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OFFICE OF THE STATE ENGINEER

WATER RESOURCES BULLETIN No. 12

CONTRIBUTIONS
TO THE
HYDROLOGY OF EASTERN NEVADA

Papers by
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Warm Spring in the SE¼, sec. 12, T. 33 N., R. 61 E. Such a conduit system could also supply water directly to the ground-water reservoir in the valley fill.

The principal source of ground water is from precipitation on the east flank of the East Humboldt Range for Clover Valley and the west flank of the Pequop Mountains for Independence Valley, but lesser amounts are supplied from the other mountain areas bordering the valleys. Much of the precipitation is lost by evaporation or transpiration before it reaches the ground-water reservoir. A reconnaissance method of estimating average annual ground-water recharge from precipitation indicates an annual increment of about 21,000 acre-feet for Clover Valley and about 9,000 acre-feet for Independence Valley. Ground water moves toward the lower parts of the valleys where it is discharged by transpiration, or evaporation from soil and free-water surfaces.

Estimates of the average annual ground-water discharge suggest that about 19,000 acre-feet are discharged from Clover Valley and about 9,500 acre-feet from Independence Valley.

Under extensive ground-water development possibly one-half ɔf the natural discharge could be recovered by wells in Clover Valley and about one-fifth of the natural discharge from Independence Valley. Most of the existing wells are used to supply itock and domestic requirements. The discharge from the springs s used principally for irrigation.

The report includes: A discussion of the general geology as t relates to ground water; the information obtained by drilling test well in Clover Valley; analyses of water from Warm Spring 33/61-12D1) and from four zones in the test well (35/62-27B1); nd tables of records of wells in Clover and Independence Valleys. The general geologic and hydrologic features are shown on 'late 3. Tables summarizing climatologic data are given and the egetation and soils of Clover Valley are discussed briefly on ıe basis of information obtained in a field reconnaissance by ·oward G. Mason, Agricultural Economist, University of Nevada gricultural Experiment Station.

ɜROUND WATER IN RAILROAD, HOT CREEK, REVEILLE, KAWICH, AND PENOYER VALLEYS, NYE, LINCOLN AND WHITE PINE COUNTIES, NEVADA

By G. B. MAXEY and T. E. EAKIN, *Geologists, U. S. Geological Survey*

This report describes a region of alternate valleys and moun-in ranges covering about 5,570 square miles in the central part the Great Basin in east-central Nevada. Railroad Valley has

interior drainage and Hot Creek and Reveille Valleys are tributary to it. Kawich and Penoyer Valleys are separate closed basins. In general, the valleys and ranges trend northward. The sparse population is engaged principally in raising livestock but there is some supplemental farming. Mining operations are limited to a few scattered localities. The principal ranches are adjacent to springs, or creeks supplied by springs. Wells are used primarily to supply stock on the range, but they supply some domestic requirements also.

The main purpose of this reconnaissance investigation was to study the source, occurrence, movement, and disposal of ground water and to obtain an estimate of the annual amount of ground water that might be recovered by wells.

The principal water-bearing beds are the more permeable sand and gravel deposits of the Tertiary and Quaternary valley fill. Several wells drilled in the lower part of Railroad Valley and a few in Hot Creek Valley have yielded water under sufficient artesian pressure to flow at the land surface. The maximum reported yield for a flowing well is 480 gallons a minute, but most wells flow less than 100 gallons a minute.

Ground water in the valleys is recharged principally by rain water and snow melt from the adjacent mountains. Discharge of ground water in the region ultimately is by evaporation and transpiration. In Railroad Valley, the estimated average annual discharge of ground water, including the discharge from Hot Creek and Reveille Valley, is about 50,000 acre-feet. The average recharge of course is the same. In Penoyer and Kawich Valleys the estimated average annual recharge to and discharge from ground water are only a few thousand acre-feet each.

Big Warm Spring at Duckwater in the northwestern part of Railroad Valley is the largest spring in the region, having a discharge that may average about 14 second-feet. It and some small nearby springs are used for irrigation on several ranches, but a considerable part of the annual flow of the springs is discharged to the southeast beyond the irrigated area. Of this "waste" water a part infiltrates to the main ground-water reservoir in Railroad Valley.

