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APPRAISAL OF WATER RESOURCES IN THE FORT McDERMITT INDIAN RESERVATION, HUMBOLDT COUNTY, NEVADA

By Freddy E. Arteaga

Open-File Report 78-139

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Appraisal of Water Resources in the
Fort McDermitt Indian Reservation,
Humboldt County, Nevada, Open-File
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ERRATA SHEET

The following changes should be made to the text and illustrative plates.

(1) page 27, 1st paragraph, line 11 -- 30-ft^3/s, 20-percent should read 20-ft^3/s, 30-percent

(2) Plates 1-4, upper right hand corner, OPEN FILE REPORT 77- should read OPEN FILE REPORT 78-139

(3) page 27, second line from the bottom -- should read 3-1,460, not 31460

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ILLUSTRATIONS

TABLES

CONVERSION FACTORS

For those readers who may prefer to use metric units rather than U.S. customary units, the conversion factors for terms in this report are listed below:

U.S. customary unit	Metric unit	Multiplication factor to convert from U.S. customary to metric quantity
Acres	Hectares (ha)	0.4047
Acre-feet (acre-ft)	Cubic meters (m^3)	1,233
cubic feet per second (ft^3/s)	Cubic meters per second (m^3/s)	.02832
Feet (ft)	Meters (m)	.3048
Gallons per minute (gal/min)	Liters per second (L/s)	.06308
Inches (in)	Centimeters (cm)	2.540
Miles (mi)	Kilometers (km)	1.609
Square feet (ft^2)	Square meters (m^2)	.09290
Square miles (mi^2)	Square kilometers (km^2)	2.590

APPRAISAL OF WATER RESOURCES IN THE FORT McDERMITT INDIAN RESERVATION, HUMBOLDT COUNTY, NEVADA

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ABSTRACT

Consideration of land-management alternatives in parts of the Fort McDermitt Indian Reservation has prompted an evaluation of water resources in the reservation and vicinity. The study area comprises (1) about 9 square miles of reservation land, plus adjacent areas, on and bordering the floor of Quinn River valley near McDermitt, Nev., and (2) the uninhabited 5.6-square-mile Hog John Ranch (also part of the reservation) and adjacent areas along the boundary between Kings River and Desert Valley, about 35 miles southwest of McDermitt.

In both areas, the valley-fill reservoir forms the principal source of ground water. The reservoir is at least 1,225 feet deep at one site near McDermitt. Volcanic rocks also form an important source of ground water for several wells near McDermitt. A 12-inch diameter, 720-foot test well drilled on the reservation near McDermitt produced 360 gallons per minute with a drawdown of 149 feet (specific capacity, 2.4 gallons per minute per foot of drawdown). A transmissivity of 640 feet squared per day for this well was obtained from a 44-hour pumping test. Transmissivities for 6 other wells in the McDermitt area ranged from 710 to 11,000 feet squared per day. In this area, water levels ranging from 3 to 250 feet below land surface have remained almost the same as those of 1964. Depth to water generally increases away from the valley lowlands.

The valley-fill reservoir in the Hog John Ranch area is at least 350 feet deep. Depth to water in the vicinity of the Ranch ranges from 0.25 to 48 feet, with deeper water levels generally found at higher land elevations. Net change in these water levels has been negligible for a period of nearly 30 years. Two adjacent test wells at the Ranch were augered to depths of 33 and 90 feet during this study, and completed with well-bottom screens. Differing water levels in the two wells indicate a minimum upward hydraulic gradient of about 0.07 foot per foot in the zone penetrated by the holes.

Water quality in the McDermitt area is generally suitable for most uses. In the Ranch area, water salinity appears to decrease with increasing well depth, and is generally suitable for irrigation at depths exceeding 50 feet.

The East Fork Quinn River, which flows directly through the inhabited part of the reservation, has an average runoff of about 20,000 acre-feet per year at the gage 7 miles east of McDermitt. Streamflow from Quinn River, Kings River, and Desert Valleys passes intermittently through the Ranch by way of the Quinn River, but the quantity of flow is not known.

INTRODUCTION

This study has been prepared in cooperation with the Economic Development Administration, U.S. Department of Commerce. Its purpose is to provide specific information about water resources on the reservation that can be used in considering economic development alternatives.

Location and General Features

The reservation is divided into two parts, the main area in the vicinity of McDermitt, Nev., and the Hog John Ranch area approximately 35 miles southwest of McDermitt (fig. 1). The two areas differ hydrologically and in the extent of development. For these reasons, the hydrology of each area is discussed separately.

The main area (hereafter referred to as "the Reservation") lies along the Oregon-Nevada border, in both the northwestern part of Humboldt County, Nev., and the southern part of Malheur County, Ore. (fig. 1). About 60 percent (27 mi^2) of the area is in Oregon and the remainder (18 mi^2) is in Nevada. Practically all the inhabitants of the Reservation, about 350, live along the flood plain of the East Fork of the Quinn River, between U.S. Highway 95 on the west and the tribal headquarters on the east (fig. 1). Tribal lands west of the highway are on the flood plains of the Quinn River, McDermitt Creek, and Oregon Canyon Creek, and are used mainly for cattle grazing and some hay cropping. Currently (1976) only four families live in this latter area. The Reservation is in the hydrographic unit known as the McDermitt subarea, a part of the Quinn River valley (Huxel, 1966).

Near McDermitt, only the reservation lands on the valley floor were dealt with. According to Huxel (1966, p. 10), the valley area is a north-trending structural trough, bounded on the east and west by uplifted mountain blocks (pl. 1). The valley, consisting of sloping alluvial fans and the Quinn River flood plain, ranges in altitude from about 4,800 ft at the bedrock-alluvium contact to about 4,400 ft at the Quinn River.

The uninhabited Hog John Ranch area (hereafter referred to as "the Ranch") is in north-central Humboldt County, Nev., about 35 miles southwest of the main reservation area. The Ranch extends along the flood plain of the Quinn River, which forms the southern boundary of the Sod House subarea of Kings River valley, and the northern boundary of Desert Valley (fig. 1), and encompasses an area of about 5.6 mi^2, extending along both sides of the Quinn River for a distance of about 12 mi. The eastern boundary of the Ranch is about 3 mi upstream from the confluence of the Kings and Quinn River, and the west boundary extends about 2 mi into adjacent Pine Forest Valley (pl. 3). Native grass grows along the flood plain of the Quinn River and this area is grazed by cattle. The altitude ranges from about 4,100 ft on the west boundary to about 4,200 ft on the eastern end.

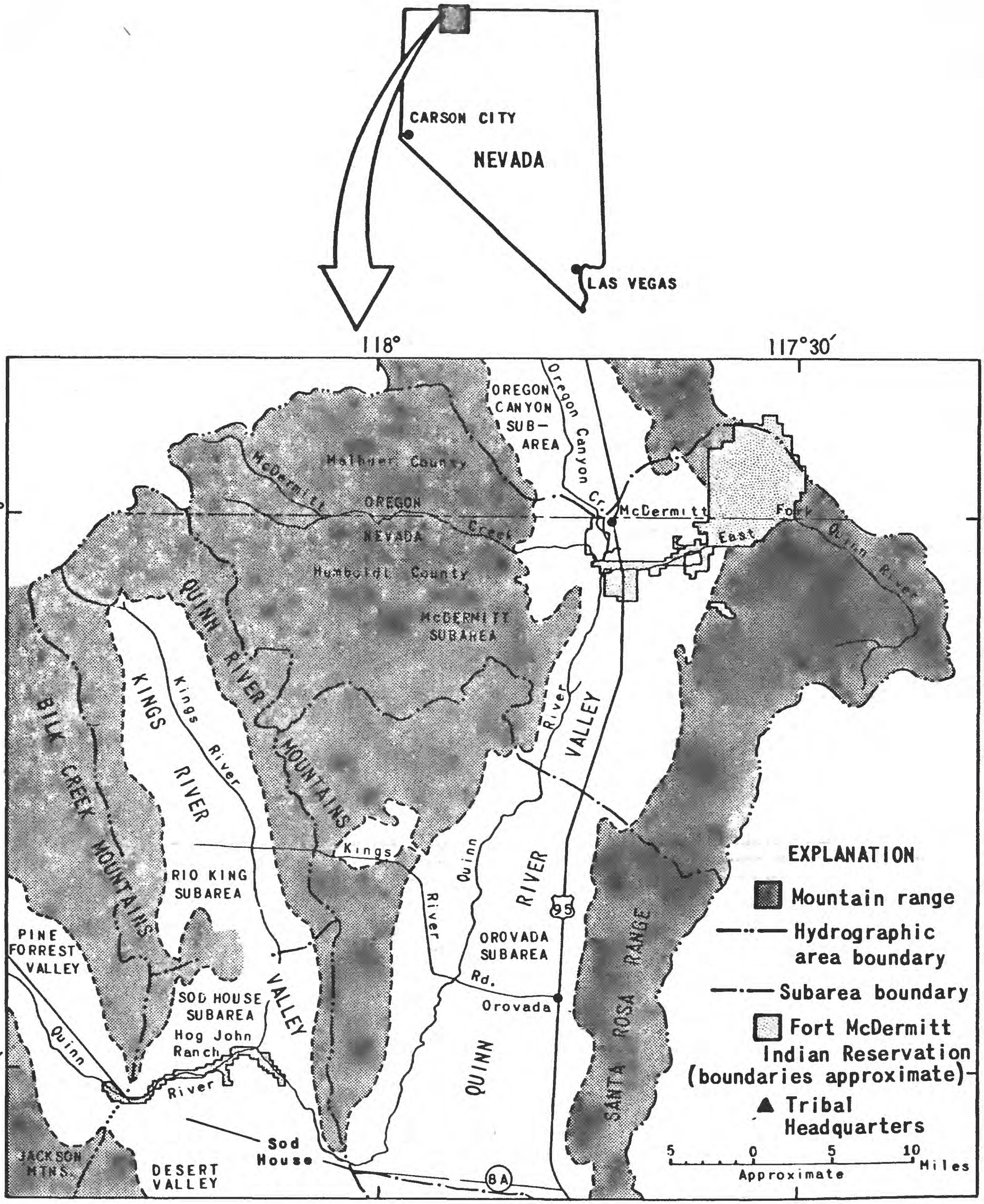


Figure 1.--Location and general physiographic features of study area.

