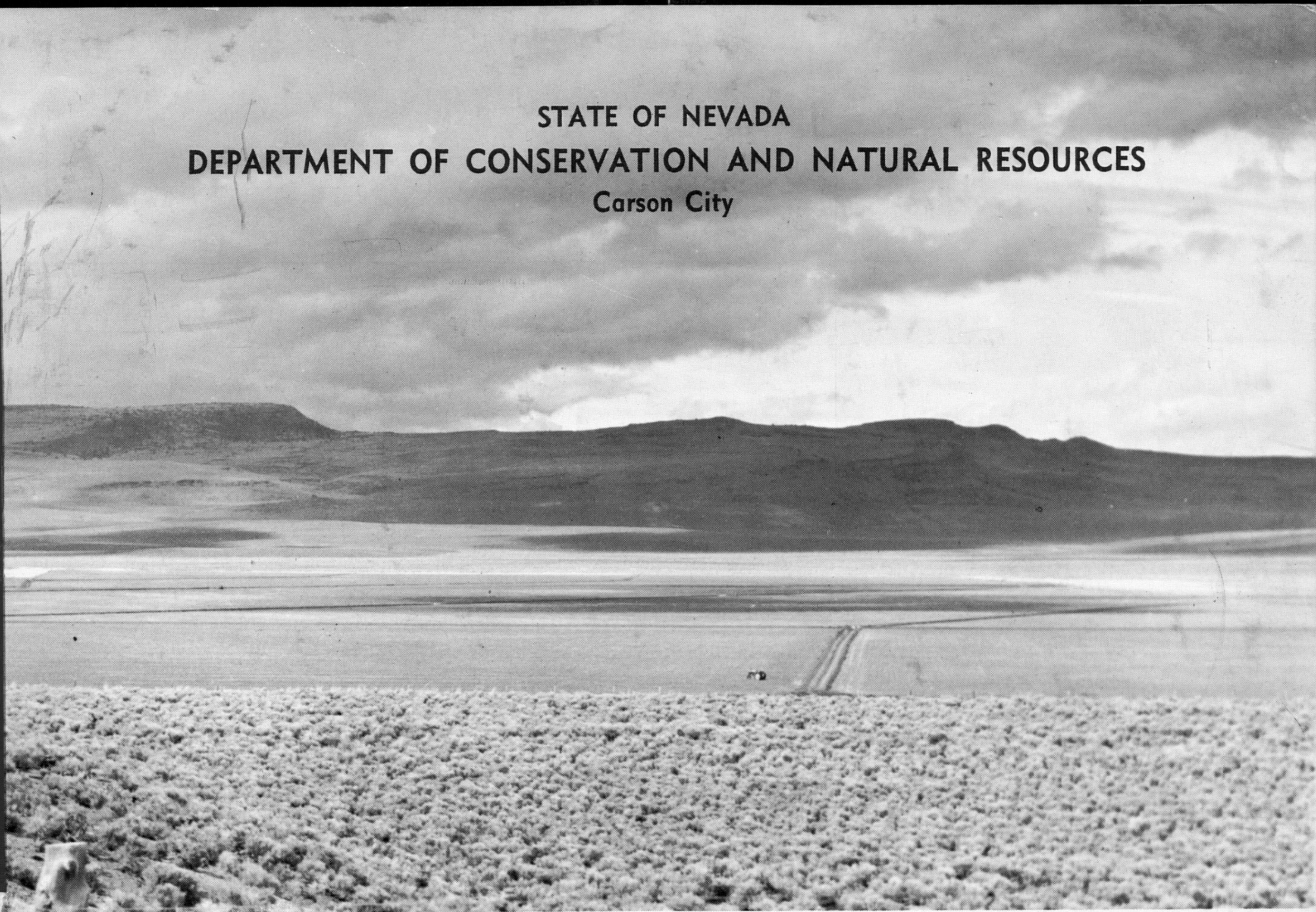
STATE OF NEVADA

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

Carson City



View north of State Route 81 in Duck Lake Valley. Cultivated fields irrigated by diversion from reservoir on Wall Creek.

GROUND-WATER RESOURCES – RECONNAISSANCE SERIES
REPORT 17

GROUND-WATER APPRAISAL OF DUCK LAKE VALLEY, WASHOE COUNTY, NEVADA

By

WILLIAM C. SINCLAIR

Geologist

With a section on

THE SOILS OF DUCK LAKE VALLEY

By

RICHARD L. MALCHOW

Soil Scientist

Prepared cooperatively by the

Geological Survey, U. S. Department of Interior

JUNE 1963

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FOREWORD

This is the 17th report in the series of reconnaissance ground-water studies which were initiated by action of the Legislature in 1960. In these seventeen reports, the ground-water resources of some twenty valleys have been appraised.

The present appraisal of the ground-water resources of Duck Lake Valley in Washoe County was made by William C. Sinclair, geologist, U. S. Geological Survey. A report on a reconnaissance survey of the soils of this area was contributed by Richard L. Malchow, Soil Scientist, Soil Conservation Service, U. S. Department of Agriculture.

These reconnaissance ground-water resources studies make available pertinent information of great value to many State and Federal agencies. As development takes place in any area, demands for more detailed information will arise and studies to supply such information will be undertaken. In the meantime these reconnaissance type studies are timely and adequately meet the immediate needs for information on the ground-water resources of the areas on which reports are prepared.

Hugh A. Shamberger
Director
Department of Conservation
and Natural Resources

July, 1963

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GROUND-WATER APPRAISAL OF DUCK LAKE VALLEY

WASHOE COUNTY, NEVADA

by
William C. Sinclair

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ABSTRACT

Duck Lake Valley is a small intermontane basin in northwestern Nevada, about 100 miles north of Reno. The climate is arid to semi-arid; precipitation ranges from less than 6 inches a year on the valley floor to about 15 inches in the surrounding mountains.

The bordering mountain blocks, composed principally of volcanic and sedimentary rocks, probably were uplifted early in the Pleistocene Epoch. Material eroded from the uplands has filled the basin with an unknown thickness of alluvial, lake, and stream deposits, which form the ground-water reservoir.

The ground-water reservoir is recharged by the infiltration of precipitation in the surrounding watershed. This reconnaissance suggests that the average annual discharge and recharge are within the range of 7,000 to 9,000 acre-feet per year, and the perennial yield is about 8,000 acre-feet. The amount of ground water stored in the upper few hundred feet of valley fill is estimated to be about 3,000 acre-feet per foot of thickness of saturated material.

Chemical analyses of five samples of water from wells in the valley suggest that the water may not be suitable for the irrigation of some crops. Further study of the quality of the ground water is advisable before any substantial development is undertaken.

INTRODUCTION

Purpose and Scope of the Investigation:

This report is the 17th in a series of reconnaissance studies of the valleys of Nevada. These studies are made by the U. S. Geological Survey in cooperation with the Department of Conservation and Natural Resources, State of Nevada, and are part of a statewide evaluation of the ground-water resources.