The report contains climatological data, data on the discharge of certain springs and of Current Creek, and the logs of several relatively deep wells not previously published.

A reconnaissance report on land classification by Howard G. Mason of the Nevada Agricultural Experiment Station is included.

DESIGNATION OF WELLS AND SPRINGS

Wells and springs are designated by a single numbering system used in all five reports of Bulletin 12. The number assigned to a well or spring in these reports is both an identification and location number. It is based on the Mt. Diablo base and meridian network of surveys established by the General Land Office.

A typical number usually consists of three units. The first unit is the township number north of Mt. Diablo base unless some of the townships in a valley or group of valleys comprising a unit of this bulletin are south of the Mt. Diablo base, in which case the township number in that unit is followed by the letter N or S to designate the township number north or south, respectively, of the Mt. Diablo base. The second unit, separated from the first by a slant, is the range number east of Mt. Diablo meridian. The third unit, separated from the second by a dash, is the number of the section in the township. The section number is followed by a letter, which designates the quarter section and finally, a number designating the order in which the well or spring was recorded in that quarter section. The letters A, B, C, and D designate, respectively, the northeast, northwest, southwest, and southeast quarters of the section.

Thus, well number 33/66-32A2 indicates this well was the second well recorded in the NE¼ of section 32, T. 33 N., R. 66 E., Mt. Diablo base and meridian. If the area covered by a report includes wells on both sides of the Mt. Diablo base the well number is modified as follows: Well number 3S/54-13D1 indicates the first well recorded in the SE¼ sec. 13, T. 3 S., R. 54 E., and well number 5N/54-32C1 designates the first well recorded in the SW¼ sec. 32, T. 5 N., R. 54 E.

Owing to space limitation wells and springs on Plates 1 and 4 and Figures 2 and 3 are identified only by section number, a letter showing the quarter section, and a number showing the order in which it was recorded in the quarter section. On Plates 2, 3, and 5, section numbers for wells are not given but they can be determined by noting the corresponding section number shown for T. 5 N., R. 55 E., Plate 5. Township and range numbers are shown on the edges of the plates.

STATE OF NEVADA

OFFICE OF THE STATE ENGINEER

GROUND WATER IN GOSHUTE-ANTELOPE VALLEY, ELKO COUNTY, NEVADA

By T. E. EAKIN and G. B. MAXEY, Geologists, and T. W. ROBINSON, Engineer,
U. S. Geological Survey

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Plate 1. Map of Goshute and Antelope Valleys showing general geologic and hydrologic conditions........In pocket

GROUND WATER IN GOSHUTE-ANTELOPE VALLEY, ELKO COUNTY, NEVADA

By T. E. EAKIN and G. B. MAXEY, *Geologists*, and T. W. ROBINSON, *Engineer, U. S. Geological Survey.*

INTRODUCTION

The area included in this report is in eastern Elko County some 20 miles west of the Nevada-Utah State line between latitudes 40°08′ and 41°09′ north and longitudes 114°14′ and 114°48′ west (see pl. 1).

Goshute Valley occupies the northern part of this area, an intermontane depression, from the vicinity of Cobre on the north to Shafter on the south. Antelope Valley extends from Shafter southward and adjoins Spring Valley in White Pine County. For this report it is defined to extend to a low alluvial divide about at the south boundary of Elko County. A tongue of the valley extends southwest from Dolly Varden siding to within 2 miles of Currie, where it is connected with Steptoe Valley by a narrow gap in the bedrock. The total drainage area is about 1,230 square miles.

The valleys are reasonably accessible by road. U. S. Highway 50 crosses Antelope Valley near the south end. U. S. Highway 40 crosses the central part of Goshute Valley. Fairly good dry-weather roads extend along the east and west sides of the valley and connect with U. S. Highways 40 and 50.

The Southern Pacific Railroad crosses the extreme north end of the valley at Cobre. The Western Pacific Railroad crosses the valley and goes through Shafter. The Nevada Northern Railroad extends south from Cobre through Shafter and leaves the valley at Currie.

The population of the valley probably does not exceed 200. The only populated places are the railroad stations of Shafter and Cobre, the highway station of Oasis, and several ranches, only two of which have permanent residents.

