GROUND WATER IN THE VICINITY OF TRINIDAD, COLORADO

By WILLIAM J. POWELL

GROUND-WATER SERIES — CIRCULAR 3

Prepared by
THE UNITED STATES GEOLOGICAL SURVEY
in cooperation with
THE COLORADO WATER CONSERVATION BOARD

Denver, Colorado
March 1952

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INTRODUCTION

This report describes the ground-water conditions in the Purgatoire River valley west of Trinidad, Colo., with emphasis on the quantity and quality of water available for municipal and industrial use.

The city of Trinidad (population about 14,000) is east of the Culebra Range in western Las Animas County, Colo. The city is served by the Colorado and Southern and the Atchison, Topeka and Santa Fe Railroads, and by U. S. Highways 85, 87, and 160. The principal industries are the railroads and coal mining.

The first municipal water supply was derived from a shallow dug well (well 2, table 1) which was used from 1876 to about 1900 when the first municipal reservoir (Madrid Reservoir) was put into operation. Madrid Reservoir is about 8 miles west of Trinidad and has a reported capacity of 70 million gallons or about 215 acre-feet. The second reservoir, North Lake, was completed in 1904 on the North Fork of the Purgatoire River, about 36 miles northwest of Trinidad. North Lake has a reported capacity of about 1,000 acre-feet. The present city water supply is derived from these two reservoirs. The water from North Lake is conducted through 28 miles of 15-inch pipe to Madrid Reservoir and then from the reservoir to Trinidad through two conduits-- a 16-inch steel pipeline north of the river and a 24-inch wooden pipeline south of the river. The principal sources of water for the two reservoirs are the tributaries of the Purgatoire River. For several years the flow of the Purgatoire River has been below normal as a result of abnormally low precipitation, which has resulted in a shortage of water at the reservoirs. The average daily consumption of water at Trinidad is about 3,500,000 gallons, which is equivalent to about 2,430 gallons a minute. The peak daily consumption during the summer is about 5,500,000 to 6,000,000 gallons or about 3,820 to 4,160 gallons a minute.

In December 1950 Mayor James J. Shew corresponded with Judge Clifford H. Stone, Director of the Colorado Water Conservation Board, regarding the feasibility of a ground-water investigation in the Trinidad area to determine the possibility of developing additional water supplies from wells. The Colorado Water Conservation Board cooperates with the Ground Water Branch of the U. S. Geological Survey in the study of the occurrence, availability, and quality of ground water in Colorado. Accordingly, Thad G. McLaughlin and S. W. Lohman of the U. S. Geological Survey met with the city officials to discuss plans for such an investigation. It was decided that, in view of the need for information on the availability of ground water for municipal and other uses, a reconnaissance could be made immediately and that a more detailed study would be made in the summer of 1951. In January 1951 Mr. McLaughlin made a reconnaissance of the Purgatoire Valley, collected water samples, and obtained records of several mines and wells in the area. In June 1951 a more detailed study involving test drilling was begun in the Purgatoire Valley west of Trinidad. The samples from these test holes were collected and studied in the field by the writer. The results of the test drilling are listed at the end of this report and are shown graphically in plate 2. The locations of the lines of test holes are shown in plate 1. V. M. Burtis obtained records of wells and springs, collected samples of water for analysis, and determined the altitudes of all test holes drilled as a part of this investigation. Information pertaining to water wells in the area is tabulated in table 1, and the water analyses are given in table 2.

In addition to the data obtained as a part of this investigation, the writer had access to considerable published and unpublished geologic and hydrologic data on this area and on adjacent areas. These included unpublished data on the geology and ground-water resources of Huerfano County, Colo., compiled by the Colorado Water Conservation Board and the U. S. Geological Survey, and published and unpublished data on the coal resources of the Trinidad-Walsenburg coal field compiled by the Fuels Branch of the U. S. Geological Survey.

GEOGRAPHY

Topography and drainage.--The area described in this report lies in the Raton section of the Great Plains physiographic province. Most of the investigation was confined to the Purgatoire River valley west of Trinidad, in which the total relief is approximately 2,500 feet. The highest point in the area is at North Lake in the westernmost part of the area which is on the flank of the Culebra Range and which has an altitude of about 8,500 feet, and the lowest point is at Trinidad, which has an altitude of about 6,000 feet.

The Purgatoire River rises in the Culebra Range west of Trinidad and upon leaving the mountains flows eastward through a narrow valley which becomes wider toward Trinidad. The Purgatoire Valley ranges in width from less than 300 feet to more than 4,000 feet. Bordering the valley on the north and south are sandstone and shale bluffs that rise abruptly from the flood plain.

The recorded annual runoff of the Purgatoire River at Trinidad has ranged from 16,730 acre-feet in 1951 to 197,400 acre-feet in 1942 and has averaged about 63,000 acre-feet during the period of record from 1934 to 1951 (fig. 1). The maximum monthly discharge normally occurs during May, June, July, and August and the minimum during the early spring. The tributary streams are largely ephemeral and contribute water mainly in the spring and after heavy rains. The Purgatoire River is an effluent or gaining stream in this part of its course; hence, its base flow is maintained largely by seepage of ground water into the stream channel.