The purpose of this study is (1) to determine the nature and extent of the aquifers; (2) to determine the occurrence and movement of ground water, including the areas of recharge and discharge; (3) to determine the sources of recharge and to estimate the average annual recharge to the aquifers;

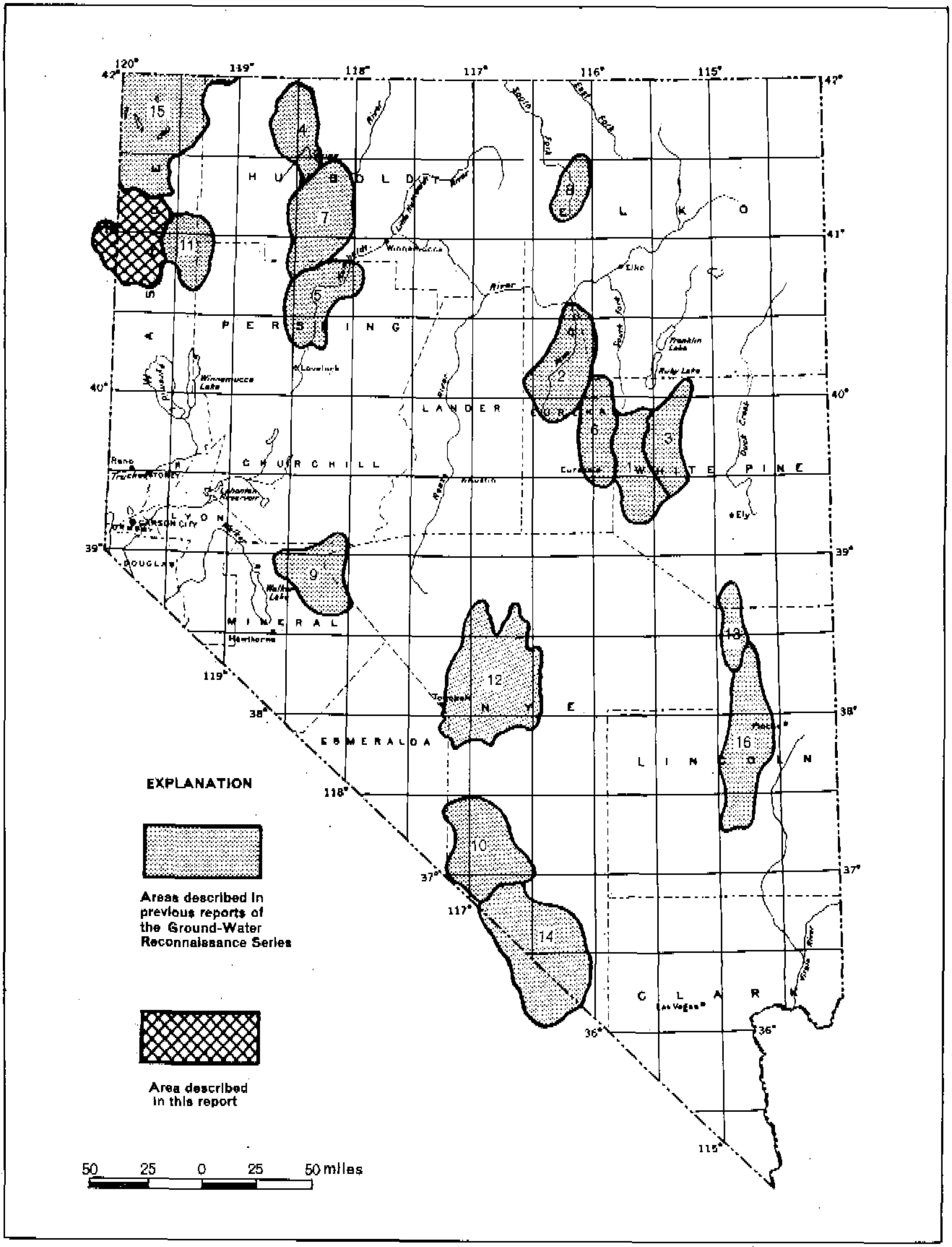

Figure 1. Map of Nevada showing areas described in previous reports of the ground-water reconnaissance series and the area described in this report

The location of wells and springs in the valley is shown on plate 1; the well data are in tables 1 and 2; and the results of chemical analyses of water from selected wells are compiled in table 3.

GEOGRAPHIC FEATURES

Mountains:

The mountains bordering Duck Lake Valley along the south and west sides rise abruptly from the valley floor, which is about 4,700 feet above sea level, to form plateaus 500 to 1,000 feet above the valley floor.

Near the southwest corner of Duck Flat the cliff bordering the west side of the valley is split by Tuledad Canyon, a narrow defile which broadens headward into an upland valley, about 50 square miles in extent, which lies largely in California. Hat Peak, at an altitude of 7,736 feet, is the highest point in the Tuledad Canyon watershed. Along the southern divide of Duck Lake Valley, the average altitude is just over 6,000 feet.

North of the valley the mountains rise more gently, although much of the country retains the "rimrock" aspect of abrupt cliffs capped by relatively flat mesas. Several peaks along the northern boundary of the drainage basin exceed 7,000 feet, the highest being Hays Canyon Peak at 7,892 feet. The highest point in the entire drainage basin is Fox Mountain, 8,222 feet, at the north end of Squaw Valley Summit, which borders the eastern side of Duck Lake Valley.

Piedmont Slopes and Valley Floor:

The lower mountain sides are buried under the products of weathering and erosion derived from the higher mountainous areas. The debris forms transitional slopes grading valleyward from the nearly vertical cliffs of some of the mountains to the level floor of the valley. The alluvium underlying these slopes is presumed to extend to considerable depth along the steep mountain fronts bordering the south and west sides of the valley. Along the northeast side the bedrock surface slopes more gently. Much of the area north of the main road, which is shown on plate 1 as alluvium, may be a veneer of unconsolidated material a few feet or tens of feet thick, mantling the bedrock.

The floor of Duck Lake Valley, locally called Duck Flat, is roughly triangular and covers an area of about 50 square miles. About 12 square miles of this is occupied by the bed of Duck Lake, which lies mainly in the southeast quarter of T. 37 N., R. 18 E.

Drainage:

The streams that drain the mountains surrounding Duck Flat are fed principally by storm runoff and snowmelt. Much of the flow, therefore, is ephemeral and occurs principally during the spring and early summer. As summer progresses, the snowpack in the mountains is depleted and the headwaters of the streams go dry. The small flow of the few perennial streams is insufficient to reach the valley floor, owing to seepage into the alluvium flanking the mountains and to losses by evaporation and transpiration. Perennial flow in the streams is thus limited to the middle reaches which are sustained by the discharge of ground water that has infiltrated the bedrock and alluvium farther upstream.

Under normal conditions of generally low precipitation, no runoff leaves Duck Lake Valley. Streamflow reaching the valley floor ponds and evaporates. However, during infrequent periods of above-average precipitation, runoff, principally from Wall Creek, flows northwestward through a narrow gorge into Surprise Valley (pl. 1).

Wall Creek drains about one-third of the total area tributary to Duck Flat and is nearly 20 miles long. The many springs and seeps in the upland region drained by Wall Creek maintain a perennial flow throughout most of its length. Under natural conditions Wall Creek discharges southward into Duck Lake through one distributary and northwestward into Surprise Valley through another. For many years past, however, the discharge to Duck Lake has been diverted to irrigate cultivated land and pasture in a part of Section 12, T. 37 N., R. 18 E. Thus deprived of its main source of water, Duck Lake has become extinct. The lakebed now supports a cover of weeds and grass, which is grazed by cattle and an occasional herd of antelope.

Several other lakes, locally called the Crater Lakes, lie atop the mesa south of the valley. These are not craters in the volcanic sense, but simply a number of broad, shallow depressions in the mesa surface which, during periods of above-average precipitation, contain water for short periods of time. During the late 1920's a number of settlers in the valley formed a company to build a ditch and utilize water from the lakes for irrigation. They were apparently unaware of the ephemeral nature of the lakes, however, and although the ditch was completed, it is doubtful whether any water was ever delivered to the valley floor.