Most of the valley area is grazing land, but small acreages are irrigated from surface runoff in the southwest part of T. 33 N., R. 66 E., by pumping from a well situated approximately in sec. 33, T. 35 N., R. 66 E., and from Johnson Springs, approximately in sec. 33, T 36 N., R. 66 E.

Previous work by the U. S. Geological Survey in this area includes a reconnaissance in 1946 by H. V. Peterson to locate stock wells in Goshute Valley and adjacent areas, and an investigation in 1942–1943 by P. E. Dennis of Johnson Springs and vicinity for a water supply for the Army Air Base at Wendover, Utah.

The present report is based on field work in May and June, 1948. Field data on essentially all the wells in the area were obtained and a reconnaissance of the geology and hydrology was made. Some additional office work was necessary to obtain other pertinent data.

CLIMATE

The climate of the valley is arid to semiarid and characterized by low precipitation, low humidity, and high evaporation, and a large temperature range both daily and seasonally. Precipitation is least on the valley floor and greatest in the higher parts of the mountains.

The only precipitation record within the area is a short, broken record for Otego. These and the other climatological data are from records of the U. S. Weather Bureau.

Average monthly and annual precipitation at *Otego, Elko County
(Broken record, period 1877–1887)

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
0.96	1.18	0.70	1.22	0.66	0.38	0.21	0.38	0.25	0.65	0.51	1.01	8.11

*Location and altitude uncertain.

The annual precipitation at Otego during the period of record ranged from 1.85 inches in 1880 to 13.32 inches in 1884.

A longer record is available at Toano, just west of Cobre. There the period of record was from 1870 to 1905. The annual precipitation ranged from 1.80 inches in 1881 to 20.38 inches in 1891. As the altitude of Toano (5,975 feet above sea level) is about 300 to 400 feet greater than that of the floor of Goshute-Antelope Valley, the precipitation may be slightly greater also. The following table summarizes the precipitation at Toano:

Average monthly and annual precipitation at Toano, Elko County
(Record broken)

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
0.92	0.85	0.87	0.81	0.92	0.66	0.28	0.22	0.25	0.44	0.64	1.30	8.16

No temperature records are available for the valley. However, Clover Valley station, about 25 miles west of Shafter, is believed representative. The temperature data are summarized below:

Temperature at Clover Valley, Elko County. Altitude 5,800 feet.

	Jan.	Feb.	Mar.	Apr.	May	June
Average*	24.6	29.3	35.7	44.3	51.0	59.4
Average minimum*	12.3	17.9	23.1	29.2	35.3	42.3
Average maximum*	36.8	40.8	48.3	59.4	66.6	76.4

	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Average*	67.2	65.8	57.5	47.0	36.7	26.3	45.4
Average minimum*	49.3	47.6	39.3	30.1	21.9	13.6	30.2
Average maximum*	85.2	83.9	75.7	63.8	51.6	39.0	60.6

*Temperature in degrees Fahrenheit; period of record 27 years, ending in 1930.

The record of the frost-free period at Clover Valley is also believed to approximate that of Goshute-Antelope Valley. At Clover Valley the frost-free period has ranged from 149 days in 1910 to 64 days in 1918 and has averaged about 100 days for the 22-year period ending in 1930. Thus, the growing season in Goshute-Antelope Valley is short and is suitable only for the production of hay and other frost-resistant or rapidly maturing crops.

VEGETATION AND SOILS

The vegetation* on the floor of Goshute-Antelope Valley, according to Soil Conservation Service maps, includes big greasewood (*Sarcobatus vermiculatus*), shadscale (*Atriplex confertifolia*), big sagebrush (*Artemisia tridentata*), white sage (*Eurotia lanata*), big rabbit brush (*Chrysothamnus sp.*), and mixed grasses and other members typical of the Northern Desert Shrub plant association.

The soils in the potential area of irrigation with ground water, although locally somewhat heavy and alkaline, appear to be suitable for crops commonly grown in eastern Nevada. These soils, however, may require treatment for continued crop production.