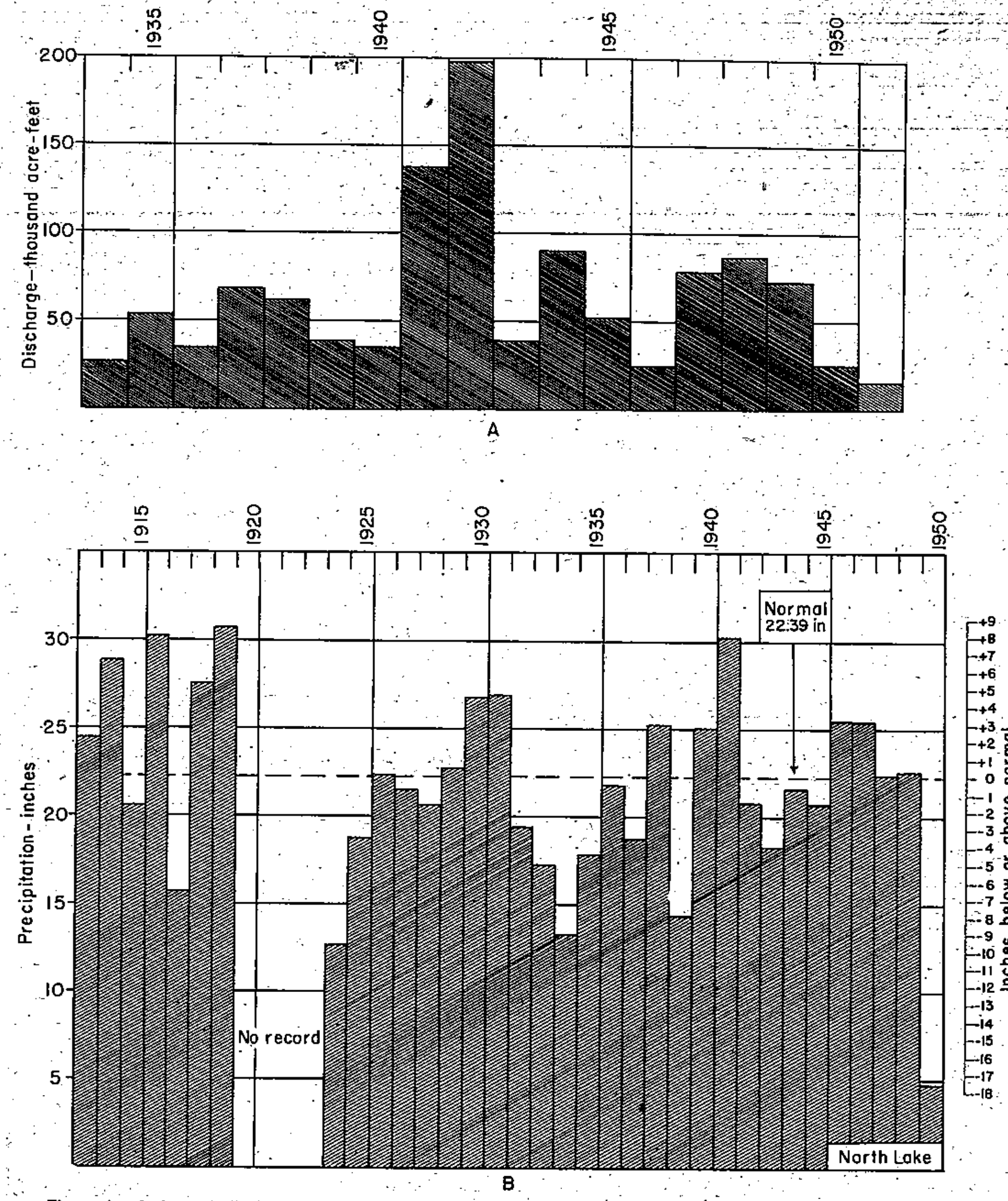

Figure 1.- A, Annual discharge of Purgatoire River at Trinidad; B, annual precipitation at North Lake.

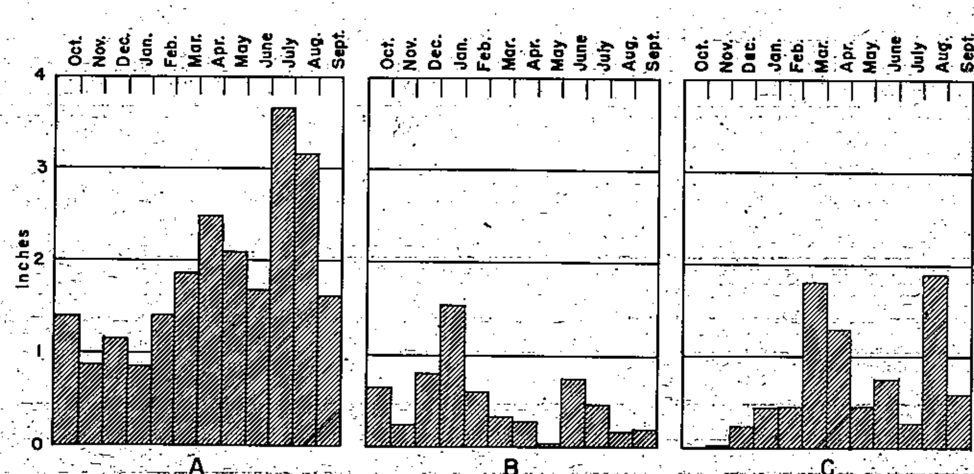

Figure 2.- Monthly precipitation at North Lake. A, Normal monthly precipitation; B, monthly precipitation for water year 1950; C, monthly precipitation for water year 1951.

Climate.--The climate in the Purgatoire River valley is characterized by low precipitation in the eastern part and moderate precipitation in the western part. During the summer the days are hot, but the nights are generally cool. The normal annual precipitation at North Lake is 22.39 inches (fig. 1). The driest year since the beginning of record at North Lake was 1950, when the total precipitation was 4.70 inches, or 17.69 inches below normal. The wettest year recorded was 1919, when the total precipitation was 30.72 inches (fig. 1). The highest precipitation at North Lake occurs during July and August and the lowest precipitation occurs during November and January.

The normal monthly precipitation and recorded monthly precipitation for the water years 1950 and 1951 at North Lake are shown in figure 2. The recorded precipitation in the water years 1950 and 1951 was far below normal (fig. 2), and its effect on the flow of the Purgatoire River may be observed in figure 1 A.

GEOLOGY AND HYDROLOGY

Bedrock Formations

Sedimentary rocks of Cretaceous and Tertiary age underlie a large part of the Purgatoire Valley. Older strata of Permian and Jurassic age crop out in the hogbacks along the flank of the Culebra Range. These older rocks are of little importance to the present study and will not be included in the following discussion.

Pierre shale.--The Pierre shale crops out in the vicinity of Trinidad. It is a hard massive blue-black shale of marine origin containing a few thin lenses of sandstone and gray limestone. The upper 100 to 200 feet of the formation is a sequence of alternating beds of shale and sandstone that have been termed the "transition zone." In places the upper part may contain joints or fractured zones.

The Pierre shale is not considered to be a good source of water. Water may be found in the small openings along the fractures and bedding planes or in the weathered material at the top of the shale. Water may be found also in the beds of sandstone in the transition zone. The supply from these sources is small, and large-diameter wells are required to furnish enough water to supply even domestic or stock needs.

The water available from the Pierre shale is of very poor quality. Although no water samples were collected in the area, data from nearby areas indicate that the water generally is very hard and has a high concentration of dissolved solids. The water may be suitable for stock use and, in some areas, for domestic use, although there are areas where the water is too highly mineralized for either stock or domestic use.

Trinidad, Vermejo, and Raton formations.--The Trinidad sandstone is a massive light-colored arkosic sandstone, which ranges in thickness from 120 to 260 feet (Wood and others, 1951). The Trinidad sandstone conformably overlies the Pierre shale and in places may intertongue with the upper strata of the Pierre shale.

The Vermejo formation consists of shale and coal-bearing sandstone which conformably overlie and intertongue with the Trinidad sandstone (Lee and Knowlton, 1917, pl. 4). According to Wood and others (1951), the thickness of the Vermejo ranges from 220 to 380 feet. The beds of sandstone are lenticular, fine-grained, and in part cross-bedded. In most places the Vermejo consists principally of shale and shaly sandstone, much of which is carbonaceous and in which are found numerous seams or thin beds of coal.

The Raton formation is composed of carbonaceous shale, sandstone, coal, and conglomerate. All the test holes in lines 1 through 6 were drilled to and a few feet into the Raton formation. The following information concerning the thickness of the Raton formation at the test-line sites was furnished by the U. S. Geological

Survey, Geologic Division, Fuels Branch, at Albuquerque, N. Mex. The test holes in line 2 were bottomed approximately in the interval of the conglomerate of the Raton, which is at the base of the formation. The test holes in line 3 bottomed in an interval that is about 800 feet below the top of the Raton formation and about 550 feet above the base. The test holes in line 4 were bottomed in an interval of the Raton formation that is approximately 530 feet below the top and about 950 feet above the base. The test holes in line 5 were bottomed in an interval in the middle of the Raton formation. The test holes in line 6 were bottomed in an interval that is about 700 feet below the top and about 850 feet above the base of the formation. The thickness of the Raton formation in the areas that were test-drilled ranged from 1,300 to 1,550 feet. The character and description of the material at the tops of the intervals described above may be found in the logs of test holes listed at the end of this report.

The conglomerate generally found at the base of the formation is composed of a massive fine to coarse sand containing very fine to very coarse gravel and ranges in thickness from 100 to 250 feet (Wood and others, 1951).

