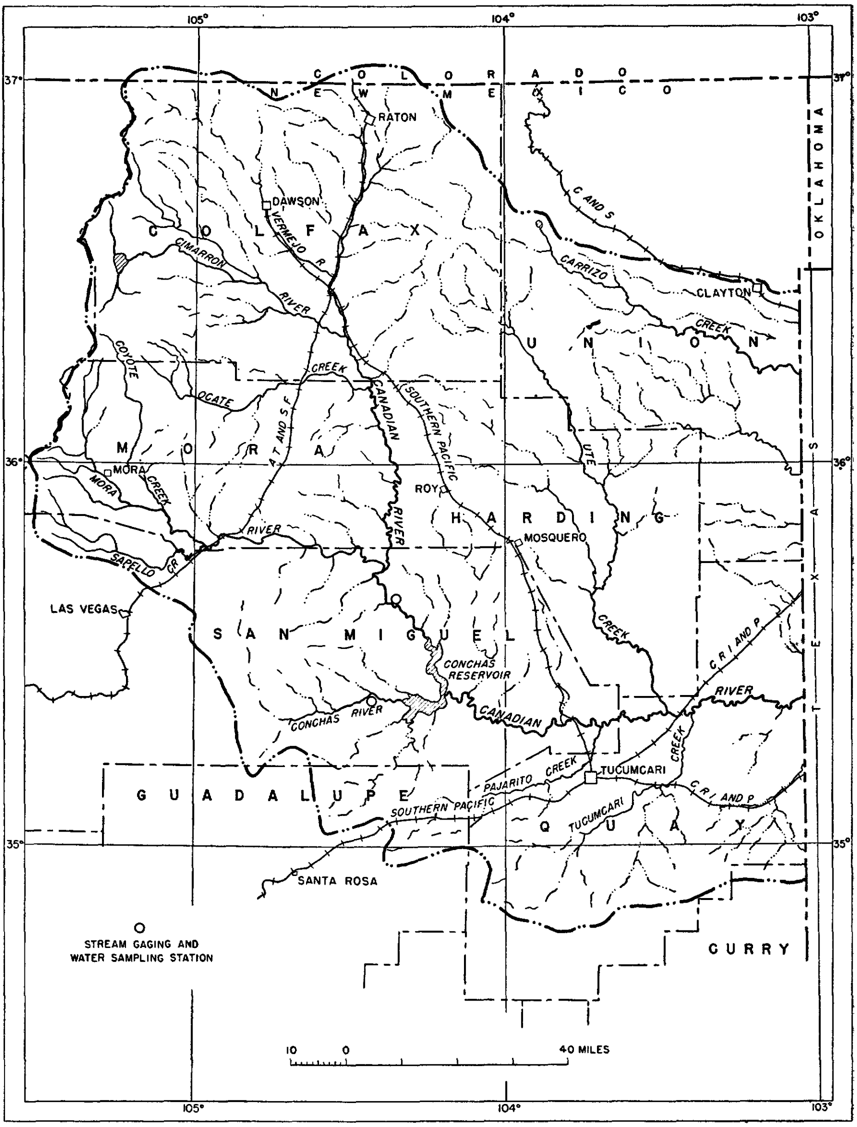

FIGURE 11.—Map of Canadian River basin.

The principal cities of the Canadian River basin in New Mexico are Raton, (pop. 7,927), Tucumcari, (pop. 8,369), and Clayton, (pop. 3,268). Of these cities only Raton is in that part of the basin above Conchas Dam, but Tucumcari is in the center of a large area irrigated with water from Conchas Reservoir.

The basin of Canadian River in New Mexico is crossed by several rail lines. Two lines of the Chicago, Rock Island, & Pacific R. R. join at Tucumcari and extend to the west as a part of the Southern

Pacific system. A branch of the Southern Pacific R. R. extends northeast from Tucumcari to Dawson. The Colorado and Southern Ry. crosses the northeastern corner of the basin at Clayton. The Santa Fe Ry. main line crosses the western part of the area between Las Vegas, just outside the basin, and Raton and extends north into Colorado.

Several paved highway routes which are heavily traveled cross the edges of the basin. U. S. Highways 66 and 54 cross the southern edge of the basin through Tucumcari, and U. S. Highways 64 and 87 cross the northern edge through Raton. U. S. Highway 85 parallels the Santa Fe Railroad between Las Vegas and Raton. Several State highways cross the interior of the basin. Parts of these routes are surfaced. The unimproved roads in the basin are very difficult to traverse in wet weather.

DESCRIPTION OF CONCHAS DAM

Conchas Dam is on Canadian River about one-eighth mile below its confluence with Conchas River, and about 35 miles northwest of Tucumcari, N. Mex. The construction project was approved by President Franklin D. Roosevelt as a part of the Works Relief Program, July 29, 1935, and was assigned to the Corps of Engineers, Department of the Army. Storage began December 29, 1938, although construction was not completed until September 15, 1939. The reservoir is intended to provide flood control, irrigation, and recreational benefits.

The main dam is a concrete gravity structure in the canyon of Canadian River (pl. 6), with a maximum height of 235 feet from the top of the roadway to the foundation and a crest length of 1,250 feet. The structure, which contains 755,000 yards of concrete, has outlets near its base to maintain low water flow and to drain the reservoir should it become necessary. There is a 340-foot ungated spillway section at the middle of the dam for passage of ordinary high-water flow. Wing dams extend north about 1,000 feet and south about 4,000 feet from the main dam. These are of earth and rock-fill construction. A concrete emergency spillway with a crest length of 3,000 feet is north of the dam; it is flanked by two earth and rock-fill dikes with an aggregate length of about 2,550 feet. An additional dike across low ground is about a mile south of the main dam. This dike has a length of about 6,400 feet and is constructed of earth and rock-fill. A small saddle dam about 3 miles south of the main dam is designed to serve as a "fuse plug" in event of extreme flood. The reservoir map (fig. 12) shows the locations of these structures.

Irrigation water is diverted from the reservoir through a tunnel under the south dike at an elevation of 4,155 feet. The crest of the spillway in the main dam is at an elevation of 4,201 feet. The crest

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of the emergency spillway is at an elevation of 4,218 feet. When the water is at the 4,155-foot level, the reservoir contains 90,800 acre-feet of water. When filled to the 4,201-foot level, the reservoir contains 370,000 acre-feet of water. The lake has a surface area of 9,707 acres at this elevation and extends 14 miles up the Canadian River valley and 11 miles up the Conchas River valley. The map of the reservoir area (fig. 12) shows the extent of the reservoir with the water at the 4,201-foot level. At the elevation of the emergency spillway, 4,218 feet, there is a storage capacity of 566,000 acre-feet. The reservoir storage figures are taken from the area-capacity table based on the 1949 resurvey of the reservoir.

The level of 4,155 feet is the lowest point to which it is anticipated the reservoir will be drawn down, and the permanent pool below this elevation is used primarily for sediment storage and for recreational purposes. The capacity between elevations 4,155 and 4,201 feet constitutes irrigation storage and amounts to 279,200 acre-feet. The portion of the reservoir between elevations 4,201 and 4,218 feet is to be used for detention storage for flood control. A 150-kw. hydroelectric generator has been installed in the main dam, and the dam was so constructed that larger generating units could be installed if use of the water for this purpose is ever required. An area near the dam has been set aside and partly developed as Conchas State Park, to enhance the recreational use of the reservoir.

TUCUMCARI IRRIGATION PROJECT

The Tucumcari Irrigation Project was authorized by Congress in 1938. Water for the project is stored in Conchas Reservoir. The Arch Hurley Conservancy District, organized under the laws of New Mexico, comprises the lands in the vicinity of Tucumcari irrigated with this water. Construction of the irrigation system was begun in 1940 but was suspended in December 1942 because of the war emergency. In 1944 the project was reauthorized as an emergency food project, and late in 1945 water was made available to 7,000 acres of project land. The construction of canals and laterals was completed in 1949. The distribution system includes about 116 miles of main canal and about 200 miles of laterals and serves about 45,000 acres of irrigable lands. The main canals have 35 siphons, with an aggregate total length of more than 28,000 feet, and 5 tunnels, with an aggregate total length of more than 30,000 feet. These structures were necessitated by the rough terrain through which the canals pass between Conchas Dam and the areas to be irrigated.

Crops grown successfully under irrigation at Tucumcari include alfalfa, cotton, small grains, corn and various forage crops, and vegetables. Farmers in the project area are experimenting with various

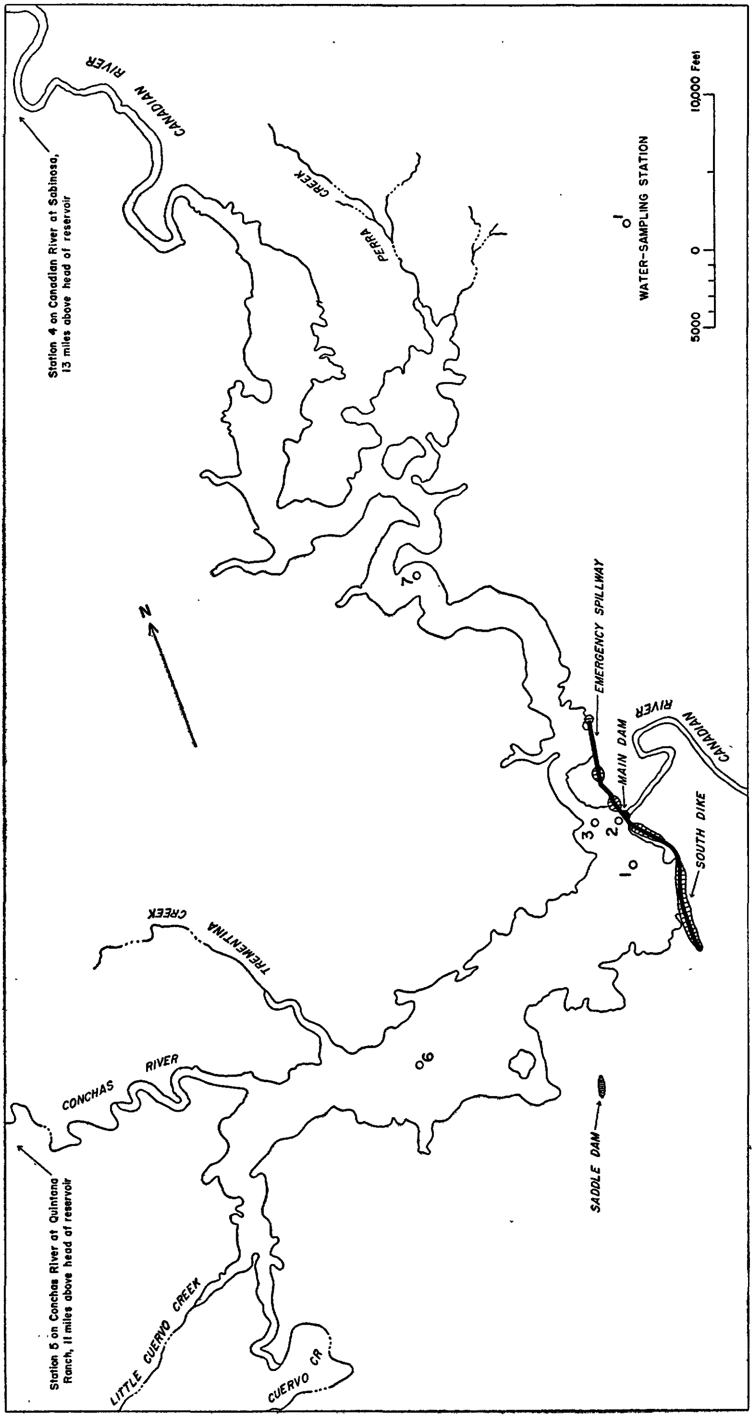

FIGURE 12.—Map of Conchas Reservoir with water level at 4,201 feet.

crops. Because of the newness of irrigation in the area, it is not now known which crops will eventually be most important.

PREVIOUS INVESTIGATIONS

Chemical analyses of water samples collected from the Conchas Reservoir and Canadian and Conchas Rivers after September 30, 1950, have been published or are to be published in Water-Supply Papers, by the Quality of Water Branch of the United States Geological Survey, for the years 1941–49. Each of the annual reports from 1946 to 1949 will also contain analyses for the Canadian River and its tributaries in the upper part of the basin in Colfax County.

Chemical analyses of samples collected near the mouth of Sapello Creek—a tributary of Mora River—at Los Alamos Post Office for the period March 1905 to April 1906 have been published. (Stabler, 1911, pp. 120–122.) It is not known to what extent conditions in the basin may have changed since these samples were collected. Therefore, the analyses may not be representative of present conditions. A few other analyses for surface waters in the basin above Conchas Dam have been published. (Griggs, 1948, pp. 172–174.)

Some data on quality of ground waters in Colfax County have been published, and a similar publication is in preparation for San Miguel County. (Griggs, 1948, pp. 159–171, 175–176.) Chemical analyses for a number of wells, springs, and surface sources in the Tucumcari Irrigation Project area are contained in an unpublished report. (Hem and Hughes, 1948.) No data on quality of surface or ground waters are available for most of the basin outside these two counties and the Tucumcari Project area.

