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MEMORANDUM ON GROUND-WATER RESOURCES AND GEOLOGY OF RAINBOW VALLEY-WATERMAN WASH AREA, MARICOPA COUNTY, ARIZONA

By
H. N. Wolcott

Prepared in cooperation with the
Arizona State Land Department
W. W. Lane, Commissioner

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MEMORANDUM ON GROUND-WATER RESOURCES AND GEOLOGY OF RAINBOW VALLEY-WATERMAN WASH AREA, MARICOPA COUNTY, ARIZONA

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Introduction

This memorandum describes briefly the ground-water resources of the Rainbow Valley-Waterman Wash area, Maricopa County, Arizona. The work was begun in 1949 and completed in August 1952, and was in cooperation with the Arizona State Land Department, W. W. Lane, State Land Commissioner.

The work included reconnaissance geologic mapping. Electrical-resistivity geophysical probing was done to determine depth to bedrock in parts of the area. Records of wells were collected and the cultivated area was mapped. Geologic mapping was by the author of this report and by D. G. Metzger. Geophysical and hydrologic field work was done by H. E. Skibitzke. The base map was prepared by G. M. Hoskins.

Water samples were analyzed by the Quality of Water Branch at Albuquerque, New Mexico. The section on quality of water was reviewed by J. D. Hem, district chemist.

Purpose

The study was made for the purpose of determining:

(1) The sources and movement of ground water in each valley;

(2) Whether a subsurface channel or passage exists through which ground water might move from one valley into the other, and the effects of pumping in either valley in relation to the ground-water supply of both valleys;

(3) The approximate average annual recharge to the ground-water supply in the Waterman Wash Valley;

(4) The probable effects of pumping for irrigation in the Waterman Wash Valley upon water levels in shallow stock wells in the valley;

(5) The probable effects of continued expansion of irrigation development in Rainbow Valley.

Geography and Physiography

The Rainbow Valley-Waterman Wash area includes two distinct bodies of ground water which lie a few miles south of the towns of Hassayampa, Buckeye, and Liberty. The area forma a broad arc extending eastward from Gillespie Dam on the Gila River to the Sierra Estrella, then southward to a low drainage divide between the Maricopa Mountains and the Palo Verde Mountains (pl. 1). The area is bounded on the northwest and north by the Buckeye Hills and outliers of the Sierra Estrella, on the northeast and east by the Sierra Estrella and the Palo Verde Mountains, and on the southeast and south by the Haley Hills and the low drainage divide already mentioned, and on the southwest and west by the Maricopa Mountains and the Gila River.

To avoid confusion in the descriptions of the two valleys, the small valley that drains into the Gila River immediately downstream from Gillespie Dam is designated in this report as Rainbow Valley (pl. 1). It is a part of a larger ground-water area known as the Gila Bend basin. The area drained by Waterman Wash is designated the Waterman Wash area. The total drainage area of Rainbow Valley is approximately 80 square miles; of Waterman Wash, approximately 400 square miles. The physiographic line of division between the valleys is a low alluvial ridge that extends northward from the Maricopa Mountains to the Buckeye Hills.

Geology

The Waterman Wash basin probably was formed by downfaulting of a block between the Sierra Estrella Mountains and the Maricopa Mountains The deepest well in the area, in sec. 23, T. 2 S., R. 2 W., was drilled to a depth of 1,263 feet without encountering bedrock (table 1). There is nothing to indicate how much deeper the basin may be, but the depth already proved is sufficient to justify the hypothesis of structural origin. Rainbow Valley is a re-entrant of the Gila River Valley, and it is probable that, except along the extreme western border, near the Gila River, bedrock lies at much shallower depths than in the Waterman Wash basin.

On the map (pl. 1) some of the areas underlain by shallow bedrock are outlined and designated as "pediment." Within these areas small quantities of water may be encountered in shallow wells. These wells may produce enough water for stock or domestic use, but the supply is not dependable and the wells are liable to go dry during periods of prolonged drought. Owing to the presence of the pediments, the ground-water storage capacity in each valley is less than would be suggested by the large alluvial areas.

Granitic and metamorphic rocks, probably pre-Cambrian in age, compose the mountain borders of both valleys and, in all probability, rocks of the same types form the hard-rock basin floors. Granite and granite-gneiss are predominant in the mountains on the northern and western sides of the area. Schist and gneiss predominate in the mountains and hills on the eastern and southern border.