The water-bearing qualities of the bedrock formations from the Trinidad sandstone through the coal series are grouped together in the following discussion, as few data are available on all the water-bearing beds in these formations. Water is available in the sandstone beds of the Trinidad, Vermejo, and Raton formations, but the supply from these sources generally is small. The principal source of much of the water found in mine workings is the Trinidad sandstone, although smaller flows come from numerous beds of sandstone throughout the coal series, as well as the basal conglomerate of the Raton formation. The reported quantity of water pumped from mine workings in the Trinidad area ranges from negligible amounts to 2,430 gallons a minute. The largest reported yield, 2,430 gallons a minute, is pumped from the combined workings of the Empire and Peerless mines.

The Tobasco mine, working the same coal seams as the Empire and Peerless mines, has a reported discharge of about 150 gallons a minute. The Morley and Frederick mines have no significant amounts of water and, at the Morley mine, water was hauled for the operation of boilers. The most complete information concerning availability of water from bedrock formations comes from a recent test of Nigger-head shaft in the vicinity of Walsenburg. The shaft is 646 feet deep and about 12 by 24 feet in cross section. The depth to water before pumping started was 107 feet and after pumping at the rate of 1,250 gallons a minute for 48 hours the depth to water was 446 feet. The specific capacity of the shaft was only about 3 gallons a minute per foot of drawdown. The principal water-bearing materials here are the sandstones and basal conglomerate of the Raton formation.

The large storage capacity of mine workings comprising many miles of tunnels that collect water over a wide area cannot be duplicated in a drilled water well; therefore, the quantity of water pumped from mines is many times as large as could be expected from a drilled well.

Three water samples were collected from sources in the bedrock formations, the analyses of which are given in table 2 and are shown graphically in figure 3. The waters range in total hardness from 156 to 836 parts per million, and hence would be considered hard to excessively hard. The percentage of sodium ranges from 31 to 86. Water having sodium in excess of 50 to 60 percent (sodium in percentage of total bases, expressed as equivalents per million; see table 2) is harmful to the soil and is considered unfit for irrigation (Scofield, 1933).

According to the U. S. Public Health Service standards, drinking water should not contain more than 1,000 and preferably not more than 500 parts per million of dissolved solids. Generally waters containing dissolved solids in excess of 1,000 parts per million have a noticeable taste and in some instances cause intestinal irritation. The samples of water obtained from bedrock formations contained from 1,340 to 1,410 parts per million of dissolved solids.

Fluoride in water in excess of 1.5 parts per million is associated with the dental defect known as mottled enamel which may appear on the teeth of children who drink water containing excess amounts of fluoride during the period of formation of permanent teeth. Waters from bedrock formations in the Purgatoire Valley contained as much as 0.9 part per million of fluoride which is considered to be entirely safe for use by children and even beneficial in reducing tooth decay. However, waters from the same bedrock formation in nearby areas contain as much as 4.5 parts per million of fluoride, so that waters containing too much fluoride for use by children possibly may be encountered in the bedrock formations of the Purgatoire Valley above Trinidad.

ALLUVIUM

Quaternary alluvium underlies most of the Purgatoire Valley west of Trinidad. During early Pleistocene time the Purgatoire River and its tributaries intrenched channels in the bedrock surface. Later in Pleistocene time the valleys of the Purgatoire River and its tributaries were filled to levels higher than the present flood plains with sand and gravel derived from the mountains to the west. Later erosion has removed most of this material but the old channels cut into the bedrock are still partly filled with sand and gravel.

<u>Character</u>.--The alluvium of the Purgatoire Valley consists of sand and gravel containing clay and minor amounts of boulders and cobbles. The sand and gravel was derived largely from sedimentary rocks but in part from igneous rocks. The coarsest material occurs in the buried channels at the base of the alluvium.

Test holes drilled along lines 3, 4, and 5 (pl. 2) encountered a layer of sandy clay before penetrating sand and gravel. The clay layer appeared to be thickest along the outer limits of the valley away from the river and thinnest toward the river, indicating that the material was derived by slope wash from the sides of the valley. Lenses of clay encountered in test holes 1 and 2 in line 1 did not extend to test holes 5 and 8 only 75 feet away. Stringers of clay in the sand and gravel that were too thin to include in the logs are represented in the cross sections by single dashed lines (test holes 8, 3, 7, and 4 in line 1, pl. 2). In areas where the clay is persistent it prevents or retards the infiltration of water from precipitation and irrigation and causes local drainage problems.

Distribution and thickness.--The flood plain, which is underlain by the major part of the alluvium in the Purgatoire Valley, ranges in width from less than 300 feet at the upper end of the valley to more than 4,000 feet in the vicinity of Trinidad. The extent and distribution of the alluvium in the tributary valleys were not studied, but alluvial deposits were reported in Lorencito and Sheep Canyons and along Guojatoyan Creek.

Test drilling indicates that the alluvium beneath the flood plain ranges in thickness from a feather edge to more than 24 feet. The thickest alluvium was found in buried channels, as shown on plate 2, line 2. The buried channels may be close to the edge of the flood plain as shown in lines 1 and 5 or may be close to the present stream channel as shown in line 6. The location of these buried channels cannot be determined from study of surface features but can be determined readily by test drilling. The test holes on the cross sections are numbered in the order in which they were drilled. Test holes 1 through 3 were first drilled at the site of line 2 to outline the general features of the bedrock surface, after which test holes 4 to 8 were drilled to delineate more clearly these irregular features. The same field procedure was used on all lines of test holes. Two or more channels were found along each line of test holes except line 6, where only one channel was found. The channels outlined in the cross sections downstream from line 6 are all narrow and deep except those along line 3, where drilling indicated a broad, shallow channel; however, deeper channels might be found south of test holes 2 and 3, but this area was inaccessible.

Occurrence of water.--Records of 24 wells that obtain water from the alluvium are given in table 1. The depth to water below land surface ranges from about 1 foot near the stream channel to about 25 feet near the edge of the valley. The saturated thickness of the alluvium ranges from less than 1 foot to more than 13 feet, as determined from measurements made in wells and data obtained in test drilling. Test drilling showed that the thickest and most uniform water-bearing sand and gravel occurs in buried channels. Only 2 of the 24 wells listed in table 1 were drilled in buried channels.

The alluvium probably is recharged mainly by the Purgatoire River and its tributaries, but a part comes from local precipitation. During periods when the water table is low, water from the Purgatoire River infiltrates into the permeable sand and gravel and maintains the water table at the level of the water in the river, and, conversely, when the water level in the alluvial material is high ground-water seeps into the river. Although no periodic water-level measurements were made, it is assumed that the water levels are lowest during the summer when evaporation and transpiration are greatest and are highest in early spring as a result of the spring runoff of the Purgatoire River.

Quantity of water.--The quantity of water that can be pumped from an aquifer is dependent upon the thickness of saturated materials in the aquifer, the permeability and storage properties of the aquifer, and the facilities for recharge. The thickness of saturated materials in the alluvium as determined by test drilling ranged from a feather edge to 13 feet and averaged about 9 feet. The thickest saturated materials are in the buried channels, as shown by the cross sections in plate 2.

It was not possible to determine the permeability of the alluvium in the

Purgatoire Valley, inasmuch as there were no large-capacity wells on which pumping tests could be run. Therefore, the only available means of estimating the probable yields of properly constructed wells in the alluvium of Purgatoire Valley is by comparison of well cuttings in the Purgatoire Valley with well cuttings in the Huerfano Valley in the vicinity of a tested large-capacity well. The well in the Huerfano Valley yielded 386 gallons a minute with a drawdown of 16.5 feet after 11.5 hours of pumping. The specific capacity of that well, therefore, is about 24 gallons a minute per foot of drawdown. Owing to the large amount of fine sand contained in the gravel in the alluvium of the Purgatoire Valley as compared to the moderate amount of fine sand in the alluvium of the Huerfano Valley in the vicinity of the tested well, it is doubtful that a properly constructed well in the alluvium of the Purgatoire Valley would have a specific capacity larger than half that of the tested well in Huerfano Valley that is larger than about 12 gallons a minute per foot of drawdown.

