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QUALITY OF WATER IN THE TUCUMCARI IRRIGATION PROJECT, Quay County, NEW MEXICO

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Introduction

In the summer of 1948 the United States Bureau of Reclamation requested that the U.S. Geological Survey make a study of quality of ground water in the Tucumcari Irrigation District. It was especially desired to learn the effects of irrigation seepage on the chemical character of water obtained from certain wells, to the extent that these effects could be determined.

Collection and Analysis of Samples

Water samples were collected by the Bureau of Reclamation from six of the observation wells put down by the Bureau within the project area, from the surface water distribution system of the project area at 20 points, and from 70 privately owned wells in the project area. The samples were analyzed in the Albuquerque laboratory of the Geological Survey under the direction of J. D. Hem, District Chemist. The analyses were made by L. S. Hughes. Analytical methods were those commonly used by the Geological Survey.* The analyses of these 96 samples are given in tables 1 to 3 of this report.

Quality of Water in Observation Wells

The Bureau of Reclamation has installed a network of observation or "drainage" wells in the project area. These wells were constructed by boring holes approximately 12 feet deep. In each hole was placed a section of 2-inch pipe, long enough to protrude a few feet above the ground surface, and perforated in the bottom several feet. Coarse gravel was then packed about the perforated end of the pipe and the hole was back-filled with earth and tamped to prevent seepage of surface water into the hole. Most of these wells were entirely above the water table in the summer of 1948 and contained no water. The wells which did contain water were sampled by bailing with a short section of 1-inch pipe, plugged at one end. The analyses of these samples are contained in table 1.

All the observation wells sampled are near the project canals and would be expected to show water similar in chemical character to the water in the canals. However, the analyses in table 1 show considerable differences. It is possible that surface runoff from rainfall may have entered some of the wells and affected the quality of the water. The method of sampling did not permit the removal of water standing in contact

*Collins, W. D., 1928, Notes on practical water analysis: U.S. Geol. Survey Water-Supply Paper 596.

TABLE 1

ANALYSES OF SAMPLES FROM "DRAINAGE WELLS," TUCUMCARI IRRIGATION PROJECT, NEW MEXICO

(Parts per million except Specific Conductance.)

Well No.	Date of collection	Depth (feet)	Specific conductance (micromhos at 25°C)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_2)	Dissolved solids	Total hardness as $CaCO_3$	Percent sodium
1	9-15-48	10	350	26	6.3	30	0	26	53	56	.3	184	91	41
2	9-15-48	11	949	26	15	164	0	141	314	28	12	617	126	74
2W-1E	9-21-48	7	1,070	15	7.9	221	0	266	247	53	.6	676	70	87
4W-1.5S	9-23-48	12	1,830	118	6.1	263	0	78	645	110	2.1	1,180	320	64
0W-1.5N	9-21-48	11	617	14	2.6	134	0	306	61	15	1.4	379	46	86
15	9-15-48	11	893	44	21	121	0	126	316	19	1.0	584	196	57

with the well casing before the sample was taken. It has been found in other areas that water standing in a well for a long period may change considerably in chemical character and may not be the same as water in the water-bearing formation surrounding the well. Therefore it is probable that the analyses in table 1 do not represent the water in the aquifers surrounding the wells, and that no definite conclusions should be based on them. Future sampling of these wells should be accomplished after more thorough bailing or pumping.

Quality of Water in Surface Distribution System

Table 2 contains analyses of 20 samples collected from the canals and laterals at various points in the project area. These samples were collected to indicate changes, if any, that may occur in the water between the head of the Conchas Canal and the points of use in the project area.

The analyses show the water to be uniform in chemical composition throughout the system. Sample 19, which contains waste water, is somewhat higher in sulfate and dissolved solids than the water entering the project area but the difference is slight. The waste water probably increased in dissolved solids by leaching soluble material from surface soil. This effect would be expected in newly irrigated land.

Changes in the composition of the water in Conchas Reservoir may be expected from month to month or from year to year. However, as long as large amounts of water are contained in the reservoir such changes, which would result from changes in rate and quality of inflow to the reservoir, will take place slowly.