Climate:

Rainfall in Nevada is controlled largely by the topography. As the eastward-moving airmasses are forced upward by the mountain ranges, the decrease in pressure and temperature causes precipitation. The high mountains of California intercept much of the moist air contained in the storms moving eastward from the Pacific Ocean; thus Nevada, lying in the rain shadow of these mountains, has a climate ranging from arid to semi-arid.

A U. S. Weather Bureau station was maintained intermittently from 1915 to 1934 at Zorro Vista Ranch, now abandoned, near the southeast corner of Duck Flat. Records for the 19 years show an average precipitation of 5.75 inches per year. The summer months of July, August, and September together averaged only 0.74 inch, or about 13% of the total for the year. Daily temperatures were recorded for 14 years, and ranged from a maximum monthly average of 66° in July to a minimum of 27° F. in January. The average date of the last killing frost in the spring was June 14 and of the first killing frost in the fall was August 28. The average period between killing frosts during the period of record was 75 days.

The rate of evaporation from a free water surface in the region is about 48 inches a year, according to Kohler, Nordenson, and Baker (1959, pl. 2). This rate of evaporation is roughly 8 times the annual precipitation on the valley floor.

THE SOILS OF DUCK LAKE VALLEY

by

Richard L. Malchow [1/]

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Duck Lake Valley may be divided, to simplify the discussion of its soils, into six kinds of general land areas.

1. The lowest part of the valley is Duck Flat, a broad, nearly level area subject to seasonal flooding. The soils are very deep, dark colored, and clayey throughout. Water moves downward through them at a slow rate. They are slightly saline-alkali in places. Under irrigation, these soils are best suited to permanent pasture. They are in the Grumusol or Humic Gley great soil groups.

2. Slightly higher are other nearly level areas dissected by shallow drainage channels. The soils are very deep, light colored, and moderately fine textured. Some have clayey subsoils high in alkali. With proper irrigation management and the use of soil conditioning measures, many of these soils could eventually be used for growing crops. These soils are in the Alluvial or Solonetz great soil groups.

3. Relatively young alluvial fans are situated along parts of both the northern and southern edges of the valley. Some are subject to damaging flash floods on occasion. Most of the soils are deep, light colored, and porous. They tend to be gravelly on the upper parts of the fan but become sandy or loamy on the lower parts. These soils are suited to irrigated crop production. They are in the Alluvial great soil group. Areas of soils similar to those on Duck Flat also occur along the northern edge of the valley.

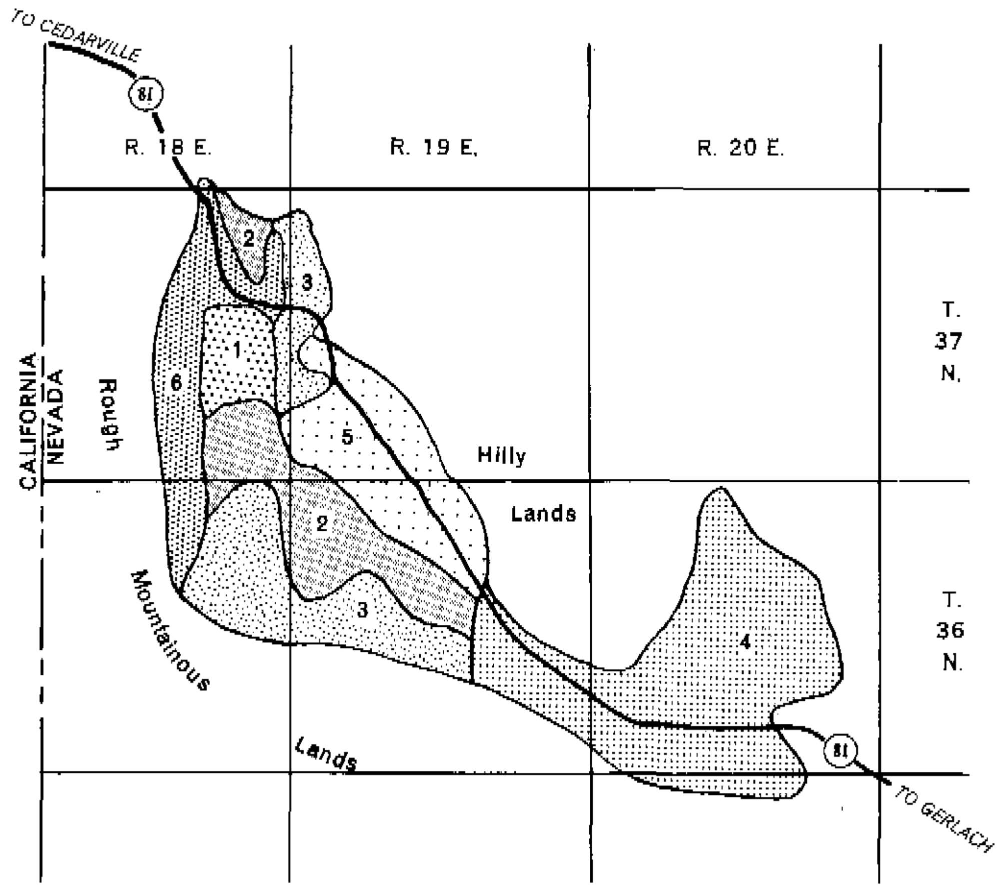
4. Older, stabilized, gently rolling alluvial fans occupy the southeastern end of the valley. The soils are deep, light colored and loamy, strata and stringers of gravel are common. A few saline-alkali spots also are found. The design of irrigation systems would be complicated by the complex relief and gravelly areas. However, most of these soils are suitable for cultivation if irrigated. The soils are in the Alluvial and Sierozem great soil groups.

5. The east-central part of the valley consists of very gently sloping lake terraces. The soils, in most cases, are underlain by sedimentary bedrock at very shallow depths and are not suited to irrigation and cultivation. These soils are in the Sierozem and Lithosol great soil groups.

1/ Soil Scientist, Soil Conservation Service,
U. S. Dept. of Agriculture.

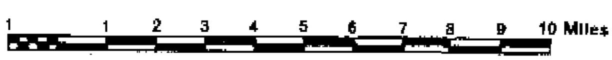
6. Moderate toe slopes and steep terrace escarpments are situated along the western edge of the valley. The soils are deep, have light colored surfaces, clayey subsoils, and silica-cemented hardpan within 12 to 20 inches of the surface. The combination of slope and hardpan would make efficient irrigation hard to achieve. These soils are in the Brown great soil group.

This resume of Duck Lake Valley soils is based upon limited soil investigation and mapping. The development of irrigation programs in this area should not be undertaken without further detailed study. A detailed study of the soils of Duck Lake Valley and the surrounding area is in progress. The results of this study will probably be available early in 1964.



EXPLANATION

1. Deep clayey soils.
2. Deep soils that are somewhat saline-alkali.
3. Deep porous soils.
4. Deep soils on gently rolling lands.
5. Very shallow soils .
6. Shallow to moderately deep soils on moderate slopes.



R. L. Malchow

Figure 2. Generalized soils map of Duck Lake Valley, Washoe County, Nevada

PREVIOUS INVESTIGATIONS

A brief memorandum report on the ground-water conditions in Duck Lake Valley was written in 1929 by O. E. Meinzer, who then was Chief, Ground Water Branch, U. S. Geological Survey. That memorandum, based on two days of field work in the valley, contains a brief description of the hydrologic conditions and a discussion of the prospects of developing irrigation supplies from wells. The pertinent results of his unpublished memorandum are incorporated in this report. The pluvial history of the valley is described by Hubbs and Miller (1948).