If the foregoing assumption that the specific capacity of wells in the alluvium of the Purgatoire Valley would be about 12 gallons a minute per foot of drawdown is approximately correct, then the maximum amount of water that could be expected from a properly constructed well would be about 150 gallons a minute. Larger yields could be obtained from a battery of wells or from an infiltration gallery, owing to the larger intake area. Construction of wells, batteries of wells, or infiltration galleries should be preceded by test drilling in order to locate the deepest buried channels.

The pumping test of the well in the Huerfano Valley indicated that the water table was lowered .01 foot or more within a distance of 340 feet from the well after 11.5 hours of pumping. Owing to the probably lower permeability of the alluvium in the Purgatoire Valley, large-capacity wells should not be spaced closer than 1,000 feet if mutual interference is to be held at a minimum. The wells in a battery system must, of necessity, be much closer together but in a battery of wells mutual interference is to be expected.

The ultimate quantity of ground water that could be developed from the alluvium of the Purgatoire Valley could not be determined by means within the scope of this investigation. The recorded annual runoff of the Purgatoire River at Trinidad has ranged from 16,730 acre-feet to 197,400 acre-feet and has averaged about 63,000 acre-feet. The average annual runoff of 63,000 acre-feet is approximately the ultimate amount of water that could be developed by means of wells under ideal conditions (disregarding evaporation, transpiration, irregular stream flow, and appropriation rights to the stream flow). Inasmuch as all these factors are present, the total quantity that could be developed is considerably less than 63,000 acre-feet a year. The base flow of the river is maintained by discharge of ground water, and a large part of this water could be salvaged by wells. In addition, if the water table were lowered, there would be some increase in the average amount of water absorbed by the sandy channel during periods of flood flow.

Any consideration of the development of ground water must take into account the prior appropriations of the Purgatoire River water. Part of the water pumped from wells will be derived from recharge by precipitation and by reduction of water loss by evaporation and transpiration and part of the water will be derived from stream flow. Any large-scale development of water from wells or infiltration galleries or any large-capacity well, battery of wells, or infiltration gallery constructed close to the edge of the stream channel would cause a measurable depletion of the stream flow and so might lead to legal action by prior appropriations. Wells or other structures located farther from the stream ultimately would have a similar effect, but it would come more slowly and would be more difficult to identify.

Quality of water.--Nine water samples were collected from wells obtaining water from the alluvium, the analyses of which are given in table 2 and are shown graphically in figure 3. The hardness of water in the alluvium decreases from east to west, ranging from 1,710 parts per million at Trinidad (well 1) to 166 parts per million at Monument Lake (well 29). The water becomes noticeably softer in the vicinity of Sarcillo School (well 9) but is still considered hard. The dissolved solids decrease noticeably westward along the Purgatoire River, ranging from 2,540 to 199 parts per million, but water collected from well 17 along the North Fork of the Purgatoire River contained more dissolved solids than would be expected from wells in the alluvium along the main stem of the river (fig. 3). The dissolved solids content of drinking water was discussed in an earlier section of this report (p. 7). In a discussion of the interpretation of analyses with reference to irrigation in southern California, Scofield (1933) states that if the concentration of dissolved salts is less than 700 parts per million there is not much probability of harmful effects in irrigation, but that if it exceeds 2,100 parts per million there is a strong probability of damage either to the crops, to the land, or to both.

Waters above Sarcillo School contain less than 500 parts per million of dissolved solids and are satisfactory for domestic and irrigation use. The dissolved-solids content of waters between Sarcillo School and Sopris range from 500 to about 2,000 parts per million. These waters are satisfactory for irrigation but many would be of questionable quality for most domestic uses. Below Sopris the alluvium overlies the Pierre shale and, hence, contains highly mineralized water. Dissolved solids in water from a well in Trinidad amounted to 2,540 parts per million. It is believed that waters obtained from wells in the alluvium in any part of the area below Sopris would contain at least 2,000 parts per million of dissolved solids and would be unsatisfactory for

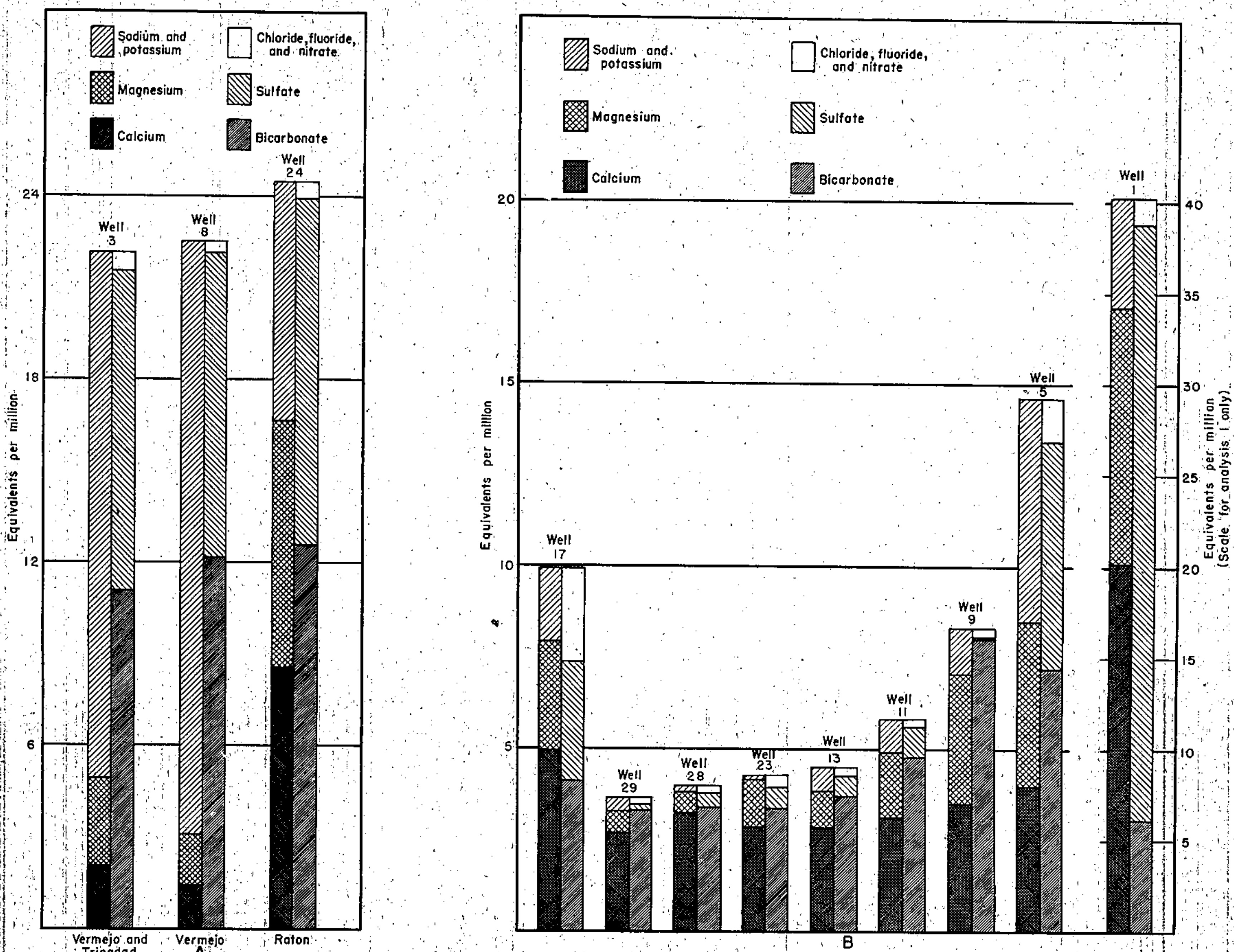

Figure 3.– Analyses of typical waters. A, bedrock formations; B, alluvium.

most uses.

