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DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
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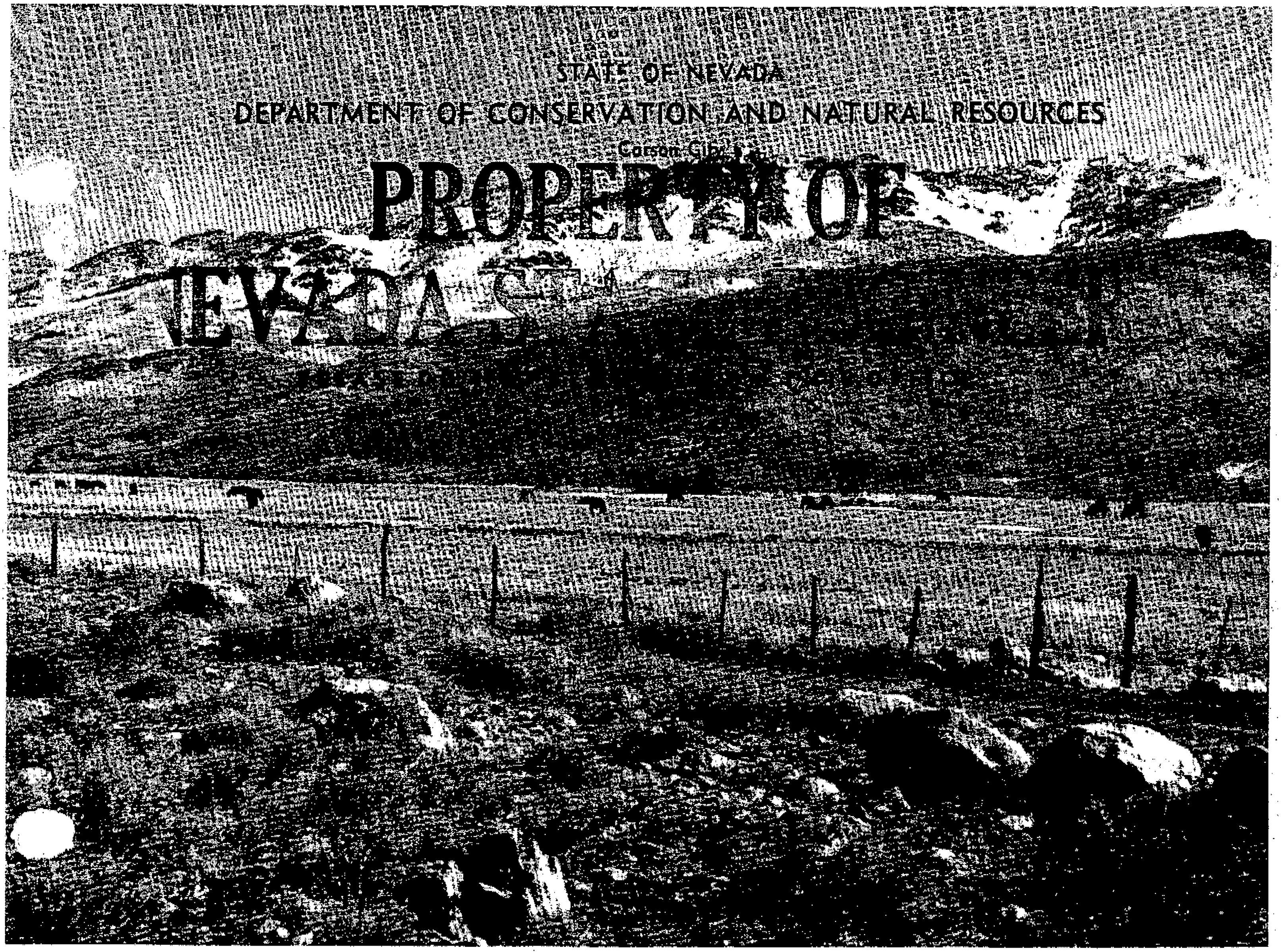


Independence Valley—View of Jack Peak, Independence Mountains

GROUND-WATER RESOURCES - RECONNAISSANCE SERIES

REPORT 8

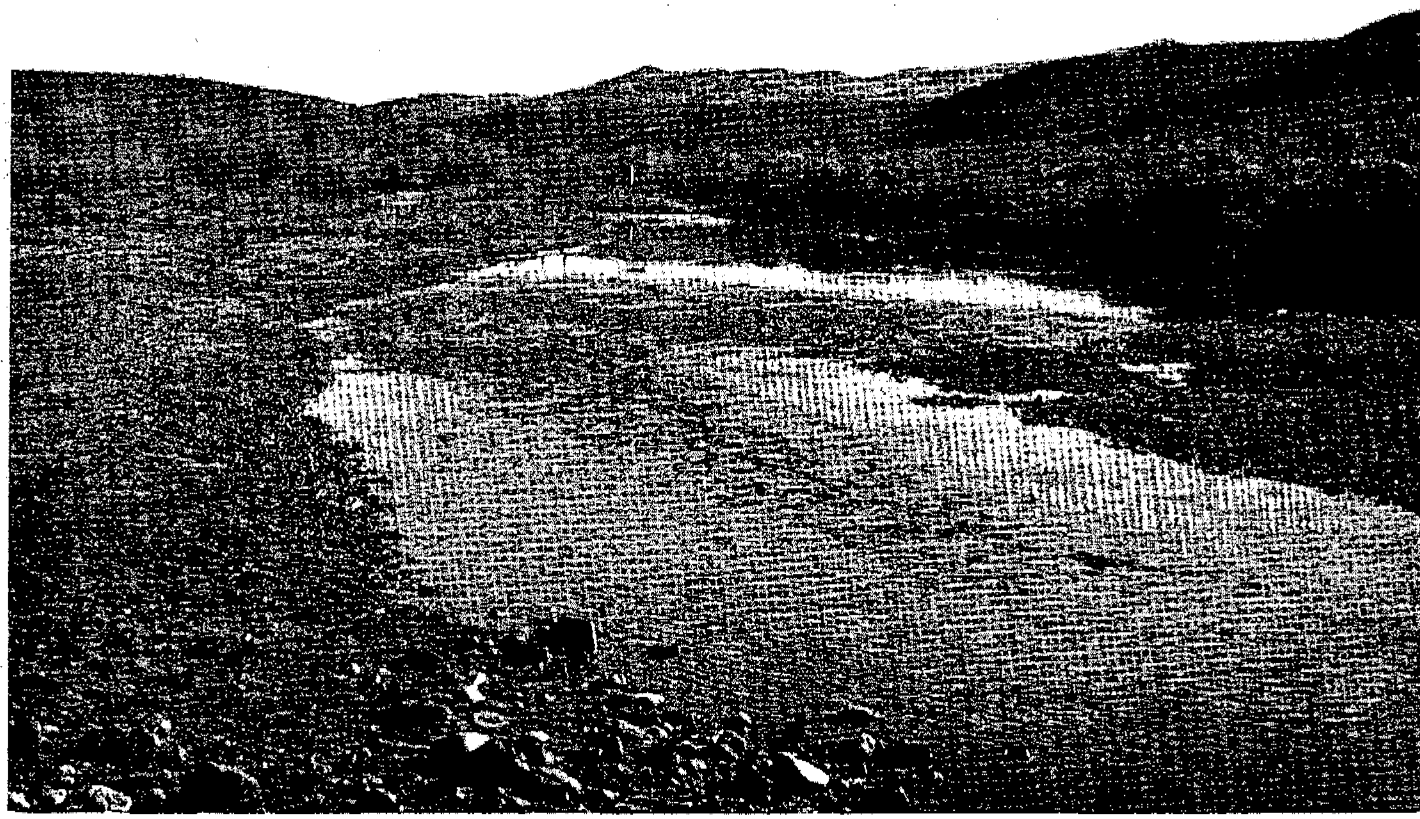
GROUND-WATER APPRAISAL OF INDEPENDENCE VALLEY, WESTERN ELKO COUNTY, NEVADA

By
THOMAS E. EAKIN
Geologist

Price $1.00

Prepared cooperatively by the
Geological Survey, U. S. Department of the Interior

MAY 1962



SOUTH FORK OF THE OWYHEE RIVER

View south-southeast of the South Fork of the Owyhee River at upstream end of the gap through which the river discharges from Independence Valley. River is flowing toward viewer, discharge 12–14 cfs, November 1961. The gaging station listed as South Fork of the Owyhee River near Spanish Ranch, can be seen on right bank in middle distance.

COVER PHOTOGRAPH

View east-southeast toward Independence Mountains from a point in the valley of Jack Creek. Irrigated meadows along Jack Creek in middle distance. Jack Peak in left center of skyline.

FOREWORD

This is the eighth in the series of ground-water reconnaissance reports which were initiated by the 1960 Legislature. Additional reports on other valleys will be printed at the rate of approximately one each month. This would indicate that within another two years most of the valleys of the State will have been reported on either under this particular program or under the more detailed ground-water study program.

The U.S. Geological Survey is to be commended for the very fine work that is being done under the federal-state cooperative program.

Hugh A. Shamberger
Director
Department of Conservation & Natural Resources

May 15, 1962.

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GROUND-WATER APPRAISAL OF INDEPENDENCE VALLEY WESTERN ELKO COUNTY, NEVADA

by
Thomas E. Eakin

SUMMARY

The results of this reconnaissance indicate that the ground-water discharge from Independence Valley is on the order of 10,000 acre-feet per year. This estimate is based principally on an analysis of streamflow records for the 1960 and 1961 water years. Because at least 2 antecedent years had deficient precipitation, the estimate may be low.

The present ground-water yield of the valley, based on the estimated discharge, is on the order of 10,000 acre-feet per year. Increased ground-water withdrawals by wells would modify the existing regimen to some extent. Depending on the location and distribution of wells, lowering of water levels resulting from development probably would induce additional recharge from precipitation and streamflow, and would reduce the natural water losses. If most of the natural losses were salvaged for beneficial use by pumping, the net draft would be equal to the perennial yield. Some of the water pumped from wells would return to the ground-water reservoir by infiltration and thereby reduce the effects of pumping on the ground-water system.