PHYSICAL CHARACTER AND WATER-BEARING PROPERTIES OF THE ROCKS

Geologic Setting:

Duck Lake Valley is a structural depression created by the vertical movement of large blocks of the earth's crust relative to one another. The present altitude of the valley floor, 4,700 feet, is the result of the relative downward movement modified by the subsequent partial filling of the basin by the erosional debris derived from the surrounding mountains. The maximum thickness of the valley fill is not known but may be in excess of 1,000 feet in the central part of the valley.

The Pleistocene Epoch, which is notable for extensive glaciation in other parts of the world, was attended by a series of lakes in many of the arid valleys of the Great Basin. In Duck Lake Valley, which was an embayment of the large Pleistocene lake in Surprise Valley, the many stages and fluctuations of the lake are recorded in the complexity of the sedimentary deposits that underlie the valley floor, and in the shoreline features that terrace the surrounding hillsides.

Bedrock:

Most of the rocks in the region are of volcanic origin; basalt and other fine-grained extrusives predominate. The basalts overlie and are interbedded with a sequence of Tertiary and Quaternary sedimentary rocks, principally sandstone, shale, diatomite, lacustrine deposits, and some water-laid tuff. The primary permeability of these rocks appears to be relatively low, and movement of ground water in them is largely through joints, fractures, and other secondary openings.

Although the total volume of water moving through bedrock may be quite large, the success of a well penetrating the bedrock is dependent on its tapping enough of the secondary water-bearing zones to yield the required amount of water. The chances of intercepting a sufficient number of water-bearing zones are generally so poor that the consolidated bedrock, whether in the mountains or buried beneath the valley fill, is not considered a potential source of ground-water supply.

Alluvium:

The alluvium is composed of rock debris eroded from the surrounding mountains. It consists of particles of all sizes, ranging from boulders to clay, generally occurring in a heterogeneous mass. The permeability of alluvium varies with the size and degree of sorting of the constituent particles. The texture of the source rock is also a controlling factor, and in most of Duck Lake Valley the fine-grained lucustrine deposits, which contribute erosional debris to the valley, result in an unusually large proportion of silt and clay in the alluvium.

The thickness of the alluvium ranges from a few feet around the margins of the valley to possibly as much as 1,000 feet toward the center. Along the northeast side of the valley, flanking the bedrock hills, it appears to be relatively thin. However, along the south and west sides, the steep bedrock slopes probably continue at their exposed angles well below the valley floor, and the alluvium may be thick, even near the edge of the valley.

Throughout much of the Pleistocene Epoch, the alluvium bordering the valley was reworked extensively by wave action in the lakes whose levels fluctuated in response to climatic changes. The winnowing action of the waves removed much of the fine material from the lake shores, leaving beaches and bars of well-sorted sand and gravel ringing the valley at several elevations, both above and below the present valley floor. In contrast, the central part of the valley is underlain principally by silt and clay deposited in the relatively still waters of the deep parts of the lakes. These thick clay and silt sections are separated by relatively thin layers and lenses of sand and gravel, which are principally stream deposits and reworked alluvium that accumulated during shallow stages of the lakes and periods of desiccation.

The lenses and layers of sand and gravel formed by wave action probably constitute the best aquifers in the valley. They probably are best developed along the western edge of the valley, where the steepness of the mountain front would have provided an abundant supply of rock debris for the development of sand and gravel beach deposits. Beach deposits accumulating on a steep slope, such as this, would present a thicker section of reworked alluvium and gravel to a vertical well than would similar deposits on a gentle slope, where the near-shore wave action would tend to move more in a horizontal direction with varying lake levels.

GROUND WATER

Occurrence and Movement:

Ground water moves from recharge areas in the mountains and alluvial slopes downgradient toward the central part of the valley where, under natural conditions, it is discharged by evaporation from springs and seeps and transpired by plants. Virtually no ground water moves through the canyon to Surprise Valley.

Most of the available ground water in Duck Lake Valley occurs in the unconsolidated deposits of the valley fill. Where the valley fill consists of fine-grained material such as silt and clay, or of poorly sorted alluvium, the permeability is low and only small yields can be expected from wells. In contrast, lenses of well-sorted sand and gravel have moderate to high permeabilities and will yield water readily to properly constructed wells.

Recharge:

The ultimate source of recharge to the ground-water reservoir of Duck Lake Valley is precipitation. Although the average annual precipitation is less than 6 inches on the valley floor (p. 5), precipitation increases with increasing altitude, as described by Hardman and Mason (1949), and the entire drainage basin can be subdivided into precipitation zones based on altitude, as tabulated below:

Altitude of precipitation zone (feet)	Area of precipitation zone (acres)	Average Annual precipitation Range (inches)	Average (feet)	Percent recharged	Estimated recharge (acre-feet per year)
Duck Lake Valley					
Above 6,500	33,000	12-15	1.12	7	2,600
5,000-6,000	253,000	8-12	.83	3	6,300
Below 5,000	69,200	less than 8	-	0	0
TOTALS	355,000				9,000
Surprise Valley (within Nevada, South of Hays Canyon)					
Above 6,500	1,600	12-15	1.12	7	125
5,000-6,500	14,800	8-12	.83	3	370
Below 5,000	11,100	less than 8	-	0	0
TOTALS	27,500				500

Only a small part of the total precipitation ever reaches the ground-water reservoir in the valley; most of it is transpired and evaporated. Part of the remainder runs off immediately and part infiltrates into the rocks of the mountain ranges and the alluvial fans, from which it eventually moves directly into the valley fill or comes to the surface along the stream courses and at springs. Further loss by evaporation and transpiration takes place along the stream courses.

The figures used in the above table for "percent recharged" were determined empirically by Eakin and others (1951) from studies in eastern Nevada. If these factors are valid in Duck Lake Valley, the total recharge to the ground-water reservoir is on the order of 9,000 acre-feet per year.

Recharge to the ground-water reservoir of Surprise Valley, in that part of the drainage basin within Nevada and south of Hays Canyon, is estimated to average about 500 acre-feet per year.

Discharge:

Ground water in Duck Lake Valley is discharged to the surface by springs, seeps, and pumping. It is returned to the atmosphere by evaporation from the land surface and by transpiration through plants.

Springs: Springs and seeps are common in the mountains surrounding Duck Lake Valley. They are principally the gravity type, occurring where the land surface intercepts the water table or where infiltrating ground water encounters an impermeable rock stratum and is forced laterally to the surface. A few springs and seeps in the central part of the valley floor are fed by upward leakage from underlying artesian aquifers.

The discharge of the few springs on the valley floor is included in the estimate of ground water discharged by transpiration. Although there are no large springs in the region, the total discharge of the many small springs in the mountains may represent a considerable volume of ground water.

Pumpage: About 30 wells have been drilled in the valley and are described in tables 1 and 2. Most are pumped by windmill and used to water stock. One irrigation well (36/18-11c1) has been drilled and will yield about 800 gallons per minute, or 200 acre-feet per growing season when put into operation. The total discharge of ground water by pumping, to date, is an insignificant factor in the hydrologic regimen of the valley.

Evaporation and Transpiration: Evaporation from the ground-water reservoir occurs where the capillary fringe reaches or is near the land surface. The capillary fringe ordinarily reaches the land surface where the depth to the water table is only a few feet below the surface. In Duck Lake Valley, the areas where the water table is near enough to the surface for a significant amount of evaporation to take place are limited, although a small amount of ground water probably is discharged in this manner.

Transpiration, on the other hand, accounts for most of the natural discharge of ground water from the valley. Large quantities of ground water are transpired by plants known as phreatophytes, whose roots descend to the water table or to the capillary fringe above it. Greasewood is the most common phreatophyte in the region, and its presence is generally an indication that the water table is within about 30 feet, or less, of the land surface. Other less common phreatophytes are saltgrass and rabbitbrush. The total area of phreatophytes is about 30,000 acres.

