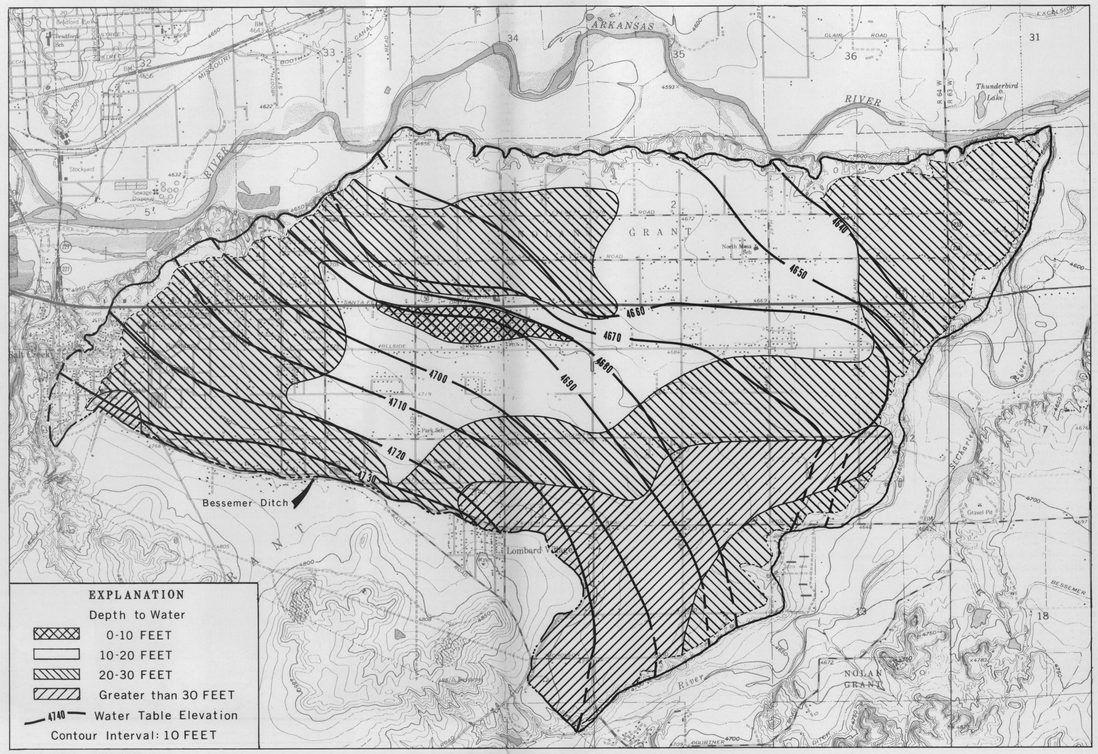
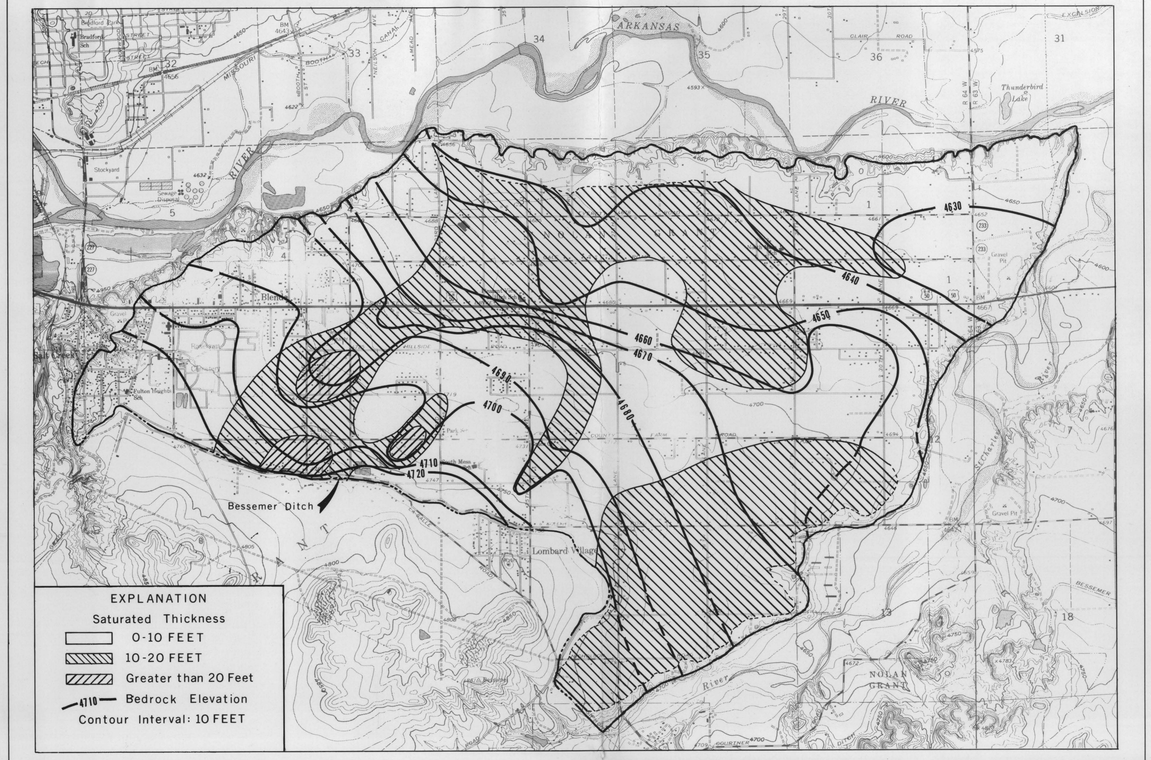
DEPARTMENT OF NATURAL RESOURCES
COLORADO GEOLOGICAL SURVEY
JOHN W. ROLD, DIRECTOR