Present ground-water pumpage for irrigation is small, probably less than 200 acre-feet in 1961, and has little effect on the existing ground-water system.

The total amount of ground water in storage was not estimated. However, an estimated 250,000 acre-feet is stored in the upper 100 feet of saturated deposits underlying a 25,000-acre area below the 5,800-foot land-surface contour.

As suggested by the general occurrence and movement of ground water and three chemical analyses, the chemical quality of the ground water in the unconsolidated Quaternary deposits probably is relatively good. Somewhat poorer quality water may be expected in the underlying Tertiary deposits, although locally the quality may range from about as good as that in the unconsolidated Quaternary deposits to decidedly inferior.

INTRODUCTION

The development of ground water in Nevada has shown a substantial increase in recent years. Part of this increase is due to the effort to bring new land into cultivation. The increasing interest in ground-water development has created a substantial demand for information of ground-water resources throughout the State.

Recognizing this need, the State legislators enacted special legislation (Chapt. 181, Stats. 1960) for beginning a series of reconnaissance studies of the ground-water resources of Nevada. As provided in the legislation, these studies are being made by the U.S. Geological Survey in cooperation with the Nevada Department of Conservation and Natural Resources.

Interest in ground-water resources currently includes many areas and is extending to additional areas almost continuously. Thus, the emphasis of the studies under this special legislation is to provide as quickly as possible a general appraisal of the ground-water resources in particular valleys or areas where information is urgently needed. For this reason each reconnaissance study is limited severely in time, the field work for each area generally averaging about 2 weeks.

The Department of Conservation and Natural Resources has established a special report series to expedite publication of the results of these reconnaissance studies. Figure 1 shows the areas for which reports have been published in this series. The present report is the eighth in the reconnaissance series. It describes the physical conditions of Independence Valley and includes observations of the interrelation of climate, geology, and hydrology as they affect ground-water resources. It also includes a preliminary estimate of the average annual discharge from the ground-water reservoir.

The investigation was made under the administrative supervision of Omar J. Loeltz, district engineer in charge of ground-water studies in Nevada. The writer wishes to acknowledge his appreciation to personnel of the district office for constructive discussions and review, relative to this report, all of which have been most helpful.

Location and General Features:

Independence Valley, in western Elko County, lies within an area enclosed by lat 41°07' and 41°34' N. and long. 115°58' and 116° 19' W. It is the Independence Valley in which Tuscarora is located, northwest of Elko, and should not be confused with the Independence Valley in eastcentral Elko County, east and southeast of the town of Wells. The valley is about 32 miles long, and about 20 miles wide in maximum dimension between drainage divides. The long axis of the valley trends about north-northeast. The drainage area as defined is about 350 square miles.

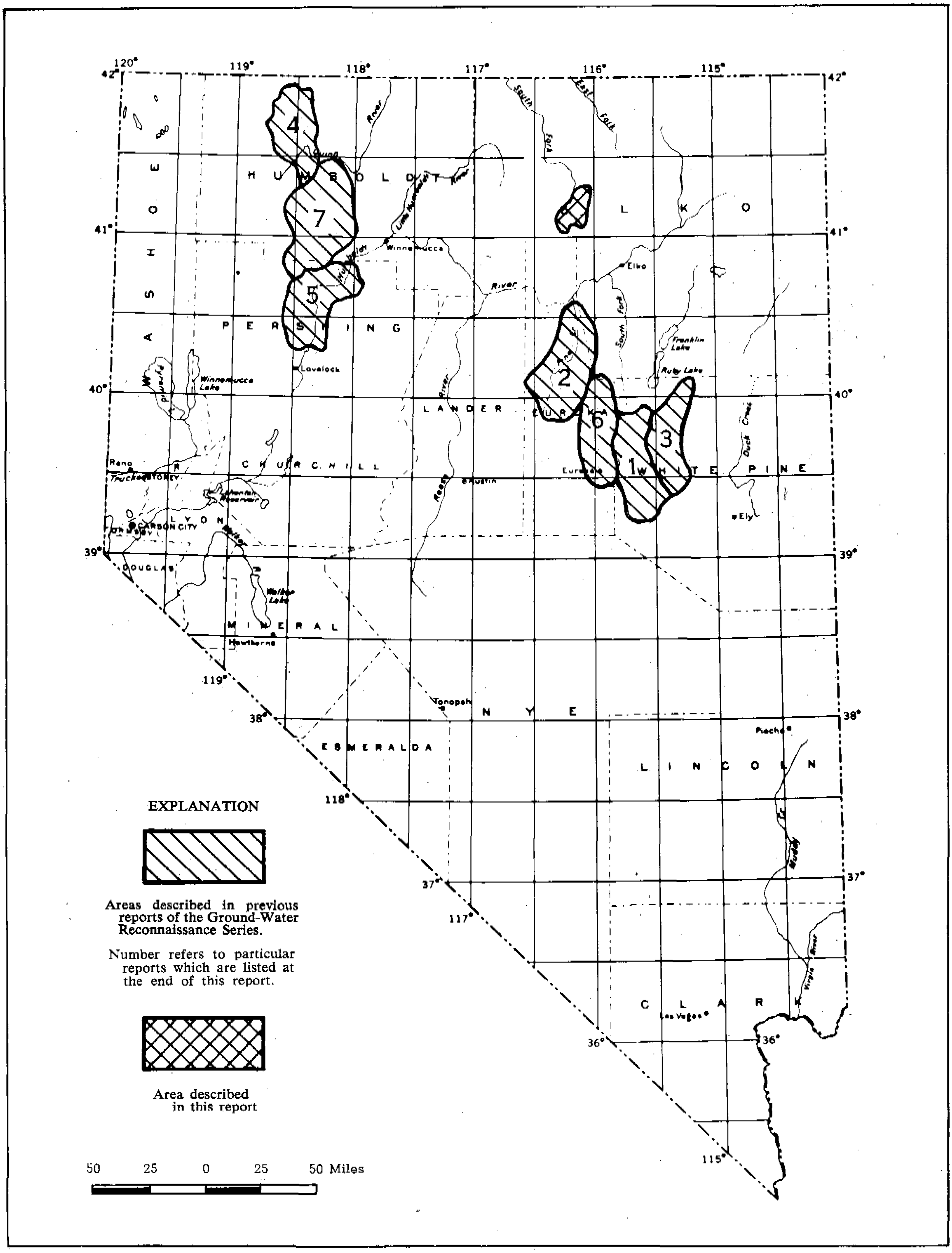


Figure 1.—Map of Nevada showing areas described in previous reports of the Ground-Water Reconnaissance Series and in this report.

The South Fork of the Owyhee River drains the valley through a gap in the northwest side (Photograph 2). The lowest part of the valley, at the gap, is about 5,550 feet above sea level. The crests of the Independence Mountains on the east side of the valley commonly are higher than 8,000 feet above sea level, and Jack Peak, altitude of 10,198 feet, is the highest point.

Principal access to the valley is from the southeast through Taylor Canyon, by State Highway 11. The old mining town of Tuscarora is about 52 miles northwest of Elko. State Highway 11 traverses the east side of the valley and is paved to a point beyond the northern drainage divide of the valley. Two gravel roads connect Tuscarora with State Highway 11. A gravel road links Tuscarora with Midas about 42 miles to the southwest. Trails or unimproved roads provide access to various points in the valley during good weather.

The economy of Independence Valley is based principally on livestock. Extensive development of irrigated meadow provides winter feed for cattle.

Tuscarora, which currently has a small population, was the center of considerable mining activity. Early mineral production was from placer deposits, but lode mining provided most of the total output of ore. The district yielded silver, gold, lead, and copper, and quicksilver. The estimated total value of silver and gold produced from 1867 to 1950 was about 10.7 million dollars, of which silver accounted for about 7.3 million dollars and gold for about 3.5 million dollars. Production of other minerals was very small.

Climate:

The climate of north-central Nevada is characterized by low precipitation and humidity and high summer temperatures and rates of evaporation. Precipitation is very irregular in areal distribution but generally is least on the floors of the valleys and greatest in the highest parts of the mountains. Winter precipitation generally occurs as snow. Summer precipitation usually occurs as localized showers. Both daily and seasonal variations in temperature are large. The growing season is relatively short.

Records of precipitation in Independence Valley have been maintained for many years, and are published by the U.S. Weather Bureau. The observations of precipitation formerly were made at Williams Ranch, about 9 miles northeast of Tuscarora, but was changed to Tuscarora in 1961. The ranch, now owned by Charles Van Norman, is on the east side of the valley in the SE 1/4 sec. 24, T. 40 N., R. 52 E., and is about 300 feet above the floor of the valley. For comparison, table 1 lists data for both the Tuscarora and Elko stations.

Table 1.--Summary of precipitation at Elko and Tuscarora, Nev.

1a.--Mean monthly and annual precipitation, in inches (1931-60)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Elko	1.16	.89	.83	.82	.96	.71	.40	.30	.34	.75	.88	1.01	9.05
Tuscarora	1.75	1.40	1.30	1.34	1.58	1.13	.37	.29	.55	1.16	1.19	1.41	13.47

1b.--Annual precipitation, in inches (1931-60)

Year	Elko	Tuscarora	Year	Elko	Tuscarora	Year	Elko	Tuscarora
1931	6.07	8.34	1941	16.24	17.93	1951	7.97	a--
1932	12.23	16.80	1942	12.23	14.21	1952	7.28	17.26
1933	6.65	9.30	1943	9.56	a--	1953	7.04	10.50
1934	6.72	11.94	1944	9.57	13.61	1954	6.58	a--
1935	8.23	13.96	1945	12.62	19.35	1955	9.52	13.16
1936	10.52	13.78	1946	10.18	14.48	1956	10.04	13.05
1937	7.10	a--	1947	7.23	12.96	1957	10.10	a--
1938	9.83	a--	1948	7.49	12.09	1958	6.40	11.73
1939	7.78	12.85	1949	7.10	14.05	1959	5.51	9.90
1940	10.76	14.64	1950	14.60	13.04	1960	7.84	12.87

a. Record incomplete.