Scope of the Project

Much of the Reservation is in mountainous areas that characteristically are not suitable for large-scale ground-water development. In this study, as a result, evaluation of the ground-water resources of the Reservation was restricted to areas on the valley floor which generally are the more favorable for development. However, the water resources of the Reservation could not be adequately evaluated without developing an understanding of hydrologic conditions in adjacent areas. Consequently, the discussion of the Reservation includes pertinent information on adjacent parts of Quinn River valley, and the evaluation of the Ranch area includes pertinent information on adjacent parts of Desert Valley and the Sod House subarea of Kings River valley.

Major items of work have included review of existing information, canvassing of selected wells, measuring of water levels, collection of water samples for chemical analysis, aquifer tests on selected wells, and analysis and interpretation of the information collected. A 12-inch diameter, 720-foot deep test hole was drilled on the Reservation in September 1976, and four small-diameter, shallow test holes were augered on the Ranch during December 1975 and January 1976. The latter wells were used to supplement existing control points for water-level contours, water-quality sampling, and detection of vertical hydraulic gradients (pl. 1-3).

Previous Investigations

Previous work on the hydrology of the Reservation area included reconnaissance studies of ground-water conditions in the Quinn River valley by Bryan (1923) and Visher (1957), and a more detailed study of the valley by Huxel (1966). The first report discussed ground-water conditions mainly around Orovada, approximately 30 miles south of the Nevada-Oregon border. The second study included sections on the climate, physiography, geology, surface water, ground water, water quality, and the development of ground water as of 1954. Data on 17 wells in the vicinity of McDermitt were included. Two of these wells were on the reservation and both were less than 20 ft deep. The third report dealt with a reappraisal of the hydrology of the valley, with special emphasis on the effects of ground-water development in the Orovada subarea for the period 1947 and 64. Data for part of the study area, referred to in that report as the McDermitt subarea, included information on seven wells within the Reservation. The geology of the McDermitt area was mapped by Willden (1964, pl. 1), Walker and Repenning (1966), and Greene (1972). A soil survey made in 1974 by L. I. Larsen (U.S. Soil Conservation Service, written commun., 1975) on the Reservation identified four different types of soils and five vegetative assemblages in parts of sections 21 and 28, T. 47 N., R. 38 E.

Two reports prepared under the cooperative program between the State of Nevada and the U.S. Geological Survey have been drawn upon extensively in evaluating the Hog John Ranch area. The first report

(Zones, 1963) contains the results of a reconnaissance study made in 1958-59 of the ground-water resources of the Kings River valley. It gives a brief description of the geology, hydrology, and water quality of the valley. The second report (Malmberg and Worts, 1966) included a determination of the effect of pumping during the period 1957-63 on the flow system in the Rio King subarea. The southern part of the valley, referred to in that report as the Sod House subarea, includes the Ranch. A water budget was computed for each subarea. Additionally, a water-table-altitude map, analyses of well-water quality, and the drilling of 18 small-diameter (2-in) wells were completed during that study. Of those 18 wells, 12 are within the vicinity of the Ranch. Most of these were used in the present study to depict current depth to water (pl. 3) and water-quality parameters.

In addition, reports concerning Pine Forest and Desert Valleys (Sinclair, 1962) include information on well construction and logs in the areas immediately east and south of the Ranch, respectively. The geology of the area encompassing the Ranch was mapped by Willden (1964, pl. 1). The soil survey made by Larsen on the Ranch (written commun., 1975) identified five different types of soils and eight vegetative assemblages throughout the Ranch.

Numbering System for Wells

The well-numbering system used in this report indicates the location of the wells by hydrographic areas and by official rectangular subdivisions of the public lands. Nevada has been divided into 14 hydrographic regions and basins, and approximately 250 individual hydrographic areas or valleys (Rush, 1968) which are used to compile information pertaining to water resources in the State. The local well number uses 12 to 16 digits to locate the site by hydrographic area, township, range, section, and section subdivision.

The first segment of the local well number specifies the hydrographic area as defined by Rush. The remainder of the number specifies the township north of the Mount Diablo base line, the range east of the Mount Diablo meridian, the section, and subdivision of the section. In Oregon, the first unit indicates the township south of the Willamette base line and the second unit indicates the range east of the Willamette meridian. Sections are divided into quadrants labeled counterclockwise from upper right as A, B, C, and D. Each quadrant is then similarly subdivided as many as three times, depending on the accuracy of available maps; thus, each section of about 640 acres may be subdivided into tracts of approximately 300 ft on a side containing about 2.5 acres. Lettered quadrants are read from left to right with the largest subdivision on the left. Sites within the smallest listed subdivision are numbered sequentially with 1 digit. For example, as shown in figure 2, a well in the McDermitt subarea of Quinn River valley (hydrographic area 33B) located within the shaded area of section 6, township 47 north, range 38 east, would have the number 33B N47 E38 6CCC1. A second well within the same 2.5-acre tract would be numbered 33B N47 E38 6CCC2.

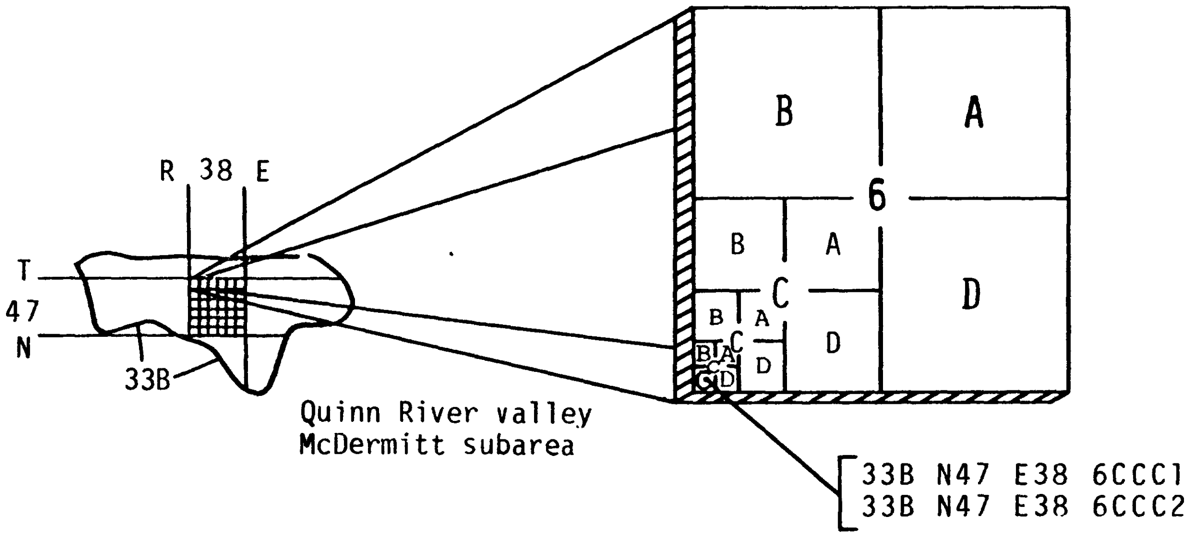


Figure 2.--Numbering system used in Nevada for hydrologic sites.

Acknowledgments

The author wishes to acknowledge the cooperation of ranchers and townspeople of McDermitt, for allowing their wells to be tested and for providing general information about the area; and the U.S. Public Health Service, Indian Health Service, and residents of the Fort McDermitt Indian Reservation for providing data on construction, location, and water quality for existing wells within the Reservation.

Geologic Units and Their Water-Yielding Properties

Geologic units in the vicinity of the Reservation and Ranch are divided into two highly generalized groups, on the basis of their hydrologic properties, as follows: Consolidated volcanic rocks of low to possibly moderate permeability; and valley fill, consisting of unconsolidated to semiconsolidated older and younger sedimentary deposits principally underlying the valley floor and generally having moderate to high permeability (Huxel, 1966, p. 10; Malmberg and Worts, 1966, p. 11). The permeability of a rock or deposit is a measure of its ability to transmit fluid, such as water, under a hydropotential gradient (Lohman, 1972, p. 4). Well 33B N47 E37 24BAC2 is in an area of extensive faulting (pls. 1, 2). These faults may have caused increased fracturing of the basalt which may account for the relatively high yield of that well (tables 5, 7).

Extent and Boundaries of the Ground-Water Reservoirs

Sedimentary deposits and volcanic rocks constitute the two ground-water reservoirs in the study area. The areal and vertical extent of these generalized units is shown on plates 2 and 3, and described in table 1. The contact between the two units doubtless is leaky to a varying degree, permitting ground-water flow from one unit to the other. Hydraulic boundaries, or barriers to flow, within the units include faults and lateral or vertical changes in sedimentary grain size or volcanic rock type.

Near McDermitt, the western one-third of the Reservation is uderlain by as much as 1,225 ft of valley fill, which is the principal ground-water reservoir in the area (table 7). The remaining two-thirds, including almost all Reservation land in Oregon, is underlain by the generally less permeable volcanic rock. The known vertical extent of these geologic units is indicated in table 1. Younger and older sedimentary deposits form the principal ground-water reservoir in the valley.

The Ranch and vicinity is underlain by water-bearing valley fill that exceeds 350 ft in thickness southeast of the Ranch (tables 1, 7). Volcanic rock may underlie the valley fill in this area, but as yet only well 30B N42 E33 10DDB1, 2½ mi north of the Ranch and half a mile from the valley fill-consolidated rock contact, has penetrated the volcanic rocks (tables 1, 7).

Source, Occurrence, and Movement of Ground Water

In the Quinn River valley, which encompasses almost all of the Reservation, ground water is derived from infiltration of precipitation that falls within the drainage basin. Most deep infiltration is from stream channels, and occurs on the upper slopes of the alluvial aprons. In the area surrounding the Ranch, ground water is also derived from local infiltration, and additional quantities enter the area as underflow from the Rio King subarea to the north, from Quinn River valley to the east, and from Desert Valley to the south (Malmberg and Worts, 1966, p. 33).

Table 1.--Principal geologic units and their water-yielding properties

[Geology modified from Willden, 1964, pl. 1; Huxel, 1966, p. 10-12; Malmberg and Worts, 1966, p. 11-16; Walker and Repenning, 1966; and Greene, 1972.]

Geologic age		Geologic unit		General characteristics and extent	Water-yielding properties
TERTIARY AND QUATERNARY	Pleistocene and Holocene	Valley fill	Younger sedimentary deposits	Unconsolidated stream, lake, and mass-wasting deposits of boulders, gravel, sand, silt, and clay, exposed in valley lowlands and along active stream courses. Deposits of Pleistocene age associated with Lake Lahontan are present at altitudes below about 4,400 ft. Maximum thickness generally less than about 200 ft.	Partly above zone of saturation. Coarser-grained sediments below water table may yield several tens of gallons per minute, or more, to properly constructed wells. Finer-grained sediments, including lake-deposited silt and clay yield little water.
TERTIARY AND QUATERNARY	Miocene to Pleistocene	Valley fill	Older sedimentary deposits	Semiconsolidated to unconsolidated deposits similar to those described above. Unit includes tuffaceous sedimentary deposits of Tertiary age mapped near McDermitt by Walker and Repenning (1966) and Greene (1972). Exposed along margins of valley lowlands, generally at altitudes above about 4,400 ft; moderately dissected, and cut by faults in places. Underlie younger deposits beneath valley lowlands. At or near Reservation, depth of unit exceeds 1,225 ft at well 33B S41 E42 23CCB3 and 720 ft at well 33B N47 E38 21DAA1. Near Ranch, depth exceeds 350 ft at well 31 N41 E34 13DD1 and 230 ft at well 31 N42 E34 36BBB1.	Partly above zone of saturation. Principal source of ground water in McDermitt area, where coarser-grained sediments below water table yield several hundred gallons per minute, or more, to properly constructed wells. Deposits largely untested in vicinity of Ranch.
TERTIARY	Miocene and Pliocene	Consolidated rocks	Volcanic rocks	Principally rhyolite and dacite, with smaller areas of basalt and andesite, and some sedimentary rocks. Rhyolite and dacite dominate west of Reservation and east and north of Ranch, and are accompanied by basalt and andesite in east part of Reservation and southwest of Ranch. Maximum thickness exceeds 2,000 ft. At and near Reservation, volcanic rocks extend from 80 to at least 270 ft at well 33B N47 E37 24BAC2 and from 57 to at least 400 ft at well 33B N47 E39 7ADC2. Near Ranch, volcanic rocks were penetrated at a depth of 181 ft in well 30B N42 E33 10DDB1.	Transmits some water along fractures, joints, bedding planes, and interflow zones. In and adjacent to Reservation, yield to wells is variable. Volcanic rocks are virtually untested in vicinity of Ranch.

In both the Reservation and Ranch areas, ground water occurs in saturated parts of the valley fill at shallow depth, where it occupies interstices among the granular clastic deposits. Its occurrence in volcanic rocks is known in several wells in and near the Reservation, wells 33B N47 E37 24BAB2 and 24BAC2, 33B N47 E38 17DAA1 and 21DAA1, and 33B N47 E39 7ADC2. It occurs under both water-table (unconfined) and leaky artesian (semiconfined) conditions. Water-table conditions exist where the saturated materials are not confined by overlying strata of low permeability and where the water pressure at the top of the zone of saturation, the water table, is equal to atmospheric pressure. Artesian conditions occur where saturated permeable materials are overlain by less permeable materials and where the water at the top of the confined unit is at greater-than-atmospheric pressure.

Ground water, like surface water, moves from areas of higher head (water-level altitude) to areas of lower head. The direction of ground-water flow in the Reservation area follows the general direction of surface flow from the generally upland recharge areas toward the central part of the Quinn River valley. Most ground water within the Kings River and Desert Valleys moves from recharge areas in the mountains or on the adjacent alluvial slopes toward the Quinn River in the vicinity of the Ranch, where the water is discharged at the land surface by evapotranspiration or, in the western part of the area, at depth by subsurface movement westward to Pine Forest Valley. Ground water from Desert Valley partly discharges into the Quinn River (Malmberg and Worts, 1966, p. 28).

Horizontal ground-water flow is perpendicular to the water-surface contours shown on plates 2 and 3, and in the direction of decreasing water-surface altitude. The general directions of movement thus indicated on these plates are virtually identical to those described by Huxel (1966) and Malmberg and Worts (1966).

In addition to horizontal movement, the ground water has a downward component of flow in areas of recharge, and an upward component in areas of evapotranspiration along the Quinn River. Water levels in two wells near the Tribal Headquarters (pl. 2) indicate downward movement of water. Land-surface altitude at both wells is approximately 4,640 ft. Static water level in the shallower well (33B N47 E39 7ACDB1, 75 ft deep) is about 6 ft below land surface. Static water level in the nearby deeper well (33B N47 E39 7ADC1, 404 ft deep) is about 182 ft below land surface. This decrease in head with well depth supports the idea that recharge occurs in areas adjacent to the mountains. A pair of adjacent test wells at the Ranch (31 N42 E34 20DBC1 and 2, pl. 3), which were drilled to depths of 90 and 33 ft with screens at the bottom, provide evidence of a strong upward component. The water level in the deeper test well was 5.16 ft below land surface, whereas that in the shallow well was 9.24 ft below land surface, indicating a minimum upward vertical hydraulic gradient of about 0.07 ft/ft in the zone penetrated by the wells. The other two test wells, 30B N42 E33 27DBA1 and 27DBA2, were also drilled approximately 10 ft apart to depths of 127 ft and 92 ft, respectively. The results indicate that water at depth is generally under confined or semiconfined conditions.

Test Well

Drilling and Development

A prime component of this study was the drilling of a deep test well on the Reservation. During the summer of 1976, the well (33B N47 E38 21DAA1) was drilled to a depth of 720 ft about half a mile east of U.S. Highway 95 (pl. 1). The purpose of this test well was to determine subsurface geology, water quality, and probable well yield, thus permitting an evaluation of the potential use of adjacent lands for job-creating enterprises.

The drilling was by the conventional rotary method; the 12-inch test hole was reamed to a diameter of 17½ inches and cased with 12-inch diameter casing. Preperforated casing was placed at two intervals, 149-328 ft and 398-616 ft. The perforations were 1/8-in by 3-in slots spaced at 14 slots per ft. These intervals were selected on the basis of data in electric, geologic, and drilling-time logs. The electric and drilling-time logs are shown on plate 4, and the geologic log is shown in table 7.

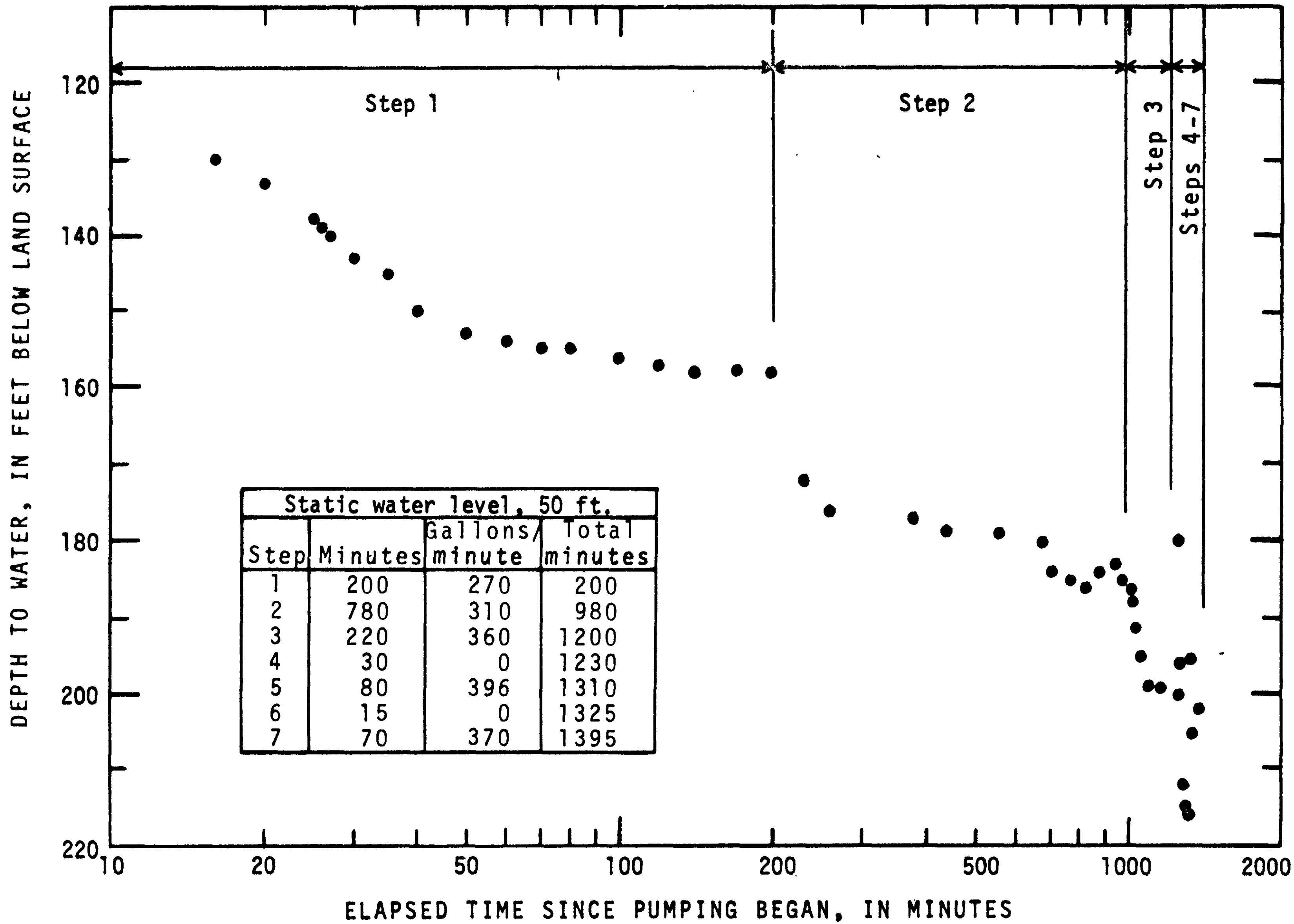
Well development and subsequent testing began Sept. 28, 1976. The development consisted of (1) recirculating the drilling mud while gradually thinning it with water and adding 250 lbs of tri-sodium polyphosphate, and then (2) pumping the well at various discharge rates (200 to 400 gal/min). This procedure removes residual drilling mud that temporarily decreases the water-yielding ability of the sedimentary deposits.

Step-Drawdown Pumping Test

Testing was accomplished by pumping the well at rates increasing from 270 to 396 gal/min for a period of 23 hours, during which water-level measurements were made to determine drawdown versus time. This type of test is known as a step-drawdown test. The well was then shut off and another series of water-level measurements was made for a period of 20 hours to determine the rate of recovery in the well. The data were analyzed using standard methods.

During the pumping phase of the test, the well was pumped at successive rates of 270, 310, and 360 gal/min. The resulting variation in depth to water is shown in figure 3. After an elapsed time of 1200 minutes, mechanical difficulties forced a cessation of pumping for 30 minutes. The pump was then restarted and the well was pumped at an average rate of 396 gal/min for 80 minutes. This resulted in water levels approaching the bottom of the pump impellers at 220 ft, forcing another stoppage. After a delay of 15 minutes, the well was pumped for a final period of 70 minutes at 370 gal/min and a water sample was obtained for chemical analysis (table 8). Discharge rates and corresponding drawdowns for the first three steps of the test were used to derive an expression for the total drawdown in the well versus pumping rate, using a method described by Rorabaugh (1953, p. 1-23):

$$SW = BQ + CQ^n,$$



Static water level, 50 ft.			
Step	Minutes	Gallons/minute	Total minutes
1	200	270	200
2	780	310	980
3	220	360	1200
4	30	0	1230
5	80	396	1310
6	15	0	1325
7	70	370	1395

Figure 3.--Water levels in well 33B N47 E38 21DAA1 during pumping test of Sept. 29-30, 1976.

where SW = drawdown, in feet, after 200 minutes of pumping
B = aquifer constant, in second/(feet)^2,
C = well-loss constant, in (second)^2/(feet)^5
Q = pumping rate, in (feet)^3/second, and
n = dimensionless exponent.

The term BQ indicates the component of total drawdown due to laminar flow, and the term CQ^n represents the component due to turbulent flow (known as "well loss"). The equation derived for the Reservation test well is:

$$SW = 130\ Q + 65\ Q^{1.52}$$

if Q is expressed in cubic feet per second, or

$$SW = 0.29\ Q + 0.006\ Q^{1.52}$$

if Q is in gallons per minute.

Close agreement between observed and theoretical drawdowns after 200 minutes of pumping was obtained with the equation (table 2). An example of the equation's utility is the prediction of drawdown resulting from a discharge rate of 500 gal/min. Thus:

$$SW = 0.29\ (500) + 0.006\ (500)^{1.52} = 221 \text{ ft.}$$

For a discharge rate of 1,000 gal/min, the theoretical drawdown would be 508 ft. If the pumping period were to exceed 200 minutes, one should expect an increase in the drawdown.

Table 2.--Step-drawdown test data

Step (200-min duration)	Discharge (Q) in, Gallons per minute	Discharge (Q) in, Cubic feet per second	Drawdown, in feet: Theoretical: Laminar flow (BQ)	Drawdown, in feet: Theoretical: Well loss (CQ^n)	Drawdown, in feet: Theoretical: Total (SW)	Drawdown, in feet: Actual	Specific capacity (Q/SW), in gallons per minute per foot o drawdown
1	270	0.60	78	30	108	108	2.5
2	310	.69	90	37	127	128	2.4
3	360	.80	104	46	150	149	2.4

Aquifer Characteristics [1]

The capacity of a rock or sedimentary deposit to yield water to wells is determined by its permeability or hydraulic conductivity, a measure of the ease of movement of water through the material under a hydraulic gradient. The permeability is governed chiefly by the number, size, shape, and degree of interconnection of the primary and secondary openings. The U.S. Geological Survey has adopted the term hydraulic conductivity to include the properties of natural ground water that affect its ease of movement (Lohman, 1972, p. 5).

The transmissivity (T) indicates the capacity of an aquifer to transmit water through its entire thickness. It is defined as the rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of the aquifer under a unit hydraulic gradient (Lohman, 1972, p. 6).

The storage coefficient (S) describes the capacity of an aquifer to store water. It is defined as the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head (Lohman, 1972, p. 8). The storage coefficient for unconfined aquifers is virtually equal to the specific yield, provided gravity drainage is complete. The specific yield of a rock or sedimentary deposit is the ratio of (1) the volume of water which the rock or deposit, after being saturated, will yield by gravity, to (2) the volume of the rock or deposit itself (Meinzer, 1923, p. 28). The specific yield of most unconfined aquifers ranges from about 0.1 to about 0.3 and averages about 0.2. In contrast, the storage coefficient of most confined aquifers ranges from about 10^{-5} to 10^{-3} (Lohman, 1972, p. 8).

Transmissivities and storage coefficients are commonly determined by means of aquifer tests. By use of drawdown or recovery data in conjunction with the Theis modified nonequilibrium formula: $T = 35.3\ Q/\Delta s$, an estimate of transmissivity, T, in feet squared per day, is obtained. In the equation, Q is the discharge rate of the well, in gallons per minute, and Δs is the change, in feet, in the recovery or drawdown over one log cycle of time (Ferris and others, 1962, p. 99).

The test well and six privately-owned irrigation wells near the Reservation were tested to determine transmissivity values and to obtain a measure of the areal variability in that characteristic. In particular, the relative variability was sought between the test well (33B 47N 38E 21DAA1) and nearby irrigation well 33B 47N 38E 17DAA1. They are both

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1. An aquifer is a geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs (Lohman and others, 1972, p. 2).

similar in depth (720 and 700 ft, respectively) but different in construction (table 5). The recovery of water levels in the two wells after pumping is shown in figures 4 and 5, where residual drawdown is plotted against the ratio t/t'. In the ratio, t and t' are the elapsed times since pumping began and ceased, respectively. The residual drawdown is the depth to water at time t', minus the water level prior to pumping. The resulting values of T, 640 ft^2/day for the test well and 710 ft^2/day for the irrigation well, are virtually the same. However, the value of 640 ft^2/day was the lowest derived from the tests; the highest transmissivity was 11,000 ft^2/day (table 3).

South of the Ranch area, two abandoned wells, 31 N41 E34 8CAC1 and 13DD1, were air-lift pumped briefly to obtain water samples. The discharge rate, approximately 30 gal/min, was measured with a 55-gallon drum container and a stop watch. Using the recovery data from these crude tests, transmissivities of 620 ft^2/day for well 8CAC1 and 1600 ft^2/day for well 13DD1 were obtained. As a comparison, Zones (1963, p. 12) estimated a value equivalent to about 3,000 ft^2/day for the area north of the Ranch.

Table 3.--Transmissivity values for selected wells near McDermitt

Well location	Transmissivity (ft^2/day)	Date	Duration of test (hours)	Type of test 1/
33B N47 E37 24BAB2 2/	11,000	4-76	5	R
33B N47 E37 24BAC2	9,400	4-76	4	R
33B N47 E38 5AACD1	4,500	5-76	72	D
33B N47 E38 17DAA1	710	6-76	210	R
33B N47 E38 21DAA1	640	9-76	44	R
33B N48 E38 32DDB1	1,200	9-66	72	R
OREGON:				
S41 E42 22CDCD1	4,700	5-76	21	R

1. R, recovery test; D, drawdown test.
2. Storage coefficient = 0.00018. Values were not derived from other well tests.

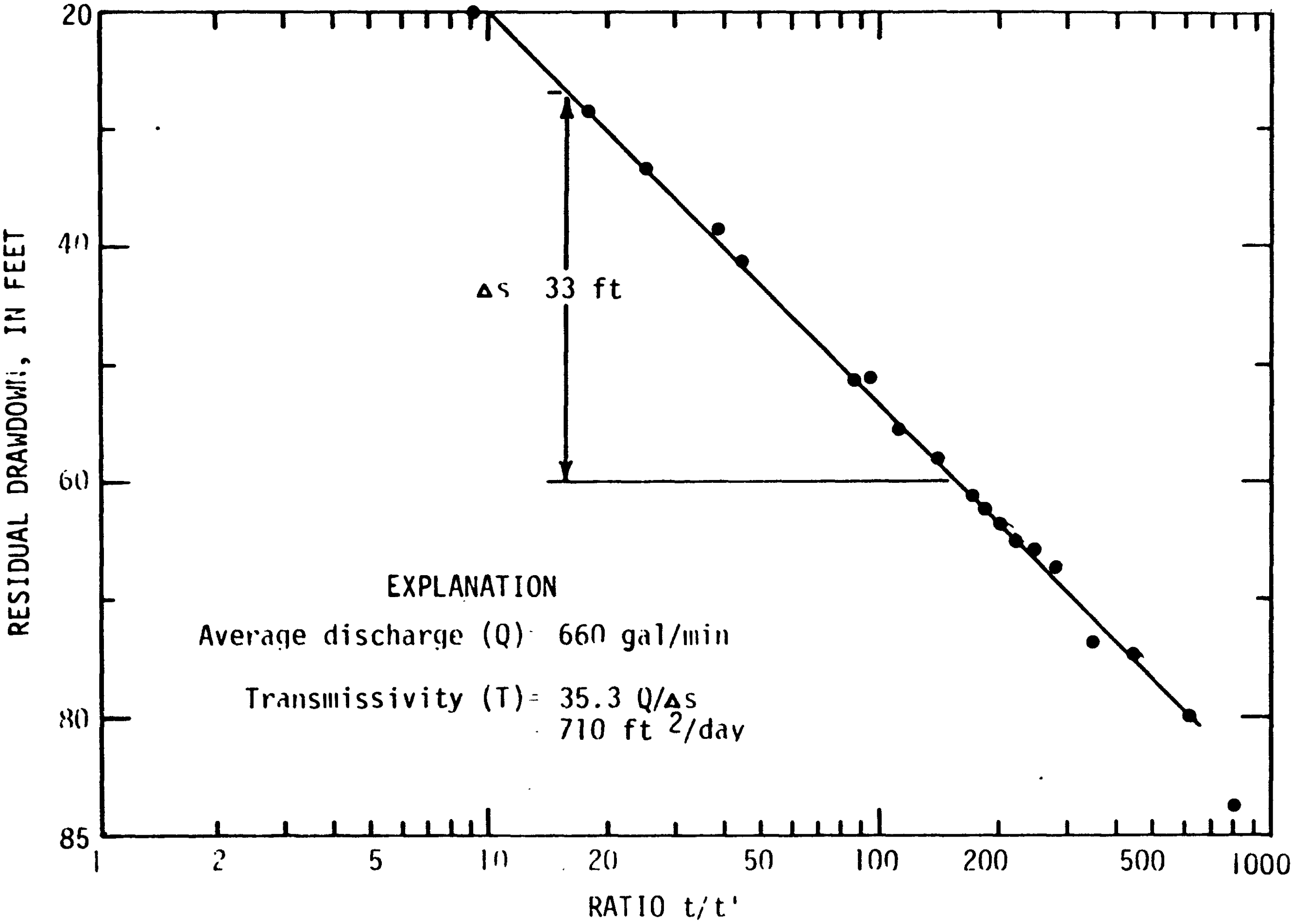

Figure 4.--Time-recovery curve for well 33B N47 E38 17DAA1, JUNE 16-17, 1976.

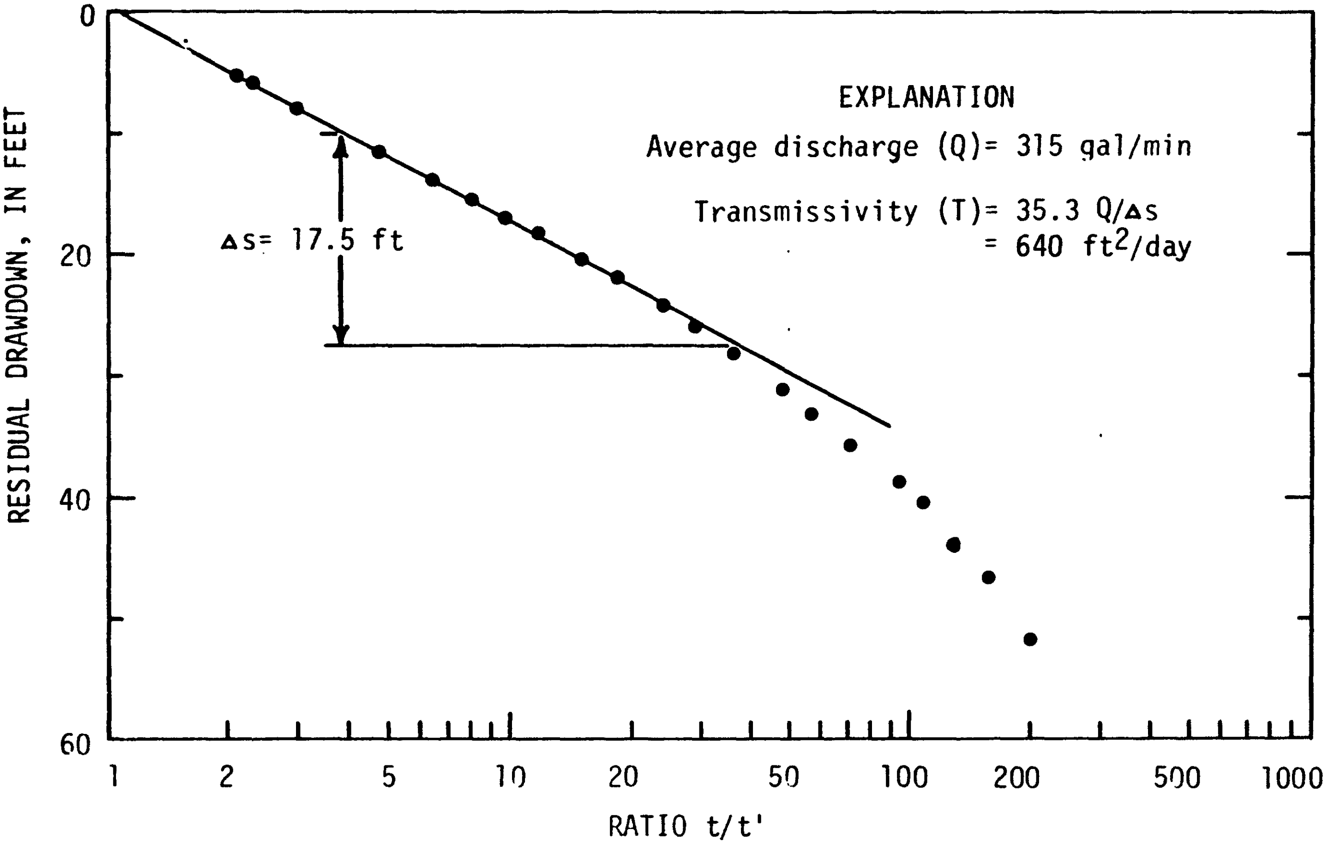

Figure 5.--Time-recovery curve for test well 33B N47 E38 21DAA1, Sept. 30,-Oct. 1, 1976

Theoretical Effects of Pumping

One of the principal uses of pumping-test results is in calculating the theoretical effect of pumping on water levels, generally by the Theis nonequilibrium method (Ferris and others, 1962, p. 99) or by an analysis of time-drawdown or distance-drawdown relations. Plots of observed data can be used to approximate the effect of pumping in a pumping well and in a well field.

The data derived from the test well 33B 47N 38E 21DAA1 were used to construct distance-drawdown curves for various times. Assuming a storage coefficient (S) value of 0.20 1/ and a transmissivity value (T) of 640 $ft/^2$day (4,790 gal/day/ft), theoretical curves depicting the effect of a pumping well on water levels were constructed for periods of 1, 10, 100, and 1,000 days. These curves, shown in figure 6, indicate that at the end of 10 days and at a distance of 100 ft from the well, the water level would be drawn down by about 20 ft. In contrast, after the same period but at a distance of 420 ft, the water level would be drawn down only 1 ft. This information should be used as a guide in spacing any additional wells in the same general vicinity of the test well.

Domestic Wells

In the early 1960's, a drilling program of the U.S. Public Health Service provided domestic wells at each residence on the Reservation. Approximately 40 wells, generally less than 100 ft deep, were constructed during this period, and all but six have subsequently been abandoned or are inoperable. These wells are listed in table 6 and their logs, where available, are listed in table 7. Their locations are shown on plate 1. This system of individual wells has since been replaced by a water-distribution system supplied by two wells, 33B N47 E39 7ADC1 and 7ADC2, which ensures water of uniform and suitable quality.

Ground-Water Quality

General Characteristics

As the ground water moves from areas of recharge toward areas of discharge, the chemical constituents are acquired by the solution of minerals from the materials through which the water percolates. In general, the dissolved-solids concentration of the water is determined by the solubility of the rock or soil, the area and duration of contact, and other factors.

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1. This value is generally representative of unconfined materials of the type found in the area.

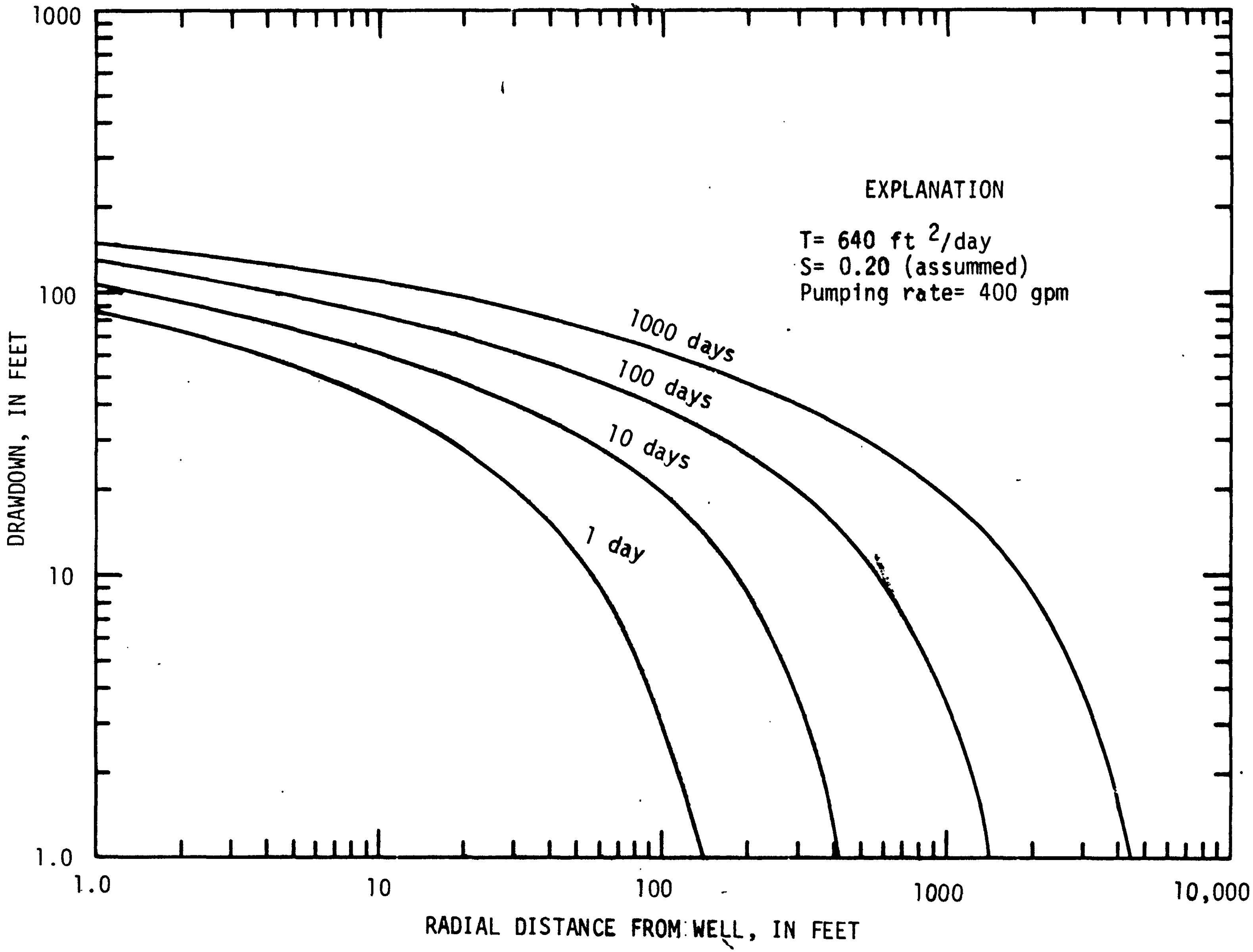

Figure 6.--Theoretical distance-drawdown curves for periods of 1, 10, 100, and 1000 days for well 33B N47 E38 21DAA1.

Water-quality data for the study area are listed in tables 6, 8, and 9. The data suggest that most ground water in and adjacent to the Reservation is fairly uniform chemically. The specific conductances 1/ of most well waters range from 200 to 500 micromhos, with bicarbonate, and sodium and (or) calcium as the principal dissolved constituents.

At and near the Ranch, sodium and bicarbonate dominate, and specific conductances characteristically are wider in range and higher than in the McDermitt area (measured values range from 357 to 37,000 micromhos).

The temperature of water from wells sampled in the Reservation area ranged from 16.5°C to 33.5°C (table 8). Of particular interest was the variation of temperature during the testing of wells 33B N47 E38 17DAA1, and 33B S41 E42 22CDCD1 (fig. 7). The former well had previously been pumped for about a week, until approximately 24 hours prior to the commencement of the test. The latter well had not been pumped in several months. The data suggest that several separate water-bearing zones may be connected via the wells themselves, with cooler water from upper zones mixing with deeper, warmer water. The difference in temperature variation between the two wells may be due to different well construction (table 5). This phenomenon did not occur during the pumping of the test well (33B N47 E38 21DAA1).

The temperature of sampled well waters in the vicinity of the Ranch ranged from 11.5°C to 13.5°C. During the study, 22 well waters in the vicinity of the Ranch were sampled for specific conductance. The results are tabulated in table 9. Wells numbers 9, 10, 14, 15, and 16 are inside the Ranch. A decrease in specific conductance (and therefore dissolved-solids concentration) with an increase in well depth is shown when comparing well 9 with 10 and 14 with 15. A general decrease in specific conductance with increasing depth within the Ranch area is suggested by figure 8. The range in specific conductance is greatest for wells less than 50 feet deep, varying from 420 to 37,000 micromhos. This reflects in part the effect of evapotranspiration, resulting in dissolved solids remaining and becoming concentrated at shallow depth in the ground water and soil. All wells deeper than 50 feet, with the exception of well 5, had specific conductances less than 800 micromhos (about 500 mg/L of dissolved solids).

1. Specific conductance, which is the measure of a water's ability to conduct electric current, is rather closely related to dissolved-solids concentration. The dissolved-solids concentration, in milligrams per liter, is characteristically 65 to 75 percent of the specific-conductance value. The complete unit of measure for specific conductance is "micromhos per centimeter at 25°C (Celsius)." For convenience, the abbreviation "micromhos" is used in this report.

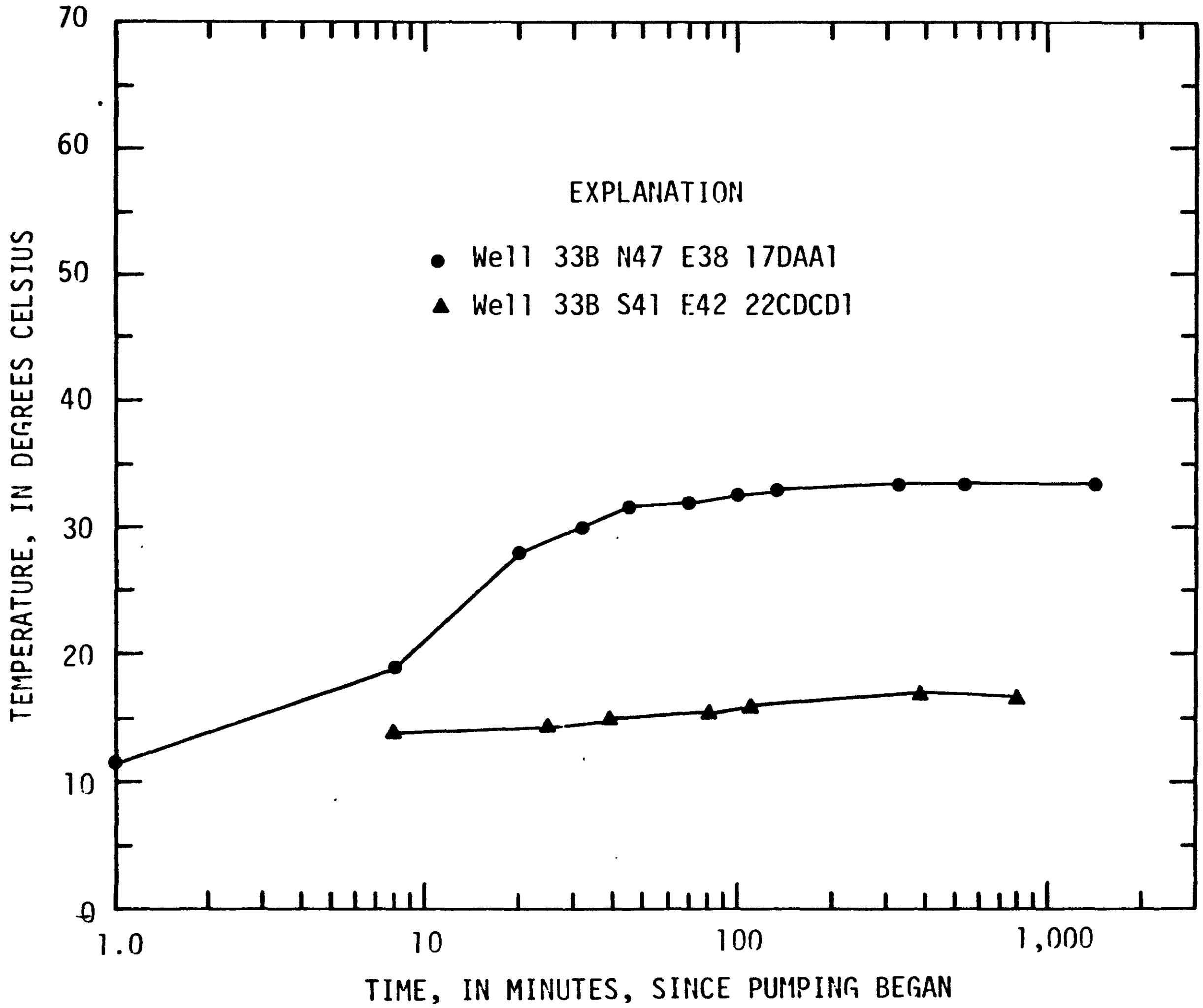

Figure 7.--Variation of temperature with time for well 33B N47 E38 17DAA1, June 17, 1976 and well 33B S41 E42 22CDCD1, May 26-27, 1976.

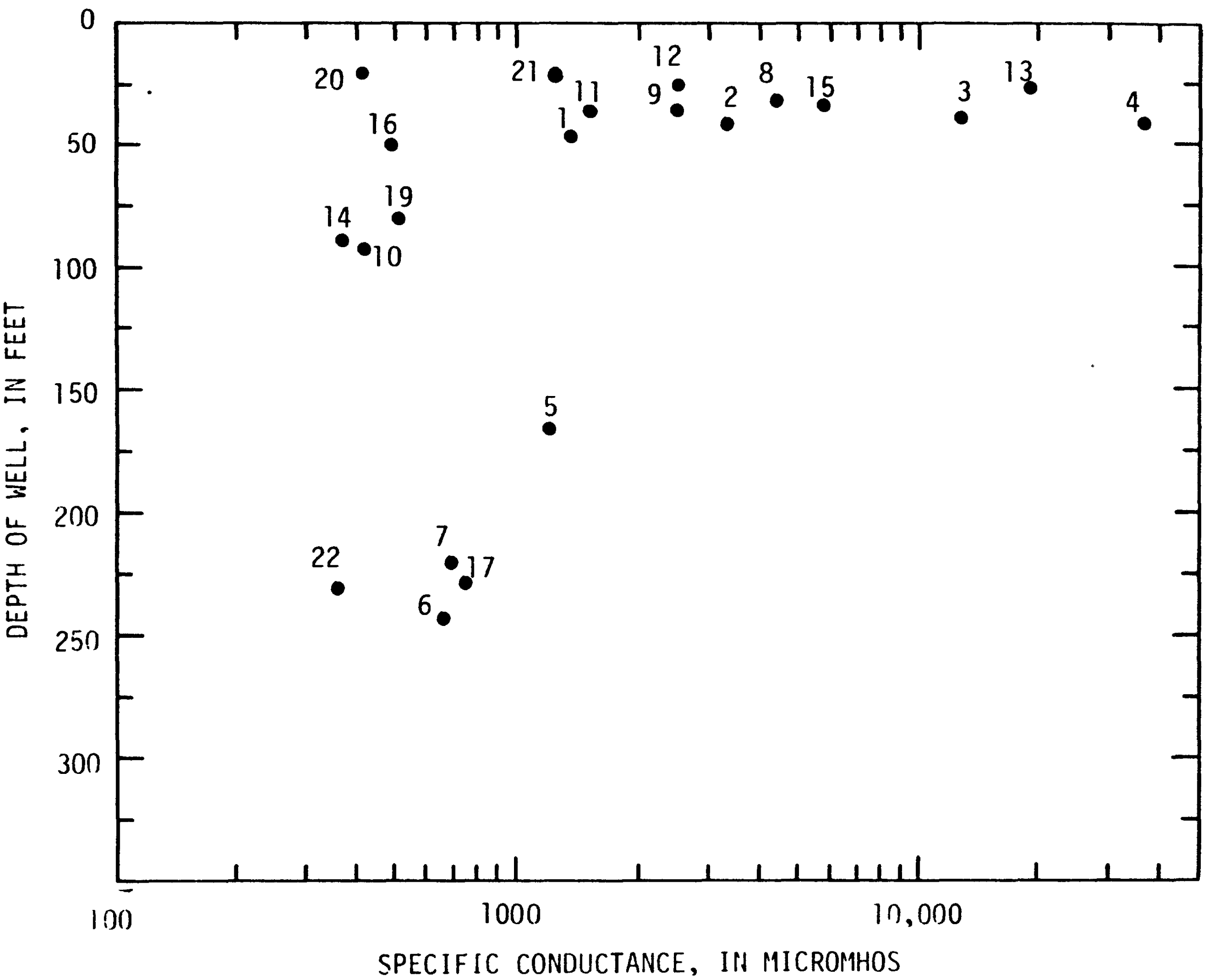

Figure 8.--Specific conductance versus well depth, Hog John Ranch area, 1976. Well numbers correspond to those used in table 9.

Suitability for Irrigation

In evaluating the desirability of a water for irrigation, the most critical considerations include the dissolved-solids concentration (salinity), the proportion of sodium relative to calcium plus magnesium, and the abundance of constituents such as boron that can be toxic to plants.

General guidelines regarding the salinity of irrigation water in arid and semiarid regions have been recommended by the National Academy of Sciences and National Academy of Engineering (1974, p. 335):

Dissolved solids (mg/L) a/	Specific conductance (micromhos)	Classification
Less than 500	Less than 750	No detrimental effects usually noticed.
500-1,000	750-1,500	Can have detrimental effects on sensitive crops.
1,000-2,000	1,500-3,000	Can have detrimental effects on many crops; careful management practices required.
2,000-5,000	3,000-7,500	Can be used for tolerant plants on permeable soils with careful management.
More than 5,000	More than 7,500	Of little value for irrigation.

a. Milligrams per liter.

Large proportions of sodium have an adverse effect on soil drainage, and therefore plant growth, owing to physical changes brought about in certain clay minerals by adsorption of the sodium. One measure of the degree to which sodium will be adsorbed from a given water is the Sodium Adsorption Ratio (SAR), which is calculated as follows, with concentrations expressed in milliequivalents per liter:

$$\frac{\text{sodium}}{\sqrt{\frac{\text{calcium + magnesium}}{2}}}$$

As a general guideline, waters with SAR values as great as 8 to 18 are suitable for many crops, although the tolerance limit relative to sodium also depends on salinity and clay-mineral type (National Academy of Sciences and National Academy of Engineering, 1974, p. 330). The SAR values ranged from 1.3 to 29, and all but two samples had values less than 8. These two samples were obtained from wells 31 N41 E33 22ACA1 and 31 N41 E35 20A1, located about 3 and 5 miles from the Ranch, respectively (table 8, pl. 3).

Small concentrations of boron are essential to plant growth. Larger amounts are toxic, but the tolerance for boron differs with plant type. Maximum concentrations of 1,000 and 2,000 ug/L (micrograms per liter) have been recommended for semitolerant and tolerant plants, respectively (National Academy of Sciences and National Academy of Engineering, 1974, p. 341). Boron concentrations ranged from 60 to 370 ug/L in the Reservation area and from 160 to 440 ug/L in the Ranch area.

On the basis of dissolved solids, water quality was found to be suitable for crops in the Reservation area. In the Ranch area, water may be of suitable quality in wells extracting water from depths exceeding 50 ft and in some parts from less than 50 feet deep. Using the SAR and boron guidelines, water-quality samples were found to be suitable for crop use in both areas.

Suitability of Water for Domestic Supply

Interim drinking-water standards that include values for three constituents listed in table 8 have been established by the U.S. Environmental Protection Agency (1975, p. 59570):

Constituent	Maximum permitted concentration
Arsenic (As)	50 ug/L
Fluoride (F)	1.8 mg/L 1/
Nitrate (NO_3)	44 mg/L

1. Based on an average maximum daily air temperature of 18.2°C at Orovada, Nev.; period of record, 1940-70.

In addition, upper limits for three other constituents in table 8 have been recommended by the U.S. Environmental Protection Agency (1977, p. 17146):

Constituent	Maximum recommended concentration
Chloride (Cl)	250 mg/L
Iron (Fe)	300 ug/L
Sulfate (SO_4)	250 mg/L

The data indicate that the arsenic limit was exceeded in water from well 33B N47 E37 21DAB1 (200 ug/L). The chloride limit was exceeded in water sampled from well 31 N41 E33 22ACA1 (280 mg/L). Fluoride exceeds the recommended drinking-water limit in four irrigation wells in the McDermitt area with values ranging from 2.2 to 5.3 mg/L (table 8). Recommended limits for nitrate and sulfate were not exceeded in any of the water samples. The iron limit was exceeded in two well waters, but both values, 340 and 2,370 ug/L, represent the total concentration (dissolved plus particulate) (table 8). The value of greatest concern is the dissolved concentration, which may be considerably less than the total.