MAP SERIES 2



Base from U. S. Geological Survey
7-1/2 minute quadrangle

Water Table and Depth to Water



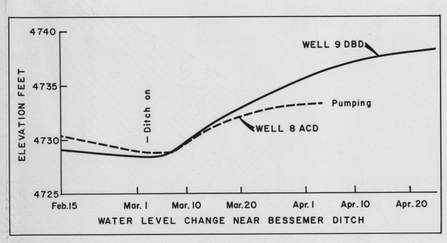
Base from U. S. Geological Survey
7-1/2 minute quadrangle

Bedrock and Saturated Thickness

WATER QUALITY SAMPLING SITES

CHEMICAL ANALYSES OF WELLS AND SPRINGS
(ANALYSES BY COLORADO DEPARTMENT OF HEALTH)
in milligrams per liter

LOCATION	TEMP. °C	pH	CONDUCTANCE	DISSOLVED SOLIDS	NITRATE NITROGEN	PHOSPHORUS	M.B.A.S.	CHLORIDE	FLUORIDE	SULFATE	TOTAL HARDNESS	CALCIUM AS CaCO3	MAGNESIUM	SODIUM	IRON	ZINC	REMARKS
Township 21S, Range 63W																	
1. 6 BBC	----	7.9	1810	----	69.7	----	-	43	----	----	----	----	----	75	----	----	
2. 6 CAC	9.5	7.7	1450	1212	3.1	0	0	23	1.4	761	800	496	74	---	.05	.02	SPRING
3. 6 CCC	14	8.0	2200	----	73.8	----	-	31	----	----	----	----	----	60	----	----	
Township 21S, Range 64W																	
4. 1 BAB	9.5	7.6	1870	1447	12.5	0	0	42	1.4	820	960	640	78	---	.00	.00	SPRING
5. 1 DBC	----	7.9	1360	1100	3.0	0	0	25	1.2	600	800	510	71	55	----	----	
6. 2 AAC	13.5	7.8	1700	----	22	----	-	38	----	----	----	----	----	90	----	----	
7. 2 DBC	----	7.7	1580	----	69.7	----	-	30	----	----	----	----	----	77	----	----	
8. 3 ADA	----	8.0	2260	----	21.3	----	-	55	----	----	----	----	----	85	----	----	
9. 3 BAB	7	7.8	2153	1987	4.4	0	0	37	1.2	815	1390	992	97	---	.15	.02	SPRING
10. 3 DCB	13	7.6	2200	2060	3.9	0	0	68	1.5	600	1400	1000	97	100	----	----	
11. 4 DCB	8	7.5	2600	----	14.8	----	-	68	----	----	----	----	----	80	----	----	
12. 5 DCA	14.5	7.8	1360	1060	6.0	0	0	24	1.9	1140	710	444	65	65	----	----	
13. 8 BDB	16	7.1	572	350	0.1	0	0	10	0.7	161	236	160	18	---	.20	.03	
14. 9 ACD	14	8.2	720	----	53.3	----	-	16	----	----	----	----	----	30	----	----	
15. 10 CCA	13	8.0	722	500	0.5	0	0	16	1.2	310	360	270	21	30	----	----	
16. 11 CAA	13.5	7.9	2030	2000	3.2	0	0	18	1.3	1130	1380	950	100	60	----	----	
17. 12 DBB	19	7.8	1240	----	13.9	----	-	19	----	----	----	----	----	55	----	----	
18. 12 DCC	11	7.4	2420	2265	4.5	0	0	19	1.1	1454	1420	1140	68	---	.04	.04	SPRING
19. 14 BBD	----	7.4	2600	----	2.5	----	-	20	----	----	----	----	----	60	----	----	