Table 1a lists the average monthly and annual precipitation of the two stations for the period 1931-60. Table 1b lists the annual precipitation for complete years for the same period. During the 30-year period, the maximum recorded annual precipitation in the valley was 19.35 inches in 1945, and the minimum was 8.34 inches in 1931. During the period 1951-60, annual precipitation for Elko has been below average in 8 of 10 years and for Tuscarora in 4 of the 6 years for which annual precipitation is given.

Observations of temperature were begun in the valley in 1958. Table 2 lists the mean monthly and annual temperature. A maximum temperature of 98°F was recorded on August 15, 1958, and July 19, 1960. A minimum temperature of -12°F was recorded on January 4, 1959.

Table 2.--Mean monthly temperature, in degrees Fahrenheit, at Tuscarora, Nev. 1958-60

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1958	--	--	--	--	--	--	--	70.1 m	57.8	50.8	36.6	36.5	--
1959	30.0	27.5	34.6 m	45.4	45.2 m	61.4 m	69.6	64.4 m	52.4	47.3	37.4	28.6	45.3
1960	22.8	23.4	36.3	41.9	48.3 m	61.9 m	70.7 m	63.5	59.7	45.4 m	34.3	27.3	44.7

m- Less than a complete month of record available.

Freeze data are published by the U.S. Weather Bureau. The dates are listed for the last spring minimum and the first fall minimum by the following temperature groups: 32°F or below, 28°F or below, 24°F or below, 20°F or below, and 16°F or below. Also published by the Weather Bureau is the number of days between the last spring minimum and the first fall minimum for each temperature group. The following tabulation shows the number of days for four of the temperature groups for the calendar years 1959-60 as recorded at Williams Ranch.

	Number of days between temperatures of:			
	32°F or below	28°F or below	24°F or below	20°F or below
1959	72	109	148	148
1960	63	63	141	166

Houston (1950, p. 12, 13, 16) lists the average growing season for Upper Salmon Falls Creek, Upper Owyhee River, and Upper Humboldt River areas as follows:

Area	Average at	Growing season (days)	Dates	Latitude	Altitude (ft. above sea level)
Upper Salmon Falls Creek	San Jacinto	81	June 10 to Aug. 30	42°	5,200
Upper Owyhee River	Owyhee	90	June 4 to Sept. 2	42°	5,400
Upper Humboldt River	Elko	103	June 1 to Sept. 12	41°	5,100

The higher altitude of the floor of Independence Valley suggests that the average growing season probably is less than that at Elko and may be on the order of the average growing season at San Jacinto and Owyhee.

Physiography and Drainage:

Independence Valley is drained through a gap in its northwest side and is the headwater area of the South Fork of the Owyhee River, a tributary of the Snake River. Jack Creek, which drains the northern part of the valley, is the principal tributary in the valley.

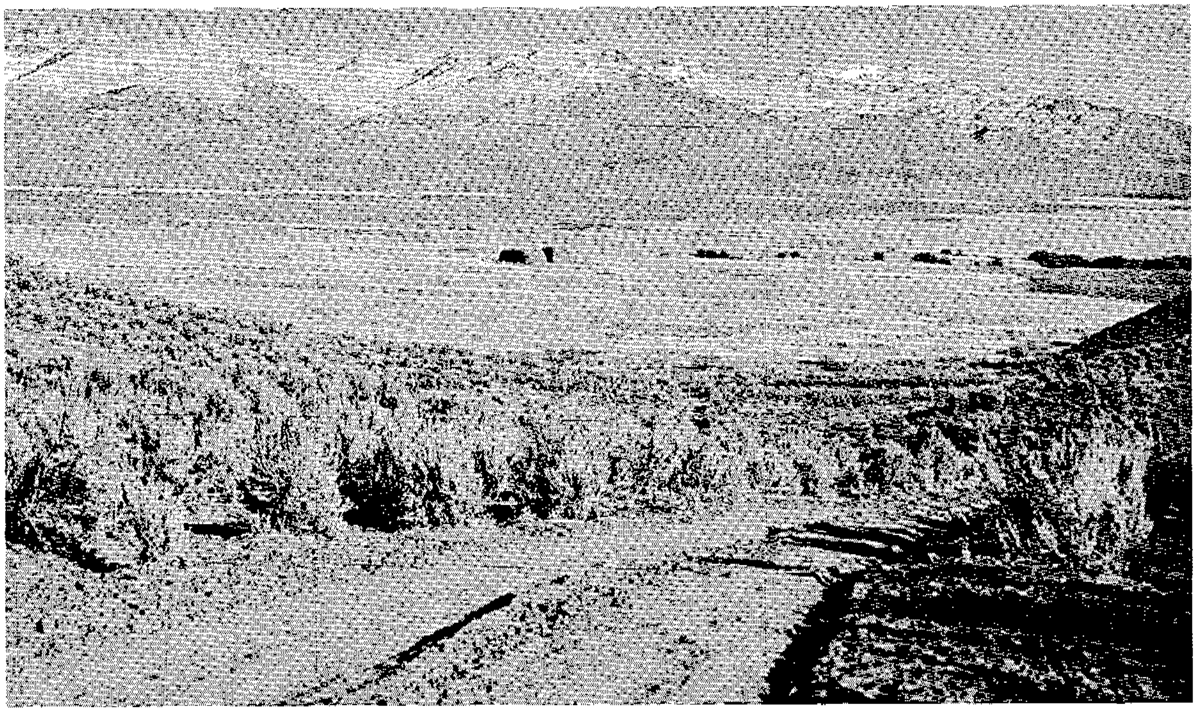
The gradient of the valley floor along the South Fork of the Owyhee River is 10 to 12 feet per mile near the gap and increases to 20 to 25 feet per mile in the latitude of Tuscarora. Elsewhere, valley gradients are steeper, with slopes commonly between 50 to 100 feet per mile.

The mountain areas are characterized by steep slopes and relatively steep, incised canyons (Photographs 3 and 4). Generally, the northern end of the Independence Mountains are more rugged than the other mountain areas.

Streamflow Records:

Streamflow has been measured at three stations in Independence Valley. The South Fork of the Owyhee River was gaged from June to October in 1913 at a point in sec. 28, T. 40 N., R. 52 E. Jack Creek was gaged from June 1913 to June 1925 at a point in sec. 35, T. 42 N., R. 52 E.

The mean monthly and annual discharge in cfs (cubic feet per second) and annual runoff in acre-feet of Jack Creek for the period of record is given in table 3, and is based on published records of the U. S. Geological Survey (1956, p.297).



Photograph 3. View north-northeast toward Jack Peak area of Independence Mountains from hill one-half mile north of the gaging station on the South Fork of the Owyhee River. Irrigated meadows in middle distance receive water principally from Jack Creek. The meadows are part of the Spanish Ranch, owned by the Ellison Ranching Co.

Photograph 4. View east-southwest to south-central part of the Independence Mountains from a point near "pole-line" road crossing of the South Fork of the Owyhee River. Canyon of Burnt Creek is in left center middle distance; canyon of Smith Creek is in right center middle distance; Wheeler Mountain is high point of skyline on right. Williams (formerly) Ranch is at mouth of Burnt Creek, and C. Van Norman Ranch is at mouth of Smith Creek.

The drainage area of Jack Creek above the gaging station is about 31 square miles. For the period of record the discharge averaged 31.1 cfs. The unit rate of runoff of about 1 cfs per square mile is relatively large for most streams in Nevada.

In August 1959, a gaging station was established on the South Fork of the Owyhee River at the outlet from the valley in sec. 19, T. 41 N., R. 52 E. Daily records for the 1960 and 1961 water years are listed in table 4. This station is favorably located for obtaining data for hydrologic studies.

Table 3.--Mean monthly and yearly discharge, in cubic feet per second, and annual runoff, in acre-feet, of Jack Creek near Tuscarora, Nevada, 1913-25.

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Year cfs.	Year Acre-feet
1913	--	--	--	--	--	--	--	--	62.8	16.4	18.4	3.71	--	--
1914	5.72	7.57	6.5	7.5	6.59	43.0	153	151	99.8	21.6	4.19	3.45	42.5	30,800
1915	10.1	6.60	3.29	2.00	3.73	13.7	52.5	98.1	85.9	18.3	2.65	2.51	25.0	18,100
1916	5.22	6.07	6.46	4.53	9.52	30.2	51.1	64.4	88.3	28.4	5.04	2.76	25.9	18,800
1917	5.22	5.90	4.48	3.12	4.69	6.08	90.2	191	170	27.7	3.60	1.57	44.6	32,200
1918	2.00	2.37	3.23	4.26	5.68	18.5	45.0	68.5	71.2	6.7	1.90	1.8	19.1	13,800
1919	4.10	4.13	3.77	3.00	3.00	14.4	84.8	109	53.0	6.29	2.77	3.17	24.3	17,600
1920	5.90	7.60	4.81	6.45	8.28	10.7	45.2	138	80.5	20.7	2.06	2.17	27.8	20,100
1921	5.5	11.6	9.3	8.9	24.4	54.3	127	257	173	35.1	6.8	2.2	59.7	43,200
1922	2.9	3.3	3.6	1.9	2.5	7.4	54.7	174	150	20.2	5.9	3.4	35.9	26,000
1923	2.9	4.0	5.0	3.5	4.3	7.0	39.0	65.5	84.5	25.5	2.2	2.6	20.5	14,800
1924	7.2	7.1	5	5	8	10.6	64.3	68.3	14.5	2.8	1.2	1.2	16.3	11,800
1925	3.2	5.0	5.1	5.2	11.6	29.5	86.3	123	62.4	--	--	--	--	--

Table 4a.--Daily discharge, in cubic feet per second, of South Fork of the Owyhee River at Spanish Ranch, near Tuscarora, Nevada, for the year ending September 30, 1960.

(unpublished records, subject to revision.)