METHODS OF COLLECTION AND ANALYSIS OF WATER SAMPLES

LOCATION OF SAMPLING STATIONS

The first samples collected from Canadian River in this area were obtained in January 1936 near the site of Conchas Dam short distances above and below the mouth of Conchas River. Sampling was discontinued later in that year. Beginning in November 1939, daily samples were obtained from Canadian River from flowing water immediately above the reservoir, 8 to 10 miles downstream from the gaging station. In February 1941 the sampling station was moved upstream to the bridge on State Highway 65 (locally known as Garms Bridge) which is the site of the gaging station. In February 1942 the sampling station was moved farther upstream to Sabinoso, 5 miles above the gaging station, where it remained until the end of the study. Samples collected at these various points were believed to be comparable and representative of water passing the gaging station and entering the reservoir. Although several small tributaries enter the river between Sabinoso and the head of the reservoir, they are all ephemeral.

In 1936, a few samples were collected from Conchas River at its mouth, and beginning in November 1939 samples were obtained from flows in Conchas River immediately above the reservoir, some 7 or 8 miles below the gaging station at Variadero. Samples were collected at the gaging station from March 1941 to April 1942, and subsequently at Quintana Ranch 4 miles upstream from the gaging station. Quality of water records for Conchas River are fragmentary.

The locations of five regular sampling points within the reservoir are shown on the reservoir area map, figure 12. Station 1 is described as being in the former channel of the Conchas River, 3,500 feet above Conchas Dam. Station 2 is below the confluence of Conchas and Canadian Rivers, at the upstream face of Conchas Dam. Station 3 is in the former Canadian River channel, 1,300 feet above the dam. These three stations are in the downstream end of the lake, and samples were first taken at these points in April 1939. Station 6 is in the Conchas River arm of the reservoir, 5 miles above the dam, and station 7 is in the Canadian River arm, 5 miles above the dam. Sampling at stations 6 and 7 was begun in October 1941. Samples of water were collected at the reservoir surface each week at stations 1, 2, and 3, and sets of samples at different depths from the surface to the bottom of the reservoir were taken two to five times a year at each of the five stations. A few samples were collected during the study at other locations in the reservoir.

For the investigation the station on Canadian River above the reservoir was called station 4 and the station on Conchas River above the reservoir was called station 5. These stations have been described previously. Their locations are shown on figure 11 and the position of stations 4 and 5 with respect to the other reservoir stations is indicated on figure 12.

ANALYTICAL PROCEDURES

COLLECTION AND ANALYSIS OF SAMPLES

Specific conductance was determined for each sample collected. Daily samples of inflow to the reservoir were combined into composite samples for analysis. Generally the samples for a month from Canadian River were combined into three composites, one for the period from the first to the tenth of the month, the second for the eleventh to the twentieth, and the third for the remaining days of the month. When the daily conductance values showed excessive day-to-day variation, the composites were made for shorter periods, so that only daily samples of similar conductance were included in any composite sample. Samples collected from Conchas River were sometimes made into composite samples covering periods longer than 10 days.

Samples collected weekly at the surface in the reservoir were combined into composites each covering a month. Sets of samples collected at various depths were not composited.

Analyses of the composite samples from Canadian River near Sanchez generally included determinations of specific conductance, pH, silica, iron, calcium, magnesium, bicarbonate, sulfate, chloride, fluoride, nitrate, and boron. From these data sodium plus potassium, total and noncarbonate hardness, and percent sodium were calculated. During the 1947 water year, however, only a few determinations were made on composite samples from this station. Composite samples from Conchas River were usually analyzed for only a few constituents. Composites of reservoir water often were analyzed for only a few constituents because of the nearly constant composition of the reservoir water. Generally, for one or more of the samples in each set taken from several depths, determinations were made of conductance, calcium, magnesium, bicarbonate, sulfate, chloride, and nitrate. For each of the remaining samples in the set only two or three constituents were determined.

Analytical procedures were those commonly used by the Geological Survey. (Collins, 1928, pp. 235:261; Amer. Pub. Health Assoc. 1946, pp. 1–112.)

SIGNIFICANCE OF SPECIFIC CONDUCTANCE

The specific conductance of a water is a measure of its ability to conduct an electric current. Conductance, the reciprocal of resistance, is expressed in reciprocal ohms, or mhos, but since the mho is an inconveniently large unit to use in studies of natural waters, millionths of mhos or micromhos are commonly used in reporting the specific conductance of natural waters. In the records of quality of waters in the United States that were obtained by the Geological Survey prior to October 1, 1947, conductance values are expressed as $K \times 10^5$ at 25 C. These values may be converted to micromhos by multiplying them by a factor of 10.

The conductance of a water in general varies with the concentration of dissolved solids and is usually higher for more concentrated waters, but there is no direct proportional relationship between conductance and dissolved solids that applies to all natural waters. This is true because dissolved minerals affect the conductance differently. For waters such as those entering or stored in Conchas Reservoir, however, a fairly consistent relationship exists between dissolved solids concentrations and conductance. For water in the Conchas Reservoir area specific conductance in micromhos multiplied by 0.7 gives approximate dissolved solids in parts per million.

EXPRESSION OF RESULTS

Table 1 contains previously unpublished analyses of samples collected between January 8 and July 19, 1936. Table 2 contains previously unpublished analyses of samples collected between November 11, 1939, and October 1, 1940, and a summary of analyses for Canadian River for water years 1941–49. For each of the 9 water years beginning with 1941 the analyses of the composite samples having maximum and minimum dissolved solids are given, and the annual weighted-average analysis is given for each year except 1942 and 1949. Table 3 contains data for Conchas River above the reservoir, but no weighted averages are shown for this station as none could be computed on the basis of available fragmentary records. Previously unpublished analyses for the period from April 1939 to September 1940 and two or three typical analyses of reservoir water for each water year from 1941 to 1949 are shown in tables 4, 5, and 6. Tables 4 to 8 contain typical analyses showing variations in quality with depth at each sampling point in the reservoir. One set of observations is given for each water year for which such data are available.

Fluctuations in concentration of dissolved solids in Canadian River inflow and in stored water for one station during the period are shown graphically in figure 13. Chemical character of inflow and stored water are shown graphically in figures 14 and 15.

Weighted-average analyses were computed by multiplying the discharge for the period of such composite sample by the quantities of the individual contstituents for the corresponding period and dividing the sum of the products for each constituent by the sum of the discharges. The weighted-average analysis represents approximately the composition of the water that passed the sampling station during the year had all the water been retained in a reservoir and thoroughly mixed.

CHEMICAL CHARACTER OF INFLOW

Records of stream flow show that the water stored in Conchas Reservoir comes largely from the Canadian River. From the time storage began in the reservoir until the end of the 1948 water year the total annual discharge of Conchas River into the reservoir ranged from 86,000 acre-feet during water year 1941 to 1,990 acre-feet during water year 1945. During 6 years of the period 1939 to 1948 the Conchas River discharge was 5 percent, or less, of that of Canadian River into the reservoir. During this same period, the annual discharge of Conchas River never was more than about 14 percent of the discharge of Canadian River for the same year. Therefore, although few complete analyses are available for Conchas River, the data which are lacking are of little practical importance. Inflow from small streams directly tributary to the reservoir probably is even less than inflow from the Conchas River.

CANADIAN RIVER

The water of Canadian River above the reservoir fluctuates widely and rapidly in dissolved solids concentration. This fact is strikingly illustrated in figure 13, where the specific conductances of composite samples are plotted against time for the period of record. Had daily conductance values been used in this illustration, even greater fluctuations would be shown. Rapid fluctuation in the concentration of dissolved solids is characteristic of many streams in the southwestern United States (Hem, 1948, pp. 80–83), and Canadian River above Conchas Reservoir shows fluctuations similar in some respects to those of Pecos River and the Rio Grande. The fluctuations are related to such factors as the geology of the drainage basin, the nature of rainfall and runoff in the basin, and the manner in which water is diverted from or returned to the stream. Large areas of sedimentary rock are exposed in the lower parts of the basin above Conchas Dam. Some of these sedimentary rocks, and soils derived from them, contain soluble salts which are carried into the river by surface runoff and ground-water inflows. These rocks are the primary source of soluble matter in Canadian River both at high and low stages.

Waters containing less than 200 parts per million of dissolved solids occur in tributaries rising in the mountains at the west side of the basin. However, these waters are extensively used for irrigation, and the return flow from irrigated tracts carries increased concentrations of dissolved solids. Low flow in Canadian River near Sanchez commonly contains more than 1,000 parts per million of dissolved solids, and concentrations sometimes exceed 2,000 parts per million.

When rainstorms occur in those areas of the basin where soluble salts are exposed at the surface, the resulting runoff may contain considerable amounts of dissolved matter. Rises occurring after prolonged low-flow periods also have a flushing effect in the main river channel, dissolving soluble salts left by evaporation and flushing pools of stagnant highly mineralized water. As a result, the first water of such a rise to reach the gaging station may be as high as or higher than preceeding low flow in dissolved solids. The highest dissolved-solids concentration for the period of record was 2,320 parts per million; it occurred in water of a small rise on June 10 and 11, 1943, following about a week of moderately low flow. A rise occurred in Canadian River at Taylor Springs and near Roy, upstream from Sanchez, at this time, but none was observed in any of the tributaries from the west on which gaging stations were in operation.

The lowest concentrations of dissolved solids are observed during major flood periods, generally some time after the beginning of high flow. A series of high flows occurred in Canadian River basin late in September 1941 as a result of widespread and heavy rainfall in the basin

AERIAL VIEW NORTHWEST, MAIN SECTION OF CONCHAS DAM, SEPTEMBER 2, 1941
Photograph furnished by Corps of Engineers, Albuquerque district

during the last 2 weeks of the month. The first important rise of the period at Sanchez occurred on September 21, and the specific conductance of the sample collected that day was 447. The peak flow was reached the next day, September 22, and the sample collected that afternoon had a conductance of 213. Conductance values increased as the stage receded on subsequent days. A second large rise occurred on September 28 whan a conductance of 294 was obtained, and on the

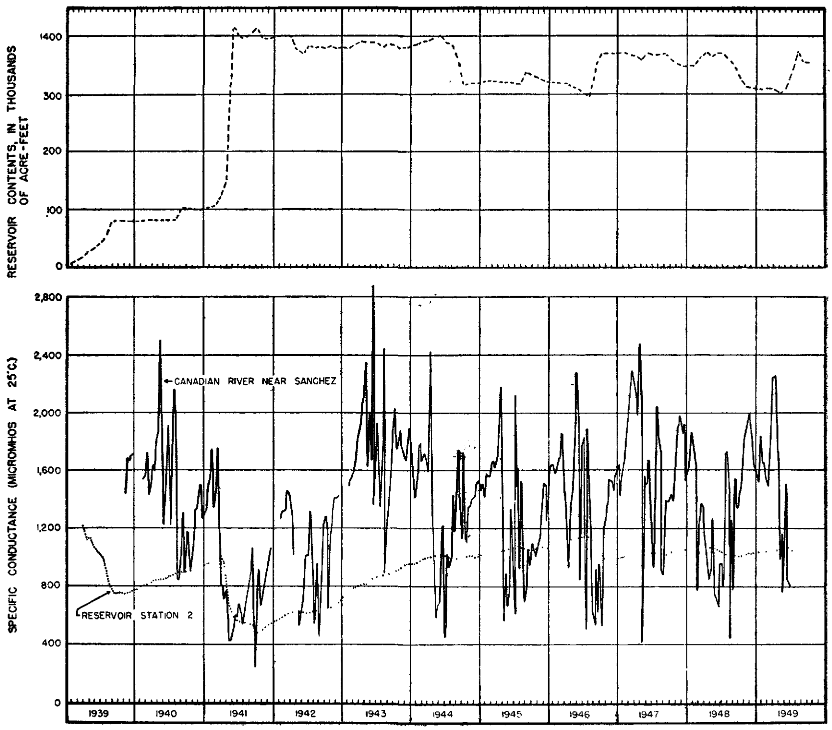

FIGURE 13.—Specific conductance of composite water samples from Canadian River near Sanchez, N. Mex., and the surface of Conchas Reservoir at station 2 (upstream face of dam), and monthly contents of reservoir, 1939–49.

following day, during a higher stage, the conductance was 203. The lowest concentration of dissolved solids for a composite sample at this station during the period of record was 133 parts per million (specific conductance 241) for the 3 days September 22, 28, and 29. This dissolved solids value, however, does not include silica, which was not determined for the sample.

The chemical character of the water of Canadian River entering the reservoir is shown in figure 14. The diagrams were prepared according to the system developed by Collins (1923, p. 394). Maximum and minimum annual weighted-average analyses for the period of record are shown, as well as maximum and minimum analyses of composite samples for the period of record.

Sulfate is normally the principal anion in the water of Canadian River at the Sanchez station, and there is a lesser amount of bicarbonate and a relatively small amount of chloride. Calcium, magnesium and sodium are present in important quantities, and usually no single cation predominates. At low concentrations, however, the water is of the calcium bicarbonate type.

The diagrams in figure 14 show that the maximum annual weighted-average analysis has more than twice the concentration of dissolved solids of the minimum weighted-average. During the same period, the composite sample of maximum concentration is about 17 times as high in concentration of dissolved solids as the composite sample of minimum concentration. These relationships show the variations in chemical quality typical of the stream, and also they show that important variations occur in the annual average concentration.