20. 9 BDD	----	----	1180	880	8.5	.05	-	26	2.5	430	558	361	48	55	0	---	ST. JOSEPH WATER CORP. 9-5-73
9 BDD	----	----	1085	824	7.0	.15	-	26	1.9	400	511	328	45	54	----	.08	ST. JOSEPH WATER CORP. 1-25-71
21. 9 DBD	----	----	700	572	2.0	----	-	20	0.7	269	320	228	22	46	.10	----	MESA SOFT WATER SERVICE 4-18-73
9 DBD	----	----	572	414	----	.10	-	14	0.8	159	273	179	23	22	.15	----	MESA SOFT WATER SERVICE 1-25-71
22. Composite	----	----	650	518	2.0	----	-	17	0.9	238	300	204	23	39	----	----	ST. CHARLES MESA WATER ASSN. 4-18-73
Composite	----	----	825	621	----	.10	-	20	1.0	275	367	238	31	47	.10	----	ST. CHARLES MESA WATER ASSN. 1-25-71



St. Charles Mesa is located immediately east of the C.F. and I. steel mill and was first developed in the late 1800's as truck-garden farms by the mill workers. The communities of Salt Creek and Blende developed to serve the agricultural and industrial population. In the last decade, however, the mesa has become a popular suburban area of Pueblo, and the land use is gradually changing from agricultural to one-acre residential tracts. Residential development has occurred sporadically over the mesa, with greatest density in the northwest part and least in the southeast. The population has varied from 7,400 in 1960 to 6,900 in 1970 and is estimated at 8,000 in 1975.

As determined by the 1970 census, the number of households on the mesa was 1,844. Since then, there have been an additional 482 building permits issued for the mesa. A count of wells registered with the Colorado Division of Water Resources shows at least 752 wells on St. Charles Mesa. There are developed for domestic and irrigation purposes. Use for irrigation purposes is an estimated additional 400 to 500 unregistered wells.

Domestic water on the mesa is furnished by the St. Charles Mesa Water Association and by two small water companies. Prior to 1965, all domestic water was obtained from individual domestic wells or from water-hauling companies. The association presently serves 1,936 customers with water from five wells and from treated Bessemer Ditch water. In 1974, the association supplied 554 acre-ft or 180 million gallons of water to its customers.