The estimated rate of ground-water use by phreatophytes is based largely on work done by White (1932, p. 28-93) in Escalante Valley, Utah, and on more recent investigations by Young and Blaney in California (1942, p. 41-246). The results of these investigations suggest that the rate of ground-water use by greasewood in an environment such as Duck Flat, probably is on the order of 0.2 foot per year. On this basis, the volume of ground water discharged by phreatophytes in the valley amounts to about 6,000 acre-feet per year.

The total natural discharge from the valley is the sum of the spring discharge, evaporation, and transpiration. This reconnaissance suggests that the total discharge averages not more than 7,000 acre-feet per year.

Perennial Yield:

The perennial yield of a ground-water reservoir may be defined as the amount of water that can be pumped, or otherwise diverted, from the reservoir without causing an excessive depletion of the stored water. In other terms, perennial yield is the amount of water that can be salvaged from natural discharge, and is ultimately limited to the amount of recharge to the reservoir.

In any undeveloped ground-water basin the long-term average annual recharge to the reservoir is necessarily balanced by the discharge from the reservoir. This is a dynamic balance, however, and periods of above-average precipitation or drought are not necessarily accompanied by an equivalent increase or decrease in the natural discharge; rather, the imbalance is compensated for mainly by short-term changes in the amount of ground water in storage, as is evidenced by fluctuations of water levels.

For Duck Lake Valley, the difference in the estimates of the average annual recharge of 9,000 acre-feet and average annual discharge of 7,000 acre-feet is not due to any current imbalance in the hydrologic system, but is the result of errors inherent in the assumptions made and in the methods of estimation themselves. Nevertheless, the estimates probably are as accurate as could be made with the limited data at hand, and the actual value of average annual recharge and discharge probably lies somewhere within this range. Accordingly, this reconnaissance suggests that the perennial yield is on the order of 8,000 acre-feet.

The development and use of the ground-water resources of Nevada is predicated on the State law which states that the rate of ground-water withdrawal from a basin be limited to the "reasonable lowering of the static water level" (Hutchins, 1955, p. 61). Accordingly, the perennial yield is now the limiting factor in any permanent or long-range development of the ground-water resources of Nevada.

The perennial yield of a basin can be determined more accurately only after several years of development have been closely observed and much additional data have been collected and evaluated. The pumpage from a basin may exceed the average annual recharge to the extent that some of the applied water returns to the ground-water reservoir. Also, in the early stages of development, some ground water must be removed from storage to induce ground-water movement toward the wells being pumped. In the final analysis, however, the perennial yield of a basin will be determined largely by the amount of natural discharge that can be salvaged or diverted to beneficial use.

Ground Water in Storage:

An estimate of the amount of recoverable ground water in storage in the alluvium of the valley can be obtained by computing the amount of ground water that will drain from the deposits for each foot of lowering of water level. An average specific yield of 10 percent is considered to be a conservative estimate of the amount of water by volume that will drain from the alluvium. The valley floor covers an area of about 30,000 acres. Thus, the amount of ground water that could be recovered by a uniform lowering of water levels throughout the valley would be on the order of 3,000 acre-feet per foot of lowering. This estimate serves to show that, although the amount of water in storage beneath the valley floor is considerable, it is not unlimited.

CHEMICAL QUALITY OF THE GROUND WATER

The chemical constituents in ground water are acquired chiefly by the solution of minerals in the material through which the water percolates. In general, the dissolved-solids content of the water is determined by the solubility of the rock or soil, the area and duration of contact, and other factors, such as pressure and temperature.

Table 3 lists the chemical analysis of water from five wells in the valley. Five samples are not an adequate representation of the water quality throughout the valley, but they serve to illustrate the possible types of water and water-quality problems that may be encountered.

The sample from well 36/19-21dl was highest in dissolved-solids content. This water is objectionable for domestic and irrigation use because of the high salinity and sodium (alkali) hazard. The mineral content is mainly sodium, sulfate, and chloride.

Three of the other four samples are relatively low in salinity, and the fourth is marginal. These four samples indicate that the water is objectionable or of marginal value for irrigation because of the high bicarbonate ion concentration.

Residual sodium carbonate (RSC), which may be defined by the formula $RSC=(CO_3^{--} + HCO_3^{-}) - (Ca^{++} + Mg^{++})$, in which concentrations are expressed in equivalents per million, is a measure of the hazard involved in the use of water having a high bicarbonate content. If residual sodium carbonate is greater than 2.5 epm (equivalents per million), the water is not suitable for irrigation. The water is marginal if the residual sodium carbonate is between 1.25 and 2.5 epm, and it is probably safe if the residual sodium carbonate is less than 1.25 epm (U.S. Salinity Laboratory Staff, p. 81).

Although the sodium sulfate water from well 36/19-21d1 may reflect a relatively local condition, the high bicarbonate ion concentration that is present in the other water samples is fairly typical of water from the lakebeds of other closed basins in Nevada, and may be characteristic of the ground water throughout Duck Lake Valley.

Water moves slowly through fine-grained material, and particles of silt and clay become readily involved in ion-exchange with the percolating water because of their chemical composition and large surface area. The rapid movement of water through gravel aquifers, on the other hand, coupled with the chemical stability of most pebbles, provides little opportunity for significant changes of water quality within the aquifer. It is noteworthy, therefore, that three of the five wells sampled have extremely low yields (table 1). Yields of the other two wells were not available. It seems likely that an aquifer permeable enough to yield sufficient water for irrigation will be composed largely of well-sorted, clean sand and gravel, and if precautions are taken to case off the mineralized silt and clay which compose much of the alluvium, the water-quality problems can be overcome. In any event, further study of the quality of the ground water, its possible reactions with the soils and its probable effect on crops, should be studied in detail prior to substantial agricultural development.

CONCLUSIONS

The potential sources of ground-water supply in Duck Lake Valley are the sand and gravel aquifers contained in the less permeable lake clays and other fine-grained materials of the alluvium. The aquifers probably will prove to be most productive along the south and west margins of the valley.

This reconnaissance suggests that the perennial yield is 8,000 acre-feet. The extent to which the ground-water reservoir would sustain or approach this yield will depend largely on the amount of natural discharge that can be salvaged by pumping and other water-conservation measures that are employed.

Although some ground water must be withdrawn from storage in order to induce movement of water toward areas of ground-water development, the net draft on the ground-water reservoir should not exceed the perennial yield, if a long-term decline in water levels and an excessive depletion of the water in storage are to be avoided.

Chemical analyses of water from five wells suggest that the water is not suitable, or is marginal, for irrigation. Although these samples may not be representative of water from the principal, or most productive, aquifers in the valley, their high concentration of the bicarbonate ion indicates that careful consideration must be given to the effect of applying this water to the soils and crops that might be irrigated.