The logs of various wells in the Waterman Wash basin (table 2) indicate that the alluvial fill is similar in character to that in other basins of the desert region. Gravel, sand, silt, and clay are encountered at various depths and in varying thicknesses. The basin appears not to have been in the course of any major drainage, and therefore the alluvial-fill materials probably have been derived from the nearby hills and mountains.

Clay deposits thus far encountered appear to be lenticular and none is of any great lateral extent, suggesting that there was no protracted interruption of drainage from the basin, and, hence, no extensive accumulation of lake sediments, during the period of alluvial deposition. It is probable that the closure of the basin outlet was the result of geologically recent uplift along the line of the Buckeye Hills, after deposition of most of the alluvium.

Ground-water Resources

Sources and Movement

Recharge to the ground-water reservoir underlying Rainbow Valley is received from four sources: (1) Underflow along the Gila River; (2) runoff of rainfall in portions of the Buckeye Hills and the Maricopa Mountains; (3) seepage from canals and irrigated lands; and (4) seepage from floods or other occasional surface flows in the Gila River channel.

The principal sources of recharge to the Waterman Wash Valley are runoff from rainfall within the drainage basin and seepage from irrigation of approximately 3,500 acres of land near the center of the valley. There is no entry of water into the basin from the Santa Cruz River or its tributaries. Vekol Wash may have discharged at one time into Waterman Wash, but its present course is deflected eastward into the Santa Cruz River in the vicinity of the Palo Verde Mountains. The slight underflow along Vekol Wash probably parallels the surface channel.

Ground water in Rainbow Valley moves westward toward the Gila River. In the vicinity of the river, movement is from north to south.

In the Waterman Wash Valley there appears to be no definite trend of ground-water movement except as indicated by a slight downward gradient of the water table from the hard-rock borders toward the center of the valley. In the area where outflow might be expected northward through the narrows (secs. 29, 30, 31, and 32, T. 1 S., R. 2 W.), the water-table gradient at present is slightly downward toward the south. Therefore, no discharge occurs by underflow in this locality. The moderately heavy plant growth along this part of the wash probably is supplied from a zone of shallow water, and evapotranspiration from the plants constitutes the only natural discharge at present.

Possibility of Movement of Ground Water from Waterman Wash into Rainbow Valley

The two basins are separated on the surface by only a low alluvial divide, and there has been some speculation as to whether ground water might move from the Waterman Wash area into Rainbow Valley beneath the surface of the divide. In the geologic study of the area, considerable time was spent along the divide. Electrical resistivity probes were made for the purpose of checking and verifying conclusions drawn from the geologic work.

The results of the work all indicate that, about 2 miles west of the alluvial divide and at shallow depths below the surface, there is a continuous rock ridge extending northward from the Maricopa Mountains to the Buckeye Hills Low, inconspicuous outcrops of granitic and metamorphic rocks occur at several places along the line of the ridge, and geophysical probes were run at intermediate points between the outcrops. The probes indicated the presence of bedrock at shallow depths beneath the alluvial surface. There is, therefore, no possibility of any substantial ground-water movement from Waterman Wash basin into Rainbow Valley, and pumping in either valley should have no effect upon the water resources of the other valley.

Estimated Average Annual Recharge to the Ground-Water Supply in Waterman Wash Valley

As far as could be determined, there is no way in which ground water escapes at present from Waterman Wash Valley as underflow from the basin. Evaporation of ground water and transpiration by phreatophytes is small, and the only important discharge of ground water from the valley is by pumping for irrigation. A prolonged wet cycle probably would cause the water table to rise sufficiently to bring about the discharge of ground water as underflow through the narrow gap in the hills at the north end of the valley.

Recharge.--As already stated, the principal sources of recharge to the area are runoff from rainfall within the drainage limits of the basin and seepage from irrigation. The average annual recharge to the ground-water reservoir is, therefore, approximately the amount of rainfall runoff that infiltrates from the sandy washes to the ground-water reservoir.