The fluoride content of waters from alluvium ranged from 0.1 part per million in well 17 in North Fork Purgatoire Valley to 1.4 parts per million in well 5 in the Purgatoire Valley near Valdez. These concentrations are within the safe limits for use by children, but it is possible that water in some parts of the alluvium may contain more than 1.5 parts per million of fluoride.

CONCLUSIONS

The sediments in the bedrock formations west of Trinidad are fine-grained and yield only small quantities of water to wells. The water from the bedrock formations is of poor quality, being excessively hard and highly mineralized.

Small to moderate quantities of very hard to moderately hard water are available to properly constructed wells in the alluvium of Purgatoire Valley. Test drilling revealed buried channels having as much as 13 feet of saturated material. The quantity of water that could be obtained from a well in these buried channels is estimated to be 150 gallons a minute but larger quantities could be expected from batteries of wells or from infiltration galleries.

Waters in the alluvium above Sarcillo School are of satisfactory quality for domestic and irrigation use and are expected to contain less than 500 parts per million of dissolved solids. Waters in the alluvium below Sopris probably contain dissolved solids in excess of 2,000 parts per million and are not satisfactory for most uses.

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WELL LOGS

Listed in the following pages are the logs of 42 test holes that were prepared by the writer on the basis of drill cuttings taken at the time of drilling. These test holes were drilled by A. R. Ormsbee for the Colorado Water Conservation Board in cooperation with the Ground Water Branch of the U. S. Geological Survey. The location of the lines of test holes is shown on plate 1, and cross sections along lines 1 to 7 are illustrated on plate 2.

1. Sample log of test hole 1 in line 1 in NW 1/4 NW 1/4 sec. 29, T. 33 S., R. 67 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 7,142.3 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, soft, sticky, slightly sandy	3	3
Sand and gravel, fine to very coarse, containing some small cobbles	5.5	8.5
Raton formation		
Shale, firm, carbonaceous	1	9.5
Sandstone, hard	5.5	15

2. Sample log of test hole 2 in line 1 in NW 1/4 NW 1/4 sec. 29, T. 33 S., R. 67 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 7,149.4 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, soft, slightly sandy, brown	10	10
Gravel, fine, to small cobbles, containing some sand and clay	3.5	13.5
Raton formation		
Shale, soft, blue, containing layers of soft coal	9	22.5

3. Sample log of test hole 3 in line 1 in NW 1/4 NW 1/4 sec. 29, T. 33 S., R. 67 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 7,153.1 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand, very fine to fine, clayey, brown	3.7	3.7
Sand and gravel, very fine to very coarse, containing a little clay	12.8	16.5
Raton formation		
Shale, firm, hard, light-gray to dark-gray	6	22.5

4. Sample log of test hole 4 in line 1 in NW 1/4 NW 1/4 sec. 29, T. 33 S., R. 67 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 7,151.1 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand, very fine to fine, clayey, brown	7	7
Sand and gravel, fine to very coarse, containing some small cobbles and a little clay	9.7	16.7
Raton formation		
Shale, firm, dark-gray	5.8	22.5

5. Sample log of test hole 5 in line 1 in NW 1/4 NW 1/4 sec. 29, T. 33 S., R. 67 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 7,143.9 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand, very fine to fine, clayey	2.5	2.5
Sand and gravel, very fine to very coarse	6.2	8.7
Raton formation		
Shale, firm, carbonaceous, dark-gray	.8	9.5
Sandstone	.5	10
Shale, firm, carbonaceous, dark-gray	7.5	17.5

6. Sample log of test hole 6 in line 1 in NW 1/4 NW 1/4 sec. 29, T. 33 S., R. 67 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 7,141.0 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand, very fine to fine, clayey, brown	1.5	1.5
Sand, very fine to very coarse, containing some fine to coarse gravel	4.7	6.2
Raton formation		
Shale, firm, carbonaceous, dark-gray	7.8	15

7. Sample log of test hole 7 in line 1 in NW 1/4 NW 1/4 sec. 29, T. 33 S., R. 67 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 7,151.6 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand, very fine to fine, clayey	5	5
Sand, very fine to fine, containing some coarse gravel	2.5	7.5
Sand, very fine, to gravel, very coarse, containing some small cobbles	4.5	12
Raton formation		
Shale, firm, carbonaceous, dark-gray	8	20

8. Sample log of test hole 8 in line 1 in NW 1/4 NW 1/4 sec. 29, T. 33 S., R. 67 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 7,151.0 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand, very fine to fine, clayey, brown	8.6	8.6
Sand and gravel, very fine to very coarse, containing some small to large cobbles	6	14.6
Raton formation		
Shale, firm, dark-gray	5.4	20

9. Sample log of test hole 1 in line 2 in SE 1/4 NE 1/4 sec. 35, T. 33 S., R. 65 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,267.2 feet.

	Thickness, feet	Depth, feet
Alluvium		
Gravel, fine to coarse, containing large cobbles	2.3	2.3
Sand, very fine, to gravel, very coarse, containing some small cobbles	5.2	7.5
Raton formation		
Shale, blue-gray	5	12.5

10. Sample log of test hole 2 in line 2 in SE 1/4 NE 1/4 sec. 35, T. 33 S., R. 65 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,269.3 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand and gravel, very fine to very coarse, containing some small cobbles	10	10
Gravel, fine to very coarse, containing medium to very coarse sand and some small cobbles	8	18
Raton formation		
Sandstone, granular, hard, gray to buff	4.5	22.5

11. Sample log of test hole 3 in line 2 in SE 1/4 NE 1/4 sec. 35, T. 33 S., R. 65 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,270.1 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand, very fine to coarse, containing fine to coarse gravel and a little clay	2.5	2.5
Sand and gravel, fine to very coarse, containing some small cobbles	4	6.5
Boulder	1	7.5
Sand, very fine to coarse, contains some fine gravel	1	8.5
Boulder	1.5	10
Sand, very fine to coarse, contains some fine gravel	2	12
Raton formation		
Sandstone, soft to hard, grayish-tan	8	20

12. Sample log of test hole 4 in line 2 in SE 1/4 NE 1/4 sec. 35, T. 33 S., R. 65 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,268.7 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand and gravel, fine to very coarse, containing small to large cobbles	12.5	12.5
Raton formation		
Sandstone, fine-grained, hard, gray	2.5	15

13. Sample log of test hole 5 in line 2 in SE 1/4 NE 1/4 sec. 35, T. 33 S., R. 65 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,269.2 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand and gravel, very fine to very coarse, containing small to large cobbles	5	5
Sand, fine to coarse, containing fine to very coarse gravel	6	11
Raton formation		
Shale, carbonaceous, dark-blue	1	12
Sandstone, hard, bluish-gray	6	18

14. Sample log of test hole 6 in line 2 in SE 1/4 NE 1/4 sec. 35, T. 33 S., R. 65 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,269.3 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand and gravel, fine to coarse, containing a few small cobbles	9	9
Raton formation		
Shale, carbonaceous, dark-blue	.5	9.5
Sandstone	8	17.5