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Table 1.--Record of wells and springs in Duck Lake Valley, Washoe County, Nev.
Use of water: D, Domestic; I, irrigation; S, stock.
Water level: M, measured; R, reported.
Altitude: Determined from altimeter readings.
BLM: Bureau of Land Management

Well or spring number and location	Owner	Date drilled	Diameter (inches)	Depth (feet)	Depth of main aquifers (feet)	Measuring Point: Altitude (feet)	Measuring Point: Above land surface (feet)	Measuring Point: Description	Water level: Below measuring point (feet)	Water level: M or R	Water level: Date	Use	Remarks
39/18-33b1	Etta Langstrom	- -	4	- -	- -	4540	- -	- - -	- -	-	- - -	S	Flows about 10 gpm
39/19-33c1	Etta Langstrom	- -	-	- -	- -	4540	- -	- - -	- -	-	- - -	S	Flows about 15 gpm
39/20-12a1	BLM	10-54	8	220	94-220	- - -	- -	- - -	52	R	10-54	S	
38/18-15c1	BLM	9-54	6 5/8	111	68-80	- - -	1	hole in csg.	41.70	M	12-62	S	Pumps 5 gpm
38/18-34d1	- -	- -	8	- -	- -	4665	1	hole in plate	49.98	M	7-62	S	
38/19-32c1	BLM	- -	8	224	143-167	4890	1	top of csg.	120.68	M	2-63	S	
37/18-2b1	BLM	9-54	6 5/8	103	84	4655	.5	top of csg.	21.16	M	7-62	S	Drawdown 50 ft. Bailing 6 gpm
37/18-12a1	- -	- -	8	55	- -	4680	1	top of csg.	8.87	M	12-62	S	
37/18-34a1	BLM	3-54	6	200	42-75	4715	1	top of csg	38.16	M	12-62	S	Bailed 20 gpm
37/19-18a1	- -	- -	8	89	- -	4715	1	top of csg	18.56	M	12-62	S	
37/19-19c1	L. Cockrell	- -	-	15	- -	4680	1.4	top of csg	12.39	M	2-63	S	
37/19-30c1	- -	- -	-	- -	- -	- -	-	- -	- -	-	- -	S	Spring
37/20-30c1	Bare Ranch	- -	24	- -	- -	- -	1.2	top of csg	15.9	M	- -	D,S	
36/18-11b1	- -	- -	6	- -	- -	4710	- -	- -	- -	-	- -	S	
36/18-11c1	Charles Stevenson	- -	14	363	- -	4720	3	pumpbase	30.38	M	2-63	I	Drawdown 140 ft. pumping 800 gpm
36/18-24b1	- -	- -	8	16	- -	4705	.5	top of csg	11.2	M	11-62	S	
36/19-21b1	Mutual Land Improvement Co., David Vose	1919	6	400	160-175	- -	-	- -	20	R	1919	-	Abandoned
36/19-21d1	- -	- -	- -	- -	---	4740	1.0	top of csg	28.0	M	3-63	S	
36/19-25c1	- -	- -	- -	- -	- -	- -	2.2	top of csg	13.2	M	- -		Not used
36/20-1d1	BLM	- -	6	190	- -	- -	- -	- -	164	R	12-59	S	
36/20-15d1	Bare Ranch	- -	6	157	- -	4910	3	top of csg	64.4	M	11-62	S	
36/20-28c1	- -	- -	4	- -	- -	4830	2	top of csg	23.78	M	11-62	D,S	Not used
36/20-31a1	- -	- -	2	- -	- -	4785	0	top 2"pipe	4	M	11-62	D,S,	Not used
35/20-33a1	Oscar Marguardt	1949	16	273	- -	4825	1.5	top of csg	16.84	M	2-63	-	Bailed 60 gpm
35/20-34b1	- -	- -	6	41.5	- -	4825	1	top csg	17.2	M	2-63	S	
35/19-1a1	Rye Patch Ranch	- -	4	- -	--	4780	1	top csg	25.88	M	2-63	S	
35/19-1b1	Rye Patch Ranch	1947	8	134	100-126	- -	-	- -	25	R	10-47	S	Drawdown 12 ft. pumping 8 gpm
35/20-7b1	- -	- -	-	- -	- -	- -	-	- -	-	-	- -	S	Spring

Table 2. --Drillers' logs of wells in Duck Lake Valley, Washoe County, Nev.

Well	Thickness (feet)	Depth (feet)
39/30-12a1		
Casing perforated 158-218 ft; perforations 3/16" x 6"		
Clay, sandy	152	152
Sand, fine, and silt	38	190
Gravel, sand, and silt	30	220
38/18-15c1		
Casing perforated 60-109 ft; perforations 3/16" x 6"		
Boulders and sand	4	4
Sand, clay, and gravel	64	68
Sand and rocks	21	89
Sand, gravel, and clay	22	111
38/19-32c1		
Casing perforated 205-224 ft; perforations 3/16" x 5/8"		
Rock and clay	11	11
Clay, pink	42	53
Rock, brown, broken	21	74
Rock, gray	16	90
Rock, gray, broken	45	135
Gravel and black mud	8	143
Rock, gray	24	167
Rock, red	11	178
Rock, gray	15	193
Rock, red	14	207
Rock, gray	17	224
37/18-2b1		
Casing perforated 80-101 ft; perforations 3/16" x 12"		
Silt	63	63
Sand and clay	21	84
Rock, broken	17	101
Rock, solid	2	103
37/18-34a1		
Casing perforated 154-175 ft; perforations 1/8" x ?		
Sand	6	6
Gravel and boulders	3	9
Gravel	6	15
Sand	24	39
Gravel and boulders	3	42
Sand	36	78
Gravel	7	85
Sand	11	96
Gravel and boulders	11	107
Clay, yellow	10	117
Rock; water at 157 ft.	40	157
Sand	2	159
Gravel and boulders	16	175
Log missing ?		200
36/18-11c1		
Casing perforated 60-80 ft. and 120-160 ft.		
Sand, gravel	15	15
Clay	16	31
Gravel, sand	5	36
Clay	11	47
Sand, clay	6	53
Clay, gravel	5	58
Sand, gravel	13	71
Clay	3	74
Sand, gravel	5	79
Clay, gravel	37	116
Clay	6	122
Sand, gravel	10	132
Clay	10	142
Sand and gravel	15	157
Shale, blue	206	363

Table 2.--Drillers' logs - continued

Well	Thickness (feet)	Depth (feet)
36/19-21b1		
Sand and clay	28	28
Clay and gravel; water	10	38
Sandstone, soft, and clay	122	160
Sand and gravel	15	175
Rock, gray, with soft and hard strata	225	400
36/20-1d1		
Clay, yellow	60	60
Lava, gray	58	118
Clay, sandy, yellow	46	164
"Water"	1	165
Clay, yellow	25	190
36/20-33a1		
Top soil	16	16
Clay and sand	19	35
Clay, blue	5	40
Shale, blue	15	55
Shale, broken, logs; water	20	75
Shale, hard, gray	10	85
Shale, broken	40	125
Logs, redwood	10	135
Shale, broken	40	175
Shale, broken, rotten, sticky	14	189
Sand, loose; little water	6	195
Sand; water	3	198
Shale, rainbow, very sticky	47	245
Shale, hard, gray	14	259
Sand, broken shale	5	264
Shale, hard, gray	9	273

Well	Thickness (feet)	Depth (feet)
35/19-1b1		
Casing perforated 120-134 ft; perforations 1/4" x 8"		
Sediments, soft, brown	10	10
Gravel, sand, silt and clay, yellow	4	14
Gravel, sand, clay, light-brown and green	2	16
Clay, light-yellow - brown	10	26
Hardpan, brown-yellow, black gravel; water	4	30
Sediment rock, brown	10	40
Sediment rock, brown and seams, black clay	7	47
Rock, dark-gray-black	3	50
Rock, dark-gray-black and 2" clay strata	10	60
Rock, dark-gray-black, some white quartz	10	70
Rock, dark-gray-black, pyrite	20	90
Clay, hard, blue, purple, clay strata 2" thick	5	95
Clay, blue, 2" hard and soft seams	5	100
Clay, blue, 2" hard seams; loss of mud	16	116
Sediment black, alternate hard and soft, 1 ft. thick	10	126
Rock, brown and green purplish-brown muddy clay, gummy mess of mud	8	134
Gravel packed from top to bottom		

Table 3.--Chemical analyses of ground water in Duck Lake Valley, Washoe County, Nev.

/Analyses by U.S. Geological Survey. Constituents in parts per million/

Well	Date of collection	Temperature (°F)	Silica (Si)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Hardness as $CaCO_3$		Specific conductance (micromhos at 25°C)	Dissolved solids residue at 180°C	Sodium adsorption ratio (SAR)	Residual sodium carbonate (RSC) in equivalents per million	pH
															Noncarbonate	Calcium and magnesium					
37/18-2b1	5-6-61	53	42	24	15	206	4.9	5	311	164	94	0.7	0.2	0.45	0	120	1100	702	8.2	2.9	8.3
37/18-34a1	5-6-61	56	56	32	9.0	88	3.8	22	268	42	10	.6	.2	.23	0	116	561	393	3.5	2.8	8.7
37/19-19c1	5-6-61		34	6.4	.2	55	.6	0	128	15	11	.3	.3	.32	0	17	264	186	4.2	1.8	8.2
36/19-21d1	5-6-61		23	345	122	1140	40	0	196	2070	1160	.1	1.1	.51	1200	1360	6860	5160	13.3	0	7.3
35/19-1b1	5-6-61		42	45	9.5	71	1.7	0	273	52	24	.6	.9	.24	0	152	574	372	1.8	1.5	8.1

(4) to estimate the quantity of ground water that can be developed perennially; and (5) to determine the chemical quality of the ground water and its suitability for irrigation and domestic use.

Most of the field work for this report was done during parts of December 1962 and February 1963. It consisted of a brief study of the physiographic features of the area and the water-bearing character of the geologic units, an inventory of the wells and springs, and the collection of water samples for chemical analysis.

Information provided by residents of the area about wells and springs is gratefully acknowledged. Much of the information concerning wells drilled for the U. S. Bureau of Land Management was obtained through the courtesy of Mr. Stuart Porter of that agency's office at Susanville, California. The area of phreatophytic vegetation delineated on plate 1 is adapted from a forage-type survey being conducted by Mr. Howard Gebel and his associates of the Bureau of Land Management.

Location and Extent of the Area:

Duck Lake Valley is in northern Washoe County, about 100 miles north of Reno (fig. 1). The valley floor is roughly triangular, the long axis trending northwestward. It covers an area of about 50 square miles. The entire drainage area tributary to the valley covers about 550 square miles, including about 50 square miles of Tuledad Creek drainage in Lassen County, California. During periods of high runoff, Duck Lake Valley drains northwestward into Surprise Valley, which lies principally in California. That portion of Surprise Valley, which lies within Nevada and south of Hays Canyon, an area of about 50 square miles, also is considered in this report.

Duck Lake Valley is traversed by State Route 81, a well-maintained gravel road which connects Gerlach, a stop on the Western Pacific Railroad about 40 miles southeast of the valley, with Cedarville, California about 40 miles northwest of the valley.

Numbering System for Wells and Springs:

The well-numbering system used in this report indicates the location of the wells within the rectangular subdivisions of the public lands referenced to the Mount Diablo meridian and base line. The first two segments of a well number designate the township north and range east; the third segment is the number of the section followed by a letter which designates the quarter section in which the well or spring is located. Following the letter is a number indicating the order in which the well or spring was recorded within the quarter section. The letters "a", "b", "c", and "d" designate, respectively, the northeast, northwest, southwest, and southeast quarters of the section. For example, well number 36/18-11c1 designates the first well recorded in the SW 1/4 sec. 11, T. 36 N., R. 18 E., Mount Diablo base line and meridian.

United States Department of Interior
Geological Survey

State of Nevada
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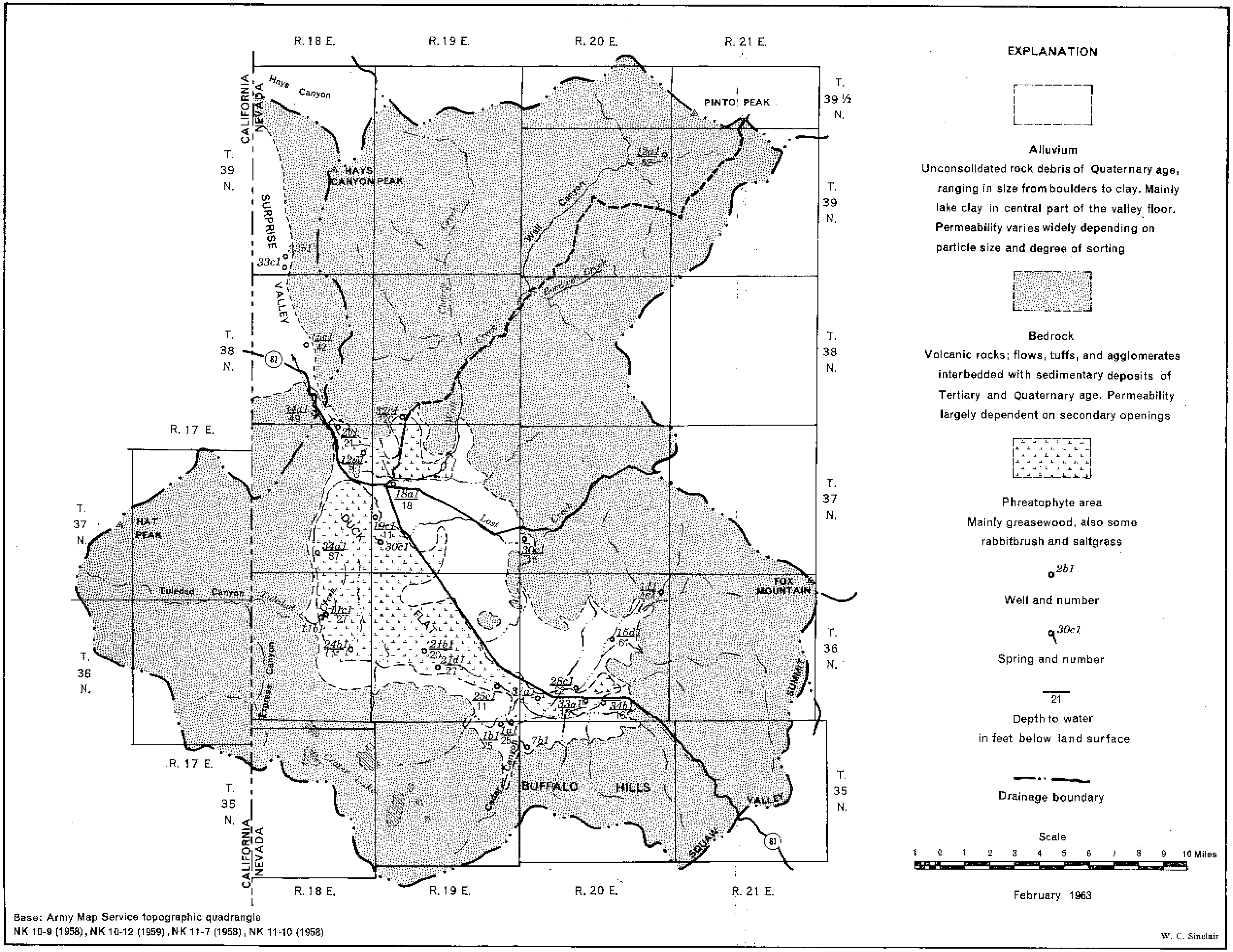

PLATE 1. GENERALIZED GEOLOGIC AND HYDROLOGIC MAP OF DUCK LAKE VALLEY WASHOE COUNTY, NEVADA

PREVIOUSLY PUBLISHED REPORTS OF THE GROUND-WATER RESOURCES - RECONNAISSANCE SERIES

Rep. No.	
1	Ground-Water Appraisal of Newark Valley, White Pine County, Nevada. Dec. 1960, by Thomas E. Eakin.
2	Ground-Water Appraisal of Pine Valley, Eureka and Elko Counties, Nevada. Jan. 1961, by Thomas E. Eakin.
3	Ground-Water Appraisal of Long Valley, White Pine and Elko Counties, Nevada. June 1961, by Thomas E. Eakin.
4	Ground-Water Resources of Pine Forest Valley, Humboldt County, Nevada. Jan. 1962, by William C. Sinclair.
5	Ground-Water Appraisal of the Imlay Area, Humboldt River Basin, Pershing County, Nevada. Feb. 1962, by Thomas E. Eakin.
6	Ground-Water Appraisal of Diamond Valley, Eureka and Elko Counties, Nevada. Feb. 1962, by Thomas E. Eakin.
7	Ground-Water Resources of Desert Valley, Humboldt County, Nevada. April 1962, by William C. Sinclair.
8	Ground-Water Appraisal of Independence Valley, Western Elko County, Nevada. May 1962, by Thomas E. Eakin.
9	Ground-Water Appraisal of Gabbs Valley, Mineral and Nye Counties, Nevada. June 1962, by Thomas E. Eakin.
10	Ground-Water Appraisal of Sarcobatus Flat and Oasis Valley, Nye County, Nevada. Oct. 1962, by Glenn T. Malmberg & Thomas E. Eakin.
11	Ground-Water Resources of Hualapai Flat, Washoe, Pershing, and Humboldt Counties, Nevada. Oct. 1962, by William C. Sinclair.
12	Ground-Water Appraisal of Ralston and Stonecabin Valleys, Nye County, Nevada. Oct. 1962, by Thomas E. Eakin.
13	Ground-Water Appraisal of Cave Valley in Lincoln and White Pine Counties, Nevada. Dec. 1962, by Thomas E. Eakin.
14	Ground-Water Resources of Amargosa Desert, Nevada - California. March 1963, by George E. Walker and Thomas E. Eakin.
15	Ground-Water Appraisal of the Long Valley-Massacre Lake Region, Washoe County, Nevada, by William C. Sinclair; also including a section on The Soils of Long Valley by Richard L. Malchow. May, 1963.
16	Ground-Water Appraisal of Dry Lake and Delamar Valleys, Lincoln County, Nevada. May 1963, by Thomas E. Eakin.

United States Department of Interior
Geological Survey

State of Nevada
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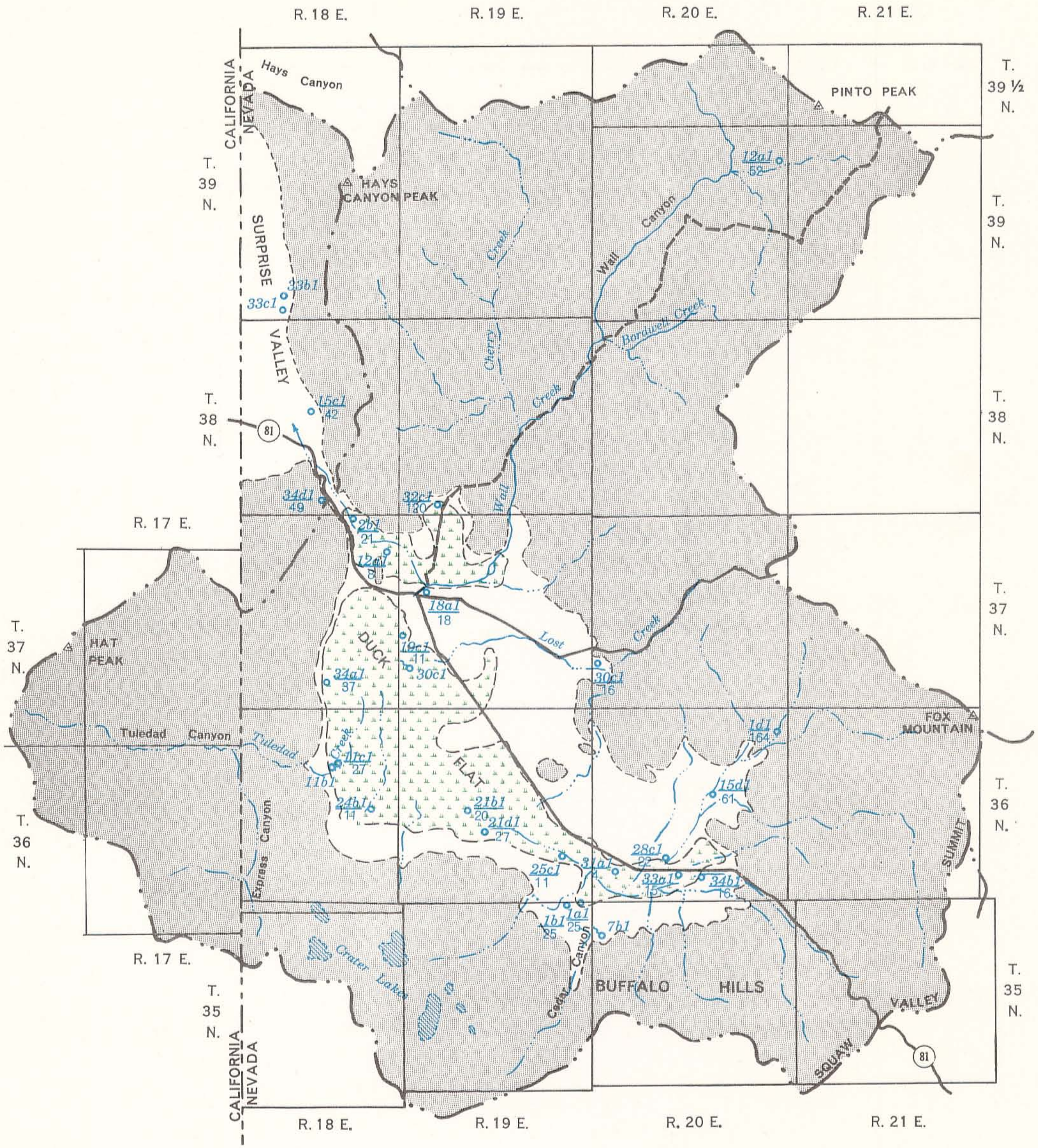

EXPLANATION

Alluvium
Unconsolidated rock debris of Quaternary age, ranging in size from boulders to clay. Mainly lake clay in central part of the valley floor. Permeability varies widely depending on particle size and degree of sorting

Bedrock
Volcanic rocks; flows, tuffs, and agglomerates interbedded with sedimentary deposits of Tertiary and Quaternary age. Permeability largely dependent on secondary openings

Phreatophyte area
Mainly greasewood, also some rabbitbrush and saltgrass

2b1 — Well and number

30c1 — Spring and number

21 — Depth to water in feet below land surface

Drainage boundary

Scale
1 0 1 2 3 4 5 6 7 8 9 10 Miles

February 1963

Base: Army Map Service topographic quadrangle
NK 10-9 (1958), NK 10-12 (1959), NK 11-7 (1958), NK 11-10 (1958)

W. C. Sinclair

PLATE 1. GENERALIZED GEOLOGIC AND HYDROLOGIC MAP OF DUCK LAKE VALLEY WASHOE COUNTY, NEVADA