Experimental work in other parts of Arizona has shown that in the average year there is little or no direct recharge from rain that falls upon the flat valley floors (Turner and others, 1943, p. 42). Some of the rain runs off and some penetrates a few inches into the soil and is lost through transpiration by desert plants and by evaporation. Of the rain that falls upon the hard-rock mountain surfaces, part is evaporated and part becomes runoff that percolates into the porous sands and gravels along washes and eventually reaches the ground-water reservoir

Average annual rainfall at Phoenix is 7.80 inches and at Gila Bend, approximately 6 inches. As Waterman Wash Valley lies between the two cities, an average annual rainfall of 7 inches on the Waterman Wash area was assumed for the purpose of estimating the quantity of recharge from runoff of rainfall.

Neither aerial photographs nor topographic maps were available for all the mountains surrounding the basin, and the total hard-rock area within the drainage limits of the basin could be only approximated. A maximum of 50,000 acres might be thus classified.

Experimental work in 1943 on Queen Creek, in the eastern part of the Salt River Valley area, showed that 6 to 10 percent of the total rainfall on terrain of this type finds its way into washes as runoff (Turner, S. F., personal communication, 1950). Of this amount, as much as 50 percent percolates as recharge to the ground-water reservoir (Babcock and Cushing, 1942, pp. 49-56). The balance is lost by evaporation and transpiration.

Assuming a maximum hard-rock area of 50,000 acres, an average annual rainfall of 7 inches, a maximum factor of 10 percent for rainfall runoff into sand washes, and a factor of 50 percent for runoff contributing recharge to ground water, it is estimated that a maximum of 1,500 acre-feet might be recharged annually to the ground-water reservoir from rainfall upon the hard-rock areas. If the runoff factor used were 6 percent instead of 10 percent, the annual recharge would amount to less than 1,000 acre-feet.

In addition, there will be some recharge from rainfall that reaches sand washes as runoff after falling upon the flat valley surfaces. During heavy storms, rain sometimes falls more rapidly than it can be absorbed by the soil, and the excess water follows small branches that lead into the major washes. The average amount of recharge from this source probably does not exceed 1,000 acre-feet per annum, and might be as little as 500 acre-feet. On the basis of these figures, it is estimated that the total average annual recharge from rainfall to the Waterman Wash ground-water reservoir does not exceed 2,500 acre-feet, and may be as little as 1,500 acre-feet.

Recharge from water applied to the land for irrigation is estimated on the basis of experimental work in Safford Valley (Turner and others, 1941, p. 30). In 1952 there was a total of about 3,500 acres under cultivation in Waterman Wash Valley. Assuming an annual consumptive use of 5 acre-feet of water per acre and a factor of 15 percent of water returned as recharge from irrigation, the total annual recharge from this source would amount to approximately 2,600 acre-feet.

Adding the estimated quantities of recharge received from precipitation, and from irrigation of lands under cultivation in 1952, the approximate total recharge is believed to be between 4,000 and 5,000 acre-feet per year.

Pumpage.--Withdrawal of ground water for irrigation in the valley in 1952 is estimated to be about 17,000 acre-feet on the basis of duty of water of 5 acre-feet per acre and a total irrigated area of 3,500 acres. If this factor for use were as low as 4 acre-feet per acre, total pumpage in 1952 would be 14,000 acre-feet. The amount of ground water withdrawn in 1952, therefore, will exceed recharge by approximately 10,000 to 12,000 acre-feet. This difference between recharge and pumpage will be withdrawn from storage.

Storage.--Agricultural development in the valley has been so recent that data are not yet available regarding the rate of decline of the water table in response to withdrawals from storage, nor are data available upon which to base an estimate of the quantity of ground water stored in the valley. Continued pumping, even from deep aquifers near the center of the valley, will result in an accelerated movement of ground water toward the points of withdrawal and a lowering of water levels throughout the area. Water levels in comparatively shallow stock or domestic wells will be affected, and some wells that are now producing water are likely to become dry.

Quality of Water

Although a few analyses available indicate that the quality of the ground water in Waterman Wash Valley is suitable for irrigation at present some account should be taken of the increase in mineral content that will result from continued use and re-use of the ground water in the basin. With no ground-water discharge to areas outside the valley to flush out accumulated salts, the water may eventually become so highly mineralized that it will be unfit for use. It is impossible to estimate how long it may take for such a condition to be brought about because the length of time depends upon two unknown factors--the quantity of water in storage and the rate at which it may be used for irrigation.