The minimum annual weighted-average concentration for Canadian River water for the period was probably that reported for the 1941 water year. The runoff in the 1941 water year was 656,500 acre-feet as compared with 949,500 acre-feet in the 1942 water year. Because of lack of data for high flow in April 1942 and for several low-flow periods in 1941 and 1942, it is not possible to compute an accurate weighted-average analysis for the 1942 water year. The data available indicate that the minimum annual weighted-average concentration almost certainly could not have occurred in 1942, even though the annual runoff at the sampling point that year was the highest in the period of record. A tentative weighted average—not included in table 2—computed for the period for which adequate samples were available in the 1942 water year, and which represents about 67 percent of the total discharge for the year, shows an average concentration of 515 parts per million of dissolved solids. If all the unsampled water had a concentration of dissolved solids equal to the minimum observed for the year at high flow in September, the weighted average for the dissolved solids would have been about 440 parts per million. This tentative value may be compared with the weighted average of 368 parts per million for the dissolved solids that was computed on the basis of practically complete data for the year ended September 30, 1941 (see table 2). Actually, the concentration of dissolved solids during the periods in 1942 when no samples were taken probably would have averaged considerably above the recorded minimum for the year because the river was at moderately low stages for a considerable part of the time when no samples were taken. Probably the weighted-average concentration of dissolved solids for

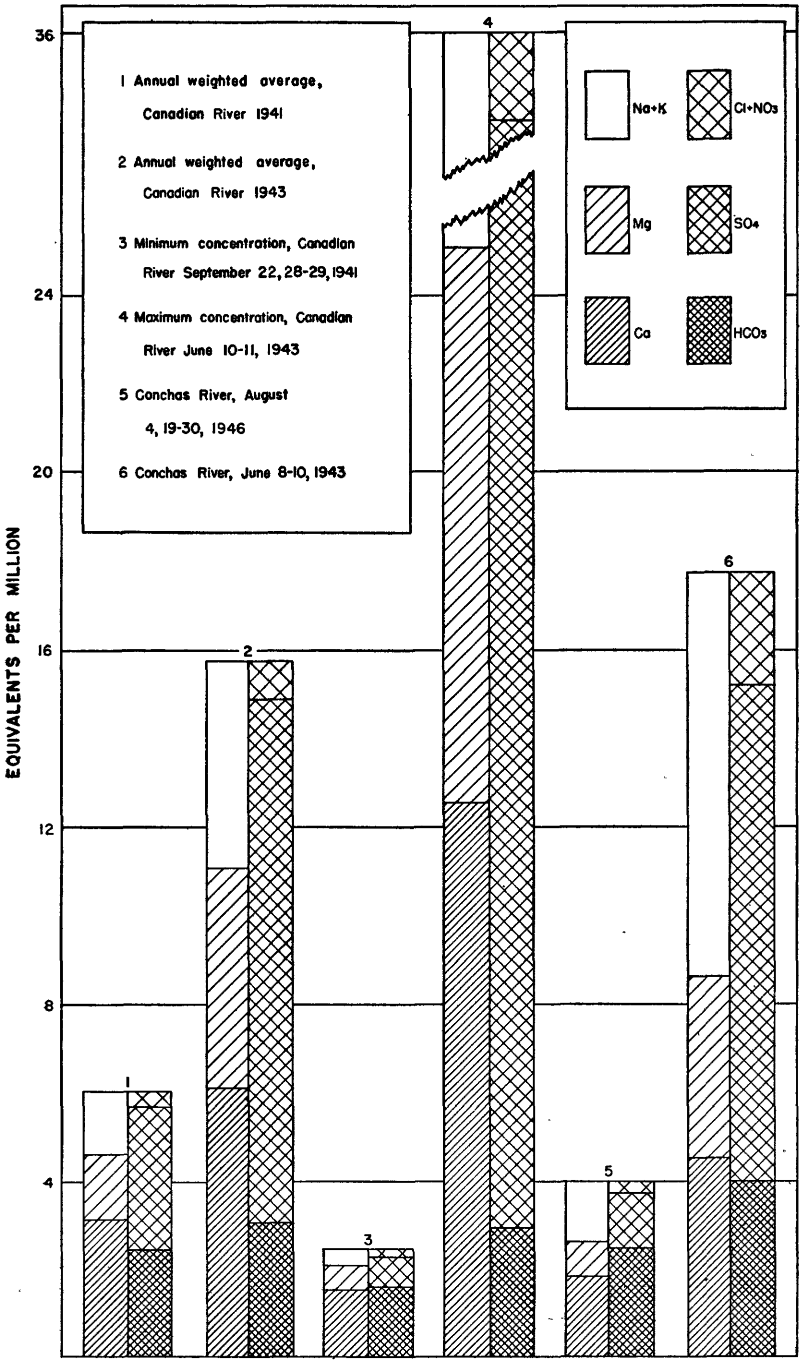

FIGURE 14.—Minimum and maximum annual weighted-average and individual analyses, Canadian River near Sanchez, N. Mex., and analyses of low and high concentration, Conchas River at Variadero, N. Mex., 1939–49.

the year ending September 30, 1942, would have been somewhere between 515 and 440 parts per million had an adequate number of samples been collected throughout the year.

The fact that the years of maximum total flow are not necessarily the years of the minimum average concentration of dissolved solids and vice versa has been observed in studies of other streams in New Mexico. Rocks exposed in the drainage basin of streams of the State may differ widely from place to place in their soluble mineral content. Hence, certain streams may contain comparatively high concentrations of soluble matter when carrying flood waters which originate in those parts of the drainage basin where exposed rock formations contain large amounts of soluble mineral matter. For such streams the distribution of precipitation in the basin and the spacing of flood flows with respect to time during the year are perhaps more important in producing runoff with low concentrations of dissolved solids than is high total annual runoff.

The fact that the maximum annual weighted-average concentration occurred in the 1943 water year is also of interest, because the flow in that year was greater than that in the succeeding 4 years for which records are available and was actually fourth highest for the period of record. (See table 2.) It is possible that the high-average dissolved solids (993 parts per million) for the 1943 water year was partly the result of increased ground-water runoff, which would have maintained an unusually large base flow of rather highly mineralized water in the river. This increase in ground-water runoff would be expected to follow the two abnormally wet years of 1941 and 1942. Definite proof of an increase in ground-water runoff is lacking, but discharge records for the station indicate a probable high base flow in 1942 and 1943. The high weighted-average concentration of dissolved solids in the 1943 water year may also have been the result of unusually low spring runoff. Under these conditions a subnormal quantity of dilute water would pass the station and would tend to increase the weighted-average concentration for the year.

CONCHAS RIVER

Conchas River carries no flow at the sampling point near the Variadero gaging station except during and shortly after storm periods. A rather small number of analyses are available for this stream, and most of these are not complete enough to show the chemical character of the water. Two analyses are shown diagrammatically in figure 14 to illustrate the chemical character of water of different concentrations. Data available are not complete enough to permit diagramming of maximum and minimum concentrations for the period of record on this stream.

CHEMICAL CHARACTER OF STORED WATER

Figure 13 provides a comparison of the fluctuation of dissolved solids of Canadian River with changes in concentration of the water in storage as sampled at the surface of the reservoir at station 2 (see fig. 12). Specific conductances of monthly composites of the surface samples from the reservoir are plotted in figure 13. Had conductances of individual weekly samples been used, however, only slightly greater fluctuations would be shown. In general, the illustration shows that the water at the surface of the reservoir at the dam maintains a remarkably constant concentration, even though there are wide and rapid fluctuations in quality of inflow and although the inflow was not completely mixed with stored water during high-flow periods. Even the rather large year-to-year variation in weighted-average concentration that characterizes the inflow from Canadian River does not cause variations of equal magnitude in the reservoir water. Most of the changes took place in the first 2 years of record, when the reservoir was being filled for the first time.

Figure 13 also shows the quantity of water in storage in the reservoir at the end of each month from 1939 to 1949. Storage began near the end of December 1938, but the reservoir contents did not reach 100,000 acre-feet until late in the summer of 1940. During the period of filling to this level, the small volume of water held in the reservoir was considerably affected by quality of inflow. The first samples were collected from the reservoir on April 8, 1939, when only about 15,000 acre-feet of water was in storage. The concentration of dissolved solids in the sample taken at station 3 (869 parts per million) was the highest of record for stored water at the surface of Conchas Reservoir, and it represented accumulated winter low flow. As the spring and summer runoff was added to the stored water, its concentration of dissolved solids decreased. However, from the fall of 1939 until early in the spring of 1941, inflow to the reservoir was small in volume. The runoff of Canadian River at Sanchez in the 1940 water year (34,210 acre-feet), was the lowest total annual runoff of any of the years covered in this report. From the fall of 1939 until the spring of 1941, the concentration of reservoir water gradually increased. In March, April and May of 1941 inflow was sufficient to fill the reservoir to the level of the spillway and water was spilled in large quantities during 1941 and 1942.

The minimum conductance of stored water at the dam for the period of record was observed in October of 1941 when several samples collected from the surface at station 2 had conductances of 454 to 456 micromhos. Mixing of inflow with stored water, however, probably was incomplete during this period. The concentration of the stored water increased slowly from October 1941 through most of 1942. It increased for the subsequent years to a conductance of 1,150 micromhos in mid-1946 which was the peak for the period since storage volume first exceeded 25,000 acre-feet in 1939. The concentration decreased late in 1946, then fluctuated in a narrow range near conductivity 1,000 to the end of the period of record. Figure 15 shows diagrammatically the analyses for reservoir water of near-maximum concentration in 1945 and near the minimum in 1941. Analyses of stored water are included in tables 4 to 8.

Probably the principal reason for the effectiveness of Conchas Reservoir in maintaining the water in storage at so nearly a constant concentration during the period of record was the large volume of water held in storage. At all times after initial filling, in 1941 the amount of water in storage was large compared to the amount that entered during a single flood. Any such flood, therefore, when mixed with the water in storage could have only a minor effect on the concentration of dissolved solids of the water.

It may be anticipated that water stored in Conchas Reservoir will continue to have a comparatively minor fluctuation in concentration of dissolved matter, although fluctuations greater than those that occurred between 1944 and 1949 may be expected. The reservoir will probably be operated so as to maintain a pool of 100,000 acre-feet or more, primarily for recreational purposes. This water, held back from year to year, will mix with the inflow and tend to minimize changes in the quality of stored water, unless the inflow is very great as it was in 1941. So long as a permanent pool of this size is maintained, however, it is unlikely that minimum concentrations of reservoir water will drop much below those observed in 1941. While the permanent pool is maintained the reservoir can never be completely filled with flood waters of minimum dissolved solids concentration. The gradual filling of the permanent pool with sediment will eventually decrease the size and the effectiveness of the pool in minimizing fluctuations in dissolved solids concentration of stored water.

As previously noted, the facilities for delivery of irrigation water to the entire Tucumcari Project area were not complete at the time this investigation was closed. Consequently, during the period of record, considerably less water for irrigation was withdrawn annually from the reservoir than may be normally expected in the future. Larger withdrawals for this purpose will tend to draw down the reservoir more nearly to the level of the irrigation outlet at the top of the permanent pool each summer and will probably result in a smaller average quantity of water in storage than during the period of record since 1941. Years of high discharge such as 1941 and 1942 also are likely to occur infrequently. A smaller volume of water available in the reservoir to mix with inflow will result in more fluctuation of the dissolved solids concentration of stored water than occurred in most of the period of record. A succession of dry years, resulting in the maintenance of little more than the permanent pool in storage might raise the concentration of the dissolved solids in the stored water to a maximum considerably above that observed during the period of record. Evaporation from the lake has an important effect, and losses from this source may at times exceed the inflow to the reservoir. Evaporation tends to increase the concentration of dissolved matter in the remaining water and would play an important part in increasing the concentration of dissolved solids in the stored water during long dry periods.

In order to regulate the releases from the reservoir so as to maintain the stored water at the best possible quality, a continuing study of the chemical quality of the stored water is desirable. This study is especially needed if proposed municipal use of the stored water materializes.

Figure 15 shows the approximate variation of chemical character of stored water, based on analyses for the water of low concentration in storage in September 1941 and the water of considerably higher concentration in storage in July 1945. These analyses represent water at the surface at the upstream face of the dam (sampling station 2). It is recognized that somewhat higher concentrations were reached at this point in 1946, but none of the samples collected that year were analyzed completely enough to permit the preparation of a diagram. It is also recognized that at times the water at the surface of the reservoir at this sampling point might not have been representative of all the water stored in the reservoir. The data in figures 14 and 15 show that water in storage is very similar in chemical character to the weighted-average analyses for Canadian River water. During the period of record the concentration of dissolved solids in stored water, however, has never reached as high a level as the maximum annual weighted average shown in figure 14.

CHANGES OCCURRING DURING STORAGE

PRECIPITATION OF CALCIUM CARBONATE

The analyses for samples collected from water in storage show that water at the surface of the reservoir generally has a lower concentration of bicarbonate than that of the inflow from Canadian River which contributed to the stored water. This apparent difference in bicarbonate concentration probably is the result of precipitation of calcium carbonate from the water during storage. The effect has been observed in other reservoirs (Howard, C. S., personal communication) as well. The available analyses for reservoir water are very incomplete, and for a part of the period of record, at least, the water in storage was poorly mixed. It is not possible, therefore, with the data available to make any quantitive estimate of the effect of precipitation of calcium carbonate in Conchas Reservoir.