The total number of water customers is about 300 fewer than the total number of houses. These 300 families either use domestic wells or haul water for their needs. It has been determined that most of these individual supplies are located near the ditch or in the northeast part of the mesa. As time passes, many of these families will be served by the association because of convenience or the desire for better water quality. Based on ground water conditions, Colorado, to make a reconnaissance investigation of the hydrogeology of the mesa. The purposes of the investigation were to obtain a better understanding of the ground-water system of the mesa and to determine if there are any water quality problems resulting from the large number of septic tanks in the area. This report should benefit both local planning agencies and residents for development of ground-water supplies in the St. Charles Mesa area.

St. Charles Mesa is located in T. 21 S., R. 64 W., 6th P.M., Pueblo County. The mesa is bounded by the Arkansas River on the north, by the St. Charles River on the east, and by Salt Creek on the west. The Bessemer Ditch, which provides irrigation water to the mesa lands south of the Arkansas River, was chosen as a convenient southern boundary of the study area. The Bessemer Ditch is located near the change in slope at the southern edge of the mesa. The edge of the mesa is bounded by steep cliffs about fifty feet high. The study area contains 6,200 acres, or 9.7 square miles.

INTRODUCTION

St. Charles Mesa, an area immediately east of Pueblo, Colorado, is rapidly undergoing urbanization. As the mesa has a large concentration of population dependent to some degree on ground water supplies and a large development of ground water, the Colorado Geological Survey contracted with Hydro Engineering of Pueblo, Colorado, to make a reconnaissance investigation of the hydrogeology of the mesa. The purposes of the investigation were to obtain a better understanding of the ground-water system of the mesa and to determine if there are any water quality problems resulting from the large number of septic tanks in the area. This report should benefit both local planning agencies and residents for development of ground-water supplies in the St. Charles Mesa area.

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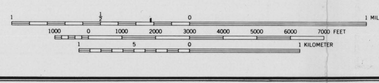

The alluvial deposits on the mesa, as mapped by Scott (1969b), are the Slocum, Louviers, and Broadway, all of glacial outwash origin. These deposits contain a coarse mixture of sand, gravel, and cobbles. The majority of the cobbly material is of granitic or metamorphic origin and came from outcrops in the mountains to the west, but there is some intermixing of sandstone and limestone gravels from the Cretaceous formations that outcrop to the south. The coarse deposits are overlain by a clayey sand colluvium or eolian sand of local origin.

The Slocum Alluvium occupies the highest terrace level on the mesa, 120 ft above the Arkansas River. The Louviers Alluvium occupies the middle terrace level, 80 ft above the Arkansas River, and the Broadway Alluvium occupies the lowest terrace level at the north edge of the mesa, 50 ft above the river. The lower portion of the alluvial deposits contains a conglomerate layer that is exposed in many gravel pits along the mesa edge. This conglomerate has a dense carbonate cement and is referred to as "cement rock" by local drillers. This unit, sometimes noted to occur immediately above the water-bearing zones, is probably related to fluctuations of the water table and high carbonate content of the ground water.

The thickness of the alluvial deposits was determined from drilling logs filed with the Colorado Division of Water Resources and from the report by McGovern and others (1964). The alluvium varies in thickness from 10 to 60 ft throughout the mesa, due to the irregular nature of the bedrock surface with the greatest thickness of alluvium occurring near the Bessemer Ditch. The bedrock contours shown on the above map are based upon the drilling logs. The accuracy of these logs is somewhat questionable; thus, the contour accuracy is probably ± 5 ft. The contours indicate a rolling topography for the bedrock surface, which is similar to that of the bedrock outcrops south of the mesa.