Effect of Continued Expansion of Agricultural Development in Rainbow Valley

No quantitative estimate of the recharge to or discharge from Rainbow Valley was attempted, because of the complexity of the problem and lack of necessary data. Recharge to the area is from several different sources, some of which would be difficult or impossible to evaluate. As there is no surface or subsurface division between Rainbow Valley and the Gila Bend basin, the ground-water reservoir is common to both. It is possible, however, to anticipate certain results that probably will follow a continued expansion of agricultural development in Rainbow Valley.

Chemical analyses of water from wells in this area (see table 3) show a high mineral content in the ground water paralleling the Gila River channel. Dissolved solids are highest in the wells nearest Gillespie Dam, where the water is derived principally from the river underflow. Downstream, the water improves somewhat in quality as a result of dilution by ground water of better quality moving westward in Rainbow Valley.

Increasing irrigation development in Rainbow Valley will eventually lower the water table sufficiently to cause movement of highly mineralized water eastward, away from the river, toward the area where pumping is heaviest. Evapotranspiration in the irrigated area will cause an increase in content of undesirable minerals in the root zone. If the quantities of salts in the soil and in the ground water that is used for irrigation becomes too high, some land will be forced out of cultivation.

The irrigable area in Rainbow Valley is not large and, from the standpoint of quantity alone, overdevelopment probably is not imminent, but the deterioration of quality of the ground water in this area may eventually become a factor limiting withdrawals. Pumpage figures for Rainbow Valley are included in the section on the Gila Bend basin.

Summary and Conclusions

The Rainbow Valley-Waterman Wash area includes two distinct ground-water reservoirs.

The lower part of Waterman Wash Valley is enclosed by hard-rock boundaries and there can be no underflow out of the basin as long as the water table remains at or near its present level. Rainbow Valley is a re-entrant of the Gila River Valley and therefore is a part of the Gila Bend basin.

The alluvial fill in Waterman Wash basin is composed of gravel, sand, silt, and clay, and it has a proved depth, in places, of more than 1,200 feet. Deposition of the alluvium has been characteristically irregular, and there is no great continuity of individual beds or lenses, either vertically or laterally. The total thickness of alluvium in Waterman Wash is probably greater than in Rainbow Valley.

Recharge to the ground-water reservoir in Rainbow Valley is from various sources, but the recharge in Waterman Wash basin is derived principally from runoff of rainfall and by seepage from irrigated lands.

The ground-water reservoirs of the two valleys are separated by a hard-rock barrier, and there is no appreciable movement of ground water from either valley to the other. Pumping in either valley will have no effect upon the ground-water supply of the other valley.

The recharge to Waterman Wash Valley in 1952 is estimated to be not more than 5,000 acre-feet, and it may be as little as 4,000 acre-feet. Continued use of ground water for irrigation in the valley will lower water levels and may result in some of the shallow stock or domestic wells becoming dry.

Continued expansion of irrigation development in Rainbow Valley will result in increasing mineralization of the ground water in that area, and the deterioration in quality of the water may ultimately force some land out of cultivation.

REFERENCES

Babcock, H. M., and Cushing, E. M., 1942, Recharge to ground water from floods in a typical desert wash, Pinal County, Ariz.: Am. Geophys. Union Trans., Part I, pp. 49-56.

Turner, S. F., and others, 1941, Water resources of Safford and Duncan-Virden Valleys, Ariz. and N. Mex., U. S. Geol. Survey, mimeographed, 108 pp.

Turner, S. F., and others, 1943, Ground-water resources of the Santa Cruz basin, Ariz., U. S. Geol. Survey, mimeographed, 84 pp.

Table 1.--Records of representative wells in Rainbow Valley-Waterman Wash area, Maricopa County, Ariz.