PHYSIOGRAPHY AND DRAINAGE

Goshute-Antelope Valley of this report lies within the Great Basin section of the Basin and Range physiographic province. It occupies a structural trough elongated in a general north-south direction. In its south part the valley is separated into southwest- and southeast-trending tongues separated by the Antelope Range. The valley is about 70 miles long and the valley floor averages 8 to 10 miles in width. The lowest part of the valley is nearly flat in both east-west and north-south directions. This is indicated in part by a level line along the Nevada Northern Railroad where, for a distance of 22 miles between Dolly Varden siding and Shafter, there is an altitude differential of only 10

*See list of references at end of report.

feet. The altitude of the valley floor is about 5,600 feet above sea level.

The valley is bounded on the east by the Goshute Mountains to the south and the Toano Range to the north. The Pequop Mountains bound the valley on the west. The north end of the valley is terminated by a mountain mass extending southward and merging with the Pequop Mountains and the Toano Range in low passes. A low range of hills connects the Pequop Mountains with the Antelope Mountains to the south, and a low alluvial divide connects the Antelope Mountains with the Goshute Mountains.

The summit altitude of the Pequop Mountains commonly ranges between 7,000 and 8,000 feet above sea level but exceeds 10,000 feet westward from Johnson Springs. In the Toano-Goshute Range, the summit altitude is somewhat above 8,000 feet from a point about east of Shafter to a point about 5 miles north of U. S. Highway 50. Elsewhere the mountains are lower.

Intermittent streams drain the flanks of these mountains adjacent to the valley. Some surface discharge may occasionally enter the valley near Currie from Steptoe Valley. There is no surface discharge from the Goshute-Antelope Valley.

GENERAL GEOLOGY

The oldest rocks in the area are exposed in the mountains surrounding the valley. They consist of limestones and associated sedimentary rocks of Paleozoic age. Quartz monzonite of Mesozoic(?) age is intrusive into the Paleozoic sedimentary rocks in the north part of the Antelope Range (the Dolly Varden Mountains), in Silver Zone (Middle Zone) Pass of the Toano Range, and in the White Horse district of the Goshute Range (Hill, 1916). The Paleozoic and Mesozoic(?) rocks are overlain unconformably by Tertiary(?) lava flows of two periods of extrusion. Most of the valley fill is of Tertiary age and is believed to consist primarily of lacustrine sediments together with marginal alluvial-fan deposits (see log of well 34/67-6A1 in well table). Deposits of Pleistocene age are of minor importance but appear to form a thin lacustrine mantle on the valley floor. They occur most prominently in the forms of beaches, bars, spits, and other shore features on the lower parts of the alluvial fans. Deposits of Recent age appear to be very minor. A tentative geologic history is given below:

1. Deposition of limestone and associated sediments of Paleozoic age.

2. Quartz monzonite intrusion accompanied by folding and faulting (Mesozoic(?) age).
3. Erosion. The debris resulting from this erosion may have been minor, covered by later deposits, or it may have been removed from the area.
4. Extrusion of andesitic lava flows and associated ejectamenta of early(?) Tertiary age.
5. Faulting, involving the flow rocks.
6. Erosion in the mountains. Detritus from this erosion possibly related to lower member of Humboldt formation as defined by Sharp (1939).
7. Extrusion of rhyolitic lava of Tertiary age (contemporaneous(?) with the Humboldt formation as defined by Sharp (1939)).
8. Faulting and tilting involving rhyolitic flow rocks.
9. Erosion in mountains. Deposition of bulk of valley fill, predominantly lacustrine sediments with marginal alluvial fans; of Tertiary age but probably also of early Pleistocene age. (Related in part(?) to upper member of Humboldt formation as defined by Sharp (1939).)
10. Development of lake during late Pleistocene time. Two prominent shore lines and several minor shore lines developed during stages of the lake. Deposition primarily as lake-shore features.
11. Desiccation of the Pleistocene lake.
12. Minor erosion and deposition in Recent time.

GROUND WATER

The chief source of the ground water in Goshute-Antelope Valley is precipitation within the valley and on the adjacent flanks of the mountains. A small amount of water may enter the valley occasionally from Steptoe Valley.

Most of the valley floor and marginal alluvial fans has an average annual precipitation of about 8 inches, which probably does not contribute materially to the ground-water reservoir. Thus, essentially all of the contribution to the ground water is derived from precipitation on the flanks of the mountains adjacent to the valley floor.