15. Sample log of test hole 7 in line 2 in SE 1/4 NE 1/4 sec. 35, T. 33 S., R. 65 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,269.5 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand, very fine, to gravel, coarse, containing a few small boulders	6	6
Sand, very fine to very coarse; contains a little fine to coarse gravel and a few small cobbles	10.5	16.5
Raton formation		
Sandstone, hard, gray	5.5	22

16. Sample log of test hole 8 in line 2 in SE 1/4 NE 1/4 sec. 35, T. 33 S., R. 65 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,269.0 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand and gravel, very fine to very coarse, containing small cobbles	14	14
Raton formation		
Sandstone, hard, brown	6	20

17. Sample log of test hole 1 in line 3 in SW 1/4 SW 1/4 sec. 34, T. 33 S., R. 66 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,608.2 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand and gravel, very fine to very coarse, containing some large cobbles	9	9
Boulder	.5	9.5
Sand, very fine to coarse	.5	10
Raton formation		
Shale, carbonaceous, dark-brown	5	15

18. Sample log of test hole 2 in line 3 in SE 1/4 SE 1/4 sec. 33, T. 33 S., R. 66 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,608.4 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, soft, slightly sandy, brown	3.5	3.5
Sand, very fine, to gravel, coarse, containing some small cobbles	8	11.5
Raton formation		
Shale, firm, blue	6.5	18
Sandstone, fine-grained, hard, tan	2	20

19. Sample log of test hole 3 in line 3 in NW 1/4 NW 1/4 sec. 3, T. 34 S., R. 66 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,608.9 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, soft, sticky, slightly sandy, brown	4.2	4.2
Sand and gravel, very fine to coarse, containing some small to large cobbles	7.7	11.9
Raton formation		
Sandstone, hard, grayish-tan with thin layers of brown shale	8.1	20

20. Sample log of test hole 4 in line 3 in NE 1/4 NE 1/4 sec. 4, T. 34 S., R. 66 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,613.5 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, soft, sandy, brown	10	10
Sand and gravel, fine to very coarse, containing some small cobbles	2.5	12.5
Raton formation		
Shale, firm, carbonaceous, gray	6.5	19

21. Sample log of test hole 5 in line 3 in SW 1/4 SW 1/4 sec. 34, T. 33 S., R. 66 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,608.8 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, soft, slightly sandy, brown	4	4
Sand, very fine, to gravel, coarse, containing some large cobbles	4.2	8.2
Raton formation		
Shale, firm, light-gray to dark-gray, containing thin seams of coal	6.8	15

22. Sample log of test hole 6 in line 3 in SW 1/4 SW 1/4 sec. 34, T. 33 S., R. 66 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,608.3 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, soft, sticky, slightly sandy	3	3
Sand and gravel, very fine to coarse, containing some large cobbles	5	8
Coal wash	1	9
Sand, very fine to very coarse, containing some coarse gravel	1	10
Raton formation		
Sandstone, hard, fine-grained, tan	4.8	14.8
Shale, firm, hard	5.2	20

23. Sample log of test hole 7 in line 3 in SW 1/4 SW 1/4 sec. 34, T. 33 S., R. 66 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,609.1 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, soft, sticky, sandy, brown	3	3
Sand, very fine, to gravel, coarse, containing some large cobbles	8.5	11.5
Raton formation		
Shale, firm, slightly sandy, gray	6	17.5

24. Sample log of test hole 1 in line 4 in SW 1/4 SE 1/4 sec. 13, T. 33 S., R. 68 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 7,358.1 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, soft, slightly sandy	8.2	8.2
Sand, very fine to very coarse, containing some fine to very coarse gravel	6	14.2
Raton formation		
Sandstone	3.3	17.5

25. Sample log of test hole 2 in line 4 in SW 1/4 SE 1/4 sec. 13, T. 33 S., R. 68 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 7,355.8 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, firm, slightly sandy, brown	6.5	6.5
Sand, very fine to very coarse, containing some fine to coarse gravel	6	12.5
Boulders	2.5	15
Gravel, fine to very coarse, containing some medium to coarse sand	2.5	17.5
Raton formation		
Sandstone	9	26.5

26. Sample log of test hole 3 in line 4 in SW 1/4 SE 1/4 sec. 13, T. 33 S., R. 68 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 7,351.8 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, firm, sticky, slightly sandy, brown	3.8	3.8
Sand and gravel, very fine to very coarse, containing some small to large cobbles	6	9.8
Raton formation		
Sandstone, hard, fine-grained, brown	10.2	20

27. Sample log of test hole 4 in line 4 in SW 1/4 SE 1/4 sec. 13, T. 33 S., R. 68 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 7,358.5 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, soft, sticky, brown	8.5	8.5
Gravel, fine to very coarse, containing some fine to coarse sand	2	10.5
Raton formation		
Sandstone, hard, fine-grained, brown	9.5	20

28. Sample log of test hole 5 in line 4 in SW 1/4 SE 1/4 sec. 13, T. 33 S., R. 68 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 7,356.9 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, soft, sticky, slightly sandy, brown	11.2	11.2
Sand, very fine to coarse, containing some very fine to medium gravel	2.8	14
Raton formation		
Sandstone	7	21

29. Sample log of test hole 1 in line 5 in NE 1/4 NE 1/4 sec. 36, T. 33 S., R. 67 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,798.0 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand, fine to medium, clayey, brown	12.5	12.5
Gravel, coarse, to sand, very fine, containing some small cobbles	5	17.5
Gravel, very coarse, to sand, very fine, containing small to large cobbles	2.3	19.8
Raton formation		
Coal, containing thin layers of brown sandstone	5.7	25

30. Sample log of test hole 2 in line 5 in NE 1/4 NE 1/4 sec. 36, T. 33 S., R. 67 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,796.1 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, slightly sandy, brown	7.3	7.3
Sand, very fine to coarse, containing some fine gravel; clayey	7.7	15
Sand, very fine to coarse, containing some fine to coarse gravel and a little brown clay	2.5	17.5
Sand, very fine, to gravel, medium, containing some clay	3.5	21
Raton formation		
Shale, carbonaceous, brown to blue	4	25

31. Sample log of test hole 3 in line 5 in NE 1/4 NE 1/4 sec. 36, T. 33 S., R. 67 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,784.8 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand, medium, to gravel, medium	4.5	4.5
Sand, very fine, to gravel, coarse	4	8.5
Raton formation		
Shale, firm, blue, containing thin layers of coal	6.5	15

32. Sample log of test hole 4 in line 5 in NE 1/4 NE 1/4 sec. 36, T. 33 S., R. 67 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,795.8 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, slightly sandy, brown	4.3	4.3
Sand and gravel, fine to medium, containing clay	5.7	10
Sand and gravel, fine to coarse, containing a little clay	4	14
Boulder	.5	14.5
Gravel, fine, to cobbles, small, containing fine to coarse sand	5.5	20
Raton formation		
Shale, firm, blue	7.5	27.5

33. Sample log of test hole 5 in line 5 in NE 1/4 NE 1/4 sec. 36, T. 33 S., R. 67 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,796.3 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, soft, sandy, brown	3	3
Sand, very fine, to gravel, very coarse	7	10
Clay, soft, brown	1.5	11.5
Gravel, very coarse, to sand, fine, containing some small cobbles and a little brown clay	9.5	21
Raton formation		
Shale, firm, blue	1.5	22.5