HYDROLOGY

The climate of St. Charles Mesa is semiarid, with the average precipitation being less than 11 in. per year. The major source of water on the mesa is the Bessemer Ditch, and any area not receiving irrigation water has a very sparse cover of vegetation. This ditch, which carries water diverted from the Arkansas River at the Pueblo Dam west of Pueblo, was developed to provide irrigation water for the small farms on the mesa and the lands east of Avondale. Both the water that is applied to the land and that seeping from the ditch are the major sources of recharge for the alluvial aquifer on the mesa. The rapid effect of this recharge is shown on the accompanying water-level graph of two wells near the ditch. As shown, the water-level in these wells began to rise within five days after water was turned into the ditch.

There are two possible sources of ground water on the mesa. The more important and better developed source is the alluvial deposits aquifer. Of lesser importance and with minimal development is the Cretaceous age Dakota sandstone aquifer. This aquifer occurs at depths of 1,200 to 1,800 ft below the surface and can probably yield up to about 60 gallons per minute (gpm) to wells. In other areas of Pueblo County and southeastern Colorado, the Dakota is an important source of ground water. In the Pueblo area, the Dakota is a confined aquifer and has sufficient artesian pressure to flow at the land surface.

The chief deterrent to any extensive development of the Dakota aquifer on the mesa is the cost of drilling a deep well when compared with the cost of drilling a shallow well to tap the alluvial aquifer. An estimated 10 wells tap the Dakota aquifer in the vicinity of St. Charles Mesa. This source of ground water could be developed more in the future.

Because of its economic advantage and accessibility for development, the alluvial aquifer has been extensively developed for domestic and irrigation purposes. Use for irrigation purposes is generally to supplement water delivered by the Bessemer Ditch when water rights are curtailed or to "speed up" the irrigation coverage of a field.

To determine the nature of the alluvial aquifer on the mesa, a series of water level measurements were made during February 1975. This time was selected because the aquifer is least affected by man's activities during the winter. As the Bessemer Ditch was shut off on December 24, 1974, there was a 2-month period for the aquifer to have approached a steady-state condition before the measurements were made. During the measurement period the depth to water was measured in 52 irrigation wells. From these measurements the elevation of the water table was calculated.

A water-table contour map was then prepared from these calculations (see map above). The contours indicate a gradient of the water surface, with resulting ground-water flow, away from the Bessemer Ditch. Over most of the mesa, the gradient is northeast toward the Arkansas River; however, on the southeast side of the mesa, the gradient is eastward toward the St. Charles River. This indication of discharge along the north and east edges of the mesa was verified by field inspection, where it was noted that the mesa's edge is dotted with small springs of 5 to 250 gpm flow occurring at the alluvium-bedrock contact. The slope of the water table over the mesa is generally ½0 ft per mile with a much steeper slope in sections 3 and 4 because of a sharp break in the bedrock surface.

The saturated thickness of the alluvial aquifer was calculated by determining the difference between the bedrock contours and the water-table contours. The saturated thickness ranges from 2 to 27 ft with the greatest thickness occurring in the area immediately north of the Bessemer Ditch. These thicknesses were for the hydrologic situation that existed in February 1975, before the Bessemer Ditch flow resumed. After the ditch flow began, the water table rose, and the thickness increased.

The variation in saturated thickness governs the yield of wells throughout the mesa; in areas of large saturation, the wells yield up to 500 gpm., where the saturation is small, the wells produce less than 50 gpm. This variation in yield is demonstrated by the median well discharge for each section reported in the files of well statistics. These reported yields tend to be optimistic, but the relation between sections should be valid.

A rough estimate of a water budget for St. Charles Mesa was prepared to determine the magnitude of water moving through the alluvial aquifer. In a very simple context, a water budget is a balance of the water entering the mesa, the consumptive use of water on the mesa, and the discharge from the mesa. The annual inputs are 11,000 acre-ft from the Bessemer Ditch plus 6,000 acre-ft from precipitation. Subtracted from this is the annual consumptive use of the crops grown, or 4,800 acres times 1.5 ft of water equals approximately 7,200 acre-ft. Thus the budget indicates that about 10,000 acre-ft per year are discharged from the mesa. Because there is a very little surface runoff, it is estimated that about 9,000 acre-ft per year moves through the alluvial aquifer and discharges through the springs at the edge of the mesa. This is equal to a steady discharge of 13 cubic ft per second.