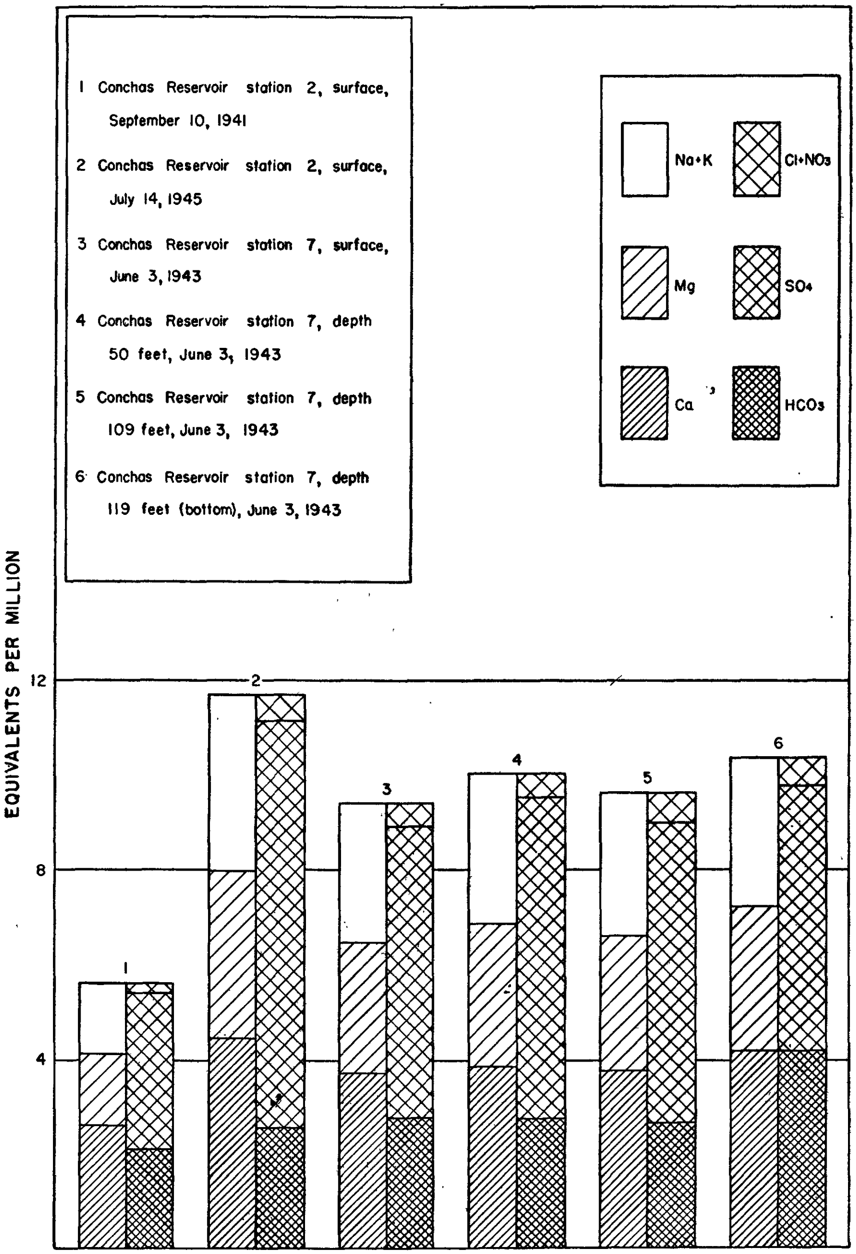

FIGURE 15.—Typical analyses of low and high concentrations and analyses of samples from different depths, Conchas Reservoir, N. Mex.

EVAPORATION

The fact that evaporation measured in a land pan at Conchas Dam averages more than 8 feet a year has already been cited. This high evaporation rate indicates that there may be a considerable increase in concentration of dissolved matter in stored water resulting from loss of water to the atmosphere. Attempts to evaluate the effect closely, however, have encountered difficulties. The records of water released from the reservoir are incomplete and it is uncertain what the quality of the spilled water was. Furthermore, available analyses for stored water may not represent satisfactorily the average composition of all water in the reservoir. Tentative computations, which are subject to these inaccuracies, show that at the end of the 1940 water year the water in storage was about 5 percent higher in dissolved solids than it should have been as computed from data on quantity and quality of inflow. This difference probably was the result of evaporation.

MIXING OF STORED WATER

The analyses in tables 4, 5, 6, 7, and 8 give indications of the extent to which the water entering the reservoir mixes with that already in storage. In many reservoirs it has been found that mixing is far from complete at times, and that flows of water may pass through a reservoir and be discharged without appreciable changes in their chemical composition even thought a large volume of water is in storage. The irregular shape of Conchas Reservoir and the variable quality of inflowing water might be expected to be factors contributing to poor mixing and to lack of uniformity of the quality of stored water in the two main arms of the lake.

Data collected during the study show no significant consistent difference in water samples collected on the same day at the surface of the reservoir at stations 1, 2, and 3. However, these sampling points are near the dam and at a maximum distance from points of inflow, so that the mixing effect should be most complete in that part of the reservoir. Surface samples taken on the same day at stations 6 (Conchas arm) and 7 (Canadian arm) both of which are 5 miles above the dam, sometimes differed appreciably during the years of high flow in the first part of the study. From 1944 to the end of the investigation, however, sets of samples taken on the same day at all five points in the reservoir show practically uniform composition of water at the surface.

The samples taken at various depths show a lack of complete mixing at stations 1, 2, and 3 on several occasions, notably in February 1942 and December 1942. The analyses for these periods show water of comparatively low concentration of dissolved solids overlying more concentrated water. Probably during periods of high inflow to the reservoir in 1941 and 1942, considerable amounts of water compara-

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tively low in dissolved solids spread over more highly mineralized water already in storage and passed down the reservoir to the dam without gaining appreciably in concentration. The time of sampling at stations 6 and 7 during 1941 and 1942 does not coincide exactly with that at stations 1, 2, and 3, but the results show lack of mixing at depth at least part of the time during those years. The available data do not show definitely that individual flows of water pass through the reservoir at depth without mixing, however, it is possible that such flows may occur at times.

Abnormally high concentrations of bicarbonate were noted in several samples of water collected at the surface of the sediment layer, or of water in the upper part of the sediment layer in the bottom of the reservoir. These abnormally high bicarbonate concentrations sometimes were associated with below-normal sulfate concentrations, as shown in figure 15, where results of analyses of a set of depth samples collected at station 7 are shown diagrammatically.

RELATION OF QUALITY OF WATER TO USE

IRRIGATION

The principal future use of water from Conchas Reservoir probably will be for irrigation in the Tucumcari Project area. For satisfactory results, water to be used for irrigation should be free from excessive quantities of dissolved solids. However, the quality of water in the root zone of the irrigated plants is the controlling factor, and this is influenced by various conditions other than the quality of the irrigation supply. Among these conditions are the nature of the soil, effectiveness of drainage, amount of water applied, and amount of rainfall. In addition, crop plants differ considerably in their tolerance of salinity.

The water applied to a field in the process of irrigation invariably contains some dissolved mineral matter. The evaporation from the land surface and the transpiration of the plants dispose of what essentially may be considered distilled water. The dissolved matter originally contained in this water is left behind. Some of this material is utilized by the plants in their structure, but a large part is not usable and is left behind either in residual water or in the soil. As a result the water in the root zone commonly has a higher content of dissolved solids than the original irrigation water. In order to keep the water of the root zone within acceptable limits of salinity, it is necessary occasionally to apply an excess of irrigation water. A part of this excess passes downward through the root zone to the water table, carrying with it soluble matter which may have accumulated in the soil and root zone. This leaching may be accomplished also by heavy rainfall. However, leaching can be effective only if the drainage is sufficiently complete to keep ground water levels from rising excessively. Where the water table is very near the surface the continuous evaporation of water from the moist surface soil causes the visible accumulation of soluble salts commonly called "alkali."

Another factor of considerable importance in the evaluation of irrigation water is sodium percentage. The percent sodium of a water is the proportion of sodium to the total cations—calcium, magnesium, sodium, and potassium. Waters with excessively high sodium percentages may enter into a base-exchange reaction with the soils which they irrigate. As a result of this reaction, the soil is deflocculated and hardened and becomes progressively less permeable to water. This reaction is not stopped by adding excess water but may often be controlled by adding substances like gypsum to the soil.

The diagram in figure 16 has been adapted from that of Wilcox (1948, p. 26) and can be used as an aid in the evaluation of an irrigation water by plotting conductance against sodium percentage and noting the area on the diagram in which the resulting point falls.

The presence of boron in irrigation water in concentrations toxic to certain boron-sensitive plants constitutes a further problem in some areas. No boron concentrations sufficient to cause damage, however, were found in analyzing any surface water from this area.

On the whole the water stored in Conchas Reservoir was "good to permissible" for irrigation most of the time from 1939 to 1949. For a time in 1941 and 1942 it was "excellent to good." Little difficulty should be experienced in using this water on well-drained land. The sodium percentage of the stored water appears to be less than 40 at all times.

By way of contrast, the inflow to the reservoir from Canadian River, during the investigation, ranged from "excellent to good" to "unsuitable."

DOMESTIC USE

Standards for drinking water supplied in common carriers have been published by the U. S. Public Health Service (1946, pp. 371–384). According to these standards a satisfactory drinking water should contain no more than 1.5 parts per million of fluoride and preferably no more than 250 parts per million of chloride or sulfate, 125 parts per million of magnesium, or 500 parts per million of dissolved solids. However, concentrations of dissolved solids as much as 1,000 parts per million may be permitted if better water is not available. These standards are commonly used for evaluation of drinking water, but it is recognized that waters of higher concentration are used continuously by many people without apparent ill effects. During the period of record, the water of Conchas Reservoir always contained less than 1,000 parts per million of dissolved solids, but for a considerable part of the time the sulfate concentration was more than 250 parts per million. Fluoride concentrations in the stored water appear to be low.

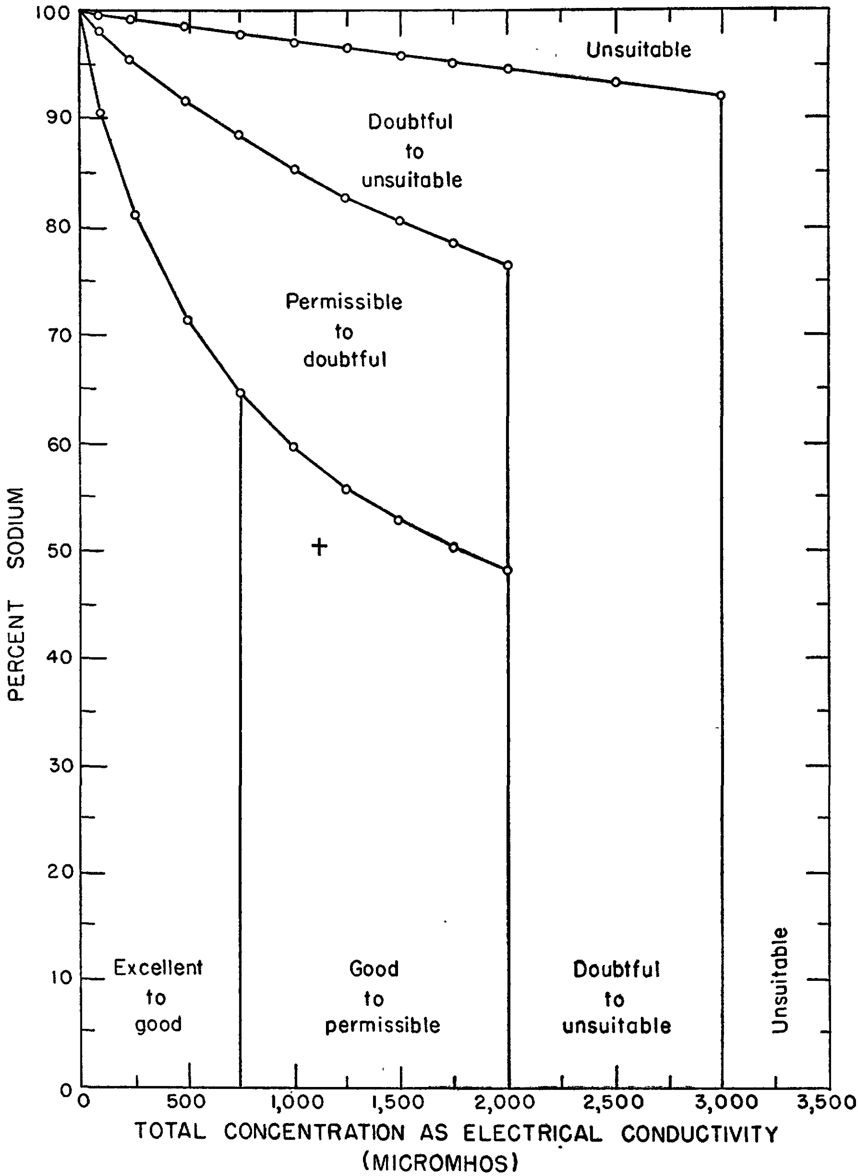

FIGURE 16.—Diagram for use in interpreting the analysis of irrigation water.

Hardness in water is caused principally by dissolved calcium and magnesium. Excessive hardness in a domestic water supply is objectionable principally because of the excessive amounts of soap consumed in washing and the scale deposits left in water heating equipment. The water of Conchas Reservoir is very hard. If it were necessary, the water from Conchas Reservoir could be used satisfactorily as a municipal supply. Treatment to assure sanitary purity would be required, and treatment to reduce the hardness would be desirable.

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ANALYSES

The following tables summarize the data obtained during the period 1939–49 on the quality of inflowing water at Conchas Reservoir and on the quality of water in storage. All analyses in these tables for samples collected prior to October 1, 1940, and the weighted-average analyses for the Canadian River for water years prior to 1944 have not previously been published.

TABLE 1.—*Chemical analyses, in parts per million of water from Canadian River near Conchas Dam site, 1936*

LOCATION.—Various points near site of Conchas Dam.

RECORDS AVAILABLE.—January to July 1936.

EXTREMES, 1936.—Dissolved solids: Maximum 1,609 parts per million Mar. 21–27; minimum 332 parts per million July 12.
Total hardness: Maximum 804 parts per million Mar. 21–27; minimum 174 parts per million July 12.

Date of collection	Mean discharge (second-feet)	Specific conductance (micromhos at 25° C.)	Temperature (° F.)	pH	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids			Hardness as $CaCO_3$		Percent sodium
																	Parts per million	Tons per acre-foot	Tons per day	Total	Noncarbonate	
Canadian River 200 feet above confluence with Conchas River																						
Jan. 13–20, 1936	37.9				6.2	0.04	112	48	91	3.8	191	451	34	0.2	0.59	<0.1	841	1.14	86	477	320	29
Jan. 21–31	31.5				12	.02	133	54	102	4.3	229	515	40	.2	.51	<.1	974	1.32	83	554	366	28
Feb. 1–10	24.4				11	.02	129	52	109	4.5	242	490	47	.3	.73	<.1	963	1.31	63	536	337	30
Feb. 11, 12, 19, 20	23.8				12	.03	140	55	107	4.6	232	539	40	.3	.33	<.1	1,013	1.38	65	576	385	29
Feb. 21–29	20.3				15	.04	125	55	104	4.6	211	514	39	.3	.10	<.1	961	1.31	53	538	365	29
Mar. 1–10	5.2				6.4	.02	140	58	127	5.1	226	573	64	.2	.24	<.1	1,085	1.48	15	588	403	32
Mar. 11–20	[1] .5				8.6	.02	164	63	164	6.1	252	652	108	.1	.16	<.1	1,290	1.75	1.7	668	462	35
Mar. 21–27	[2]				12	.02	197	76	221	7.7	279	772	185	.3	.60	<.1	1,609	2.19		804	576	37
June 2–10	148				17	.06	97	34	69	5.1	142	373	19	.5	2.0	<.1	687	.93	275	382	266	28
June 13, 15–20	408				19	.31	88	29	54	4.8	139	314	13	.4	1.1	<.1	592	.81	652	339	225	25
June 21–30	29.8				18	.07	139	51	107	6.2	184	566	37	.5	.33	<.1	1,016	1.38	82	557	406	29
July 1–4, 6–10	36.1				15	.06	140	52	114	6.0	147	619	34	.5	.40	<.1	1,053	1.43	103	563	443	30
July 11	332						138	52	118		165	604	35		.45		1,029	1.40	922	558	423	31
July 13	126						58	18	51		103	220	11		2.0		411	.56	140	219	134	34
July 15	344						182	64	115		281	680	21		.30		1,201	1.63	1,120	717	487	26
July 16	172						128	43	115		136	581	18		5.2		957	1.30	444	496	385	33
July 17	80						105	37	101		115	495	15		4.4		814	1.11	176	414	320	35
July 18	40						116	39	99		169	481	17		2.0		837	1.14	90	450	312	32
July 19	30						103	37	85		166	422	11		2.7		742	1.01	60	409	273	31

Canadian River at Conchas Dam site below confluence with Conchas River

Jan. 8, 1936	------	------	------	------	8.6	0.05	134	52	111	4.8	234	483	62	0.4	0.50	<0.1	972	1.32	------	548	356	30
July 12	------	------	------	------	------	------	50	12	53		181	105	23	------	.20	------	332	.45	------	174	26	40
July 14	------	------	------	------	------	------	69	19	48		178	166	26	------	.30	------	416	.57	------	250	104	30

Canadian River 4 miles below Conchas Dam site

Jan. 22–24, 26, 27, 29–31, 1936	------	------	------	------	13	0.01	134	53	111	3.8	227	500	59	0.3	0.57	<0.1	986	1.34	------	552	366	30
Feb. 3–7	------	------	------	------	------	------	------	------	------	------	------	479	------	------	------	------	------	------	------	------	------	------

[1] No flow at gaging station Mar. 14–20.

[2] No flow at gaging station Mar. 21–May 21.

TABLE 2.—*Chemical analyses in parts per million, of water from Canadian River above Conchas Reservoir, 1939–49*

LOCATION.—At sites 8 miles downstream to 5 miles upstream from gaging station which is at bridge on State Highway 65, 3 miles northeast of Sanchez, 1 mile upstream from Lagartija Creek, and 10 miles downstream from Mora River.

DRAINAGE AREA.—5,925 square miles.

RECORDS AVAILABLE.—November 1939 to June 1949.

EXTREMES, 1939–40.—Dissolved solids: Maximum, 1,942 parts per million May 11, 16–20; minimum, 591 parts per million Aug. 21–23, 25–31.

Total hardness: Maximum, 1,045 parts per million May 11, 16–20; minimum, 328 parts per million Aug. 11–19.

EXTREMES, 1939–40.—Dissolved solids: Maximum, 2,320 parts per million June 10–11, 1943; minimum, 133 parts per million Sept. 22, 28–29, 1941.

Total hardness: Maximum, 1,260 parts per million, June 10–11, 1943; minimum, 104 parts per million Sept. 22, 28–29, 1941.

Date of collection	Mean discharge (second-feet)	Specific conductance (Micromhos at 25° C.)	Temperature (° F.)	pH	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids			Hardness as $CaCO_3$		Percent sodium
																	Parts per million	Tons per acre-foot	Tons per day	Total	Noncarbonate	
Water Year October 1939 to September 1940																						
Nov. 11–20, 1939	10.7	1,420			7.5	0.15	135	62	106	8.2	196	613	30	0.2	0.10		1,059	1.44	31	592	431	28
Nov. 21–30	13.0	1,670			10	.15	159	73	128	7.2	196	741	37	.3	.10		1,252	1.70	44	697	536	28
Dec. 1–6, 9–10	20.2	1,660			8.5	.15	153	74	129	6.8	190	738	36	.3	.10	<0.1	1,239	1.69	68	686	530	29
Dec. 11–15, 17–20	16.4	1,690			12	.12	156	77	135	6.4	190	760	37	.6	.10	<.1	1,278	1.74	57	706	550	29
Dec. 21–22 [1]		1,710									196											
Feb. 15–17, 1940	41.1	1,530			10	.12	144	70	117	6.0	201	667	30	.3	.30	<.1	1,137	1.55	126	647	482	28
Feb. 24–29	42.1	1,550			8.0	.08	143	71	118	7.0	192	681	30	.2	.20		1,153	1.57	131	649	491	28
Mar. 1–3, 5–10	38.0	1,720			8.0	.12	155	80	136	8.3	202	774	34	.3	.20		1,296	1.76	133	716	550	29
Mar. 11–20	48.9	1,420			12	.08	127	65	111	8.0	194	602	29	.2	.20		1,050	1.43	139	584	425	29
Mar. 21–31	20.3	1,500			12	.08	132	72	115	3.6	188	650	31	.2	.35	<.1	1,109	1.51	61	625	471	28
Apr. 1–10	12.5	1,630			8.4	.20	139	76	134	7.6	176	716	34	.5	.20		1,203	1.64	41	659	515	30
Apr. 11–20	13.2	1,590			8.0	.20	136	72	141	7.2	169	696	34	.0	.25		1,178	1.60	42	635	497	32
Apr. 21–30	5.72	1,790			9.6	.08	150	83	138	7.2	163	814	41	.7	.10		1,324	1.80	20	715	582	29
May 1–5, 9–10	1.60	1,870			8.0	.12	160	84	145	8.4	151	860	45	.0	.50		1,379	1.88	6.0	744	621	29
May 11, 16–20	5.72	2,500			9.6	.10	223	119	205	8.0	151	1,239	58	.0	.20		1,942	2.64	30	1,045	922	30
May 21–31	125	1,780			13	.12	158	80	144	7.0	154	808	37	.1	1.2		1,324	1.80	447	723	597	30
June 1–10	57.5	1,210			18	.20	112	48	93	7.2	182	473	20	.1	2.6		864	1.18	134	477	328	29
June 11–20	1.85	1,480			12	.08	130	63	118	7.2	162	630	29	.2	.50		1,070	1.46	5.3	583	451	30

June 21-30	66.8	1,270			14	.16	115	52	98	7.4	153	522	26	.2	1.3		911	1.24	164	501	375	29
July 1-2, 4-10	5.95	1,220			12	.08	110	48	95	7.2	160	489	26	.1	1.0		867	1.18	14	472	341	30
July 11-13	42.9	1,020			23	.04	90	35	92		197	358	22	.5	1.8	<.1	719	.98	83	368	207	35
July 14-20	27.4	1,910			17	.18	176	80	171		149	922	40	.4	.40	<.1	1,480	2.01	109	768	646	33
July 21-31	1.80	2,150			14	.04	190	94	205		178	1,049	48	.3	.30	<.1	1,688	2.30	8.2	860	715	34
Aug. 1-5	4.72	1,980			12	.08	164	84	190		155	930	50	.3	.50	.1	1,507	2.05	19	755	628	35
Aug. 6-10	737	901			25	.02	86	32	66		198	291	14	.5	4.2	<.1	616	.84	1,230	346	184	29
Aug. 11-19	136	858			25	.08	87	27	63		151	308	13	.5	1.2	<.1	599	.81	220	328	204	29
Aug. 21-23, 25-31	251	842			19	.10	93	27	57		167	299	12	.5	.79	<.1	591	.80	401	343	206	27
Sept. 1-10	18.7	1,020			31	.04	98	37	79		187	372	18	.5	.71	<.1	728	.99	37	396	243	30
Sept. 11-20	55.4	1,300			31	.05	126	46	109		202	521	22	.5	.88	<.1	956	1.30	143	504	338	32
Sept. 21-30	100	893			25	.08	90	30	67		183	309	14	.4	1.8	<.1	627	.85	169	348	198	30
Weighted average [2]	47.1	1,160			19	.09	111	46	91		179	458	21	.4	1.7		836	1.14	106	466	320	30
Maximum, minimum and weighted average, water year October 1940 to September 1941																						
Mar. 11-14, 1941	19.0	1,750			6.4	0.12	158	84	140	4.5	198	810	35	0.4	0.20	<0.1	1,336	1.82	69	740	578	30
Sept. 22, 28-29	8,500	241					31	6.6	8.5		103	34	2.2				133	.18	3,050	104	20	15
Weighted average	907	557			15	.08	62	18	30	3.7	155	152	7.5	.6	2.9	<.1	368	.50	901	228	102	22
Maximum and minimum, water year October 1941 to September 1942																						
Mar. 11-18, 20, 1942	106	1,460			12	0.18	130	68	113	2.0	210	617	25	0.4	2.1	0.1	1,073	1.46	307	604	432	29
Sept. 1, 6	28,000	455					59	12	22		142	114	7.0				284	.39	21,500	196	80	20
Maximum, minimum and weighted average, water year October 1942 to September 1943																						
June 10-11, 1943	153	2,880					251	153	256		178	1,506	69		1.6		2,324	3.16	960	1,256	1,110	31
Oct. 18, 1942	3,750	639					65	18	54		125	223	14				436	.59	4,190	236	134	33
Weighted average [3]	184	1,340			13	0.13	122	61	106		184	570	28	0.4	2.0	<0.1	993	1.35	493	556	404	29

See footnotes at end of table.

Date of collection	Mean discharge (second-feet)	Specific conductance (Micromhos at 25° C.)	Temperature (° F.)	pH	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids			Hardness as $CaCO_3$		Percent sodium
																	Parts per million	Tons per acre-foot	Tons per day	Total	Noncarbonate	
Maximum, minimum and weighted average, water year October 1943 to September 1944																						
Oct. 1-8, 1943	28.3	2,020	......	7.7	10	0.02	176	95	182		164	982	47	0.4	0.6	<0.1	1.570	2.14	120	830	695	32
June 29-30, July 1-2, 1944	501	454	......	8.1	......	......	49	13	26		127	113	6.8	......	1.5	<.1	272	.37	368	176	72	24
Weighted average	167	1,000	......	......	15	.05	93	42	74		171	384	18	.3	2.1	<.1	713	.97	321	404	264	28
Maximum, minimum and weighted average, water year October 1944 to September 1945																						
July 17-18, 1945	168	2,600	......	......	......	......	263	124	224		194	1,360	56	......	0.2	......	2,120	2.88	962	1,170	1,010	30
May 6-10	245	586	......	......	13	0.10	62	22	29		160	157	8	0.3	2.5	<0.1	373	.51	247	245	114	21
Weighted average	105	1,160	......	......	10	.10	108	51	90		178	471	23	.4	1.7	<.1	843	1.15	239	479	333	29
Maximum, minimum and weighted average, water year October 1945 to September 1946																						
May 21-31, 1946 [4]	1.1	2,280	......	7.3	10	0.02	201	115	206		200	1,130	56	0.4	1.4	0.2	1,820	2.48	5.4	974	810	31
July 17, 20	49.0	487	......	......	......	......	53	14	36		144	129	10	......	2.7	......	316	.43	42	190	72	29
Weighted average	168	742	......	......	13	.20	78	27	49		162	245	11	.4	1.0	<.1	504	.69	229	306	173	26
Maximum, minimum and weighted average, water year October 1946 to September 1947																						
Apr. 21-30, 1947	20.3	2,480	......	......	......	......	......	......	......	......	208	1,250	......	......	......	......	......	......	......	......	......	......
May 9	556	392	......	......	......	......	......	......	......	......	158	72	......	......	......	......	......	......	......	......	......	......
Weighted average	173	955	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......

Maximum, minimum and weighted average, water year October 1947 to September 1948

Nov. 21-30, 1947	26.7	1,980	------	7.8	8.6	0.02	184	93	168	193	940	47	0.3	0.4	0.4	1,540	2.09	111	842	684	30
Aug. 5-7, 1948	398	420	------	8.2	20	.03	56	13	22	173	84	6.0	1.2	.4	<.1	288	.39	309	193	51	20
Weighted average	191	906	------	------	14	.04	93	37	59	179	326	15	.3	2.1	------	635	.86	327	384	238	25
Maximum and minimum for period October 1948 to June 1949																					
Apr. 1-10, 1949	31.1	2,250	------	8.0	11	0.01	198	118	195	179	1,140	48	0.4	0.6	0.08	1,800	2.45	151	979	832	30
May 17-20	881	752	------	8.1	17	.05	81	29	43	167	249	11	.4	1.8	.10	515	.70	1,230	321	184	22

[1] Discharge Dec. 21-22 included in discharge reported for Dec. 11-15, 17-20.
[2] Based on analyses representing 91 percent of total discharge for the water year.
[3] Based on analyses representing 88 percent of total discharge for the water year.
[4] No flow at gage during a part of period.

TABLE 3.—*Quality of inflow to Conchas Reservoir from Conchas River 1939–49*

LOCATION.—At sites from 8 miles downstream to 4 miles upstream from gaging station which is 1.6 miles northeast of Variadero, and 15 miles west of Conchas Dam.

Records available: Chemical analyses, November 1939 to July 1949.

Date of collection	Mean discharge (second-feet)	Specific conductance (Micromhos at 25° C.)	Temperature (° F.)	pH	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Parts per million	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Total	Hardness as $CaCO_3$: Noncarbonate	Percent sodium
Analyses, in parts per million, water year October 1939 to September 1940																						
Dec. 6, 1939 [1]		829									182											
Dec. 31 [1]		798									165		19									
Feb. 16–17, 1940	0.5	1,060					54	29	145		279	219	79				663	0.90	0.9	254	25	55
Mar. 5, 13, 20, 27	1.8	1,060									255											
Apr. 17 [1]		877									165		28									
May 30	2.0	346									183		8									
June 2	1.0	518									171		27									
Aug. 6–8	397	354									194		4									
Aug. 12–13	1.0	562									217		13									
Aug. 21–22	69.5	395									177		7									
Typical analyses for water year October 1940 to September 1941																						
Apr. 13, 1941 [2]		982									275		30									
Mar. 23–25	45.0	717			15	0.14	47	21	81	3.4	262	140	19	0.5	0.5	0.1	457	0.62	56	204	0	46
Mar. 26–31	30.7	402			13	.06	38	11	33	2.5	167	58	8.5	.4	3.2	<.1	250	.34	21	140	3	33
Sept. 29–30	4,291	243									114		3.0									
Maximum and minimum, water year October 1941 to September 1942																						
Nov. 11–23, 1941	14.4	952					71	32	96		240	254	38		3.4		613	0.83	24	308	122	40
Oct. 3–5	520	362									139		10									

Maximum and minimum, water year October 1942 to September 1943																					
June 8-10, 1943	9.0	1,630	------	------	------	------	89	51	213	241	542	92	------	2.8	------	1,108	1.51	27	432	234	52
July 24-25	12.5	463	------	------	------	------	46	13	34	175	77	13	------	1.5	------	271	.37	9.1	168	25	31
Maximum and minimum, water year October 1943 to September 1944																					
Sept. 28-30, 1944	0.2	784	------	------	------	------	------	------	------	172	200	16	------	------	------	------	------	------	------	------	------
July 4-6, 9, 14-15	10.6	590	------	------	------	------	------	------	------	182	116	11	------	------	------	------	------	------	------	------	------
Maximum and minimum, water year October 1944 to September 1945																					
Aug. 8, 1945	28	927	------	------	------	------	------	------	------	208	242	------	------	------	------	------	------	------	------	------	------
Aug. 10-11	28.5	345	------	------	------	------	------	------	------	160	33	------	------	------	------	------	------	------	------	------	------
Maximum and minimum, water year October 1945 to September 1946																					
July 9-10, 15, 1946	2.9	1,130	------	------	------	------	------	------	------	250	302	63	------	------	------	------	------	------	------	------	------
Sept. 2, 8-9	60	292	------	------	------	------	------	------	------	135	29	8.5	------	------	------	------	------	------	------	------	------
Maximum and minimum, water year October 1946 to September 1947																					
Oct. 4-9, 1946	196	334	------	------	------	------	------	------	------	140	48	------	------	------	------	------	------	------	------	------	------
May 8, 1947	42	1,640	------	------	------	------	------	------	------	294	533	83	------	------	------	------	------	------	------	------	------
Maximum and minimum, water year October 1947 to September 1948																					
May 29-31, June 1-2, 5-6, 1948	------	945	------	------	------	------	------	------	------	258	223	40	------	------	------	------	------	------	------	------	------
June 19, 25-29	------	446	------	------	------	------	------	------	------	196	52	14	------	------	------	------	------	------	------	------	------
Maximum and minimum, period October 1948 to July 1949																					
June 21-25, 1949	------	589	------	------	------	------	------	------	------	190	116	20	------	------	------	------	------	------	------	------	------
June 30, July 1-5, 8-10	------	392	------	------	------	------	------	------	------	174	47	9	------	------	------	------	------	------	------	------	------

[1] No flow at gaging station. Sampled at head of reservoir.
[2] No flow at gaging station.

TABLE 4.—*Chemical analyses, in parts per million, of water from Conchas Reservoir at station 1, Conchas River arm of reservoir about 3,500 feet above dam, water years 1939 to 1949*

Date of collection	Depth (feet)	Specific conductance (Micromhos at 25° C.)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Dissolved solids	Total hardness as $CaCO_3$
SURFACE SAMPLES										
Water year October 1938 to September 1939										
Apr. 8, 1939			116	54	90 | 7.0	195	481	25	878	511
Apr. 29, 30		1,160				188	457	22		
May 1–10		1,150				185	443	20		
May 11–20		1,100								
May 21–31		1,090								
June 1–10		1,060				183		20	728	
June 11–20		1,040	95	45	79	180	397	23		422
June 21, 28		1,020				176		21		
July 5, 12, 19, 26		981	91	41	72	174	364	21	675	396
Aug. 2, 9, 16, 23, 30		825	74	35	56	156	287	16	545	328
Sept. 6, 13, 20, 27		748	69	27	53	144	251	14	485	283
Water year October 1939 to September 1940										
Oct. 4, 11, 18, 28, 1939		748	63	27	64	148	257	13	497	268
Nov. 8, 15, 22, 29		755	74	27	52	146	258	14	497	296
Dec. 6, 13, 20, 27		762				154				
Jan. 10, 17, 25, 31, 1940		760				153				
Feb. 7, 15, 21, 28		795				155		15		
Mar. 6, 13, 20, 27		804				158		16		
Apr. 3, 10, 17, 24		838				153				
May 1, 9, 16, 22, 29		841				156		17		
June 5, 12, 19, 26		848				152		19		
July 12, 18, 31		866				150		19		
Aug. 8, 14, 22		884				146		19		
Sept. 3, 11, 18, 25		888				148		18		
Maximum and minimum, water year October 1940 to September 1941										
Mar. 5, 9, 12, 1941		982				160		22		
Sept. 4, 18, 23		542				127		10		
Maximum, minimum, and intermediate analyses, water year October 1941 to September 1942										
Aug. 6, 13, 20, 25, 1942		638								
Oct. 1, 8, 15, 22, 31, 1941		464				115		9.0		
May 7, 8, 15, 28, 1942		622	60	23	40	141	189	13	394	244
Maximum, minimum, and intermediate analyses, water year October 1942 to September 1943										
Sept. 2, 10, 16, 23, 30, 1943		893				156				
Oct. 7, 1942		612				138	186	14		
Feb. 3, 12, 18, 26, 1943		782	69	29	59	148	265	15	511	291
Maximum and minimum, water year October 1943 to September 1944										
June 15, 22, 1944		[1] 1,020				165	384			
Oct. 7, 14, 21, 28, 1943		914				160				
Maximum and minimum, water year October 1944 to September 1945										
June 8, 14, 23, 30, 1945		[2] 1,070				165	411			
Oct. 6, 12, 1944		[3] 1,010					379			

See footnotes at end of table.

TABLE 4.—*Chemical analyses, in parts per million, of water from Conchas Reservoir at station 1, Conchas River arm of reservoir about 3,500 feet above dam, water years 1939 to 1949*—Continued

Date of collection	Depth (feet)	Specific conductance (Micromhos at 25° C.)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Dissolved solids	Total hardness as $CaCO_3$
Maximum and minimum, water year October 1945 to September 1946										
June 1, 8, 15, 21, 28, 1946		1,150				450				
Oct. 5, 12, 18, 25, 1945		1,070				156	405			
Maximum and minimum, water year October 1946 to September 1947										
Dec. 3, 11, 18, 27, 1946		981				150	367			
June 5, 10, 17, 26, 1947		1,040	85	40	82	159	378	22	686	376
Maximum and minimum, water year October 1947 to September 1948										
May 5, 11, 28, 1948		1,070				161	410	24		
Sept. 6, 14, 20, 27, 1948		[4] 1,010					387			
Maximum and minimum, for period October 1948 to July 1949										
June 8, 13, 26, 1949		1,070					420			
Oct. 4, 22, 26, 1948		1,010					405			
SAMPLES FROM DIFFERENT DEPTHS										
Nov. 7, 1939	Surface	758				150				
	25	761				151				
	50	765				152				
	84	773				153				
Sept. 10, 1941	Surface	543				127		9.0		
	25	544	54	19	32	127	159	9.0	336	212
	50	540				127		10		
	75	535	52	19	29	126	151	8.0	321	208
	93	559	64	18	28	166	141	8.0	341	234
Feb. 13, 1942	Surface	589	60	20	39	144	175	11	377	232
	25	591								
	50	587								
	75	597								
	100	592								
	105	704	74	26	45	160	231	12	468	292
	110	742								
	115	750								
	120	752				168	248	13		
	125	767								
Dec. 17, 1942	Surface	697	68	24	46	141	221	16	445	268
	25	696								
	50	701								
	78	819	80	32	60	155	298	17	564	331
	83	825								
	88	823								
	93	822								
	98	820								
	103	824	77	31	61	156	290	16	552	320
Apr. 3, 1944	Surface	1,010	84	40	84	166	370	25	685	374
	25	992								
	50	995								
	75	1,000								
	100	995								
	113	1,000				168				
	118	1,000								
	123	1,000				167				
	128	1,010				180				

See footnotes at end of table.

TABLE 4.—*Chemical analyses, in parts per million, of water from Conchas Reservoir at station 1, Conchas River arm of reservoir about 3,500 feet above dam, water years 1939 to 1949*—Continued

Date of collection	Depth (feet)	Specific conductance (Micromhos at 25° C.)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Dissolved solids	Total hardness as $CaCO_3$
SAMPLES FROM DIFFERENT DEPTHS—continued										
Jan. 12, 1945	Surface	1,010	86	42	83	162	384	24	699	387
	25	1,020								
	50	1,020								
	75	1,020								
	100	1,050								
	105	1,050								
	110	1,050								
	115	1,040								
	120	1,080	99	43	84	186	402	24	746	424
Apr. 29, 1946	Surface	1,130				167	435	28		
	25	1,120								
	50	1,120								
	75	1,120								
	95	1,120								
	100	1,120								
	105	1,120								
	110	1,120								
	115	1,120								
	120	1,120								
July 16, 1947	Surface	1,040								
	25	1,020								
	50	1,030	86	38	89	160	386	21	699	370
	75	1,020								
	100	1,020								
	105	1,010								
	110	1,020								
	115	1,020								
	120	1,050								
	125	1,600								
Apr. 27, 1948	Surface	1,070				161	406	27		
	25	1,060								
	50	1,060								
	75	1,060				160	412	25		
	102	1,070								
	107	1,070								
	112	1,070								
	117	1,080								
	122	1,090				175	415	30		
Oct. 19, 1948	Surface	1,010				148	386	24		
	25	995				152	383	23		
	50	1,010								
	75	1,010								
	100	1,030								
	105	1,040				172	385	23		
	110	1,030								
	115	1,030								
	120	1,070				214	385	23		

[1] Also reported for period May 4, 11, 20, 28, June 9, and July 14, 18.
[2] Also reported for period July 4, 19, 27, and Aug. 4, 11, 19, 23, 29.
[3] Also reported for period Dec. 7, 16, 21, 30.
[4] Also reported for period Aug. 3, 9, 16, 24, 30.

TABLE 5.—*Chemical analyses, in parts per million, of water from Conchas Reservoir at station 2, at upstream face of main section of Conchas Dam, water years 1939 to 1949*

[See fig. 12]

Date of collection	Depth (feet)	Specific conductance (Micromhos at 25° C.)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Dissolved solids	Total hardness as $CaCO_3$
SURFACE SAMPLES										
Water year October 1938 to September 1939										
Apr. 8, 1939			114	55	88 6.2	193	479	24	870	510
Apr. 29–30		1,120				187	453	21		
May 1–10		1,130				183	440	22		
May 11–20		1,090								
May 21–31		1,070								
June 1–2, 4–10		1,050				177		19		
June 11–20		1,030	98	45	75	182	394	23	725	430
June 21, 28		1,020				176		21		
July 5, 12, 19, 26		976	92	41	70	176	362	21	673	398
Aug. 2, 9, 16, 22, 30		814	76	35	51	152	289	14	540	334
Sept. 6, 13, 20, 27		737	68	27	51	141	249	12	476	280
Water year October 1939 to September 1940										
Oct. 4, 11, 18, 28, 1939		749	68	26	61	146	261	13	431	276
Nov. 8, 15, 22, 29		744	72	25	58	149	256	14	498	282
Dec. 6, 13, 20, 27		764				155				
Jan. 10, 17, 25, 31, 1940		767				154				
Feb. 7, 15, 21, 28		796				154		15		
Mar. 6, 13, 20, 27		808				157		15		
Apr. 3, 10, 17, 24		837				157				
May 1, 9, 16, 22, 29		837				156		18		
June 5, 12, 19, 26		846				157		17		
July 12, 18, 31		872				150		19		
Aug. 8, 14, 22		890				146		18		
Sept. 3, 11, 18, 25		894				148		19		
Maximum and minimum, water year October 1940 to September 1941										
Mar. 5, 12, 19, 1941		985				158		20		
Sept. 4, 18, 23		543				128		9.0		
Maximum, minimum, and intermediate analyses, water year October 1941 to September 1942										
Aug. 6, 13, 20, 25, 1942		638								
Oct. 1, 9, 15, 22, 1941		466				114		7.0		
May 7, 8, 15, 28, 1942		622	60	23	40	138	192	12	395	244
Maximum, minimum, and intermediate analyses, water year October 1941 to September 1942										
Sept. 2, 10, 16, 23, 30, 1943		896				156				
Oct. 1, 1942		609				133	187	12		
Feb. 4, 12, 18, 26, 1943		781	70	29	60	151	265	16	515	294
Maximum and minimum, water year October 1943 to September 1944										
June 15, 22, 1944		[1]1,020				166	385			
Oct. 7, 14, 21, 28, 1943		908				161				
Maximum and minimum, water year October 1944 to September 1945										
July 4, 19, 27, 1945		[2]1,070				159	416			
Nov. 16, 23, 30, 1944		[3]1,010				379				

See footnotes at end of table.

TABLE 5.—*Chemical analyses, in parts per million, of water from Conchas Reservoir at station 2, at upstream face of main section of Conchas Dam, water years 1939 to 1949*—Continued

Date of collection	Depth (feet)	Specific conductance (Micromhos at 25° C.)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Dissolved solids	Total hardness as $CaCO_3$
Maxmum and minimum, water year October 1945 to September 1946										
July 5, 20, 25, 1946		1,150					447			
Oct. 5, 12, 18, 25, 1945		1,060				158	415			
Maximum and minimum, water year October 1946 to September 1947										
June 5, 10, 17, 26, 1947		[4]1,030	84	41	81	159	381	19	685	378
Nov. 13, 23, 27, 1946		976					371			
Maximum and minimum, water year October 1946 to September 1947										
May 5, 11, 21, 28, 1947		[5]1,060				165	412	25		
Sept. 6, 14, 20, 27		[6]1,010					383			
Maximum and minimum, period October 1948 to July 1949										
June 3, 8, 26, 1949		1,070					416			
Oct. 4, 22, 26, 1948		1,010					394			
SAMPLES FROM DIFFERENT DEPTHS										
Nov. 7, 1939	Surface	772				150				
	25	760				151				
	50	766				152				
	70	770				153				
	90	1,390				816				
Apr. 23, 1940	25	833				164				
	50	841				164				
	75	848				162				
	86	848				174				
	88	900				198				
Sept. 10, 1941	Surface	541				127		9.0		
	25	541	54	18	34	129	158	9.0	337	208
	50	539				128		9.0		
	75	529				128		9.0		
	100	499	52	17	27	126	139	8.0	305	200
	125	603				268	98	8.0		
Feb. 13, 1942	Surface	590								
	25	587								
	50	590								
	75	591	61	21	38	143	182	10	383	238
	100	675				156	221	12		
	111	734								
	116	704								
	121	744								
	126	757	77	30	52	170	257	14	515	314
	131	832								
Dec. 17, 1942	Surface	703	60	25	60	148	230	15	464	252
	25	699								
	50	704								
	75	823	88	29	47	157	276	17	535	338
	112	829								
	117	823								
	122	828								
	127	828								
	132	827	82	33	53	156	293	16	554	340

See footnote at end of table.

TABLE 5.—*Chemical analyses, in parts per million, of water from Conchas Reservoir at station 2, at upstream face of main section of Conchas Dam, water years 1939 to 1949*—Continued

Date of collection	Depth (feet)	Specific conductance (Micromhos at 25° C.)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Dissolved solids	Total hardness as $CaCO_3$
SAMPLES FROM DIFFERENT DEPTHS—continued										
Apr. 3, 1944	Surface	1,000	91	41	80	170	374	28	698	396
	25	992								
	50	992								
	75	995				168				
	100	1,000								
	117	1,000								
	122	1,000								
	127	997								
	132	997	83	40	83	168	367	23	679	372
	137	1,050	102	39	80	196	381	22	721	415
Jan. 12, 1945	Surface	1,020	86	42	86	164	386	26	707	387
	25	1,020								
	50	1,020								
	75	1,020								
	100	1,040								
	107	1,040								
	112	1,050								
	117	1,050								
	122	1,050								
	127	1,070	95	44	80	176	399	22	728	418
Apr. 29, 1946	Surface	1,130				169	435	27		
	25	1,130								
	50	1,120								
	75	1,120								
	95	1,120								
	100	1,120								
	110	1,120								
	115	1,120								
	120	1,120								
	125	1,120								
	130	1,120								
	135	1,130								
July 16, 1947	Surface	1,030	84	41	84	154	388	22	695	378
	25	1,010								
	50	1,030								
	75	1,020								
	100	1,020								
	105	1,020								
	110	1,020								
	115	1,010								
	120	1,020								
	125	1,010								
	130	1,020								
	135	1,190				492	249			
Apr. 27, 1948	Surface	1,060				164	408	25		
	25	1,070								
	50	1,060								
	75	1,070								
	100	1,070								
	115	1,070								
	120	1,070								
	125	1,070								
	130	1,070								
	135	1,140				266	369	23		
Oct. 19, 1948	Surface	1,010				151	382	24		
	25	1,010								
	50	989				157	382	24		
	75	1,020								
	100	1,030								
	105	1,030								
	110	1,040				172	386	24		
	115	1,030								
	120	1,080				207	386	24		

[1] Also reported for period May 4, 11, 20, 28, June 9, July 14, 18.
[2] Also reported for period June 8, 14, 23, 30 and Aug. 4, 11, 19, 23, 29.
[3] Also reported for period Oct. 6, 12 and Dec. 7, 16, 21, 30.
[4] Also reported for period July 2, 10, 16, 23, 31.
[5] Also reported for period April 1, 7, 12, 20.
[6] Also reported for period Aug. 3, 9, 16, 24, 30.

TABLE 6.—*Chemical analyses, in parts per million, of water from Conchas Reservoir at Station 3, Canadian River arm of reservoir about 1,300 feet above dam, water years 1939 to 1949*

[See fig. 12]

Date of collection	Depth	Specific conductance (Micromhos at 25° C.)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Dissolved solids	Total hardness as $CaCO_3$
SURFACE SAMPLES										
Water year October 1938 to September 1939										
Apr. 8, 1939	------	------	114	54	89 5.6	192	480	24	869	506
Apr. 29, 30	------	1,140	------	------	------	186	449	19	------	------
May 1–10	------	1,120	------	------	------	183	437	20	------	------
May 11–20	------	1,090	------	------	------	------	------	------	------	------
May 21–31	------	1,060	------	------	------	------	------	------	------	------
June 1–2, 4–10	------	1,040	------	------	------	177	------	18	------	------
June 11–20	------	1,030	96	45	72	176	391	21	712	424
June 21, 28	------	1,010	------	------	------	176	------	21	------	------
July 5, 12, 19, 26	------	970	------	------	------	172	------	22	------	------
Aug. 2, 9, 16, 23, 30	------	816	74	35	51	155	283	13	532	328
Sept. 6, 13, 20, 27	------	735	68	26	56	142	253	13	486	276
Water year October 1939 to September 1940										
Oct. 4, 11, 18, 28, 1939	------	752	68	27	56	146	253	13	489	280
Nov. 8, 15, 22, 29	------	741	74	26	55	148	257	16	501	292
Dec. 6, 13, 20, 27	------	762	------	------	------	153	------	------	------	------
Jan. 10, 17, 25, 31, 1940	------	786	------	------	------	154	------	------	------	------
Feb. 7, 15, 21, 28	------	798	------	------	------	157	------	16	------	------
Mar. 6, 13, 20, 27	------	810	------	------	------	158	------	14	------	------
Apr. 3, 10, 17, 24	------	834	------	------	------	158	------	------	------	------
May 1, 9, 16, 22, 29	------	839	------	------	------	157	------	17	------	------
June 5, 12, 19, 26	------	858	------	------	------	156	------	19	------	------
July 12, 18, 31	------	881	------	------	------	151	------	19	------	------
Aug. 8, 14, 22	------	896	------	------	------	146	------	18	------	------
Sept. 3, 11, 18, 25	------	896	------	------	------	147	------	18	------	------
Maximum and minimum, water year October 1940 to September 1941										
Mar. 5, 12, 19, 26, 1941	------	986	------	------	------	160	------	20	------	------
June 11, 18, 25	------	[1] 544	------	------	------	116	------	9.0	------	------
Maximum, minimum, and intermediate analyses, water year October 1941 to September 1942										
Aug. 6, 20, 25, 1942	------	652	------	------	------	------	------	------	------	------
Oct. 1, 9, 15, 22, 1941	------	462	------	------	------	114	------	9.0	------	------
May 7, 8, 15, 28, 1942	------	618	61	22	37	138	189	10	387	242
Maximum, minimum, and intermediate analyses, water year October 1942 to September 1943										
Sept. 2, 10, 16, 23, 30, 1943	------	917	------	------	------	157	------	------	------	------
Oct. 7, 1942	------	621	------	------	------	------	------	------	------	------
Feb. 3, 7, 12, 18, 26, 1943	------	762	62	28	65	143	254	20	500	270
Maximum and minimum, water year October 1943 to September 1944										
June 15, 22, 1944	------	1,030	------	------	------	165	379	------	------	------
Oct. 7, 14, 21, 28, 1943	------	910	------	------	------	162	------	------	------	------
Maximum and minimum, water year October 1944 to September 1945										
July 4, 19, 27, 1945	------	[2] 1,070	------	------	------	161	413	------	------	------
Oct. 6, 12, 1944	------	[3] 1,010	------	------	------	------	379	------	------	------

See footnotes at end of table.

TABLE 6.—*Chemical anayses, in parts per million, of water from Conchas Reservoir at Station 3, Canadian River arm of reservoir about 1,300 feet above dam, water years 1939 to 1949*—Continued

Date of collection	Depth (feet)	Specific conductance (Micromhos at 25° C.)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Dissolved solids	Total hardness as $CaCO_3$
Maximum and minimum, water year October 1945 to September 1946										
June 1, 8, 15, 21, 28, 1946		[4]1,140					468			
Oct. 5, 12, 18, 25, 1945		1,060				153	414			
Maximum, minimum, and intermediate analyses, water year October 1946 to September 1947										
July 2, 10, 16, 23, 31, 1947		1,030				160	389			
Nov. 13, 23, 27, 1946		978					372			
June 5, 10, 17, 26, 1947		1,030	84	40	85	159	383	21	692	374
Maximum and minimum, water year October 1947 to September 1948										
May 5, 11, 21, 28, 1948		1,070				163	409	23		
Sept. 6, 14, 20, 27		988					379			
Maximum and minimum, for period October 1948 to July 1949										
June 8, 26, 1949		1,070					417			
Oct. 4, 22, 26, 1948		1,000					392			
SAMPLES FROM DIFFERENT DEPTHS										
Nov. 7, 1939	Surface	768				151				
	10	767				151				
	20	760				150				
	30	765				150				
	40	768				149				
	50	770				151				
	60	775				152				
	70	770				153				
	80	774				152				
	83	764				154				
	84	807				179				
	86	1,250				840				
Sept. 10, 1941	Surface	545				128		9.0		
	25	538	56	18	30	126	156	9.0	331	214
	50	540				128		9.0		
	75	529				128		10		
	100	497	52	17	23	124	132	8.0	293	200
	125	621	82	22	25	254	126	7.0	387	295
Feb. 13, 1942	Surface	587								
	25	584	61	20	38	143	177	11	378	234
	50	585								
	75	584								
	100	695				159	230	12		
	106	754								
	111	751								
	116	751								
	121	761	78	29	51	170	254	13	510	314
	126	761								
Dec. 31, 1942	Surface	742	71	26	53	148	246	15	484	284
	25	738								
	50	740								
	75	745								
	81	746								
	85	749								
	91	748								
	96	757								
	101	898	96	32	62	217	291	17	606	371

See footnotes at end of table.

TABLE 6.—*Chemical analyses, in parts per million, of water from Conchas Reservir at Station 3, Canadian River arm of reservoir about 1,300 feet above dam, water years 1939 to 1949*—Continued

Date of collection	Depth (feet)	Specific conductance (Micromhos at 25° C.)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Dissolved solids	Total hardness as $CaCO_3$
SAMPLES FROM DIFFERENT DEPTHS—continued										
Apr. 3, 1944	Surface	995	84	41	80	170	366	23	678	378
	25	992								
	50	992								
	75	995								
	100	997								
	108	995				168				
	117	997								
	121	1,000								
	126	1,010								
	131	1,010				168				
	136	1,020				171				
Jan. 12, 1945	Surface	1,030	86	43	83	164	386	24	703	392
	25	1,030								
	50	1,020								
	75	1,020								
	100	1,040								
	105	1,050								
	110	1,050								
	115	1,050								
	125	1,080	98	44	73	186	380	24	712	426
Apr. 29, 1946	Surface	1,130				166	434	27		
	25	1,120								
	50	1,120								
	75	1,120								
	100	1,120								
	105	1,120								
	110	1,120								
	115	1,120								
	120	1,110				171	428	27		
July 16, 1947	Surface	1,040	84	41	84	156	388	20	694	378
	25	989	83	38	80	149	374	18	667	363
	50	1,030								
	75	1,020								
	100	1,020								
	105	1,010								
	110	1,010								
	115	1,010								
	120	1,020								
	122	1,440				934				
Apr. 27, 1948	Surface	1,070				161	409	34		
	25	1,070								
	50	1,060								
	75	1,070								
	105	1,070								
	110	1,070								
	115	1,070								
	120	1,070								
	125	1,180				367	326	23		
Oct. 19, 1948	Surface	1,020				151	385	22		
	25	1,010								
	50	1,010				154	387	24		
	75	1,020								
	95	1,020								
	100	1,030				166	388	20		
	105	1,040								
	110	1,030								
	115	1,140				272	400	25		

[1] Also reported for period Sept. 4, 18, 23.
[2] Also reported for period June 8, 14, 23, 30 and Aug. 4, 11, 19, 23, 29.
[3] Also reported for period Nov. 2, 9.
[4] Also reported for period May 4, 12, 18, 24, July 5, 20, 25, and Aug. 3, 13, 21, 31.

TABLE 7.—*Chemical analyses, in parts per million, of water samples from different depths, Conchas Reservoir at Station 6, Conchas River arm of reservoir 5 miles above dam, water years 1941 to 1949* [See fig. 12]

Date of collection	Depth (feet)	Specific conductance (Micromhos at 25° C.)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Dissolved solids	Total hardness as $CaCO_3$
Oct. 15, 1941	Surface	450	------	------	------	116	------	9.0	------	------
	25	448	44	14	28	114	118	8.0	268	168
	50	445	------	------	------	116	------	9.0	------	------
	58	443	------	------	------	114	------	7.0	------	------
	63	442	------	------	------	114	------	9.0	------	------
	68	436	------	------	------	113	------	8.0	------	------
	73	435	------	------	------	112	------	7.0	------	------
	75	443	44	14	26	114	115	8.0	263	168
	78	496	------	------	------	154	120	8.0	------	------
Jan. 17, 1942	Surface	555	------	------	------	------	------	------	------	------
	25	557	------	------	------	------	------	------	------	------
	50	555	------	------	------	------	------	------	------	------
	75	552	57	18	37	138	160	12	352	216
	90	566	------	------	------	------	------	------	------	------
	95	708	------	------	------	------	------	------	------	------
	100	721	------	------	------	------	------	------	------	------
	105	725	74	27	47	165	235	12	477	296
	110	725	------	------	------	------	------	------	------	------
Dec. 17, 1942	Surface	685	68	24	52	149	229	15	466	268
	25	680	------	------	------	------	------	------	------	------
	50	680	------	------	------	------	------	------	------	------
	71	734	72	25	60	150	255	17	503	282
	76	758	------	------	------	------	------	------	------	------
	81	800	------	------	------	------	------	------	------	------
	86	817	------	------	------	------	------	------	------	------
	91	775	------	------	------	------	------	------	------	------
	96	833	84	30	61	176	286	16	569	333
Apr. 3, 1944	Surface	992	85	42	85	165	372	34	699	384
	25	989	------	------	------	------	------	------	------	------
	50	989	------	------	------	------	------	------	------	------
	75	989	------	------	------	------	------	------	------	------
	80	989	------	------	------	167	------	------	------	------
	85	986	------	------	------	------	------	------	------	------
	90	989	------	------	------	172	------	------	------	------
	95	995	90	40	74	159	373	22	677	389
Jan. 12, 1945	Surface	1,020	87	43	79	162	383	24	696	394
	25	1,020	------	------	------	------	------	------	------	------
	50	1,020	------	------	------	------	------	------	------	------
	70	1,020	------	------	------	------	------	------	------	------
	75	1,020	------	------	------	------	------	------	------	------
	80	1,030	------	------	------	------	------	------	------	------
	85	1,020	------	------	------	------	------	------	------	------
	90	1,110	112	43	84	232	399	24	777	456
Apr. 29, 1946	Surface	1,130	------	------	------	168	433	------	------	------
	25	1,130	------	------	------	------	------	------	------	------
	50	1,120	------	------	------	------	------	------	------	------
	70	1,120	------	------	------	------	------	------	------	------
	75	1,120	------	------	------	------	------	------	------	------
	80	1,130	------	------	------	------	------	------	------	------
	85	1,120	------	------	------	------	------	------	------	------
	90	1,130	------	------	------	------	------	------	------	------
July 16, 1947	Surface	1,040	84	42	82	156	387	21	693	382
	25	1,030	------	------	------	------	------	------	------	------
	50	1,030	------	------	------	------	------	------	------	------
	70	1,020	------	------	------	------	------	------	------	------
	75	1,020	------	------	------	------	------	------	------	------
	80	1,020	------	------	------	------	------	------	------	------
	85	1,030	------	------	------	------	------	------	------	------
	90	1,020	------	------	------	------	------	------	------	------
	95	1,030	------	------	------	------	------	------	------	------
Apr. 27, 1948	Surface	1,070	------	------	------	164	408	25	------	------
	25	1,070	------	------	------	------	------	------	------	------
	50	1,060	------	------	------	------	------	------	------	------
	70	1,070	------	------	------	------	------	------	------	------
	75	1,060	------	------	------	------	------	------	------	------
	80	1,070	------	------	------	------	------	------	------	------
	85	1,070	------	------	------	------	------	------	------	------
	90	1,080	------	------	------	173	414	23	------	------
Jan. 26, 1949	Surface	1,040	------	------	------	158	396	------	------	------
	25	1,040	------	------	------	------	------	------	------	------
	50	1,040	------	------	------	------	------	------	------	------
	65	1,040	------	------	------	------	------	------	------	------
	70	1,040	------	------	------	------	------	------	------	------
	75	1,040	------	------	------	------	------	------	------	------
	80	1,040	------	------	------	------	------	------	------	------
	85	1,050	------	------	------	------	------	------	------	------
	90	1,080	------	------	------	189	406	------	------	------

TABLE 8.—*Chemical analyses, in parts per million, of water samples from different depths, Conchas Reservoir at Station 7, Canadian River arm of reservoir 5 miles above dam, water years 1941 to 1949*

[See figure 12]

Date of collection	Depth (feet)	Specific conductance (Micromhos at 25° C.)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Dissolved solids	Total hardness as $CaCO_3$
Oct. 15, 1941	Surface	464	--	--	--	115	--	7.0	--	--
	25	460	47	17	23	114	128	7.0	278	188
	50	501	--	--	--	122	--	7.0	--	--
	75	519	--	--	--	123	--	9.0	--	--
	85	543	--	--	--	132	--	9.0	--	--
	90	550	--	--	--	132	--	8.0	--	--
	95	560	--	--	--	133	--	9.0	--	--
	100	581	--	--	--	139	--	10	--	--
	100	596	--	--	--	140	178	10	--	--
	105	639	--	--	--	178	176	10	--	--
Jan. 17, 1942	Surface	594	62	21	38	145	181	11	385	241
	25	593	--	--	--	--	--	--	--	--
	50	605	--	--	--	--	--	--	--	--
	75	603	--	--	--	--	--	--	--	--
	97	629	--	--	--	--	--	--	--	--
	100	633	--	--	--	--	--	--	--	--
	102	642	--	--	--	--	--	--	--	--
	107	702	--	--	--	--	--	--	--	--
	112	786	--	--	--	--	--	--	--	--
	117	771	86	28	47	201	237	13	513	330
Dec. 31, 1942	Surface	768	72	28	62	150	273	16	525	294
	25	772	--	--	--	--	--	--	--	--
	50	779	--	--	--	--	--	--	--	--
	60	778	--	--	--	--	--	--	--	--
	65	777	--	--	--	--	--	--	--	--
	70	780	--	--	--	--	--	--	--	--
	75	784	--	--	--	--	--	--	--	--
	80	782	74	29	60	152	273	17	528	304
	85	834	84	30	60	167	292	16	566	333
Apr. 3, 1944	Surface	1,010	89	42	89	174	396	24	726	394
	25	1,010	--	--	--	--	--	--	--	--
	50	1,010	--	--	--	--	--	--	--	--
	75	1,030	--	--	--	--	--	--	--	--
	97	1,020	--	--	--	168	--	--	--	--
	102	1,040	--	--	--	--	--	--	--	--
	107	1,050	--	--	--	--	--	--	--	--
	112	1,050	--	--	--	172	--	--	--	--
	117	1,010	--	--	--	173	--	--	--	--
Jan. 12, 1945	Surface	1,020	89	43	76	162	385	22	695	349
	25	1,030	--	--	--	--	--	--	--	--
	50	1,030	--	--	--	--	--	--	--	--
	75	1,040	--	--	--	--	--	--	--	--
	88	1,060	--	--	--	--	--	--	--	--
	93	1,060	--	--	--	--	--	--	--	--
	98	1,060	--	--	--	--	--	--	--	--
	103	1,070	94	46	80	168	410	24	737	424
	108	1,070	--	--	--	--	--	--	--	--
Apr. 29, 1946	Surface	1,130	--	--	--	168	438	26	--	--
	25	1,120	--	--	--	--	--	--	--	--
	50	1,120	--	--	--	--	--	--	--	--
	75	1,130	--	--	--	--	--	--	--	--
	82	1,140	--	--	--	--	--	--	--	--
	87	1,130	--	--	--	--	--	--	--	--
	92	1,130	--	--	--	--	--	--	--	--
	97	1,130	--	--	--	--	--	--	--	--
	102	1,130	--	--	--	--	--	--	--	--
	107	1,150	--	--	--	178	436	26	--	--
July 16, 1947	Surface	1,040	82	41	88	152	395	21	702	373
	25	989	82	38	80	146	372	20	664	360
	50	1,000	--	--	--	--	--	--	--	--
	75	1,000	--	--	--	--	--	--	--	--
	100	1,000	--	--	--	--	--	--	--	--
	105	1,010	--	--	--	--	--	--	--	--
	110	1,010	--	--	--	--	--	--	--	--
	115	1,010	--	--	--	--	--	--	--	--
	120	1,010	--	--	--	--	--	--	--	--

TABLE 8.—*Chemical analyses, in parts per million, of water samples from different depths, Conchas Reservoir at Station 7, Canadian River arm of reservoir 5 miles above dam, water years 1941 to 1949*—Continued

Date of collection	Depth (feet)	Specific conductance (Micromhos at 25° C.)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Dissolved solids	Total hardness as $CaCO_3$
Apr. 27, 1948	Surface	1,070				163	409	25		
	25	1,070								
	50	1,070								
	80	1,090								
	85	1,090								
	90	1,090								
	95	1,100				166	424	24		
	100	1,230				277	437	21		
Jan. 26, 1949	Surface	1,020				158	398			
	25	1,030								
	50	1,030								
	75	1,030								
	80	1,030								
	85	1,030								
	90	1,030								
	95	1,030								
	100	1,030								
	105	1,130								

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