Ground water occurs in the zone of saturation below the water table in the valley fill and in the bedrock. However, it has been obtained by wells only in the permeable sands and gravels of the valley fill. The bedrock has not been tested by wells to determine whether suitable bedrock aquifers occur in this area.

The ground water is recharged largely by surface flow from the mountain canyons that percolates into the valley fill in the alluvial-fan areas at the edges of the mountains. The slope and movement of the ground water within the central part of the valley fill have not been determined accurately. Available data indicate that the water table is nearly flat. For example, the "highway" well (28/68-8D1) has a water-level altitude of about 5,575 feet; well 31/66-30A1 has a water-level altitude of about 5,565 feet, and the railroad wells at Shafter (34/67-6A1, 2) have water-level altitudes of about 5,560 feet. These wells are spaced about 20 miles apart. Thus, in general, slow northerly movement of ground water in the valley fill is indicated. The character of the bedrock across the north end of the valley is not favorable for underflow out of the valley; thus the water is discharged largely or entirely by evaporation and transpiration by plants.

The depth to water is least in a narrow strip lying 2 to 5 miles west of the road between Shafter and Oasis. Over most of this area, topographically the lowest in the valley, the depth to water is 15 to 20 feet below the land surface and the water table is at its lowest altitude in the valley. The water table rises eastward and southward but the land surface rises even more rapidly, so that the depth to water increases; for example, it is 64 feet in well 32/67-24C1 and 101 feet in well 29/67-1A1. The 25- and 50-foot depth-to-water contours are shown approximately on plate 1.

ESTIMATED ANNUAL INCREMENT TO GROUND WATER

The average annual increment to ground water can be estimated as a percentage of the total precipitation within the drainage basin of Goshute-Antelope Valley. The best available basis from which to estimate total precipitation is the "Precipitation map of Nevada" showing areas of assumed equal rainfall, prepared in 1936, under the supervision of George Hardman, by the Nevada Agricultural Experiment Station. On this map precipitation is shown by zones of precipitation of less than 5 inches, 5 to 8 inches, 8 to 12 inches, 12 to 15 inches, 15 to 20 inches, and over 20 inches.

Preliminary recharge studies in east-central Nevada, in which estimates of ground-water discharge by natural losses were made for 13 valleys, indicate the approximate recharge in terms of percentage of the precipitation. The rainfall was estimated for each valley, using the rainfall map as a basis. The recharge percentages were balanced by trial and error against the estimates of discharge by natural losses in the 13 valleys. Lack of

agreement in the recharge and discharge estimates for any one valley probably results primarily from insufficient detailed control for the precipitation map. The percentages derived agree reasonably well with those obtained in the Las Vegas Valley, Nevada, and the Roswell Basin, New Mexico, particularly for the zones of higher precipitation. The estimates are as follows: No significant ground-water recharge is believed to occur in the zones having precipitation of less than 8 inches. In the 8- to 12-inch zone the recharge may be about 3 percent of the precipitation; in the 12- to 15-inch zone, about 7 percent; in the 15- to 20-inch zone, about 15 percent; and in the zone having over 20 inches, about 25 percent.

For Goshute-Antelope Valley the percentage of recharge from precipitation in the 8- to 12-inch zone was reduced from 3 percent to 1 percent. This was largely because of the relatively great depth to the water table and because of the lack of collecting drainageways in the area included by the zone. Thus, there is a greater opportunity for loss of water by evaporation and transpiration by plants.

The areas of each zone of precipitation in the Goshute-Antelope Valley were determined by planimeter. The data pertinent to the estimate of recharge from precipitation are summarized in the following table:

Estimated average annual recharge from precipitation in Goshute-Antelope Valley, by zones

Precipitation (inches)	Area of zone (acres)	Percentage of recharge	Recharge (acre-feet)
8-12	340,000	1	2,800
12-15	89,000	7	7,000
15-20	2,800	15	600
Total			10,400

ESTIMATED AVERAGE ANNUAL DISCHARGE OF GROUND WATER

Discharge of ground water from Goshute-Antelope Valley is accomplished by pumpage from railroad wells; one irrigation well; and several stock wells; by spring flow, the water being disposed of eventually by evaporation and transpiration; and by natural discharge by evaporation and transpiration. Discharge by underground outflow is believed to be negligible. A summary of discharge is given in the following table: