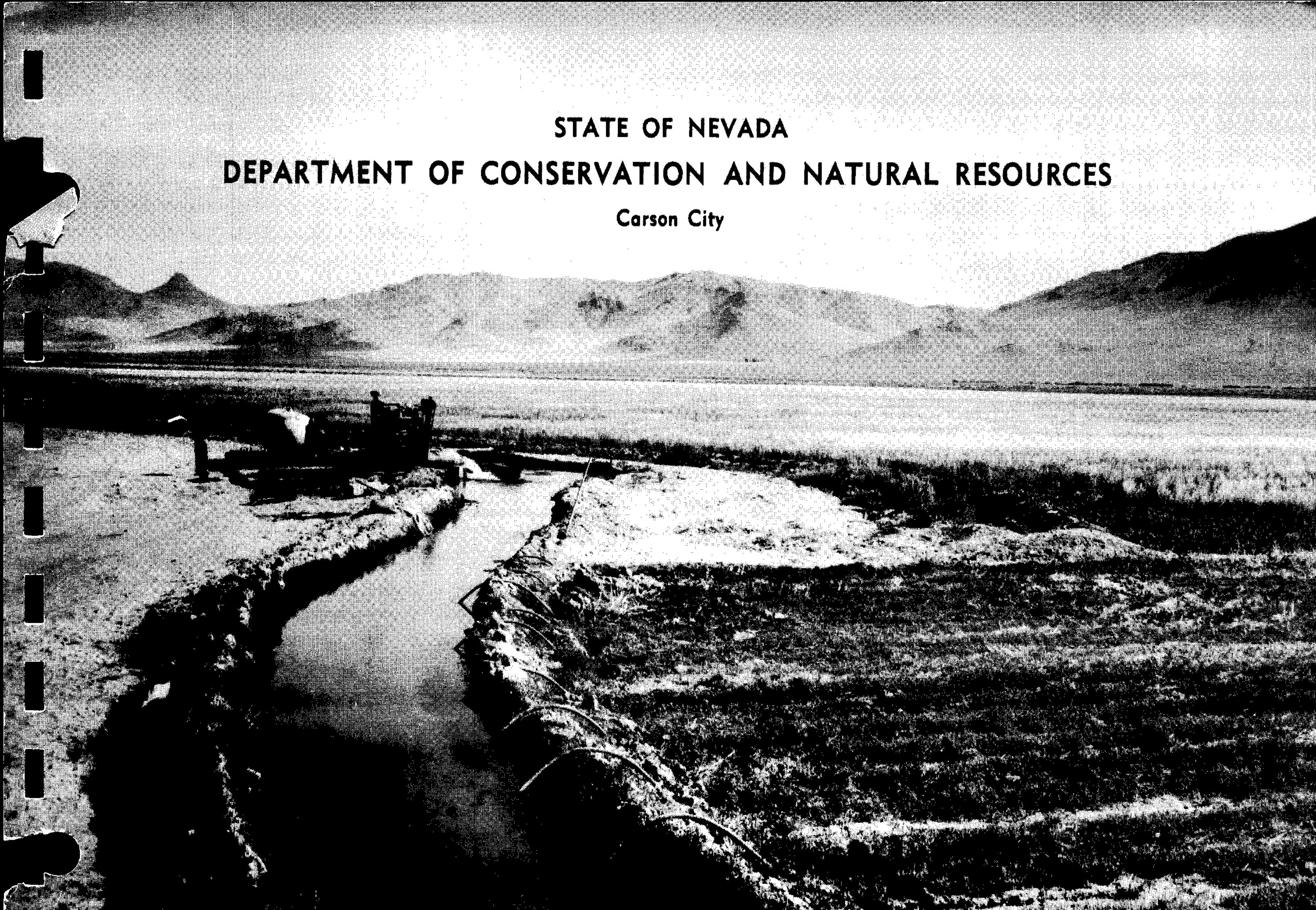
STATE OF NEVADA

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

Carson City



Pumping ground water for irrigation—Kings River Valley, Humboldt County

GROUND-WATER RESOURCES - INFORMATION SERIES

REPORT 1

THE GROUND-WATER SITUATION IN NEVADA, 1960

By

O. J. Loeltz, Engineer, and G. T. Malmberg, Geologist

Price $1.00

Prepared Cooperatively by the

Geological Survey, U. S. Department of Interior

JULY 1961

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U.S. Department of the Interior

January 1961

FOREWORD

The following report will be the first report in an information series. It is a well prepared summation of the ground water situation in Nevada in 1960 and will be a valuable contribution to our knowledge as to work that has been completed either in detail, semi-detail, or on a reconnaissance basis and also gives an idea of the tremendous job that lies ahead in determining our potential ground-water resources.

This report will be supplemented and brought up to date in 1965, and thereafter at five-year intervals.

Recently Governor Grant Sawyer requested that this department prepare a plan for a long-range development of our water resources, both surface and underground, and it would seem that this particular publication could be utilized as a part of such plan.

The picture on the cover was taken by Adrian Atwater, photographer for the State Highway Department, and shows a typical water development project in Quinn River Valley, Humboldt County, Nevada.

It is hoped that this report will stimulate the general program of ground water investigation and development throughout the State.

Hugh A. Shamberger, Director
Department of Conservation and Natural Resources

CONTENTS

TABLES

ILLUSTRATIONS

Cover photograph by Adrian Atwater, photographer,
Nevada State Highway Department.

THE GROUND-WATER SITUATION IN NEVADA, 1960

by
O. J. Loeltz and G. T. Malmberg

GEOGRAPHY

Nevada lies almost wholly in the Great Basin section of the Basin and Range physiographic province, which is characterized by roughly parallel north-trending mountain ranges separated by large alluvium-filled basins. In Nevada the mountain crests generally are several thousand feet above the valley lowlands, but in places they may be nearly 10,000 feet above the valleys. The altitudes of the valley floors generally are lowest in the southern part of the State, where some of the valley floors are less than 2,000 feet above sea level. In the western part of the State the altitudes of the valleys generally range between 4,000 and 5,000 feet, and in the northeastern part the altitudes are 5,000 to 6,500 feet.

Nevada is the eighth largest State and includes an area of 110,540 square miles; it is also the most arid State. The lofty Sierra Nevada along its western border is largely responsible for the arid climate. Only about 1 percent of the State receives more than 20 inches of precipitation, whereas about 18 percent receives less than 5 inches. For the State as a whole, the average annual precipitation is slightly less than 9 inches.

Runoff probably averages less than 4 million acre-feet annually. About half the runoff is carried by the Carson, Truckee, Walker, and Humboldt Rivers. The headwaters of the first three are in the Sierra Nevada in California. Each flows eastward less than 100 miles and terminates in either Pyramid or Walker Lakes or Carson Sink. The Humboldt River heads in northeastern Nevada, flows westward about 300 miles through several mountain ranges, and finally terminates in Humboldt Sink. It is the only major stream whose watershed is entirely within the State.

Although most of the runoff is consumed within the State, a substantial part, perhaps as much as 20 percent, crosses the State's boundaries into neighboring states. The Salmon Falls and Goose Creeks, and the Owyhee and Bruneau Rivers discharge, on the average, a total of about half a million acre-feet of water annually across the State's northern boundary. The Virgin and the Muddy Rivers, both of which are in the Colorado River drainage basin, discharge, on the average, about 180,000 acre-feet annually across the State's southern boundary.

Most of the minor streams head in the mountains bordering the numerous valleys and basins. They flow toward the valley lowlands, but during most of the year they terminate before reaching the lowest parts of the valleys. At times of high flow, however, the streams ordinarily terminate in an ephemeral lake or or playa from which the runoff eventually evaporates.

Evaporation rates are high, ranging from about 3.5 feet in the northeastern part of the State to almost 7 feet in the extreme southern part.

The mean annual temperature ranges from about 45°F in the northern part of the State to about 65°F in the southern part. Summer temperatures of 100°F and higher are common in the southern part of the State, but occur only infrequently in other parts. The highest temperature of record is 122°F and the lowest -50°F. Average growing seasons range from about 80 days in the northern part of the State to about 300 days in the extreme southern tip.

GROUND WATER

General Appraisal

The ultimate source of Nevada's ground water is precipitation. As was stated in the preceding section, the average statewide annual precipitation is slightly less than 9 inches, which is equivalent to about 53 million acre-feet. However, only a very small percentage of the annual precipitation recharges the ground-water reservoirs. Because of a complete lack of data in much of the State, it is possible to make only a very rough estimate of the average annual recharge to the ground-water reservoirs. The results of the ground-water studies that have been made, and other geologic, hydrologic, and climatologic data, suggest that the average annual recharge to the ground-water reservoirs is only 1 or 2 million acre-feet. Most of this recharge is to the unconsolidated sediments of the various intermontane valleys and basins. Of the more than 100 valleys and basins in the State, probably less than half receive an average annual recharge of 15,000 acre-feet or more. Few, if any, valleys receive on the average as much as 100,000 acre-feet of recharge per year. On the other hand, there are many valleys--the smaller ones, and even some of the larger ones, in the more arid parts of the State--for which the average annual recharge probably is less than 5,000 acre-feet.

In addition to the average annual recharge, Nevada's ground-water resources also include an extremely large but unknown quantity of ground water in storage, part of which might feasibly be mined or used nonconsumptively. On the basis of an assumed specific yield of the sediments of 10 percent, the amount of ground water in storage in the upper 100 feet of saturated unconsolidated sediments in the larger valleys in Nevada is estimated roughly at 200 million acre-feet. This represents approximately 100 to 200 years of average recharge. Because the thickness of saturated material in many valleys is many hundreds of feet, the total amount of ground water in storage represents the recharge over many centuries.

Present and Potential Problems

The limited supply.-- Many of Nevada's ground-water problems are and will be related to the limited supply that is available on a perennial basis. Because the perennial recharge to even the largest valleys probably does not greatly exceed 50,000 acre-feet and the recharge to perhaps half the valleys is less than 15,000 acre-feet, problems related to long-term development can easily arise in many areas of the State. To date, pumpage in the Las Vegas and Pahrump Valleys has exceeded the perennial recharge, but pumpage in some other valleys, notably Kings River and Quinn River Valleys, also may be exceeding the perennial recharge. The importation of water from Lake Mead can solve the supply problems of Las Vegas Valley. Water from Ash Meadows Valley migh possibly be exported to Pahrump Valley, provided a satisfactory agreement for the sale or transfer of existing water rights to the Ash Meadows Valley springs can be effected. In most areas of the State, however, importation of water is not feasible at present, so in these areas the maximum net rate of withdrawals eventually must be limited to the average annual recharge if development is to be on a perennial basis. Artificial recharge, utilizing at least a part of the runoff that otherwise would flow to playa or sink areas, probably can be used to alleviate overdraft in some areas.

Quality of water.--The chemical quality of the ground water poses serious problems in many parts of the State. Many of the problems arise from the fact that Nevada has many drainage basins in which, for practical purposes, all the ground water is discharge within the drainage basin itself, leaving the salts to accumulate. The discharge is effected principally by evaporation from the soil or land surface and by the transpiration of plants of small or no economic value. Evaporation and transpiration commonly occur in the lower parts of the valleys or basins, and as a result both the soil and the ground water in these areas become too highly mineralized for most uses.

Thick sections of highly mineralized sediments have been formed by the evaporation of surface water from the intermittent lakes or playas and the large sink areas that are common in the State. Ground water beneath these areas commonly contain moderate to substantial amounts of salts dissolved from these sediments.

The total area underlain by moderately to highly mineralized ground water is not known, but it may exceed 2 million acres. Even more difficult to estimate is the volume of moderately to highly mineralized water that is contained in the ground-water reservoir beneath these areas, because little is known about the thinkness of the saturated sediments and the amount of water they contain, or can yield to wells, per unit volume. The yield to wells may be only a small fraction of the total amount of water in storage.

In some of the larger sinks, such as the Carson and Humboldt Sinks, the saturated sediments are at least 1,000 feet thick and probably are several thousand feet thick. Even if only a small percentage of the water in storage can be diverted to wells, tens of millions and perhaps even hundreds of millions of acre-feet of water would be available for development should it prove feasible to dewater these areas to depths of several hundred feet. The native water may be satisfactory for its intended use, or partial demineralization may be necessary

The problem, therefore, is a lack of knowledge as to where moderately and highly mineralized ground water occurs, the quantity of mineralized water that can be recovered, the average annual rate of recharge to the various areas, and the degree and type of the mineralization of the water at specific locations.

Quality-of-water problems also arise because of the excessive concentration of certain chemical constituents in otherwise satisfactory water. Iron, manganese, fluoride, and boron are the more common constituents that make an otherwise satisfactory water unusable. Concentrations of fluoride above the commonly accepted limits for domestic or municipal use have been noted in the Hawthorne area and several other localities. Undoubtedly, other areas will be discovered as more data on the chemical constituents of the ground water in the State become available. Concentrations of boron sufficient to be harmful to crops commonly grown in Nevada also have been noted. Concentrations of iron and manganese sufficient to stain plumbing fixtures and to make the water unfit for laundry use are common in Washoe Valley between Reno and Carson City, the valley of the Humboldt River just west of Winnemucca, Lemon Valley north of Reno, and several areas in the Truckee Meadows. Other areas where iron or manganese is a problem are known, but information as to the concentration of these constituents is lacking for many areas. Undoubtedly, some of these also contain water of inferior chemical quality.

Yields of wells.--Obtaining moderate to high yields is or will be a problem in many areas, especially in parts of the south-central and the southern parts of the State. Even valleys in which moderate to large yields are obtainable have extensive areas where wells will yield only a fraction of a gallon per minute per foot of drawdown, or at best, a few gallons per minute per foot of drawdown.

Drainage.-- Drainage is a serious problem in some parts of Nevada. Many of the drainage problems have arisen as a result of conservation measures, usually the application of large quantities of surface water for irrigation. The Fallon, Lovelock, and the Truckee Meadows east and south of Reno are but a few of the areas having major drainage problems. Although some remedial measures have been put into effect, easier or better methods probably can be used to alleviate or solve drainage problems. For instance, in some areas the pumping of ground water may be an effective means of alleviating drainage problems. However, more detailed information about the aquifer system in which the ground water occurs is needed before the most efficient and feasible methods for solving specific drainage problems can be determined.

Water temperatures.-- Above-normal ground-water temperatures sometimes cause serious problems. Nevada has hundreds of areas where ground-water temperatures are above normal. The thermal waters are associated with areas of tectonic activity. To date, the principal problems of above-normal temperatures have arisen in connection with the development of ground water for municipal supplies for the cities of Elko, Reno, and Sparks (immediately east of Reno). Similarly, in some areas, such as certain parts of the Truckee Meadows, above-normal ground-water temperatures also cause difficulty in obtaining satisfactory domestic supplies.

Ground-water movement. -- Although Nevada is known as an area of closed basins, it has many valleys that are not closed topographically and even more that are not closed hydraulically--that is, ground water moves from one basin to another beneath topographic divides. Examples of basins that are closed topographically but not hydraulically are Gold Flat, Frenchman Flat, and Yucca Valley, all in south-central Nevada. Undoubtedly there are many others. Most of the valleys or drainage basins that have underground hydraulic interconnections with other valleys are in southern and eastern Nevada.

Basins or valleys that are not closed hydraulically give rise to many ground-water problems. An obvious one is that it may be very difficult to manage the supply in the several interconnected basins or valleys. Moreover, it may be difficult to ascertain the source, the path, and the rate of movement of water that is being discharged from a valley or basin that receives ground-water inflow from another or a series of other valleys. For example, it is possible that some of the ground water discharged in Death Valley originates as far away as 30 miles north of Tonopah. If so, by what route and over what period of time does the water reach the discharge area? Similar questions as to source, paths of movement, and travel time can be posed about the discharge of the large springs in the White River Valley drainage system, the Meadow Valley Wash drainage system and the large springs of Ash Meadow Valley. It seems likely that these spring systems include carbonate rock aquifers, some, or most of which, may be buried at considerable depth.

Water rights. -- Problems associated with infringement of water rights already exist and will increase as Nevada's water resources are developed more fully. Unfortunately, problems relating to infringement of water rights cannot be evaluated properly unless the hydraulic systems involved in the problems are known and understood. Much additional information on the numerous aquifer systems in Nevada is needed. For example, today no one knows in what area a new water development will affect the water rights of the large springs in Ash Meadows Valley or the large springs in other parts of the State. Likewise not known is the area within which contamination or pollution of ground-water supplies will affect these springs.

Problems associated with water rights are not limited to any specific areas or types of hydraulic systems. They are likely to arise wherever water rights have been established, because of a general failure to recognize the close interrelation between surface water and ground water. Most of the infringement will be against surface-water rights because the easy development of surface-water supplies has been almost completed, whereas the development of ground water is, figuratively speaking, only in its infancy. As ground water is developed in valleys or basins in which there are surface-water rights or which are tributary to valleys or basins in which there are surface-water rights, there will arise the question as to what extent the new development of ground water is infringing on recognized surface-water rights. Will the development of ground water decrease the surface-water resources to the full extent of the ground-water development or will it principally decrease the amount of water that was being discharged naturally by evaporation or by the transpiration of worthless vegetation? Will it perhaps create additional ground-water storage capacity so that surface water that formerly was wasted by evaporation from similar playas can instead be stored underground where it will be available for beneficial use? Nevada is already confronted with these problems, notably in the valley of the Humboldt River and its tributary valleys, the Truckee Meadows, and Carson, Smith, and Mason Valleys. Although no serious problems have arisen between Nevada and her neighbor states on rights to ground-water bodies that are common to each, it is practically certain that problems of this nature will arise as the demand for water increases. There are at least a dozen valleys that are common to Nevada and neighbor states.

As the demand for water approaches and exceeds the available supply, the matter of preferential use comes to the forefront. The problems are to decide the order of preferential use in the various areas and what procedure should be used for shifting established uses on the scale of preferential uses.

The water law of Nevada has provisions for granting rights on the basis of preferential uses of water. Under NRS 534.120, article 2, it is stated: "In the interest of public welfare the state engineer is authorized and directed to designate preferred uses of water within the respective areas so designated by him and from which the ground water is being depleted, and in acting on applications to appropriate ground water he may designate such preferred uses in different catagories with respect to the particular areas involved within the following limits: Domestic, municipal, quasi-municipal, industrial, irrigation, mining, and stock-watering uses."

Under this authorization, the drilling of irrigation wells has been prohibited in the highly developed part of Las Vegas Valley, although municipal and domestic wells still may be drilled. The State also has recognized preferential use of water for domestic use in that a maximum of 1,440 gallons per day per household may be withdrawn for domestic use without regard to other water rights.

Although Las Vegas Valley is the only area to date where an attempt has been made to grant rights on a preferential-use basis, undoubtedly preferential use will receive serious consideration in many more areas as the State's water resources become more fully appropriated. Many of Nevada's cities will need to develop additional ground-water supplies as the population of the State increases. Most of these additional ground-water developments will affect to some extent established surface-water and ground-water rights. The fact that municipal use is second only to domestic use on the list of preferred uses will aid Nevada's municipalities in obtaining water rights for their needs.

Radio hydrology. -- One of the big problems in Nevada is a lack of understanding of the effects of the activities at the Nevada Test Site on the State's water resources. The Atomic Energy Commission is very much interested in the effects of its thermonuclear activities on water supplies. It has authorized a study of the hydrology of Yucca Valley by the U. S. Geological Survey, which has as its principal aim a determination of the direction and rate of movement of ground water in Yucca Valley. The desirability of similar determinations for the entire test site are recognized by the Atomic Energy Commission in that the Commission has asked the Geological Survey to outline a long-range program for making these determinations. The State of Nevada is coordinating its investigations of water resources with those of the Atomic Energy Commission.

Methods for Alleviating or Resolving Problems

The basic requirement in seeking to resolve or alleviate Nevada's present and potential water problems is to have a good understanding and knowledge of these problems as they relate to the water resources of the State. Through its cooperative program with the Water Division of the Geological Survey, the State of Nevada is obtaining considerable data, not only for resolving its water problems but for making a good appraisal of the State's water resources. Although the size of the investigative program has been increasing in recent years much work remains to be done, and facets of the water resources have not been studied. Solutions for many problems were suggested in the preceding section as the different types of ground-water problems were identified. In general, problems associated with long-term development can be eliminated by prudent planning, if the nature and extent of the water resources for a particular area are known.

One method for lessening the effects of overdevelopment is to increase the recharge to the overdeveloped area. Artificial recharge, as such, has not been attempted in Nevada to date. It has been successful in other parts of the Nation, however, and undoubtedly it could be successful in some areas in Nevada also. However, many geologic, hydrologic, and economic factors bear on the success or failure of artificial-recharge projects. Areas from which the runoff is substantial should be investigated to learn if artificial recharge methods are practical because runoff onto the playas is practically a total loss to the State's water resources.

Artificial recharge might be effective along some of the major streams. To effect artificial recharge to these areas, the ground-water levels adjacent to the streams must be lowered. The lowering usually is done in areas where ground water is pumped for beneficial use. As a result of the lowering the storage capacity of the ground-water reservoir adjacent to the stream is increased, thereby permitting some streamflow that formerly passed through the area to go into ground-water storage. The method is especially beneficial if it diverts into ground-water storage, streamflow that in large part otherwise would have run onto playa and sink areas or into saline lakes at the mouths of the streams. This method for solving or alleviating an inadequate water supply often gives rise to problems relating to the infringement of existing surface-water rights. However, a clear understanding of the effects of such development should enable satisfactory adjustments to be made for the granting of new rights and for the adequate reimbursement to holders of existing rights, with a resultant improvement in the overall economy of the State. Hydrologists generally agree that a coordinated development of ground-water and surface-water resources is necessary for the optimum development of the Nation's water resources.

If weather modification becomes practical it might be used to increase the total water supply of the State. Another way for increasing the usable supply is to improve the chemical quality of water to the point where it becomes satisfactory for its intended use. Demineralization of saline water is approaching economic feasibility. Continued research in this field should disclose even more economical and better methods to demineralize water.

Suppression of evaporation from free water surfaces is a promising method for conserving water supplies. Because of the high evaporation rates that are common in Nevada, any advancement in finding economical and practical methods for suppressing evaporation would be of considerable economic significance to the State. Evaporation from all the reservoirs in the State and those bordering the State, is estimated at about 2 million acre-feet annually or about one-half the run-off of all the major streams in the State.

Present Development

In most valleys ground water is developed for irrigation, but in a few valleys, such as Las Vegas Valley and the Truckee Meadows, it is developed principally for domestic and municipal use. The principal ground-water areas are shown in figure 1 (following p. 10). In this report a principal ground-water area is one for which the average annual recharge is estimated to be at least 5,000 acre-feet. Thus, some valleys, even though well known, are not shown in the figure nor are data for them given in table 1. The principal areas are listed in numerical order on page 9 and in alphabetical order on page 10. Figure 2 (following p. 10) shows the principal areas in which the present development is less than half the estimated average annual recharge. The only areas in which the present development approaches or exceeds the estimated average annual recharge are Las Vegas and Pahrump Valleys and possibly Quinn River and Kings River Valleys. (See fig. 3, following p. 10). Whether development exceeds recharge depends on the amount of pumpage that infiltrates back to the ground-water reservoir. In some valleys a significant part of the pumpage returns to the ground-water reservoir, thereby increasing the total available supply.

Numerical index of principal ground-water areas in Nevada

Number	Area	Number	Area
1	Upper Snake River drainage basin	28	Steptoe Valley
2	Lower Snake River drainage basin	29	Spring Valley
3	Thousand Spring Creek and Pilot Creek drainage basins	30	Newark Valley
4	Snake Valley	31	Diamond Valley
5	Marys River Valley	32	Grass Valley, Lander and Eureka Counties
6	North Fork, Humboldt River drainage basin	33	Antelope-Kobeh Valleys, Eureka County
7	Maggie Creek drainage basin	34	Monitor Valley
8	Huntington and Lamoille Valleys	35	Smith Creek Valley
9	Elko area	36	Dixie Valley
10	Pine Creek Valley	37	Buena Vista Valley
11	Battle Mountain area and Boulder Valley	38	Quinn River Valley
12	Crescent Valley	39	Kings River Valley
13	Reese River Valley	40	Black Rock and Smoke Creek Deserts
14	Kelly Creek drainage area	41	Long Valley, Washoe County
15	Paradise Valley	42	Big Smoky Valley
16	Grass Valley, Humboldt County	43	Fish Lake Valley
17	Lovelock Valley	44	Ralston Valley
18	Truckee Meadows, Reno-Sparks area	45	Hot Creek Valley
19	Carson Valley	46	Railroad Valley
20	Smith Valley	47	Penoyer Valley
21	Mason Valley	48	Sarcobatus Flat
22	Clover-Independence Valleys	49	Amargosa Desert-Ash Meadow Valley
23	Ruby Valley	50	Pahrump Valley
24	Butte Valley	51	White River Valley
25	Goshute-Antelope Valleys, Elko County	52	Lake Valley
26	Long Valley, White Pine County	53	Meadow Valley Wash above Caliente
27	Jakes Valley	54	Pahranagat Valley
		55	Upper Moapa Valley
		56	Lower Moapa Valley
		57	Las Vegas Valley

Alphabetical index of principal ground-water areas in Nevada

UNITED STATES
DEPARTMENT OF INTERIOR
GEOLOGICAL SURVEY

DEPARTMENT OF CONSERVATION
AND NATURAL RESOURCES
STATE OF NEVADA

FIGURE 1, INFORMATION
REPORT 1

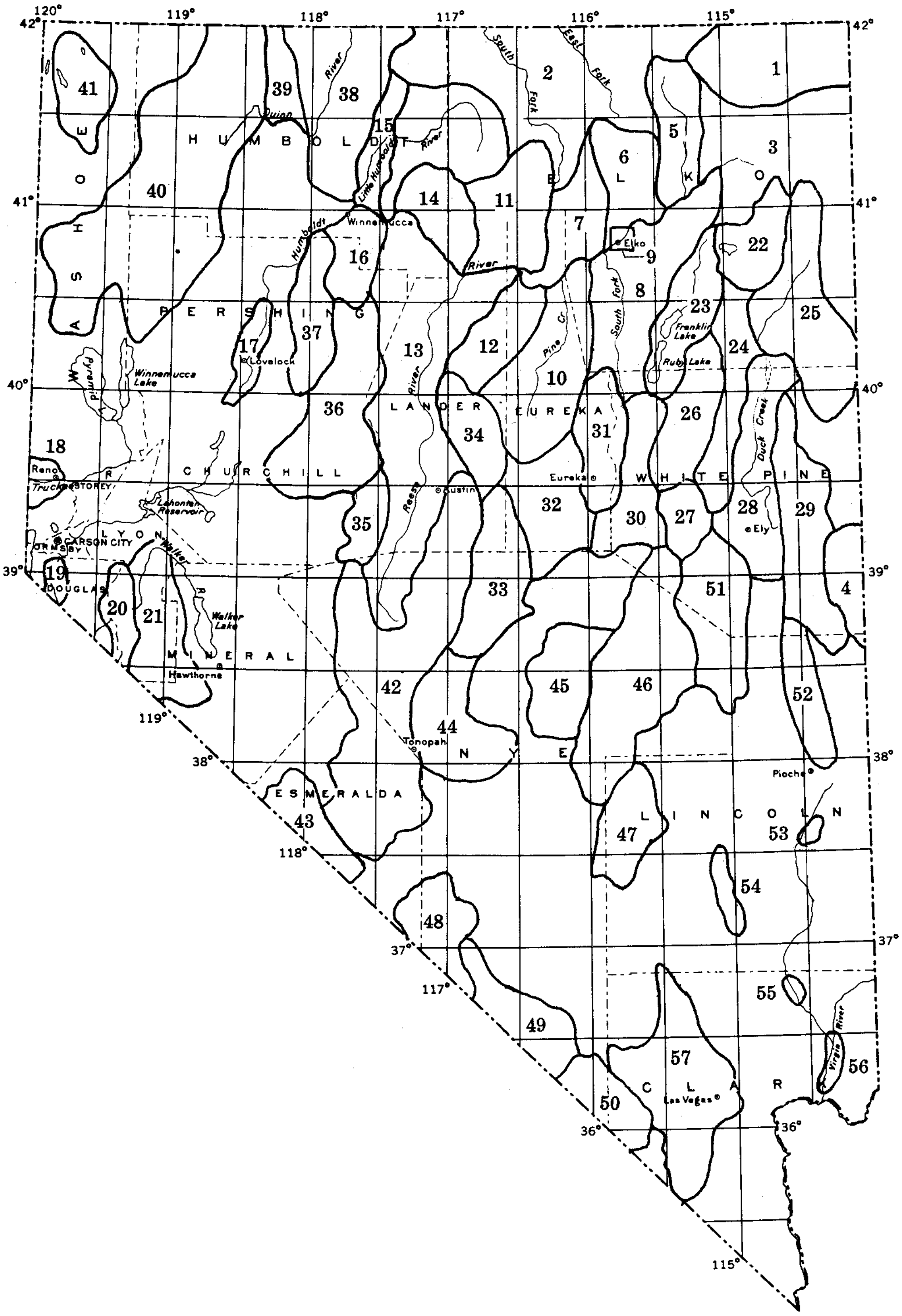

Figure 1.—Principal ground-water areas in Nevada, 1960 (Area numbers correspond to numbers in table 1.)

UNITED STATES
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FIGURE 2, INFORMATION
REPORT 1

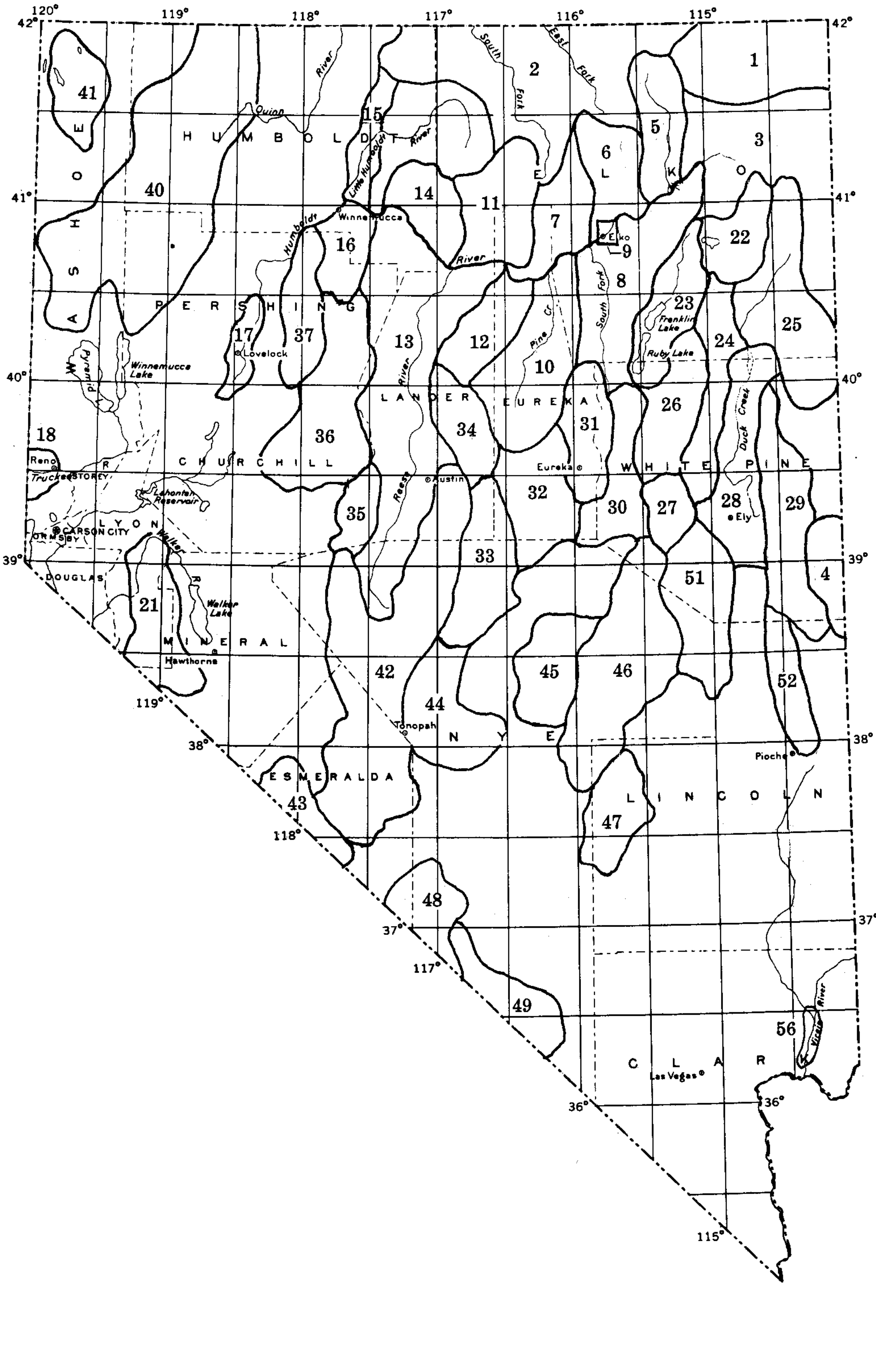

Figure 2.—Principal ground-water areas in Nevada, 1960, where withdrawal is less than 50 percent of the estimated average annual recharge. (Area numbers correspond to numbers in table 1.)

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STATE OF NEVADA

FIGURE 3, INFORMATION
REPORT 1

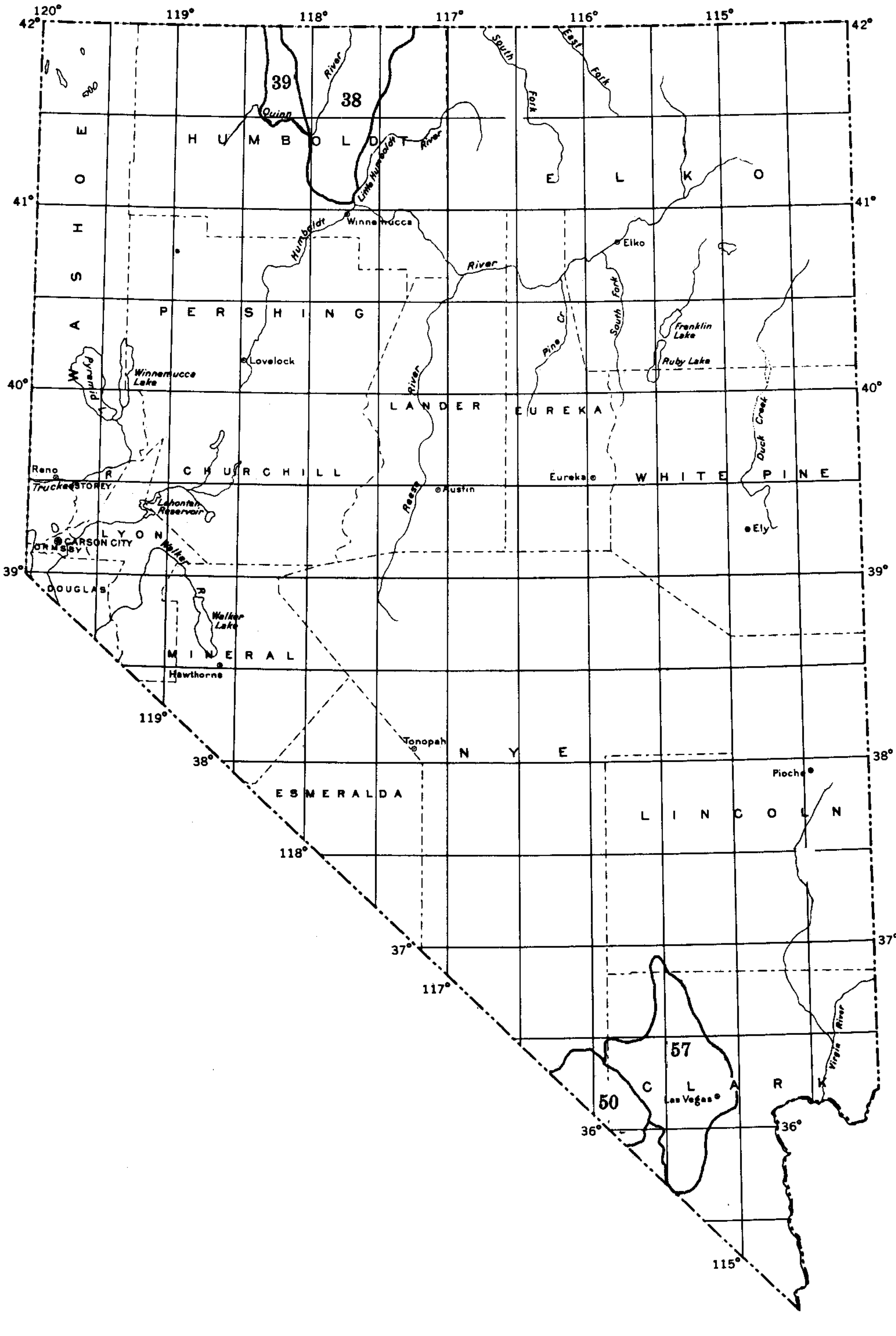

Figure 3.—Principal ground-water areas in Nevada, 1960, where withdrawal approaches or exceeds the estimated average annual recharge. (Area numbers correspond to numbers in table 1.)

Development of ground-water resources in excess of natural recharge in Las Vegas and Pahrump Valleys, in the southern part of the State, has resulted in the lowering of water levels 100 feet or more and in the decrease or cessation of the flow of many artesian wells and springs. Ground-water levels in Las Vegas Valley have declined at an accelerated rate during the last two decades principally as a result of the rapid development of the valley, with accompanying increased demand for water by municipal and commercial users. Of the total pumpage of about 53,000 acre-feet in 1960, only about 8,000 acre-feet was used for irrigation. The average annual rate of recharge to the artesian reservoir of Las Vegas Valley is estimated to be about 25,000 acre-feet.

In Pahrump Valley, ground water is used principally for irrigation. Unlike most other developed areas in the State, the entire supply of water in Pahrump Valley is ground water. In 1960 the pumpage from 65 wells in the valley was about 26,000 acre-feet. The average annual rate of recharge to the valley has been estimated at about 23,000 acre-feet.

Ground water has been developed intensively in recent years in Kings River and Quinn River Valleys, both adjacent to the Oregon border. The pumpage in Kings River Valley in 1960 was about 22,000 acre-feet. The estimated average annual recharge to the valley is about 15,000 acre-feet. In Quinn River Valley irrigation wells have been concentrated in the Orovada area with the result that during the past several years considerable interference between wells and a substantial annual rate of lowering of water levels have been noted. The pumpage in Quinn River Valley in 1960 was about 32,000 acre-feet. The average annual recharge to the valley is estimated to be about 24,000 acre-feet.

Ground water in other valleys in the State has been developed mostly as a standby or supplemental source of irrigation water, and therefore, the pumpage in any one year is largely dependent on the amount of surface water that is available for the particular year. During dry years, such as 1959 and 1960, more than the average amount of ground water is used.

Development of ground water during the last decade has been stimulated not only by the drought but also by the discovery of many new areas in which large irrigation supplies can be obtained.

Potential Development

All the areas shown in figure 1, except those which also are shown in figure 3, have significant quantities of ground water that are still undeveloped. Information on the maximum potential development in specific areas is given in table 1 under the heading "Further Development." Because of a lack of data, estimates were not made for many of the areas.