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	16	17	15		17	20	83	41	33	17	29	3.0
2	15	17	15		17	21	74	59	40	17	22	3.0
3	15	17	15		16	27	73	74	67	19	20	3.4
4	15	16	15		17	21	78	69	83	19	19	3.8
5	15	15			17	20	74	51	86	19	17	3.6
6	15	16			16	23	88	41	86	19	16	3.6
7	15	16			18	49	99	42	88	18	14	3.4
8	15	15			41	80	99	43	90	20	13	3.0
9	16	15			29	60	91	40	92	27	12	3.0
10	16	15			22	43	88	39	84	28	12	3.0
11	16	15			20	34	99	38	67	28	11	3.0
12	16	15			19	43	102	58	56	25	10	3.0
13	16	14			18	66	83	94	48	22	9.0	3.0
14	16	15			18	47	64	117	47	21	8.6	2.8
15	16	15	14	16	19	43	58	110	48	20	8.2	2.8
16	16	14			17	37	54	96	42	17	7.9	3.0
17	16	14			16	46	49	88	34	15	7.9	3.0
18	16	14			16	68	44	122	36	14	6.6	2.8
19	16	15			16	88	72	117	34	14	5.7	2.8
20	16	15			16	102	50	79	28	19	5.4	2.6
21	16	15			16	103	36	116	29	20	5.1	3.0
22	16	15			16	112	46	110	29	20	5.7	3.2
23	16	16			18	109	68	95	26	20	6.0	3.6
24	16	15			21	105	79	99	24	20	5.1	4.3
25	16	15			19	98	70	73	23	20	4.6	5.4
26	16	14			19	86	59	56	22	20	4.1	5.4
27	16	15			18	77	63	47	21	21	3.8	6.0
28	16	16			18	92	60	44	20	23	3.6	6.6
29	17	15			19	69	53	39	20	23	3.6	6.6
30	17	15				72	45	36	20	23	3.6	7.0
31	16					72		34		23	3.4	
	491	456	438	496	549	1933	2101	2167	1423	631	302.9	112.7
Mean	15.8	15.2	14.1	16	18.9	62.4	70.0	69.9	47.4	20.4	9.77	3.76
Acre-Feet	974	904	869	984	1090	3830	4170	4300	2820	1250	601	224

Max. disch., 158 cfs May 21

Year Mean 30.3
Acre-Feet 22,020

Table 4b. --Daily discharge, in cubic feet per second, of South Fork of the Owyhee River at Spanish Ranch, near Tuscarora, Nevada, for the year ending September 30, 1961.

(unpublished records, subject to revision)

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	7.0	15	17		17	24	32	14	42	7.9	12	1.0
2	7.0	17	18		17	25	30	14	52	9.0	11	1.0
3	7.0	19	17		17	25	29	14	109	12	5.7	1.2
4	7.3	18	18	>9	17	25	23	15	138	23	5.1	1.3
5	7.6	17			19	25	19	19	79	25	5.4	1.3
6	7.6	19			20	25	15	24	49	22	7.6	1.3
7	7.9	23	>16		23	25	11	39	34	21	7.9	1.1
8	8.2	20			20	27	11	26	26	17	7.0	.7
9	9.8	19			21	28	12	18	22	15	4.8	.8
10	13	18		>12	27	25	12	14	25	14	3.8	1.9
11	23	20			27	26	13	14	42	13	3.6	1.9
12	17	24			23	25	14	23	43	12	4.6	1.5
13	15	23	>15		20	30	14	23	31	13	5.1	1.6
14	14	21			22	34	9.8	18	22	13	4.6	1.6
15	14	20			23	31	9.8	35	17	13	4.6	1.5
16	14	20	18	>15	23	30	12	28	14	14	4.3	1.8
17	14	22	16		21	30	13	22	13	16	3.8	1.9
18	15	25	15		19	33	9.4	17	12	16	3.6	6.2
19	14	22		17	23	34	7.6	14	10	20	2.2	13
20	14	21		18	22	30	7.9	13	10	23	2.1	12
21	14	21		18	25	28	8.6	15	9.4	23	1.8	11
22	15	19	>13	17	25	29	11	16	8.6	23	.7	12
23	15	19		16	23	35	12	16	9.0	23	1.0	12
24	15	19		16	23	32	16	14	9.8	22	1.6	12
25	15	19		17	23	31	17	13	13	20	1.6	12
26	15	17		18	24	30	15	10	8.2	17	1.5	12
27	15	17		16	22	31	14	11	7.6	17	1.2	11
28	15	17	>10	14	25	32	14	14	6.6	15	1.2	11
29	15	16		15		40	14	15	6.0	14	1.0	11
30	15	17		16		42	13	46	6.3	13	.8	11
31	15			17		37		38		12	1.2	
	400.4	584	441	425	611	924	439.1	612	874.5	517.9	122.4	169.6
Mean	12.9	19.5	14.2	13.7	21.8	29.8	14.6	19.7	29.2	16.7	3.95	5.6
Acre-feet	794	1160	875	843	1210	1830	871	1210	1730	1030	243	336

Year Mean 16.8
Ac. Ft. 12,130

GENERAL GEOLOGY

Detailed geologic studies in the area are not available. However, some general studies have been made. Emmons (1910) made reconnaissance observations in and adjacent to a number of mining districts in Elko and other counties. Nolan (1936) reported on the Tuscarora mining district (Photograph 5). Granger, Bell, Simmons, and Lee (1957) in their reconnaissance of the geology and mineral resources of Elko County reported some observations of the geology in the vicinity of Independence Valley. Independence Valley may be divided into two principal areas on the basis of topography and occurrence of water as shown on plate 1. Consolidated rocks of Tertiary age and older are exposed in the mountains; the valley is underlain by unconsolidated deposits of Quaternary age near the surface and by the older consolidated rocks of the mountains at depth.

Consolidated Bedrock of the Mountains:

The consolidated bedrock includes rocks of Paleozoic and Tertiary age. The Paleozoic rocks include dark cherty shale in the vicinity of Taylor Canyon, according to Granger and others (1957, p. 8). They assigned these rocks by the western facies of Paleozoic rocks which Ferguson (1952) described as containing a large proportion of metamorphosed volcanic rock, chert and slate, graywacke, and impure quartzite. Whether the full range of rock types of the western facies is represented in the Independence Mountains is not known. Nolan (1936, p. 17, 18) reported an outcrop of dark quartzite and chert in the vicinity of Tuscarora. He inferred that these rocks are of Carboniferous (?) age. Their character is suggestive of types that occur in the western facies of Paleozoic rocks.

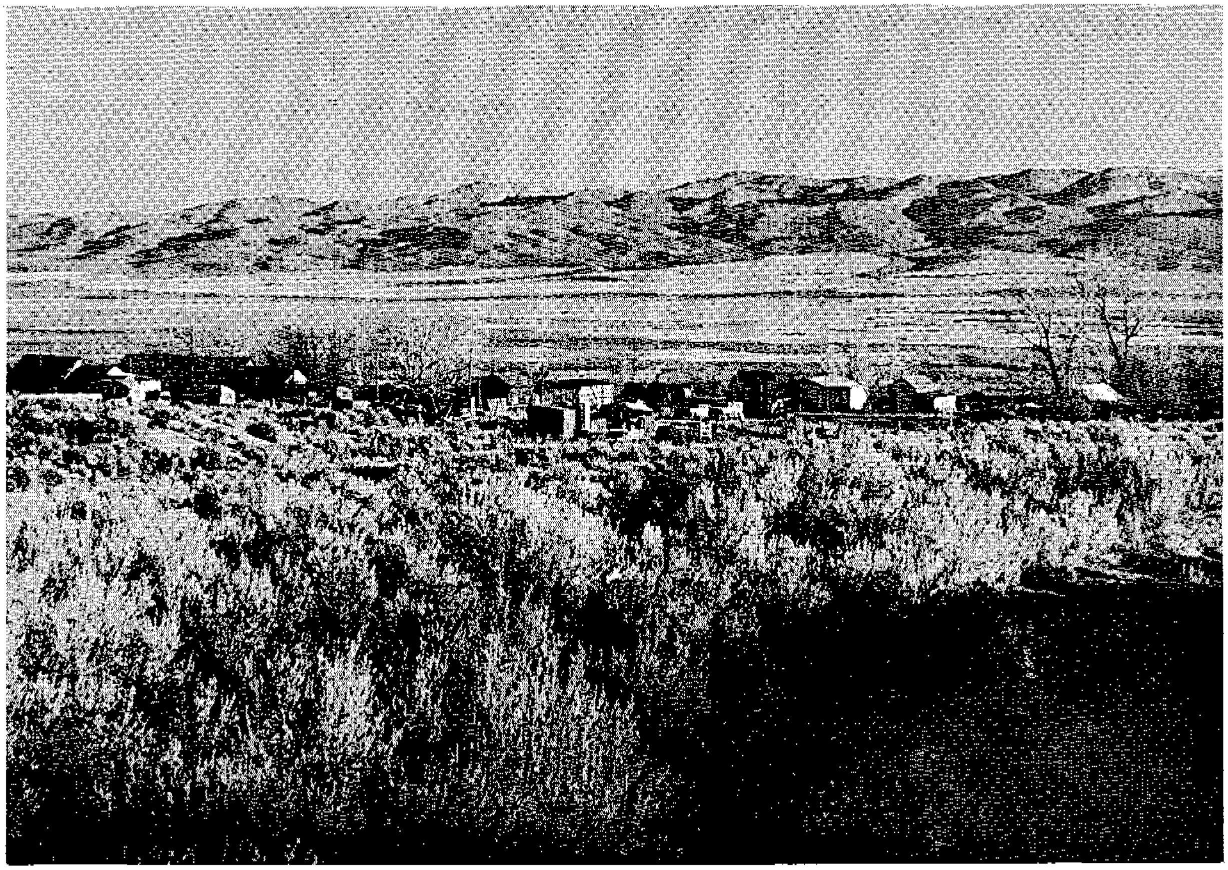
Rocks apparently of Tertiary age, exposed in the Tuscarora Mountains, include intrusive andesite and bedded lavas and associated pyroclastics, according to Nolan (1936, p. 18-21). Similar rocks also occur in the Independence Mountains.