WATER QUALITY

To determine the areal changes in water quality in the alluvial aquifer, 19 water samples were collected from springs and irrigation or domestic wells during March 1975. These samples were analyzed by the Colorado Department of Health, and the results are tabulated in the accompanying table. Also included in the table are analyses for the three watersupply systems serving the mesa. In the collection of the samples, it was attempted to achieve the best distribution of sampling locations with relatively few samples. In addition to the listed analyses, the spring samples were also analyzed for the following trace metals--arsenic, cadmium, chromium, copper, lead, and manganese. The analyses showed very low to undetectable amounts of these trace metals.

In general, the quality of the Bessemer Ditch water is very good with dissolved solids ranging from 200 to 400 milligrams per liter (mg/l). As the water enters and moves through the alluvial aquifer, however, the quality decreases quite rapidly with increasing distance from the ditch. The ground water dissolves minerals from the alluvial materials and the underlying shale, resulting in an increase in hardness and dissolved-solids concentration. In addition, irrigation return flow causes a decrease in the quality of the ground water. During irrigation some of the water is consumptively used either by the crops or evaporation, thus concentrating the remaining mineral matter in the return flow. Also, as this return flow moves through the soil, it dissolves additional mineral matter from fertilizers, animal wastes, and other materials.

This decrease in quality occurs within the first mile from the ditch. Of the 19 samples collected, 8 samples (3, 8, 9, 10, 11, 16, 18, 19) contained over 2,000 mg/l of dissolved solids. Three of the samples (12, 16, 18) contained very high concentrations of sulfates. The nitrate concentration in 9 samples (1, 3, 4, 6, 7, 8, 11, 14, 17) exceeded the Health Department limits of 10 mg/l for drinking water.

The source of nitrate in water is usually from sewage effluent, fertilizer leaching, or animal waste. The distribution of the high concentrations of nitrates appears somewhat spotty, possibly indicating localized areas of septic tank or fertilizer pollution. In view of this situation, all domestic well water should be sampled to detect unsafe drinking water.

CONCLUSIONS

The alluvial aquifer under St. Charles Mesa provides water for 8,000 persons, as well as for supplemental irrigation of farm crops. The area underlain by the alluvial aquifer is 6,200 acres. The source of recharge for the aquifer is irrigation water from the Bessemer Ditch. The discharge from the aquifer is through springs along the edge of the mesa. The estimated annual discharge is 9,000 acre-ft.

Water quality of the alluvial ground water decreases with distance from the Bessemer Ditch. Almost half of the water samples analyzed indicated high concentrations of dissolved solids and nitrate. Domestic use of the poor quality water could cause health problems.

SELECTED REFERENCES

McGovern, H. E., Gregg, D. O., and Brennan, Robert, 1964, Hydrogeologic data of the alluvial deposits in Pueblo and Fremont Counties, Colorado: Colorado Water Conserv. Board Basic-Data Release 18, 27 p.

Scott, G. R., 1969a, General and engineering geology of the northern part of Pueblo, Colorado: U.S. Geol. Survey Bull. 1262, 131 p.

_____ 1969b, Geologic map of the Southwest and Southeast Pueblo quadrangles, Colorado: U.S. Geol. Survey Map I-597.

ACKNOWLEDGMENTS

The author and the Colorado Geological Survey wish to express their appreciation to the Colorado Department of Health for their assistance rendered in this investigation. The Colorado Department of Health performed all the laboratory analyses for the dissolved mineral matter in the waters.

HYDROGEOLOGY of ST. CHARLES MESA PUEBLO COUNTY, COLORADO

by
John M. Dumeyer, Hydro Engineering

1975

COLORADO CENTENNIAL
1876

Drafted by: Robert H. Gast