34. Sample log of test hole 6 in line 5 in NE 1/4 NE 1/4 sec. 36, T. 33 S., R. 67 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,790.6 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, sandy, brown	7	7
Sand and gravel, fine to very coarse, containing some small to large cobbles	8.4	15.4
Raton formation		
Shale, carbonaceous, dark-brown	4.6	20

35. Sample log of test hole 7 in line 5 in NE 1/4 NE 1/4 sec. 36, T. 33 S., R. 67 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,796.5 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, soft, sandy, brown	4	4
Sand and gravel, very fine to fine, containing clay	2	6
Clay, soft, sandy, brown	5	11
Sand and gravel, fine to coarse	10.5	21.5
Raton formation		
Shale, firm, carbonaceous, brown	6	27.5

36. Sample log of test hole 8 in line 5 in SE 1/4 NE 1/4 sec. 36, T. 33 S., R. 67 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,801.4 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, soft, sandy, containing a little coarse gravel	14.5	14.5
Sand and gravel, fine to very coarse	5.5	20
Gravel, coarse, to sand, very fine, containing some clay	4	24
Raton formation		
Shale, firm, dark-blue	3.5	27.5

37. Sample log of test hole 9 in line 5 in NE 1/4 NE 1/4 sec. 36, T. 33 S., R. 67 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 6,799.6 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, soft, sandy, brown	3	3
Sand and gravel, fine to coarse, containing some large cobbles	5	8
Sand, very fine to coarse	2	10
Raton formation		
Coal, soft, black	5	15

38. Sample log of test hole 1 in line 6 in NE 1/4 NE 1/4 sec. 4, T. 33 S., R. 68 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 7,795.5 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand, very fine, to gravel, fine, containing some small to large cobbles	17.7	17.7
Raton formation		
Sandstone, soft, tan	4.8	22.5

39. Sample log of test hole 2 in line 6 in SW 1/4 NW 1/4 sec. 3, T. 33 S., R. 68 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 7,793.2 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand, very fine to very coarse, slightly clayey, containing a few small to large cobbles	4.5	4.5
Raton formation		
Sandstone, soft, arkosic, gray	10.5	15

40. Sample log of test hole 1 in line 7 in NW 1/4 NW 1/4 sec. 30, T. 32 S., R. 68 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 8,598.4 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand, very fine to medium, clayey, red	4.2	4.2
Sand, very fine to fine, clayey, red	2.4	6.4
Boulder	2.4	6.8
Sand, very fine to coarse, clayey, red	1.2	8
Sand and gravel, medium to very coarse, containing some small boulders and clay	3	11
Boulders	2.2	13.2
Morrison (?) formation		
Sandstone, soft to hard, fine-grained, red	9.4	22.6

41. Sample log of test hole 2 in line 7 in NW 1/4 NW 1/4 sec. 30, T. 32 S., R. 68 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 8,607.9 feet.

	Thickness, feet	Depth, feet
Alluvium		
Clay, firm, brown	5	5
Clay, soft, red, containing some coarse gravel	4.5	9.5
Clay, red to green, containing a little fine to coarse gravel	3	12.5
Gravel, very coarse, to sand, fine, containing some small cobbles and a little red clay	3.5	16
Morrison (?) formation		
Sandstone, hard and soft, fine-grained, red	6.5	22.5

42. Sample log of test hole 3 in line 7 in NW 1/4 NW 1/4 sec. 30, T. 32 S., R. 68 W., drilled for the Colorado Water Conservation Board, 1951. Surface altitude, 8,567.7 feet.

	Thickness, feet	Depth, feet
Alluvium		
Sand and gravel, very fine to very coarse, containing some large cobbles and small boulders	8.5	8.5
Morrison (?) formation		
Sandstone, soft and hard, red	14	22.5

WELL RECORDS AND CHEMICAL ANALYSES

Information pertaining to water wells and to chemical character of water in the Purgatoire Valley, Las Animas County, is listed in tables 1 and 2. The numbers in the first column of each table correspond to the well numbers on the map (pl. 1). The numbers in the first column of table 1 that are in parentheses indicate wells from which samples of water were taken for analysis.

The wells are listed in order by townships from north to south and by ranges from east to west. Within a township the wells are listed in the order of the sections.

TABLE 1.—Records of wells and spring in Purgatoire Valley in vicinity of Trinidad, Colorado.

No. on plate 1	Location	Owner or tenant	Type of well 1/	Depth of well (feet) 2/	Diameter of well (inches)	Type of casing 3/	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift 4/	Use of water 5/	Measuring Point: Description	Measuring Point: Distance above or below (-) land-surface (feet)	Depth to water level below measuring point (feet) 6/	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
(1)	T. 33 S., R. 64 W. NE SE sec. 13	Trinidad Creamery	Du	19	48	I	Sand and gravel	Alluvium	C,E	C			12		Estimated discharge, 20 gallons a minute
2	do	City of Trinidad	Du	18.5	36x60	R	do	do	N	N			9		Abandoned public-supply well. Used from 1876-1900.
(3)	T. 32 S., R. 65 W. SE NE sec. 2	Tollerburg Mine	Dr	365	10	I	Sandstone	Vermejo formation and Trinidad sandstone	N	N	Top of elbow in pipe	0.7	234.5	10-9-51	Formerly used as air vent in mine.
4	T. 33 S., R. 65 W. SE SE sec. 31	Sam Montoya	Du	26.5	36	R	Sand and gravel	Alluvium	B,H	S	Top of wooden cover, south side	2.5	24.84	10-5-51	
(5)	NW SW sec. 32	Phil Vigil	Du	14	48	R	do	do	B,H	D,S			10		
6	NE SW sec. 33	Colorado Fuel and Iron Corp.	Du	13.0	48	R	do	do	N	N	Top of concrete curb, north side	.0	12.62	8-23-51	Unused domestic well.
7	SE SE sec. 34	Rocco Maucione	Du	22.0	36	R	do	do	N	N	Top of box, north side	3.3	20.4	8-23-51	Unused stock well.
(8)	NE SW sec. 35	Allec Chavez	Dr	60	6	I	Sandstone	Vermejo formation	J,E	D					
(9)	T. 34 S., R. 66 W. NE NE sec. 4	Frank Parsons	Du	16.6	40	R	Sand and gravel	Alluvium	N	N	Top of wooden platform	2.3	15.45	10-2-51	Unused domestic well.
10	T. 33 S., R. 67 W. SE SE sec. 19	Rosedo Chaves	Du	4.0	60	C	do	do	J,E	D	Top of well cover, east side	1.0	2.27	10-22-51	
(11)	SW SW sec. 20	George Chavez	Du	23.5	48	R	do	do	Cy,H	D	Top of wooden platform	.2	19.00	9-28-51	
12	do	Joe Chavez	Du	18.6	36	R	do	do	B,H	D	Top of wooden well cover	1.3	13.70	10-10-51	
(13)	NE NE sec. 35	Louis Vigil	Du	8.9	48	C	do	do	J,E	D	Top of concrete curb	.2	5.92	10-10-51	
14	NE NE sec. 36	Frank Parsons	Dr	17.0	6	I	do	do	Cy,W	S	Top of casing	1.0	7.00	10-11-51	
15	T. 32 S., R. 68 W. NW NW sec. 6	City of Trinidad	Du	9.2	30	GI	do	do	C,E	D	Top of casing, north side	.6	4.68	10-20-51	
16	T. 33 N., R. 68 W. SW NW sec. 13	Ramone Vialpando	Du	24.0	36	R	do	do	J,E	D	Top of wooden curb, south side	2.7	23.5	10-5-51	
(17)	SE NE sec. 14	Mrs. Ray Hurtado	Du	15.1	40	R	do	do	J,E	D	Top of concrete floor	.2	13.85	10-5-51	
18	SE SE sec. 20	Stanley Barron	Dr	20.0	6	I	do	do	J,E	D	Top of casing	.8	6.83	9-28-51	
19	T. 33 S., R. 68 W. SE SE sec. 20	Stanley Barron	Dr	120.0	8	I	Sandstone	Raton (?) formation	N	N	Hole in well cover	.4	2.72	9-28-51	Water reported to have bad taste. Unused domestic well.
20	do	do	Dr	18.0	8	I	Sand and gravel	Alluvium	N	N	Top of casing	1.8	5.48	9-25-51	Permanent pump not installed.
21	SW SW sec. 21	George Chavez	Du	4.2	24	R	do	do	C,E	D	Top of concrete floor	.0	2.00	8-21-51	
22	SE SE sec. 21		Du	30	48		do	do	Cy,H	D			22		
(23)	SE NE sec. 24	E. Apodaca	Du	10.7	48	R	do	do	J,E	D	Hole in well cover	1.5	8.49	9-26-51	
(24)	NE NW sec. 24	Vigil School	Dr	103	6	I	Sandstone	Raton formation	Cy,H	D	Top of casing	.3	77.95	8-22-51	
25	NW NE sec. 29	M. M. Dale	Du	4.4	24	R	Sand and gravel	Alluvium	N	N	do	.0	3.95	8-21-51	Unused domestic well.
26	NE NW sec. 29	Colorado Fuel and Iron Corp.	Sp				Sandstone	Raton (?) formation		D,S					Estimated discharge, 2 gallons a minute.
27	SE NE sec. 30	McCarty	Du	6.2	48	T	Sand and gravel	Alluvium	J,E	D	Top of tile casing	-2.0	4.20	9-26-51	
(28)	NE NW sec. 30	E. E. Spradling	Dr	38	6	I	Sand	do	J,E	D			23		
(29)	T. 32 S., R. 69 W. NE SE sec. 25	John Hardy	Du	10.2	75	C	Sand and gravel	do	C,E	D	Top of casing, east side	1.0	4.38	9-27-51	Well is near spring.

1/ Dr, drilled well; Du, dug well; Sp, spring.

2/ Measured depths given in feet and tenths of feet; reported depths given in feet.

3/ C, concrete; GI, galvanized sheet iron; I, iron; R, rock; T, tile.

4/ Method of lift: B, bucket; C, centrifugal; Cy, cylinder; J, jet; N, none. Type of power: E, electric; H, hand; N, none; W, wind.

5/ C, cooling; D, domestic; N, none; S, stock.

6/ Measured depths given in feet and tenths of feet, reported depths given in feet.

TABLE 2.—Analyses of water from the vicinity of Trinidad, Colorado.

Analyzed by the U. S. Geological Survey. Dissolved constituents given in parts per million[a]; reacting values (in italics) given in equivalents per million[b]

No. on plate 1	Location	Depth (feet)	Source	Date of collection (1951)	Temperature (°F.)	pH	Specific conductance, in micromhos at 25° C.	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na/K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness (calculated as $CaCO_3$)		Percent sodium
																		Total	Noncarbonate	
1	T. 33 S., R. 64 W. NE SE sec. 13	19	Alluvium	1-24			2,860	14	405 *20.21*	171 *14.06*	138 *6.02*	376 *6.16*	1,570 *32.69*	40 *1.13*	0.4 *.02*	18 *.29*	2,540	1,710	1,410	15
	SW sec. 28		Purgatoire River at Sopris, Colo.	1-24			398	7.1	42 *2.096*	12 *.987*	30 *1.295*	170c *2.983*	57 *1.187*	4.5 *.127*	1.2 *.063*	1.1 *.018*	245	154	5	30
3	T. 32 S., R. 65 W. SE NE sec. 2	365	Vermejo and Trinidad formations	11-13	58		1,850	9.1	28 *1.40*	21 *1.73*	446 *19.39*	737 *12.08*	456 *9.49*	25 *.71*	.9 *.05*	.7 *.01*	1,350	156	0	86
5	T. 33 S., R. 65 W. NW SW sec. 32	14	Alluvium	1-25	47		1,250	13	80 *3.99*	57 *4.69*	136 *5.93*	438 *7.18*	306 *6.37*	22 *.62*	1.4 *.07*	23 *.37*	854	434	75	42
8	NE SW sec. 35	60	Vermejo formation	10-11	52	7.7	1,920	9.2	57 *2.84*	25 *2.06*	396 *17.22*	676 *11.08*	501 *10.43*	19 *.54*	.3 *.02*	.2 *.003*	1,340	245	0	78
	SW sec. 36		Madrid Reservoir	6-6		7.9	160	7.1	24 *1.19*	4.0 *.32*	4.7 *.179*	91 *1.49*	6.7 *.139*	1.2 *.034*	.2 *.01*	.6 *.009*	98	76	2	
9	T. 34 S., R. 66 W. NE NE sec. 4	16.6	Alluvium	10-10	52	7.5	725	17	72 *3.59*	33 *2.71*	43 *1.87*	488 *8.00*	1.2 *.02*	9.0 *.25*	.8 *.04*	1.2 *.02*	418	315	0	23
11	T. 33 S., R. 67 W. SW SW sec. 20	23.5	do	9-28	57	7.4	498	13	62 *3.09*	22 *1.81*	22 *.96*	294 *4.82*	39 *.81*	5.0 *.14*	.2 *.01*	.2 *.003*	308	245	4	16
13	NE NE sec. 35	8.9	do	10-10	52	7.6	374	9.5	56 *2.794*	12 *.987*	17 *.739*	226 *3.704*	27 *.562*	3.5 *.099*	.2 *.011*	.1 *.002*	237	189	4	16
17	T. 33 S., R. 68 W. SE NE sec. 14	15.1	do	10-5	50	7.3	864	9.5	100 *4.99*	37 *3.04*	43 *1.87*	250 *4.10*	158 *3.29*	74 *2.09*	.1 *.01*	8.4 *.14*	553	402	196	19
23	SE NE sec. 24	10.7	do	9-26	60	7.3	364	12	58 *2.894*	13 *1.069*	7.4 *.322*	212 *3.474*	29 *.604*	2.0 *.056*	.2 *.011*	2.8 *.045*	229	198	24	8
24	NE NW sec. 24	103	Raton formation	9-27	55	7.1	1,950	16	171 *8.53*	99 *8.14*	175 *7.61*	768 *12.59*	544 *11.33*	25 *.71*	.0 *.00*	3.6 *.06*	1,410	834	204	31
28	NE NW sec. 30	38	Alluvium	9-27	55	7.5	345	9.7	65 *3.244*	7.4 *.609*	3.0 *.130*	208 *3.409*	22 *.458*	2.0 *.056*	.2 *.011*	.5 *.008*	212	193	22	3
29	T. 32 S., R. 69 W. NE SE sec. 25	10.2	do	9-27	49	7.6	306	17	55 *2.745*	7.0 *.576*	8.4 *.365*	201 *3.294*	8.2 *.171*	4.0 *.113*	.2 *.011*	.5 *.008*	199	166	1	10

a. One part per million is equivalent to one pound of substance per million pounds of water and is equal to 8.33 pounds per million gallons.

b. An equivalent per million is a unit chemical weight of solute per million unit weights of solution. Concentration in equivalents per million is calculated by dividing the concentration in parts per million by the chemical combining weight of the substance or ion.

c. Sample contains 5.9 parts per million of carbonate (CO_3).