Valley Fill:

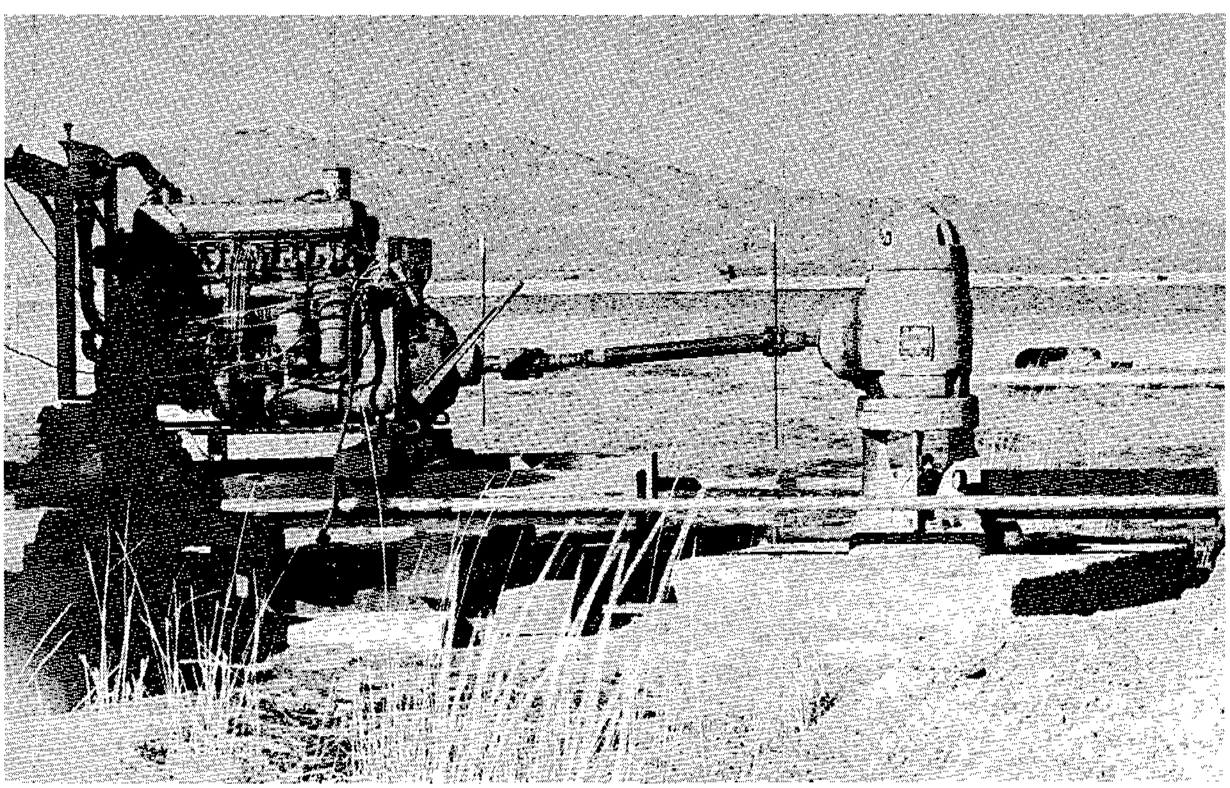
The valley fill includes unconsolidated clay, sand, and gravel of probable Quaternary age and underlying lava and other pyroclastic rocks of probable Tertiary age. Probably some sand and gravel is associated with the Tertiary rocks.

The thickness of the unconsolidated Quaternary deposits is unknown, but the maximum may be no more than a few hundred feet. Nolan (1936, p. 16) reports that gravel (or unconsolidated deposits) 20 feet or more thick overlies bedrock along the margin of the valley fill in the southeastern part of the Tuscarora mining district.

The rocks of probable Tertiary age are discussed in this report with the valley fill where they underlie alluvium because the intergranular open spaces are generally saturated with ground water. In the mountains, similar lavas and pyroclastic rocks are not saturated because of their topographic position. The



Photograph 5. View southeast across southern part of Independence Valley toward southern part of the Independence Mountains from point on hill northwest of Tuscarora. Buildings of Tuscarora in foreground.



Photograph 6. Irrigation well 39/51–26bbl, owned by Willis Packer. View northwest, Tuscarora Mountains in background.

consolidated rock that forms the floor of the valley is dense and impermeable and probably would yield little water to wells.

Water-Bearing Properties of the Rocks:

The character of the Paleozoic rocks that have been reported in Independence Valley indicates that they have relatively low permeabilities and that movement of ground water through them would be limited largely to fractures.

The Tertiary lavas probably also transmit ground water to a limited extent through fractures or broken tops and bottoms of individual flows. Associated pyroclastic rocks probably have low permeability also, but where saturated, such as they are beneath the lower part of the valley, they may store a substantial amount of ground water.

Numerous springs in the mountain areas attest to the fact that ground water is transmitted through bedrock. Many are only small seeps, but others contribute to or maintain the low flow of streams. Petaini Springs, near the mouth of Jerritt Canyon, are relatively large. The discharge rate reportedly is stable and the water is warm. The observed flow in the southwestern part of sec. 6, T. 40 N., R. 53 E., was estimated to be between 3 and 4 cfs. Reportedly, considerable loss occurs between the springs and the entrance to the pond where the flow was observed. Hot Springs in the northeast quarter of sec. 8, T. 41 N., R. 52 E., reportedly discharge 2 to 3 cfs. The flow in a ditch and in the natural channel about 2 miles below the springs was estimated to be between 1 and 1 1/2 cfs.

The unconsolidated clay, sand, and gravel of Quaternary age, where saturated, contains a considerable amount of ground water in storage. The clean sand and gravel lenses are capable of transmitting ground water rather freely.

Well 39/52-4ad1 was drilled to a reported depth of 430 feet, apparently largely or entirely in deposits of Quaternary age. It was tested at the reported rate of 1,500 gpm with a drawdown of 34 feet. The indicated specific capacity of about 44 gpm per foot of drawdown is the largest known of any well in the valley. Well 39/51-11bc1 was drilled to a reported depth of 860 feet. The driller's log suggests that the well penetrates Tertiary lava and pyroclastic rocks for most of its depth. Reportedly, a bailer test indicated a yield of 250 gpm with a drawdown of 15 feet. This would be equivalent to a specific capacity of about 17 gpm per foot of drawdown. However, under present use, it is reported that a continuous pumping rate of about 300 gpm results in the pump breaking suction in about 2 days. Although the depth of the pump intake was not reported, it would seem that the sustained specific capacity is much less than that suggested by the bailer test. Most of the yield of this well likely comes from unconsolidated gravel between depths of 25 and 35 feet rather than from the Tertiary rocks. The limited information available on well yields suggests that the Tertiary rocks of the valley fill generally yield less water to wells than the unconsolidated deposits of Quaternary age, at least in the areas tested to date.

GROUND-WATER APPRAISAL

General Conditions:

Ground water in Independence Valley is presumed to originate largely or entirely from precipitation within the drainage basin. Precipitation on the flanks of the mountains is the source of most of the ground water in the valley fill. In part, precipitation seeps into the bedrock and then moves through fractures into the valley fill, from whence it is eventually discharged from springs or as underflow. Part of the precipitation runs off and collects in streams which flow from the mountains, either perennially or seasonally. Some of the streamflow seeps into the unconsolidated deposits of the valley fill. This recharge is further augmented by irrigation diversions from the streams. The water so diverted covers large areas that are favorable for recharge. To some extent precipitation on the valley probably also contributes some recharge to the ground-water reservoir.

Ground water is stored only temporarily in the upper part of the valley fill from which it moves slowly to areas of discharge. Where ground water is near the land surface, it is discharged by evapotranspiration. It also is discharged by seepage to the South Fork of the Owyhee River and minor tributaries in the lower part of the valley, and to a minor extent by underflow in the alluvial deposits which underlie the canyon through which South Fork discharges from the valley. Most of the water discharged by wells and springs finally leaves the valley as evapotranspiration or as a contribution to the streamflow from the valley.

Generally the ground-water reservoir is maintained naturally at a full or nearly full stage. Thus any temporary increases of stored water resulting from recharge tend to be dissipated relatively quickly by increased evapotranspiration and increased seepage to the South Fork of the Owyhee River. The rapid dissipation of excess stored water is possible because of the shallow depth of the water table throughout much of the area in the lower part of the valley. The water table generally is less than 10 feet and commonly only a few feet below land surface adjacent to the South Fork of the Owyhee River through most of its course in Independence Valley.

Because of the near-full condition of the ground-water reservoir in many parts of Independence Valley, it seems likely that the natural average annual recharge to ground water from precipitation is much less than the potential average annual recharge from this source. For this reason an estimate of average annual recharge from precipitation, as derived in previous reports of this Reconnaissance Series, would not be meaningful and therefore was not made in this report. Rather, an estimate of ground-water discharge was made to indicate the probable magnitude of water annually entering and leaving the ground-water reservoir under nearly natural conditions.

Estimated Average Annual Discharge:

The principal area of potential evapotranspiration of ground water includes about 18,000 acres of irrigated meadow, as shown on the Tuscarora quadrangle of the Northeastern Nevada Cooperative Land-Use Studies (1941?) and made by the Soil Conservation Service. The average requirement of water for irrigation for pasture in Independence Valley may be similar to the 1 foot requirement listed by Houston (1950, p. 22) for the Upper Owyhee River. If this is correct, then the average amount of water consumed by the irrigated meadow would be about 18,000 acre-feet in addition to that supplied directly by precipitation. However, the proportional amounts of surface water and ground water that make up the estimated 18,000 acre-feet required cannot be determined without extensive investigation. In most of the irrigated meadow the ground-water level is no more than a few feet below land surface. Capillary action probably discharges water from the ground-water reservoir, thereby providing water for the meadow grasses. Data are not available to determine, with precision, the amount of surface water applied for irrigation. It would seem that under average conditions most of the irrigation water requirement is, in fact, supplied by surface water, and only a small fraction, tentatively estimated at no more than 2,000 or 3,000 acre-feet, is from ground water. Precise determination of the actual amount of ground water currently used by irrigated pasture vegetation may be impractical because of the extremely close and complex interrelationship between surface and ground water in the valley.

Ground-water discharge by evapotranspiration of vegetation other than pasture and meadows seemingly is small and perhaps is not more than 1,000 or 2,000 acre-feet per year, based on acreage, distribution and average depth to water table.