TABLE 2

ANALYSES OF SAMPLES FROM SURFACE-WATER DISTRIBUTION SYSTEM, TUCUMCARI IRRIGATION PROJECT, NEW MEXICO

(Parts per million except Specific Conductance.)

Location	Date of collection	Specific conductance (micromhos at 25°C)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$	Percent sodium
1 Conchas Canal	9-20-48	1,020	85	45	75	6.9	130	396	22	0.3	695	397	29
2 No. 2 Rating Section Co. line	9-21-48	1,030	-	-	-	7.9	128	-	-	-	-	-	-
3 Check No. 25, Conchas Canal	9-29-48	1,030	-	-	-	5.9	135	-	-	-	-	-	-
4 Tucumcari Check, Conchas Canal	9-29-48	1,030	-	-	-	4.9	136	-	-	-	-	-	-
5 Y on main canals, Conchas and Hudson Canals	9-22-48	1,030	-	-	-	0	146	-	-	-	-	-	-
6 Conchas Canal End	9-22-48	1,030	83	44	81	0	136	405	22	.2	702	388	31
7 Bell Lateral	9-21-48	1,030	-	-	-	0	143	-	-	-	-	-	-
8 Roberts Lateral	9-21-48	1,020	-	-	-	0	140	-	-	-	-	-	-
9 Liberty Lateral	9-21-48	1,030	-	-	-	0	140	-	-	-	-	-	-
10 Tucumcari Lateral	9-21-48	1,030	-	-	-	0	137	-	-	-	-	-	-
11 Check No. 3, Hudson Canal	9-29-48	1,040	-	-	-	0	148	-	-	-	-	-	-
12 Check No. 5, Hudson Canal	9-29-48	1,040	-	-	-	4.9	134	-	-	-	-	-	-
13 Check No. 6, Hudson Canal	9-29-48	1,020	-	-	-	7.9	119	-	-	-	-	-	-
14 Hudson End at present	9-22-48	1,040	81	44	87	0	138	404	27	.2	711	383	33
15 Farm Lateral by bridge	9-22-48	1,040	-	-	-	0	145	-	-	-	-	-	-
16 Gaudin Lateral	9-29-48	1,020	-	-	-	0	130	-	-	-	-	-	-
17 Felk Lateral	9-22-48	1,020	-	-	-	0	134	-	-	-	-	-	-
18 Bugg Lateral	9-22-48	1,020	-	-	-	0	130	-	-	-	-	-	-
19 W.W. No. A off Buff Lateral	9-23-48	1,040	78	46	85	0	112	426	23	.5	714	384	33
20 Savage Lateral	9-22-48	1,010	-	-	-	0	128	-	-	-	-	-	-

Quality of Water in Privately-Owned Wells

Table 3 contains analyses of samples collected from 70 wells in the project area. The wells sampled were chosen to give a rather complete coverage of the entire project area. Some of the wells are located in lands that have been irrigated for several years, some are in land irrigated for the first time in 1948, and others are in land that is to be irrigated in the future but for which water distribution facilities had not been completed at the time of this study.

Wide differences in chemical character and dissolved-solids concentration are typical of ground waters in the project area. A few of the waters contain less than 500 parts per million of dissolved matter and others contain more than 3,000 parts. Sodium is the principal cation in most of the waters, and in some of the more highly mineralized waters it is the predominant basic constituent. Most of the more highly mineralized waters contain large amounts of sulfate and bicarbonate, and many waters were found which apparently contain considerable quantities of carbonate.

Probably many of the differences in chemical character of the ground waters of the area are associated with differences in the geologic formations from which the waters come. Data on the nature of these formations are lacking. Variations in quality of water from place to place in the same formation also doubtlessly occur.

The well numbers in table 3 were assigned on the basis of the map locations of the wells. The first and second segments of the number represent the township and range numbers, respectively. The third segment represents the number of the section within which the well is located. The fourth segment refers to the 40-acre tract in the section in which the well is located. These numbers were assigned as follows: NE¼NE¼, 1; NW¼NE¼, 2; SW¼NE¼, 3; SE¼NE¼, 4. The four tracts in the NE¼ of each section were assigned numbers from 5 to 8 in a similar arrangement; the four tracts in the SE¼ were assigned numbers from 9 to 12, and the four tracts in the SW¼ were assigned numbers from 13 to 16. Where more than one well was sampled in any 40-acre tract, the wells in the tract were assigned consecutive numbers starting with 1, and this number constitutes a fifth segment of the well number.

Effects of Seepage on Quality of Water: Owners of some of the wells in the irrigated area have reported that they believe underground seepage from irrigation has entered their wells. Many of the wells are cased only short distances below the ground surface or have faulty casing through which such seepage could easily occur. The wells believed by the Bureau of Reclamation to have been affected by seepage are the following:

(Numbers correspond to well numbers in table 3.)

11.30. 5.4
19. 2
19. 6
21.15
29. 2
11.31. 1. 9
8. 6
14. 7
11.32.24. 2
12.30.32. 4
32.9
34. 3

1132 - 24 - 2

1230 - 32 - 4

1230 - 32 - 9

1230 - 34 - 3

No analyses are available to show the quality of water in these wells before the supposed seepage took place. The effects of seepage can be inferred to some extent by comparing the analyses with those for nearby wells not affected by seepage, but in many instances such comparisons are inconclusive because of differences in depth of wells and probable associated differences in chemical character of the water before seepage took place. The following statements are made assuming the analyses of nearby wells represent the quality of water from wells now affected by seepage before the seepage took place. It is recognized that this assumption may not be valid in all instances.

The irrigation water originally probably had a chemical character similar to that shown by analyses in table 2. However, as soon as this water enters the ground it may be expected to change in chemical character, depending on the nature of the solid rock formation through which it passes. As a rule the dissolved solids of such seepage water will increase as it percolates through the soil and rocks, and this is particularly likely to be the case in the Tucumcari area. Here there are exposed geologic formations known elsewhere in New Mexico to contain considerable amounts of soluble salts and patches of alkali are visible on the surface soil in some of the unirrigated area.

An indication of the effects of seepage on chemical character of the water in one part of the project area may be obtained from the analyses for wells 12.30.33.6, 12.30.32.4, 12.30.32.9, and 11.30.5.4. All these wells are reported to obtain water from the same sandstone bed and probably would normally contain similar water as all are located along a line about a mile long, parallel to and about ½ mile east of the main canal, just below the point where it enters the project area. Well 12.30.-33.6 is farthest upstream and is believed not to have been affected by seepage. Wells 12.30.32.4., 12.30.32.9, and 11.30.5.4 are located in downstream order along the canal and show a progressive increase in dissolved solids as indicated by conductance with the sample from well 11.30.5.4 having a conductance about 75 percent higher than water from well 12.30.33.6. The increase is principally in magnesium, sodium, bicarbonate, and sulfate. Also the water in the lowermost well is much higher in nitrate than the water from well 12.30.33.6.

Water from well 12.30.34.3 is intermediate in concentration between unaffected wells 11.30.34.14 to the west and 12.30.35.8 to the east. This would be normally expected had there been no seepage and the analyses therefore give no conclusive evidence of seepage effects at this location.

Well 11.30.19.2 has one of the most dilute waters found in the study with only 68 parts per million of sulfate as compared to about 400 in the canal water, and probably more in the seepage water. Probably the effect of seepage on the quality of water in this well is slight. Nearby well 11.30.19.6 has a higher conductance than well 11.30.19.3, and a sulfate content about three times as high. If these wells originally yielded similar water, the seepage has affected this well much more strongly than well 11.30.19.2

Well 11.30.21.15 yields water lower in dissolved matter than any of the nearby wells and less highly mineralized than water in the canal. No seepage effect can be ascertained from the analysis for this well.

Wells 11.30.29.2.1 and 11.30.29.2.2 are located close to each other. Well 1 is nearest the canal and is higher in sodium and sulfate than well 2. Apparently seepage has caused the difference in concentration, increasing the sodium and sulfate in water from well 1.

Well 11.31.1.9 is located some distance from other wells, and yields a very soft water. The effect of seepage probably would be to increase the hardness of this water. No definite statement can be made regarding the effect of seepage on this well on the basis of the analyses.

Well 11.31.8.6 is near unaffected well 11.31.6.12. The effect of seepage has been to increase the conductance, and probably the sulfate, by more than 50 percent in well 11.31.8.6 if both wells originally yielded water of the same composition.

Well 11.31.14.7 yields very highly mineralized water similar to that obtained from several wells directly to the south. Probably seepage should reduce the concentration of water at this location. The analyses do not provide a sufficient basis for conclusions regarding seepage effects on this well.

Well 11.32.24.2 has water considerably lower in dissolved matter than that obtained from other nearby wells that yield rather highly mineralized water. The reduction is probably principally in bicarbonate. The effect may be the result of seepage.

<u>Boron in Ground Water</u>: A few of the samples from the privately-owned wells were analyzed for boron. Less than 1 part per million was found in most of these samples, but one well, 11.31.24.5, gave a sample containing 1.3 parts per million and several wells gave samples that contained

nearly 1 part. The higher concentrations occurred in waters high in dissolved solids and alkalinity.

It is probable that more boron determinations should be made on ground waters from the project area. Concentrations of boron found thus far are not alarmingly high; however, because of the importance of boron in irrigation waters and the possible appearance of boron in drainage water from the project area, some additional study of this phase of the problem should be made.

Quality of Water in Conchas Reservoir

Analyses of daily samples taken from the Canadian River in the vicinity of Sanchez, N. Mex., have been published by the Geological Survey for the years ending September 30, 1941, 1942, 1943, and 1944 in Water-Supply Papers 942, 950, 970, and 1022, respectively. The publications also contain analyses of samples taken at various places within the reservoir. Weighted average analyses for the Canadian River near Sanchez for the years ending September 30, 1944, 1945, and 1946 are given in table 4 of this report.

The weighted average analyses were computed according to the following procedure. The concentration in parts per million of each constituent of each composite sample analyzed during the year was multiplied by the discharge for the period of the composite in second-foot days. The sum of these products for each constituent was divided by the total discharge for the year to obtain a weighted average value in parts per million. The weighted average analysis represents approximately the composition of the water passing the station would have when all of it was stored in a reservoir and completely mixed.

TABLE 4

WEIGHTED AVERAGE ANALYSES FOR CANADIAN RIVER NEAR SANCHEZ, N. MEX., FOR THE WATER YEARS 1944-1946

Water Year	Percent sodium	Specific conductance (micromhos at 25°C)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$
1944	28	1,000	93	42	74	0	171	384	18	0.3	2.1	713	404
1945	29	1,160	108	51	90	0	178	471	23	.4	1.7	843	479
1946	26	742	78	27	49	0	162	245	11	.4	1.0	504	306

The analyses for the Canadian River near Sanchez represent closely the quality of most of the water entering the reservoir. Other streams contribute minor amounts of water of different chemical character to the reservoir, and some changes in the chemical character of the water occur during storage. Some water is held over in the reservoir from year to year and as a result quality of ~~both~~ the water available from the reservoir at any time is likely to differ somewhat from the average quality of the inflow from the Canadian River.

Summary and Conclusions

The analyses which were made in this study show that the water in the surface distribution system of the project area is uniform in composition. The samples collected from the privately-owned wells in the project area show a wide range in quality of ground water ~~in the area~~. Much of the water contains considerable quantities of sodium, bicarbonate, and sulfate.

Future changes which may occur in quality of ground waters in the area can be interpreted by use of data collected ~~xxx~~ in this study. The study also provides a partial basis for evaluation of some changes that have already occurred as a result of seepage of irrigation water into the ground-water reservoir in certain areas. However, in most areas where such seepage is believed to have occurred it is not possible to draw from a single analysis for each well definite conclusions regarding the extent of the changes. The effects of seepage on quality of ground water in the area can be more definitely established by resampling of affected wells at a later time.

A study of the geology and ground-water conditions within the area would have been helpful in the interpretation of the results of the analysis, and probably will be needed for the correct solution of drainage problems at a later time.