Well no.	Depth of well (feet)	Water level: Depth below measuring point (feet) a/	Water level: Date of measurement	Pump and power b/	Use of water c/	Remarks
T. 1 S., R. 2 W.						
Sec. 22	-	84.15	4-18-49	None	N	
24	67	57.82	8-16-49	C,W	D,S	
30	75	61.65	6-30-49	None	N	
31	33	24.00	5--5-52	C,G	D,S	
36	208	-	-	None	N	Dry.
T. 2 S., R. 1 W.						
Sec. 15	-	312.61	2--6-51	None	N	Uncased below 2 feet.
16	-	316.10	6--3-52	C,G	S	
19	-	177.00	6-11-52	None	N	Recently drilled irrigation well.
20	-	195.00	6-11-52	None	N	Recently drilled irrigation well.
33	1030	266.70	6--2-52	H	D	Uses bailer to get water.
T. 2 S., R. 2 W.						
Sec. 1	585	188.50	4--2-52	None	N	Well abandoned.
3	136	108.38	2--1-51	None	N	
5	1122	95.25	2--7-51	None	N	
9	515	132.98	4--2-52	T,G	D,I	
12	188	185.36	2--1-51	None	N	
13	680	181.32	4--2-52	None	N	
14	-	144.00	6--1-49	C,G	S	
21	150	-	-	None	N	Well dry at 86 feet 2-7-51.
22	161	-	-	None	N	Dry.
22	1250	195.00	12-16-50	T,D	I	Estimated discharge 2500 - 3000 gpm
23	-	142.85	2--1-51	T,G	I,D	Reported discharge 1000 gpm.
23	1263	180.00	11----50	T,G	I,D	Reported discharge 3476 gpm.

a/ Measuring point was usually top of casing, top of pump base, or top of well curb.
b/ T, turbine; C, cylinder; E, electric motor; G, gasoline or natural gas; W, wind; H, hand; D, diesel.
c/ I, irrigation; S, stock; D, domestic; P, public supply; N, none.

Table 1.--Records of representative wells in Rainbow Valley-Waterman Wash area--continued.

Well no.	Depth of well (feet)	Water level: Depth below measuring point (feet) a/	Water level: Date of measurement	Pump and power b/	Use of water c/	Remarks
T. 2 S., R. 2 W.						
Sec. 23	175	168.70	4--2-52	None	N	
24	155	-	-	None	N	Dry.
26	1031	-	-	T,G	I	
27	1055	200.00	1-12-52	T,G	I	
34	112	-	-	None	N	Dry.
35	1037	213.61	4--3-52	T,G	I	
T. 2 S., R. 4 W.						
Sec. 32	450	188.15	4--1-52	T,E	I,S	
32	-	-	-	None	N	Recently drilled.
32	-	-	-	None	N	Recently drilled.
33	168	-	-	None	N	Dry.
T. 2 S., R. 5 W.						
Sec. 35	400	-	-	T,E	I	
35	386	-	-	T,E	I	
36	-	-	-	T,E	I	
36	65	-	-	None	N	Dry.
36	345	-	-	T,E	I	
T. 3 S., R. 1 W.						
Sec. 1	350	330.17	6--2-49	C,G	S	
9	-	211.30	6--3-49	C,G	S,D	
36	-	294.68	6-11-52	C,G	S	
T. 3 S., R. 2 W.						
Sec. 1	237	-	-	None	N	
T. 3 S., R. 4 W.						
Sec. 4	250	159.68	2-13-51	T,E	I	
4	492	-	-	T,E	I,D	2984 gpm 8-16-51.
6	530	-	-	T,E	I	
7	176	100.25	4--1-52	None	N	

Table 1.--Records of representative wells in Rainbow Valley-Waterman Wash area--continued.

Well no.	Depth of well (feet)	Water level: Depth below measuring point (feet) a/	Water level: Date of measurement	Pump and power b/	Use of water c/	Remarks
T. 3 S., R. 4 W.						
Sec. 7	332	-	-	T,E	I	
8	406	105.10	4--1-52	T,E	I	
8	370	113.13	2-15-51	T,E	I	
8	780	-	=	T,E	I	
9	474	185.00	4--6-52	T,E	I	
9	490	155.15	2-13-51	T,E	I	Discharge 1816 gpm 8-16-51.
9	500	-	-	T,E	I	Discharge 2280 gpm 8-16-51.
15	420	-	-	T,E	I	Discharge 3175 gpm 8-16-51.
15	465	-	-	T,E	I	Discharge 3180 gpm 8-16-51.
16	-	159.30	4--1-52	T,E	I	
17	-	-	-	T,E	I	
17	302	-	-	T,E	I	Discharge 2028 gpm 8-30-50.
20	228	-	-	-	-	
21	300	105.80	1-28-52	T,E	I	Discharge 2042 gpm 8-30-50.
21	-	-	-	T,E	I	Discharge 2160 gpm 8-30-50.
21	550	-	-	T,E	I	Discharge 2820 gpm 8-30-50.
21	812	-	-	T,E	I	Discharge 2815 gpm 8-30-50.
22	465	-	-	T,E	I,D	Discharge 3415 gpm 8-17-51.
23	372	-	-	T,E	I	
27	-	191.50	4--1-52	T,E	I	
28	918	-	-	T,E	I	Discharge 3000 gpm 8-30-51.
28	1000	-	-	T,E	I	
29	-	-	-	None	N	Well being drilled.
T. 4 S., R. 1 E.						
Sec. 21	-	-	-	-	-	Rig over well 4-3-52.
26	370	-	-	C,G	D	
28	504	-	-	T,G	D	
28	750	400.02	4--3-52	None	N	
29	-	401.60	4--3-52	None	N	