The ground-water contribution to streamflow from the valley is estimated as follows. It should be recognized that this estimate is based on only 2 years of record for the Owyhee station and prior period for the Jack Creek station. As such it is only a rough estimate at best, although 3 antecedent years of deficient precipitation may result in a more reliable value than would ordinarily be expected for a short period of record. In a later section of this report a special investigation is proposed that would provide good control data for an improved estimate of ground-water discharge to the South Fork of the Owyhee River.

Streamflow for the period October to January, inclusive, (1960 water year) averaged about 15 cfs at the South Fork gaging station. Preliminary analysis of the record for the 1961 water year suggests an average discharge of nearly 15 cfs for the same 4-month period. The flow of Jack Creek at the former gaging station site averaged about 5 cfs during October through January for the 12-year period of record 1914-25. For the same period in the 1960 and 1961 water years, it may be assumed that the flow of Jack Creek at the former gaging site probably did not average more than about 5 cfs. As streamflow losses between the two gaging station sites and direct streamflow from other potential tributaries probably were negligible during the 4-month period, then about 5 cfs represents the surface-water contribution to the 15 cfs average flow at the South Fork gaging station during the October-January period of the 1960 and 1961 water years.

This would indicate that the ground-water contribution was on the order of 10 cfs.

This analysis suggests that ground-water contributes about 10 cfs during periods of low flow when evapotranspiration and irrigation requirements are at a minimum. The reduced ground-water contribution during the summer period, when total streamflow is reduced because of evapotranspiration, is probably offset by increased ground-water contribution during the late winter and spring periods when the total streamflow is greater than during the October to January period. On this basis it is assumed that ground-water discharge as streamflow from Independence Valley provisionally is about 7,000 acre-feet per year.

In summary, the total annual ground-water discharge from Independence Valley may be on the order of 10,000 acre-feet under existing conditions. This total is represented by the estimates of about 2,000 acre-feet per year of ground-water discharge by evapotranspiration in irrigated meadow areas, about 1,000 acre-feet per year of evapotranspiration by phreatophyte vegetation other than irrigated meadow, and about 7,000 acre-feet a year by ground-water contribution to streamflow.

Perennial Yield:

The perennial yield of the ground-water system is ultimately limited by the average annual recharge and discharge into and out of the system. It is the upper limit of the amount of water that can be withdrawn for an indefinite period of time from a ground-water system without permanent depletion. The average recharge from precipitation and streams and the average discharge by evapotranspiration, discharge to streams, and underflow from a valley are measures of the natural inflow to and outflow from the ground-water system.

In an estimate of perennial yield, consideration should be given to the effects that ground-water development by wells may have on the natural circulation of the ground-water system. Development by wells may, or may not, induce recharge in addition to that received under natural conditions. Part of the water discharged by wells may re-enter the ground-water reservoir by downward percolation, especially if the water is used for irrigation.

Ground water discharged by wells theoretically should be offset eventually by a reduction of the natural discharge. In practice, however, it is difficult for well discharge to offset fully the natural discharge, it occurs only when the water table has been lowered to a level that eliminates both underground outflow and evapotranspiration in the area of natural discharge. The numerous pertinent factors are so complex that specific determination of perennial yield of a valley requires a very extensive investigation based in part on data that can be obtained economically only after there has been substantial development of ground water for several years.

As an initial guide for ground-water development of Independence Valley, the preliminary estimate of ground-water discharge of 10,000 acre-feet per year, previously discussed, may be used. Thus, the estimate of discharge as determined in this reconnaissance is also considered the preliminary estimate of the minimum yield of Independence Valley. The crude data and assumed values used in the estimate make it apparent that the minimum yield of the ground-water system may be several thousand acre-feet a year more or less than this estimate. Large ground-water withdrawals by wells probably would change the present ground-water regimen. By lowering water levels, additional ground-water recharge would be induced from rainfall and streamflow, which now are locally rejected. If ground-water withdrawals were sufficiently large and extensively distributed in areas where natural losses now occur, the potential yield would be increased accordingly. Eventually, when most of the natural losses were salvaged by pumping, the net draft on the ground-water system would be about equal to the perennial yield. It might be considerably larger than the minimum yield estimated above.

Storage:

A large amount of ground water is stored in the valley fill in Independence Valley. It is many times the annual ground-water recharge and discharge. Some concept of the magnitude of the ground water in storage may be obtained by the following calculation: The area of the valley fill lying below the 5,800-foot land-surface contour in the central part of the valley is on the order of 30,000 acres. If it is assumed that the valley fill is saturated beneath about 25,000 acres of this area, and if a value of 10 percent is assumed as the specific yield (drainable pore space) of the saturated fill, then about 2,500 acre-feet of ground water is theoretically stored in each saturated foot of thickness of valley fill. This is equivalent to about 25 percent of the estimated average annual ground-water discharge under natural conditions. On this basis the amount of ground water in storage in a 100-foot thick section of the valley fill, for the area cited, would be equal to about 250,000 acre-feet, or 25 times the natural annual discharge from the ground-water reservoir.

In addition to the water in the valley fill, an unknown amount of ground water is stored in the bedrock. The water so stored provides a reserve for maintaining an adequate supply for pumping during protracted periods of drought or for limited periods of high demand under emergency conditions. This reserve further increases the reliability of ground water as a dependable source of irrigation supply and is an important asset in semiarid regions where surface-water supplies are limited and widely variable from year to year.

Quality:

The chemical quality of ground water in interior valleys generally varies considerably as the water moves through the ground-water system. In general, the concentration of dissolved chemical constituents is low in the areas of recharge. As the water moves through the ground it comes in contact with rock materials that have different solubilities. The extent to which the water dissolves chemical constituents from the rock materials is governed in large part by the solubility, volume, and distribution of the different rock materials, the chemical character of the recharge, the time the water is in contact with the rocks, and the temperature and pressure in the ground-water system. In the areas of natural discharge the ground water is evaporated or transpired--processes which tend to concentrate dissolved chemical constituents in the remaining ground water.

The streams and springs have been used to irrigate meadow grasses for many years, apparently with no adverse effect due to the chemical quality of the water. The water of Hot Creek Springs reportedly is of poor quality for irrigation, but has been used with some success when mixed with other water.

Water from well 40/52-26ad1 has been used for supplemental irrigation of alfalfa for two seasons and with good results.

Table 5 lists chemical analyses of water from a well, a glory hole, and a spring, all near Tuscarora. The chemical quality of the water from the well is the best of the three samples.

Table 5.--Chemical analyses of selected samples of water from the vicinity of Tuscarora, Independence Valley, Nev.

	Sample Location	Glory hole 39/51-3aa1	Spring 39/51-10aa1	Well 40/52-29da1
	Date collected	10-27-48	6-27-56	10-27-48
	Specific conductance (Micromhos at 25°C)	729	1,450	329
	Dissolved solids in ppm	479	1,160	221
Constituents	Silica (SiO_2)	24	34	39
	Iron (Fe)	.07	0	.07
	Calcium (Ca)	74	242	29
	Magnesium (Mg)	27	43	7.5
	Sodium (Na)	47	44	30
	Potassium (K)	--	16	--
	Carbonate (CO_3)	--	--	--
	Bicarbonate (HCO_3)	220	272	132
	Sulfate (SO_4)	170	635	31
	Chloride (Cl)	28	14	19
	Fluoride (F)	.4	.5	.3
	Nitrate (NO_3)	.5	.4	.4
	Boron (B)	.01	--	.01
Hardness as $CaCO_3$	Total	296	781	103
	Noncarbonate	115	558	--
	Percent sodium	25	11	39
	pH	7.7	8.1	7.8

Based on the general pattern of ground-water circulation, the chemical quality of the ground water in the unconsolidated Quaternary deposits probably is relatively good. The analysis of the water from the spring suggests that it is similar to ground water moving through the mineralized volcanic rocks of the Tuscarora mining district. The water from the glory hole is more dilute than the spring water, because it may be mixing with water of lower concentration or because it may be circulating faster through restricted parts of the mineralized volcanic rocks and thus dissolving fewer minerals.

The chemical character of ground-water in the volcanic and pyroclastic Tertiary rocks in the valley fill was not determined.

Because the chemical quality of ground-water commonly varies considerably from place to place, and with depth within the valley where data are available in Nevada, it would be desirable to have chemical analyses made of the water from new wells drilled for irrigation, stock, and domestic use.

Development:

Springs and rising ground water have been used for irrigation of meadow grasses for many years. This ground water represents a substantial part of the water used for irrigation, especially late in the irrigation season. A relatively small amount of ground water has been used for stock and domestic supplies. The town of Tuscarora obtains its water through a 10- to 12-mile pipeline from Water Pipe Canyon, a tributary of Taylor Canyon in the Independence Mountains.

During the past 2 seasons, Charles Van Norman has pumped well 40/52-26ad1 to provide water for supplemental irrigation on fields just below his home ranch. The yield of this well reportedly was 950 gpm with a drawdown of about 60 feet. Recently he tested well 39/52-4ad1. The well reportedly was pumped at about 1,500 gpm with a drawdown of 34 feet; it probably will be used also for supplemental irrigation.

Well 39/52-9cc1 on the Quarter Circle S Ranch, owned by Simco, Inc., reportedly was tested at 600 to 700 gpm with a drawdown of 40 feet. Well 39/51-26bb1, owned by Willis Packer, reportedly yielded several hundred gallons per minute (Photograph 6). Well 39/51-11bc1, owned by Simco, Inc., reportedly can pump only about 2 days at a rate of about 300 gpm before breaking suction.

These are the only wells that have been used for irrigation in the valley. All are being used in conjunction with sprinkler systems. Except well 39/51-11bc1, all are used for supplemental water supply.

Total pumpage during the past year was small, probably no more than 200 acre-feet, but interest is increasing in the use of ground water for supplemental irrigation. If deficient precipitation and streamflow continue another year or two, most certainly interest in ground-water development will be further stimulated, especially in the drier southern half of the valley.

PROPOSED ADDITIONAL GROUND-WATER STUDY

In accordance with the request made by Mr. Hugh A. Shamberger, Director, Department of Conservation and Natural Resources, State of Nevada, the suggested special study listed below is one of a group of proposals made during the course of these reconnaissance investigations to obtain needed basic data and a better understanding of the factors that influence and control ground water in Independence Valley and similar areas in Nevada. These proposed studies are separate from the standard areal investigations that commonly are needed after the development of ground water in an area becomes substantial.