Initially, ground water in most of the areas probably will be developed for irrigation. The remoteness of many of the areas from transportation facilities, sources of labor, and other facilities will tend to retard the development of ground water by industry, although the demand for water and the consumptive use of water by many industries is much less than the consumptive use by agriculture.

For the State, as a whole, the total amount of additional ground water that can be developed on a perennial basis is virtually limited to the amount of ground water now being discharged non-beneficially that can be diverted to beneficial use. Most of the current non-beneficial discharge of ground water results from the evaporation of ground water from the land surface or from the transpiration by water-loving plants, known as phreatophytes. The more common phreatophytes native to Nevada that have little or no economic value include salt grass, rabbit-brush, salt bush, greasewood, and willow. It has been estimated that in Nevada phreatophytes cover almost 3 million acres, and that they annually transpire or discharge approximately 1 1/2 million acre-feet of ground water.

In order to determine the maximum practical amount of water now being consumptively wasted by phreatophytes that can be salvaged for beneficial use will require adequate knowledge of the various components of the hydrologic system in each ground-water area, the interrelations between the components, and the interrelations between areas. Much time and money will be needed to achieve this objective.

Table 1.--Water situation in principal ground-water areas in Nevada, 1960

(A principal ground-water area as used in the table is one for which the average annual recharge is estimated to be at least 5,000 acre-feet.)

Area No. on maps	Area	Current situation	Further development--based on pumpage not exceeding recharge
1	Upper Snake River drainage basin	Annual use about 5,000 acre-feet	Total potential unknown, but may be several times current use.
2	Lower Snake River drainage basin	Use small.	Significant amount of ground water probably can be developed.
	Great Salt Lake-Sevier drainage basin		
3.	Thousand Spring Creek and Pilot Creek drainage basins, Elko Co.	Use small.	" " " "
4	Snake Valley, White Pine Co.	Annual use about 15,000 acre-feet from wells and springs.	Potential for additional development not known, but probably does not exceed current use.
	Northern Great Basin		
	Humboldt River Basin		
5	Marys River Valley, Elko County	Annual use 350 acre-feet	Possible legal problem to the extent that development of ground water interferes with existing surface-water rights.
6	North Fork, Humboldt River drainage basin, Elko County.	Use small.	" " " "
7	Maggie Creek drainage basin, Elko County.	" "	" " " "
8	Huntington and Lamoille Valleys, Elko County	" "	" " " "

Table 1.--(Continued)

Area No. on maps	Area	Current situation	Further development--based on pumpage not exceeding recharge
9	Elko area, Elko County.	Municipal use about 2,600 acre-feet annually; occurrence of warm to hot water locally limits use.	Potential for additional development unknown, but may approximate current use.
10	Pine Creek Valley, Elko County.	Annual use about 4,000 acre-feet.	Potential for additional development, about 20,000 acre-feet; possible legal problems to the extent that future development of ground water will interfere with existing surface-water rights.
11	Battle Mountain area and Boulder Valley, Eureka and Lander Counties.	Annual use about 2,200 acre-feet.	Considerable potential for additional development unless development interferes with existing surface-water rights.
12	Crescent Valley, Eureka and Lander Counties.	Annual use about 2,000 acre-feet.	Potential for additional development, about 10,000 acre-feet per yr.
13	Reese River Valley, Lander County.	Annual use about 4,000 acre-feet mainly in Antelope Valley segment of lower Reese River Valley, of which about 100 acre-feet is for municipal supply at Battle Mtn. Use in upper valley is small.	Total potential is unknown, but is estimated to be between 25,000 and 35,000 acre-feet per year.
14	Kelly Creek drainage area, Humboldt and Elko Counties.	Use small, some irrigation from springs.	Potential development substantial, provided such development does not interfere unduly with existing surface-water rights.

Table 1.--(Continued)

Area No. on maps	Area	Current situation	Further development--based on pumpage not exceeding recharge
15	Paradise Valley, Humboldt Co.	Annual use about 6,500 acre-feet.	Total ground water available about 15,000 acre-feet per year.
16	Grass Valley, Humboldt County.	Annual use about 5,000 acre-feet.	Total ground water available about 10,000 acre-feet per year.
17	Lovelock Valley, Pershing County.	Annual use about 1,000 acre-feet; highly mineralized water in southern part and much of northern part of valley.	Total ground water of suitable chemical quality several times current use. Ground water satisfactory for municipal and irrigation use probably can be obtained on northeast flank of valley.
	Northern Great Basin - Truckee River Basin		
18	Truckee Meadows Reno - Sparks area, Washoe County.	Annual use about 2,000 acre-feet principally for municipal supply; warm water and highly mineralized water occurs locally.	Total ground water available estimated to be considerably more than 10,000 acre-feet per year.
	Northern Great Basin - Carson River basin		
19	Carson Valley, Douglas County	Annual use about 7,000 acre-feet, high water table in some areas.	Total potential unknown, but it is estimated that about 10,000 acre-feet of evapotranspiration waste can be salvaged annually.
	Northern Great Basin - Walker River basin		
20	Smith Valley, Lyon County.	Annual use about 3,000 acre-feet.	Total ground water available without unduly interfering with existing surface-water rights is estimated at about 5,000 acre-feet per year.

Table 1. --(Continued)

Area No. on maps	Area	Current situtation	Further development--based on pumpage not exceeding recharge
21	Mason Valley, Lyon County,	Annual use several thousand acre-feet for supplemental irrigation, about 3,000 acre-feet for industrial use.	Total ground water available will be limited to extent development interferes with existing surface-water rights.
	Northern Great Basin-ground-water basins not draining to principal streams		
22	Clover-Independence Valleys, Elko County.	Annual use in Clover Valley about 3,000 acre-feet from springs, negligible use from wells; use in Independence Valley small.	Annual recharge to Clover Valley about 20,000 acre-feet; to Independence Valley about 10,000 acre-feet; estimate about 10,000 acre-feet per year available for irrigation in Clover Valley, about 2,000 acre-feet in Independence Valley.
23	Ruby Valley, Elko and White Pine Counties.	Annual use about 5,000 acre-feet from springs.	Total of about 20,000 acre-feet per year available north of Franklin Lake.
24	Butte Valley, White Pine County.	Use small.	Total available supply estimated at 5,000 acre-feet per year.
25	Goshute-Antelope Valleys, Elko County.	Annual use probably less than 2,000 acre-feet principally from springs.	Total ground water available estimated at about 10,000 acre-feet per year.
26	Long Valley, White Pine County.	Use negligible.	Average annual recharge estimated at 10,000 acre-feet per year.
27	Jakes Valley, White Pine County	No use; depth to water excessive for irrigation.	Average annual recharge estimated at 13,000 acre-feet; probably discharges to White River Valley.