Table 2.--Logs of representative wells in Rainbow Valley-Waterman Wash area, Maricopa County, Ariz.

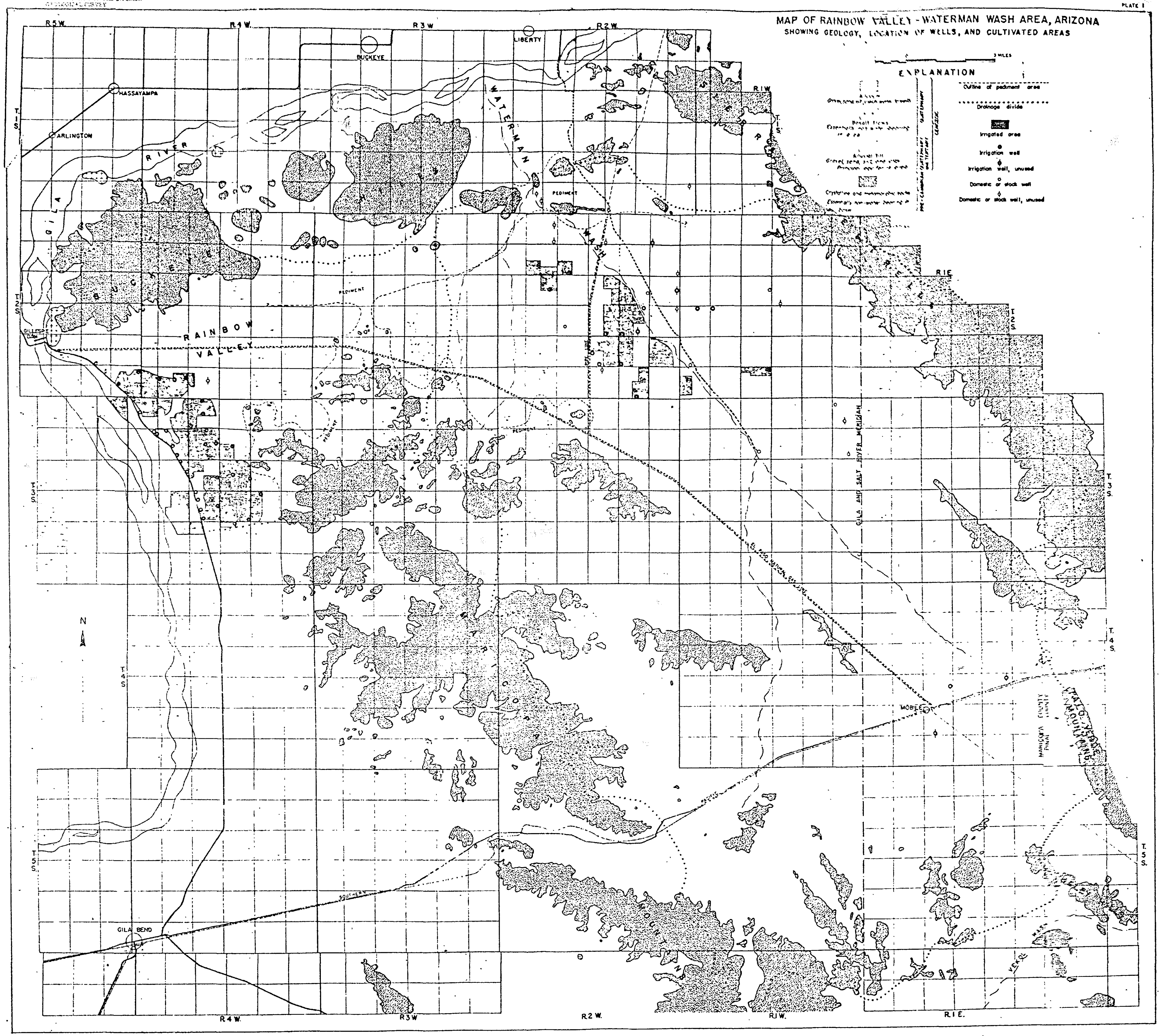
	Thickness (feet)	Depth (feet)
Sec. 33, T. 2 S., R. 1 W.		
Surface sand - - - - - - -	80	80
Clay - - - - - - - - - - - -	121	201
Clay with streaks of sand	294	495
Sand - - - - - - - - - - - -	90	585
Tight, grey sand - - - - -	91	676
Grey sand - - - - - - - - -	51	727
Grey sand with streaks of blue clay - - - - - - - -	43	770
Soft grey sand - - - - - -	51	821
Medium grey sand - - - - -	30	851
Hard streaks of grey sand	3	854
Medium grey sand - - - - -	15	869
Tight sand - - - - - - - -	17	886
Sand - - - - - - - - - - - -	99	985
Tight sand - - - - - - - - -	45	1030
TOTAL DEPTH		1030
Sec. 5, T. 2 S., R. 2 W.		
Surface sand and clay - -	120	120
Clay - - - - - - - - - - - -	20	140
Sand - - - - - - - - - - - -	70	210
Clay - - - - - - - - - - - -	5	215
Clay with streaks of sand	50	265
Sand - - - - - - - - - - - -	95	360
Clay - - - - - - - - - - - -	30	390
White sand - - - - - - - - -	20	410
Clay - - - - - - - - - - - -	50	460
Sand - - - - - - - - - - - -	125	585
Silt and sand - - - - - -	537	1122
TOTAL DEPTH		1122
Sec. 22, T. 2 S., R. 2 W.		
Surface sand, clay, caliche - - - - - - - - -	200	200
Sand, gravel, and clay - -	70	270
Sand, streaks of gravel -	100	370
Sand, gravel, thin streaks sandy clay - - - - - - -	190	560