An investigation is needed to determine quantitatively the interrelation of ground water and surface water in Independence Valley. The investigation would seek to estimate that part of the tributary streamflow from the mountain areas that recharges the ground-water reservoir in the valley fill, and that part of the ground water rising in the lower parts of the valley that contributes to the streamflow from Independence Valley.

Further, the proposed study would define the reaches where stream losses and gains occur, and would estimate the amounts of losses to and gains from ground water in time and place. The investigation would require several supplemental stream-gaging stations, a number of observation wells, and temporary precipitation gages. It would provide accurate data to describe the components of the water regimen and permit a reliable interpretation of the system.

The general character of the surface-water and ground-water system in Independence Valley is similar in greater or lesser degree to a number of other valleys in northern Nevada, which are part of the Snake River system, and also to several of the valleys in the Upper Humboldt River basin above Palisade.

DESIGNATION OF WELLS

The wells in this report are designated by a single numbering system. The number assigned to the well is both an identification number and a location number. It is referenced to the Mount Diablo base line and meridian established by the General Land Office.

A typical number usually consists of three units. The first unit is the township north of the Mount Diablo base line. The second unit, a number separated by a slant line from the first, is the range east of the Mount 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 one or two lower case letters, the first of which designates the quarter section, the second, the quarter-quarter section, and finally, a number designating the order in which the well was recorded in the smallest subdivision of the section. The letters a, b, c, and d designate, respectively, the northeast, northwest, southwest and southeast quarters and quarter-quarters of the section. For example, well number 40/52-26ad1 indicates the first well recorded in the southeast quarter of the northeast quarter of sec. 26, T. 40 N., R. 52 E.

Owing to the small scale of the map, wells on plate 1 are identified only by the section number, quarter section and quarter-quarter section letters and serial number. The township in which the well is located can be ascertained by the township and range numbers shown at the margins of plate 1.

Wells listed in table 6 are shown on plate 1.

Table 6.--Records of selected wells in Independence Valley, Nev.

39/51-9ca1. Owner, Simco, Inc. Drilled stock and domestic well; casing diameter 16 inches; depth 620 feet. Depth to water below land surface reported as 10 feet, July 4, 1952. Driller's log:

Material	Thickness (feet)	Depth (feet)
Surface	3	3
Sand and cobblestones	17	20
Volcanic tuff	80	100
Basalt, medium hard	120	220
Basalt, very hard	65	285
Basalt, softer	115	400
Clay, blue - water	6	406
Basalt	94	500
Basalt, medium hard	100	600
Andesite	20	620
Total depth		620

39/51-9cb1. Owner, Simco, Inc. Altitude 5,990 feet. Dug stock well; casing diameter 4 feet; depth 15 feet. Measuring point, north edge of cribbing, which is 0.2 foot above land surface. Depth to water below land surface 6.92 feet, August 18, 1948.

39/51-11bc1. Owner, Simco, Inc. Drilled irrigation well; casing diameter 12 inches; depth 860 feet. Casing perforated 20 to 460 feet with 6 3/16- by 3-inch perforations at 2-foot intervals. Tested by bailer at 250 gpm with a drawdown of 15 feet. Temperature of water reported as 68°F. Depth to water below land surface reported as 3 feet, April 28, 1952. Driller's terminology and log:

Material	Thickness (feet)	Depth (feet)
Surface	5	5
Sandy clay	10	15
Yellow clay	10	25
Water gravel	10	35
Yellow clay	10	45
Monzonite	15	60
Yellow clay	20	80
Monzonite	5	85
Brown hard clay (heaving)	25	110
Red sticky clay (heaving)	55	165
Gray clay	15	180
Monzonite	15	195
Rock	3	198
Sticky brown clay (heaving)	12	210
Monzonite	30	240
Rock	4	244
Yellow clay	6	250
Brown clay (heaving)	40	290
Yellow clay (soft)	35	325
Sandy brown clay	5	330
Sticky brown clay	20	350
Monzonite (brown)	10	360
Mineral ore	35	395
Blue shale	55	450
Gray rock	19	469
Yellow clay	8	477
Blue basalt	2	479
Monzonite	3	482
Conglomerate	38	520
Blue shale	55	575
Brown sandy clay and gravel	90	665
Gray shale	15	680
Rock and gravel	4	684
Gray clay	16	700
Volcanic ash	5	705
Brown monzonite	70	775
Gray clay and gravel	20	795
Brown clay	10	805
Gray clay	25	830
Volcanic gray tuff	10	840
Green shale	20	860
Total depth		860

39/51-11dd1. Owner, Simco, Inc. Dug abandoned well; diameter 3 by 4 feet; depth 10 feet. Measuring point, top of 2-inch by 12-inch plank, which is 0.4 foot above land surface. Depth to water below land surface, 4.64 feet, August 20, 1948.

39/51-13da1. Owner, Simco, Inc. Dug stock well; casing diameter 48 inches; depth 17.5 feet. Equipped with centrifugal pump and internal combustion engine. Measuring point, top of board well cover at land surface. Depth to water below land surface 7.03 feet, August 19, 1948; 7.84 feet, September 7, 1949.

39/51-25ab1. Owner, Willis Packer. Dug unused well; depth 8 feet. Equipped with lift and hand pump. Measuring point, top of 12-inch galvanized iron casing in center of 12-foot diameter well, which is 0.2 foot above land surface. Depth to water below land surface, 6.15 feet, August 20, 1948; 7.80 feet, October 27, 1948.

39/51-26bb1. Owner, Willis Packer. Drilled irrigation well; casing diameter 16 inches; depth 430 feet. Equipped with diesel pump and turbine engine. Depth to water reported as 3 feet, November 6, 1961. Driller's log:

Material	Thickness (feet)	Depth (feet)
Top soil - water	6	6
Clay and gravel	49	55
Clay, gray	6	61
Gravel and sand	9	70
Clay, sandy	15	85
Gravel, large	30	115
Clay	27	142
Gravel - water	14	156
Clay, sandy	35	191
Gravel - water	17	208
Clay, brown	31	239
Gravel - water	4	243
Clay, brown	42	285
Clay, sticky, blue	5	290
Gravel - water	5	295
Clay, blue	10	305
Gravel, large	11	316
Clay, blue	24	340
Sand	6	346
Clay, green	15	361
Sand and gravel	9	370
Clay, sticky	10	380
Sand and gravel	6	386
Clay	14	400
Sand and gravel	8	408
Clay, brown	22	430
	Total depth	430

39/52-3cd1. Owner, State Highway Department. Drilled domestic well; casing diameter 6 inches; depth 172 feet. Casing perforated 139 to 170ft. with 1/8- by 6-inch perforations. Test bailed 18 gpm, with a drawdown of 4 feet. Depth to water below land surface reported as 118 feet, December 18, 1958. Driller's log:

Material	Thickness (feet)	Depth (feet)
Boulders, gravel, and yellow clay mixed	50	50
Clay, yellow	12	62
Gravel	11	73
Clay, yellow	7	80
Gravel and clay mixed	59	139
Gravel	13	152
Sand and clay mixed	4	156
Sand and gravel	16	172
Total depth		172

39/52-4aa1. Owner, Charles Van Norman. Drilled stock well; casing diameter 4 inches; depth 148 feet. Casing perforated 76 to 145 feet with 1/8- by 6-inch perforations. Test bailed at 12 gpm with a drawdown of 20 feet. Depth to water below land surface reported as 30 feet, September 6, 1949. Driller's log:

Material	Thickness (feet)	Depth (feet)
Clay and gravel	32	32
Gravel	4	36
Clay	12	48
Clay and gravel mixed	12	60
Clay	10	70
Gravel	2	72
Clay	6	78
Gravel	6	84
Clay	22	106
Gravel	5	111
Clay	8	119
Clay and gravel mixed	29	148
Total depth		148

39/52-4ad1. Owner, Charles Van Norman. Drilled irrigation well; casing diameter 16 inches; depth 430 feet. Casing perforated 41 to 194 feet. Test pumped at 1500 gpm with a drawdown of 34 feet after seven hours of pumping. Measuring point, top of 16-inch casing which is 0.5 feet above land surface. Depth to water below land surface reported as 41 feet, September 22, 1961; measured, 44.91 feet, November 8, 1961. Driller's log:

Material	Thickness (feet)	Depth (feet)
Top soil	6	6
Boulders, small; and gravel	6	12
Clay, brown	5	17
Gravel, clay and rocks	73	90
Clay, brown, tough	20	110
Clay, brown, soft	24	134
Clay, hard; and gravel	10	144
Clay, brown, soft	134	278
Gravel, coarse, tight	4	282
Clay, brown	58	340
Clay, brown, sandy	90	430
	Total depth	430

39/52-7db1. Owner, Willis Packer. Drilled domestic and stock well; casing diameter 6 inches; depth 134 feet. Casing perforated 102 to 132 feet with 1/8- by 6-inch perforations. Test bailed at 16 gpm. Depth to water below land surface reported as 18 feet, July 4, 1949. Driller's log:

Material	Thickness (feet)	Depth (feet)
Clay, white	14	14
Clay, yellow, sandy	76	90
Gravel and clay mixed	22	112
Gravel	22	134
	Total depth	134

39/52-9cc1. Owner, Simco, Inc. Drilled irrigation well; casing diameter 16 3/4 inches; depth 297 feet. Casing perforated 32 to 203 feet with 1/4- by 3-inch perforations. Test pumped 600 to 700 gpm with a drawdown of 40 feet. Temperature of water reported as 60°F. Depth to water below land surface reported as 14 feet, December 4, 1951. Driller's terminology and log:

Material	Thickness (feet)	Depth (feet)
Top soil	5	5
Sandstone	10	15
Clay, yellow	19	34
Gravel, small, - water	3	37
Clay, yellow	26	63
Gravel - water	6	69
"Silicate", hard, black; and rock	6	75
Clay, yellow	20	95
Rock, gray	10	105
Clay, yellow	5	110
Gravel, large - water	15	125
Clay, yellow	10	135
"Monzonite", brown	5	140
"Monzonite", hard	28	168
Clay, hard	17	185
"Silicate", hard, black	5	190
"Monzonite"	10	200
Gravel, large - water	5	205
"Silicate", hard, black	19	224
"Monzonite"	3	227
Gravel, large - water	3	230
"Monzonite", hard; and gravel	53	283
Clay, yellow	10	293
Gravel, large - water	2	295
"Silicate", hard, black	2	297
	Total depth	297

40/51-25da1. Owner, Simco, Inc. Dug domestic and stock well; depth 57 feet. Temperature 49°F. Measuring point, top of board well cover which is 0.1 foot above land surface. Equipped with a lift and windmill. Depth to water below land surface; 37.12 feet, August 20, 1948, and 38.32 feet, November 8, 1961.