Table 1. -- (Continued)

Area No. on maps	Area	Current situation	Further development--based on pumpage not exceeding recharge
28	Steptoe Valley, White Pine and Elko Counties.	Annual use about 5,000 acre-feet from springs and 1,000 acre-feet from wells.	Total available supply unknown, but may be near 50,000 acre-feet per year.
29	Spring Valley, White Pine County.	Annual use about 5,000 acre-feet from springs and 5,000 acre-feet from wells.	Total available supply unknown, but estimated at about 25,000 acre-feet per year.
30	Newark Valley, White Pine and Eureka Counties.	Annual use about 5,000 acre-feet from springs and a few hundred acre-feet from wells.	Total available supply estimated at about 18,000 acre-feet per year.
31	Diamond Valley, Eureka and Elko Counties.	Annual use about 4,000 acre-feet from springs and about 8,000 acre-feet from wells.	Total available unknown, but estimated to be at least 20,000 acre-feet per year.
32	Grass Valley, Lander and Eureka Counties.	Use negligible	Total available unknown, but may be on order of 10,000 acre-feet per yr.
33	Antelope - Kobeh Valleys, Eureka County.	Annual use about 1,000 acre-feet, mostly from flowing wells and springs.	Total available unknown, but probably about 5,000 acre-feet per yr.
34	Monitor Valley, Nye and Lander Counties.	Use small.	Total available unknown, but may exceed 10,000 acre-feet per year.
35	Smith Creek Valley, Lander County.	" "	Total available unknown, but may exceed 5,000 acre-feet per year.
36	Dixie Valley, Churchill and Pershing Counties.	Use small, mostly from flowing wells.	Total available unknown, but estimated at about 10,000 acre-feet per year.

Table 1.--(Continued)

Area no. on maps	Area	Current situation	Further development--based on pumpage not exceeding recharge
37	Buena Vista Valley, Pershing County.	Use a few hundred acre-feet per year.	Total available supply estimated at 10,000 acre-feet per year.
38	Quinn River Valley, Humboldt County.	Annual use about 32,000 acre-feet; water levels declining; interference between wells.	Average annual recharge to ground-water reservoir estimated at 24,000 acre-feet.
39	Kings River Valley, Humboldt County.	Annual use about 22,000 acre-feet.	Average annual recharge to ground-water reservoir estimated at 15,000 acre-feet.
40	Black Rock and Smoke Creek Deserts - Humboldt and Washoe Counties.	Annual use may exceed 20,000 acre-feet. Development is scattered and is mostly from springs and spring-fed streams. Highly mineralized water underlies most of the playas.	At the mouths of the better tributary areas high-capacity wells probably can be developed. Development in a particular area will depend in large part on the amount of ground water of good chemical quality that recharges the area.
41	Long Valley, Washoe County.	Annual use about 500 acre-feet.	Total ground water available not known, but may exceed 15,000 acre-feet per year.
	Southern Great Basin		
42	Big Smoky Valley, Nye, Lander, and Esmeralda Counties.	Annual use about 1,500 acre-feet.	Total available probably exceeds 30,000 acre-feet per year.
43	Fish Lake Valley, Esmeralda County.	Annual use about 5,000 acre-feet from springs, and about 4,000 acre-feet from wells.	Total available estimated at about 30,000 acre-feet per year.

Table 1. -- (Continued)

Area No. on maps	Area	Current situation	Further development -- based on pumpage not exceeding recharge
44	Ralston Valley, Nye County.	Use small, principally for municipal supply.	Total supply unknown, but probably less than 10,000 acre-feet per year.
45	Hot Creek Valley, Nye County.	Annual use more than 1,000 acre-feet.	Total available estimated at 10,000 acre-feet per year.
46	Railroad Valley, Nye, White Pine, and Lincoln Counties.	Annual use about 10,000 acre-feet from springs and 1,000 acre-feet from wells.	Average annual recharge estimated at 50,000 acre-feet. Irrigation may be limited by amount of arable land.
47	Penoyer Valley, Nye County.	Annual use about 500 acre-feet.	Total available probably between 5,000 and 10,000 acre-feet per year.
48	Sarcobatus Flat, Nye County.	Use small.	Total available unknown, but recharge probably exceeds 5,000 acre-feet per year.
49	Amargosa Desert, - Ash Meadow Valley, Nye County.	Annual use in Amargosa Desert about 2,000 acre-feet; in Ash Meadow Valley most of the annual discharge of springs of about 18,000 acre-feet irrigates salt grass.	Average annual recharge to Amargosa Desert unknown, but probably less than 10,000 acre-feet. Average annual recharge to Ash Meadow Valley is represented by spring discharge of about 18,000 acre-feet annually; possibility for export of water.
50	Pahrump Valley, Clark and Nye Counties.	Annual use about 26,000 acre-feet from wells and springs.	Average annual recharge estimated at about 23,000 acre-feet.

Table 1.--(Continued)

Area No. on maps	Area	Current situation	Further development--based on pumpage not exceeding recharge
.	Lower Colorado River Basin		
51	White River Valley, White Pine, Nye, and Lincoln Counties	Annual use about 20,000 acre-feet from springs and about 2,500 acre-feet from wells.	Total available about 53,000 acre-feet, which includes about 13,000 acre-feet of underflow from Jakes Valley.
52	Lake Valley, Lincoln County	Annual use about 4,000 acre-feet from springs.	Total available unknown, but is estimated at about 10,000 acre-feet per year.
53	Meadow Valley Wash above Caliente, Lincoln County	Annual use about 3,000 acre-feet from wells and about 4,000 acre-feet from springs.	Average annual recharge estimated at about 11,000 acre-feet.
54	Pahranagat Valley, Lincoln County	Annual use about 15,000 acre-feet from springs and a few thousand acre-feet from wells. Water-logging in some areas.	Total available about 25,000 acre-feet per year.
55	Upper Moapa Valley, Clark County	Annual use about 9,500 acre-feet, of which about 4,000 acre-feet is from wells and 5,500 acre-feet from springs; water moderately to highly mineralized in much of the area.	The annual flow of spring-fed Muddy River is about 30,000 acre-feet, much of which is used in Lower Moapa Valley.
56	Lower Moapa Valley, Clark County	Annual use about 12,000 acre-feet, principally from spring-fed Muddy River.	Potential for irrigation limited by quality of water; also by existing rights to river water.
57	Las Vegas Valley, Clark County	Annual ground-water use about 53,000 acre-feet; of which about 8,000 acre-feet is used for irrigation; declining water levels about 16,000 acre-feet of water imported from Lake Mead to supplement ground water supplies.	Average annual recharge to artesian ground-water reservoir estimated at about 25,000 acre-feet.