Gravel, streaks sand - - -	290	850
Gravel sand, thin streaks clay - - - - - - - - - - -	100	950
Gravel and sand - - - - -	50	1000
Gravel, sand with hard cemented streaks of sand	250	1250
TOTAL DEPTH		1250
Sec. 35, T. 2 S., R. 2 W.		
Surface sand - - - - - - - -	100	100
Brown clay - - - - - - - - -	40	140
Sand, gravel, some boulders - - - - - - - - -	60	200
Sand, gravel some streaks of light colored clay - -	600	800
Light grey sand mixed with blue clay - - - - - - - - -	180	980
Hard light sand - - - - -	57	1037
TOTAL DEPTH		1037
Sec. 28, T. 4 S., R. 1 E.		
Surface soil - - - - - - - -	4	4
Caliche - hard streaks - -	166	170
Fine sand - - - - - - - - -	8	178
Clay and sand streaks - -	32	210
Sand and hard streaks - -	50	260
Sand - - - - - - - - - - - -	30	290
Cemented sand and boulders	11	301
Sand and boulders - - - -	69	370
Sand and boulder streaks -	30	400
Sand & boulders & clay streaks - - - - - - - - - -	60	460
Clay - - - - - - - - - - - -	6	466
Sandy clay - - - - - - - - -	54	520
Sand & clay streaks - - -	43	563
Hard clay - - - - - - - - -	57	620
Clay & sand streaks - - -	83	703
Clay & boulder streaks - -	47	750
TOTAL DEPTH		750

Table 3.--Analyses of water from representative wells in Rainbow Valley-Waterman Wash area, Maricopa County, Ariz. (Parts per million except specific conductance and percent sodium)

Well or spring no.	Date of collection	Depth of well (feet)	Temperature (°F.)	Specific conductance (micromhos at 25° C.)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$	Percent sodium
T1S., R4W.															
Sec. 9	12-15-50	250	76	5180	202	47	871	229	870	1040	3.5	86	3250	698	73
9	7-18-51	250	76	5210	-	-	-	241	-	1060	-	-	-	-	-
18	7-18-51	-	74	5210	-	-	-	267	-	1250	-	-	-	-	-
18	1-1-51	-	72	6520	298	100	1040	327	884	1530	2.6	77	4130	1150	66
T2S., R2W.															
Sec. 14	6-1-49	-	-	3030	-	-	-	160	-	760	-	-	-	-	-
23	4-7-52	1263	87	1370	17	3.4	264	101	116	282	2.6	28	783	56	91
27	4-7-52	-	89	1460	-	-	-	109	-	301	-	-	-	-	-
T2S., R5W.															
Sec. 35	4-19-46	386	-	2850	-	-	-	235	-	700	-	-	-	-	-
36	4-9-46	345	-	3580	-	-	-	270	-	920	-	-	-	-	-
36	4-9-46	400	-	3770	202	71	503	257	327	945	0.7	5.7	2180	796	58
T3S., R1W.															
Sec. 9	8-25-49	-	-	493	51	14	41	321	3.7	3	0.2	3.2	302	184	33
T3S., R4W.															
Sec. 6	5-27-46	530	-	2680	-	-	-	233	-	645	-	-	-	-	-
6	4-9-46	545	-	3390	194	63	428	247	274	835	1.1	6.7	1920	743	56
6	2-13-51	-	74	2940	152	57	384	251	231	705	1.2	6.6	1690	614	58
7	5-27-46	332	-	3100	-	-	-	259	-	772	-	-	-	-	-
8	5-27-46	370	-	2860	-	-	-	256	-	690	-	-	-	-	-
8	4-10-46	780	-	2460	-	-	-	234	-	585	-	-	-	-	-
9	2-15-51	490	70	2880	104	16	477	126	190	735	8.0	4.2	1620	326	76
9	4-1-52	500	85	2210	-	-	-	201	-	495	-	-	-	-	-
10	4-1-52	400+	-	3030	99	8.3	530	117	191	795	4.8	6.7	1720	281	80
17	4-10-46	302	-	3160	-	-	-	242	-	795	-	-	-	-	-
21	4-10-46	300	-	2690	134	46	361	186	205	660	1.1	11	1510	524	60
21	4-10-46	550	-	2610	-	-	-	254	-	620	-	-	-	-	-
22	4-1-52	400+	83	2500	76	6.3	444	128	179	615	4.4	14	1430	216	82
23	4-2-52	400	84	2090	-	-	-	114	-	480	-	-	-	-	-
28	5-27-46	1000	-	2660	-	-	-	246	-	620	-	-	-	-	-

Table 3.—Analyses of water from representative wells in Rainbow Valley-Waterman Wash area-continued.

Well or spring no.	Date of collection	Depth of well (feet)	Temperature (°F.)	Specific conductance (micromhos at 25° C.)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$	Percent sodium
T4S., R1W.															
Sec. 21	8-12-49	504	-	923	48	13	131	209	109	111	0.5	20	568	174	62
26	8-12-49	370	-	1420	55	16	227	195	223	206	1.2	13	876	203	71
Gila River near Gillespie Dam	3-7-46	Surface flow	-	6920	300	136	1090	375	891	1710	1.6	32	4350	1310	64
Do.	3/1-10/46	do.	-	8880	418	177	1420	426	1170	2360	2.2	22	5810	1770	63


MAP OF RAINBOW VALLEY - WATERMAN WASH AREA, ARIZONA
SHOWING GEOLOGY, LOCATION OF WELLS, AND CULTIVATED AREAS
3 MILES
EXPLANATION
Basalt flows
Crystalline and metamorphic rocks
Outline of pediment area
Drainage divide
Irrigated area
Irrigation well
Irrigation well, unused
Domestic or stock well
Domestic or stock well, unused
R5W.
R4W.
R3W
R2W.
R1W
R1E
R4W.
R3W
R2W.
R1W.
R1E.
T 1 S
T 2 S
T 3 S.
T 4 S
T 4 S.
T 5 S
T 5 S.
LIBERTY
BUCKEYE
HASSAYAMPA
ARLINGTON
GILA RIVER
WATERMAN
WASH
PEDIMENT
RAINBOW VALLEY
GILA AND SALT RIVER MERIDIAN
MOBILE
MARICOPA COUNTY
PINAL COUNTY
GILA BEND
SOUTHERN
N

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