40/52-2cc1. Owner, Ellison Ranching Co. Drilled well; casing diameter 4 inches; depth 105 feet. Test bailed at 16 gpm with a drawdown of 4 feet. Casing perforated 85 to 102 feet with 1/8- by 5-inch perforations. Measuring point, top collar of 4-inch casing which is 0.5 foot above land surface. Depth to water below land surface reported as 20 feet, August 13, 1952; measured, 26.97 feet, November 8, 1961. Driller's log:

Material	Thickness (feet)	Depth (feet)
Clay, hard yellow	14	14
Gravel and sand	44	58
Clay, yellow	30	88
Gravel and sand	17	105
Total depth		105

40/52-8ba1. Owner, Ellison Ranching Co. Bored (?) domestic well; casing diameter 6 inches; depth 8 1/2 feet. Equipped with lift and hand power. Measuring point, top of 6-inch casing which is 1.2 feet above land surface. Depth to water below land surface, 4.76 feet, August 21, 1948.

40/52-26ad1. Owner, Charles Van Norman. Drilled irrigation well; casing diameter 16 inches; depth 290 feet. Casing perforated 127 to 204 feet with 1/4- by 2-inch perforations. Test pumped 950 gpm with a drawdown to 190 feet. Reported depth to water, 130 feet. Driller's log:

Material	Thickness (feet)	Depth (feet)
Boulders	18	18
Clay and rocks	109	127
Gravel, loose - water	12	139
Clay and gravel	6	145
Gravel and sand	9	154
Clay, brown, tough	20	174
Gravel and sand - water	30	204
Clay and rocks	74	278
Gravel, tight	12	290
Total depth		290

40/52-26bc1. Owner, Bureau of Land Management. Drilled stock well; casing diameter 6 inches; depth 120 feet. Casing perforated 80 to 120 feet, with 1/4- by 2-inch perforations. Depth to water below land surface reported as 63 feet, June, 1955. Driller's log:

Material	Thickness (feet)	Depth (feet)
Clay, brown	6	6
Boulders, small	4	10
Hardpan, gray	8	18
Clay, brown, and gravel	64	82
Gravel	5	87
Clay	5	92
Gravel	12	104
Clay	8	112
Gravel	8	120
	Total depth	120

40/52-27db1. Well dug by W.P.A. Diameter 3 by 4 feet. Measuring point, top of wood well cover which is 2.0 feet above land surface. Depth to water below land surface; 49.07 feet, July 14, 1948; 48.74 feet, August 21, 1948; 48.85 feet, October 27, 1948; 49.11 feet, November 29, 1948; 49.65 feet, January 29, 1949; 49.89 feet, March 1, 1949; 49.28 feet, September 8, 1949. Well destroyed.

40/52-29da1. Owner, W. F. Behn. Drilled domestic well; casing diameter 6 inches; depth 86 feet. Casing perforated 66 to 83 feet with 1/8- by 6-inch perforations. Test bailed at 16 gpm with a drawdown of 52 feet. Depth to water below land surface reported as 8 feet, July 22, 1948. Driller's log:

Material	Thickness (feet)	Depth (feet)
Clay	9	9
Sand	77	86
	Total depth	86

40/52-31ac1. Owner, not determined. Dug stock well; diameter 60 inches; depth 33 feet. Measuring point, top of wood timber sill on the east side which is 1.5 feet above land surface. Equipped with a windmill. Depth to water below land surface; 7.77 feet, July 14, 1948; 10.41 feet, September 8, 1949. Well caved.

40/52-32bb1. Owner, Don Williams. Dug unused well; depth 7.5 feet. Depth to water below land surface; 7.0 feet, August 21, 1948; 7.02 feet, August 10, 1950.

41/52-27dd1. Owner, Ellison Ranching Co. Drilled domestic well; casing diameter 3 inches; depth 120 feet. Equipped with jet pump and electric engine. Depth to water below land surface reported as 15 feet, August 18, 1950.

41/52-28aa1. Owner, Ellison Ranching Co. Drilled well for fire protection; casing diameter 6 inches; depth 123 feet. Casing perforated 17 to 120 feet with 1/4- by 5-inch perforations, one per foot, and perforated 242 to 284 feet with 1/8- by 4-inch perforations. Test bailed at 15 gpm with a drawdown of 15 feet. Reported depth to water below land surface; 2 feet, July 10, 1947; measured 8.76 feet, August 21, 1948; 13.21 feet, October 26, 1948; 6.39 feet, August 18, 1950; reported 50 feet, January 10, 1956. Driller's log:

Material	Thickness (feet)	Depth (feet)
Soil	2	2
Gravel	55	57
Gravel and clay	3	60
Gravel	63	123
Deepened in January, 1956		
Sand	22	152
Clay, yellow	52	204
Sand and gravel	24	228
Clay, yellow	4	232
Gravel	5	237
Clay, yellow	28	265
Gravel	20	285
Clay, yellow	3	288
Total depth		288

41/52-32dc1. Owner, Ellison Ranching Co. Drilled domestic well; casing diameter 4 inches; depth 33 feet. Casing perforated 22 to 30 feet with 3/16- by 5-inch perforations. Measuring point, top of 4-inch casing which is 1.0 foot above land surface. Depth to water below land surface, 2.03 feet, August 21, 1948. Driller's log:

Material	Thickness (feet)	Depth (feet)
Soil and clay	7	7
Sand and gravel	26	33
Total depth		33

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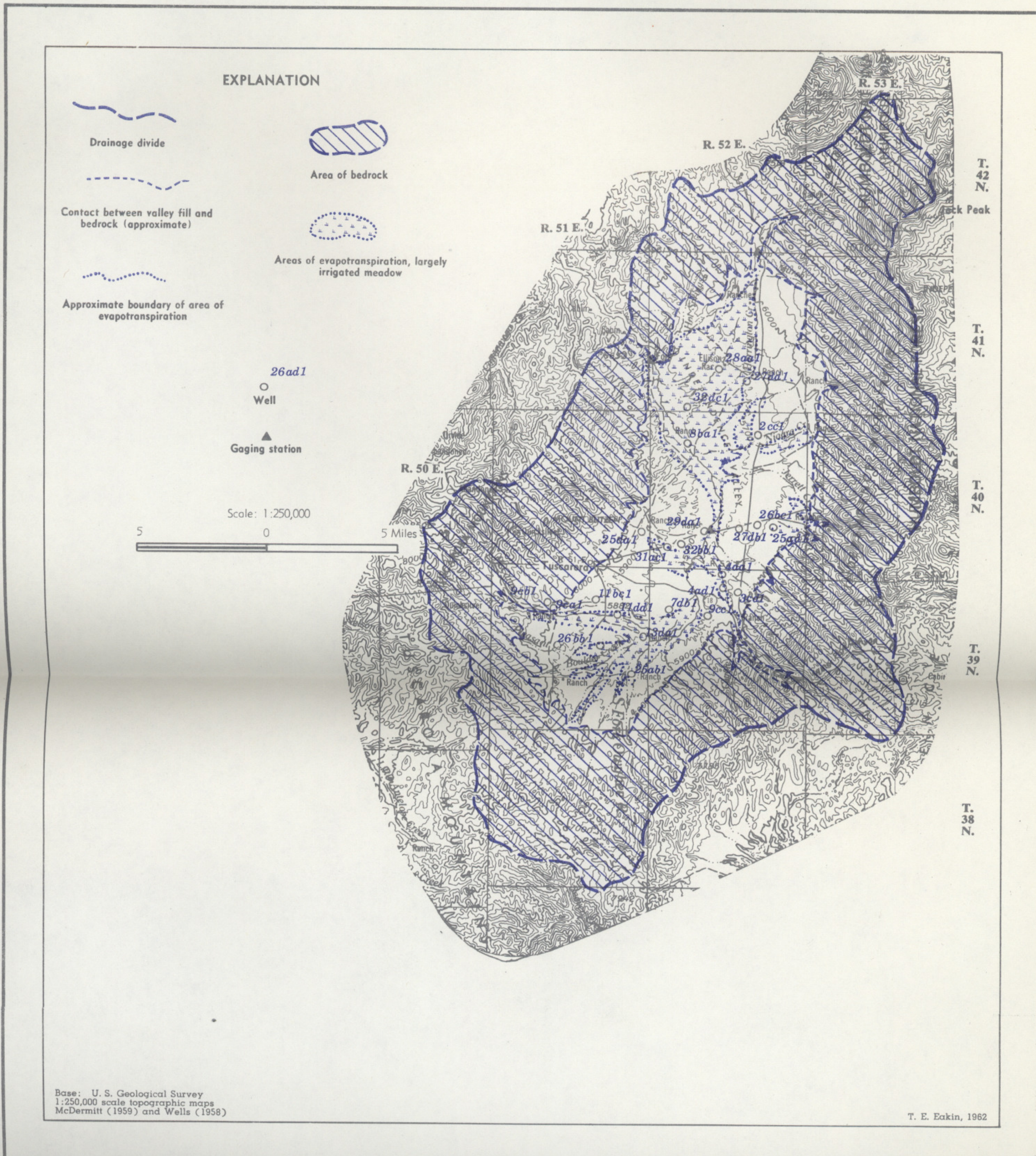

PLATE 1. MAP OF INDEPENDENCE VALLEY, WESTERN ELKO COUNTY, NEVADA

SHOWING AREAS OF BEDROCK, VALLEY FILL, AND EVAPOTRANSPIRATION, AND LOCATION OF SELECTED WELLS.