SURFACE WATER

Surface-water resources of an area can be evaluated in terms of (1) variations and frequency characteristics of streamflow, (2) the distribution and loss of streamflow, as it is related to both recharge and diversions for irrigation, and (3) surface-water quality. In the McDermitt area, surface-water resources have been evaluated in terms of variations and frequency characteristics of streamflow. In addition, the monthly distribution and loss of streamflow on the alluvial fans and valley floor is briefly evaluated because it relates to both recharge and diversion of surface water for irrigation. A paucity of streamflow data exists in the Ranch area and immediate vicinity, thus prohibiting any substantive analysis of this resource.

Streamflow Records Available

Two continuous-recording streamflow gaging stations operate inside the study area, on the East Fork Quinn River and McDermitt Creek near McDermitt (sta. nos. 10352500 and 10353000; see pl. 1). A third station, on the Quinn River approximately 15 miles south of McDermitt (sta. no. 10353500), is not shown on plate 1. Data for these stations prior to 1961 are published in summaries (U.S. Geol. Survey, 1960, 1963). Data for 1961-75 are published in annual volumes (U.S. Geol. Survey, 1962-65, 1966-76). One continuous-recording streamflow station was operated within the Ranch itself, on the Quinn River, at the intersection of the river with State Highway 8A (sta. no. 10353650; pl. 3). This station was operated from October 1963 to September 1967. Flow occurred in only 11 of those 48 months with the greatest flow for a 1-month period being 635 acre-ft in February 1967 (U.S. Geol. Survey, 1968, p. 131).

Variations in Streamflow

Runoff from snowmelt provides most of the surface water in the McDermitt area. Figure 9 shows average monthly flows at the three gaging stations. The East Fork Quinn River is similar to McDermitt Creek in runoff quantities. The mean annual flow of the East Fork (27.2 ft^3/s) is only about 15 percent less than that of McDermitt Creek (31.4 ft^3/s). The drainage area upstream from the East Fork station is about 38 percent smaller than that for the McDermitt Creek station. In contrast, the mean annual water yield per square mile is 140 acre-ft for the East Fork station, versus only 100 acre-ft for the McDermitt station. The prime reason is that the mountains surrounding the Quinn River valley receive more precipitation on west-facing mountain slopes than on the east-facing slopes (Huxel 1966, p. 15). The combined drainage area for both stations (365 mi^2) represents only 33 percent of the total area gaged at the Quinn River station near McDermitt (1,100 mi^2), yet the combined average flows are always larger than those at the latter station (the combined annual flow averages 58.6 ft^3/s, compared with only 35.6 ft^3/s for the Quinn River station). This is caused by diversions for irrigation, infiltration of streamflow to the ground-water system, and evapotranspiration losses from phreatophytes along the main channel.

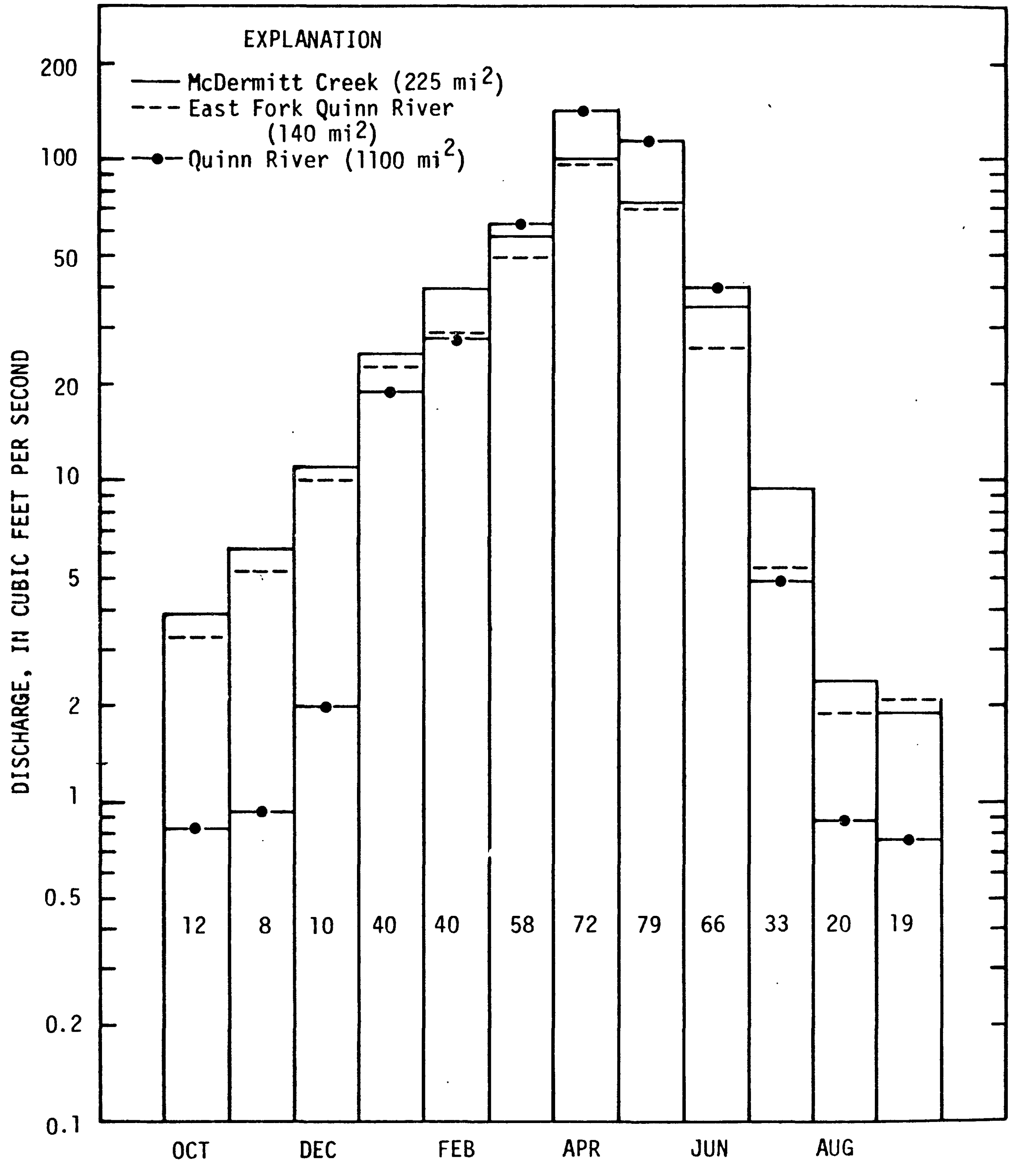

Figure 9.--Average monthly discharges at gaging stations on McDermitt Creek, East Fork Quinn River, and Quinn River near McDermitt, for period October 1948-September 1975. Number within each monthly bar is percentage of combined flow at McDermitt Creek and East Fork gages that reaches Quinn River near McDermitt gage.

Duration curves for the daily mean flow at the three gaging stations are shown in figure 10. These curves were based on streamflow records from 1948 to 1975. The curves are of the cumulative-frequency type, showing the percentage of time specified discharges were equaled or exceeded for the indicated period. A 90-percent duration indicates a low discharge--one that has been equaled or exceeded 90 percent of the time. Similarly, a 10-percent duration indicates a high value, one that has been equaled or exceeded only 10 percent of the time. The curves for McDermitt Creek and the East Fork Quinn River are similar except that the East Fork sustains flows below 1 ft^3/s for a greater time span. The major contrast in the three curves occurs below about the 30-ft^3/s, 20-percent point, when flows at the Quinn River near McDermitt station recede more quickly than those of the other two stations. This is caused by the same reasons previously cited, and these effects are more pronounced at lower flows.

In the Ranch area, runoff from the Kings River, Desert, and Quinn River Valleys leaves the area via the Quinn River. Some of this runoff may at times be impounded by two earthen dams in N42 E34 sections 20 and 25 (pl. 3). Their impact on flows, while not known, would need to be determined to evaluate the streamflow characteristics properly. Zones (1963, p. 7) stated "The Quinn River seldom carries an appreciable amount of water beyond Sod House, even during years of normal runoff." Estimates of streamflow for the area were given by Malmberg and Worts (1966, p. 33). These estimates are as follows:

1. Inflow from the Quinn River valley = 5,000 acre-ft.
2. Rio King to Sod House subarea = 1,000 acre-ft.
3. Outflow from Quinn River to Pine Forest Valley = 1,000 acre-ft.

No values are given for inflow from Desert Valley (see fig. 11). These estimates, when combined with the components of ground water, evapotranspiration, diversions, and flow contributions from springs, determine a "water budget" of the area, and are discussed in a later section.

Surface-Water Quality

A general appraisal of the suitability of water from streams in the McDermitt area was made by Everett (1966, p. 37-40) and included chemical analyses of water in McDermitt Creek, Washburn Creek, Quinn River at Giacometto Ranch, and East Fork Quinn River. Everett (p. 37) stated that "All the streams discharge water which most of the time is suitable for irrigation." Detailed water-quality data, including chemical analyses, water temperatures, and biologic, microbiologic, and suspended-sediment data, are available on a monthly basis for McDermitt Creek (sta. 10352500) from October 1974 to the present (1977) (see U.S. Geol. Survey, 1976, p. 273-275, and 1977, p. 269-276). Seasonal variability of several of the evaluated constituents and properties is pronounced. Ranges of values for several of the key indices during the period January 1975-December 1976 are: Specific conductance, 160-431 micromhos; sodium-adsorption ratio (SAR), 0.8-2.1; total nitrogen, 0.22-4.0 mg/L; total phosphorus, 0.04-1.5 mg/L; water temperature, 0.0-30.0°C; and suspended sediment, 31,460 mg/L. Water-quality data for streams entering the Ranch were not available.

3-1,460

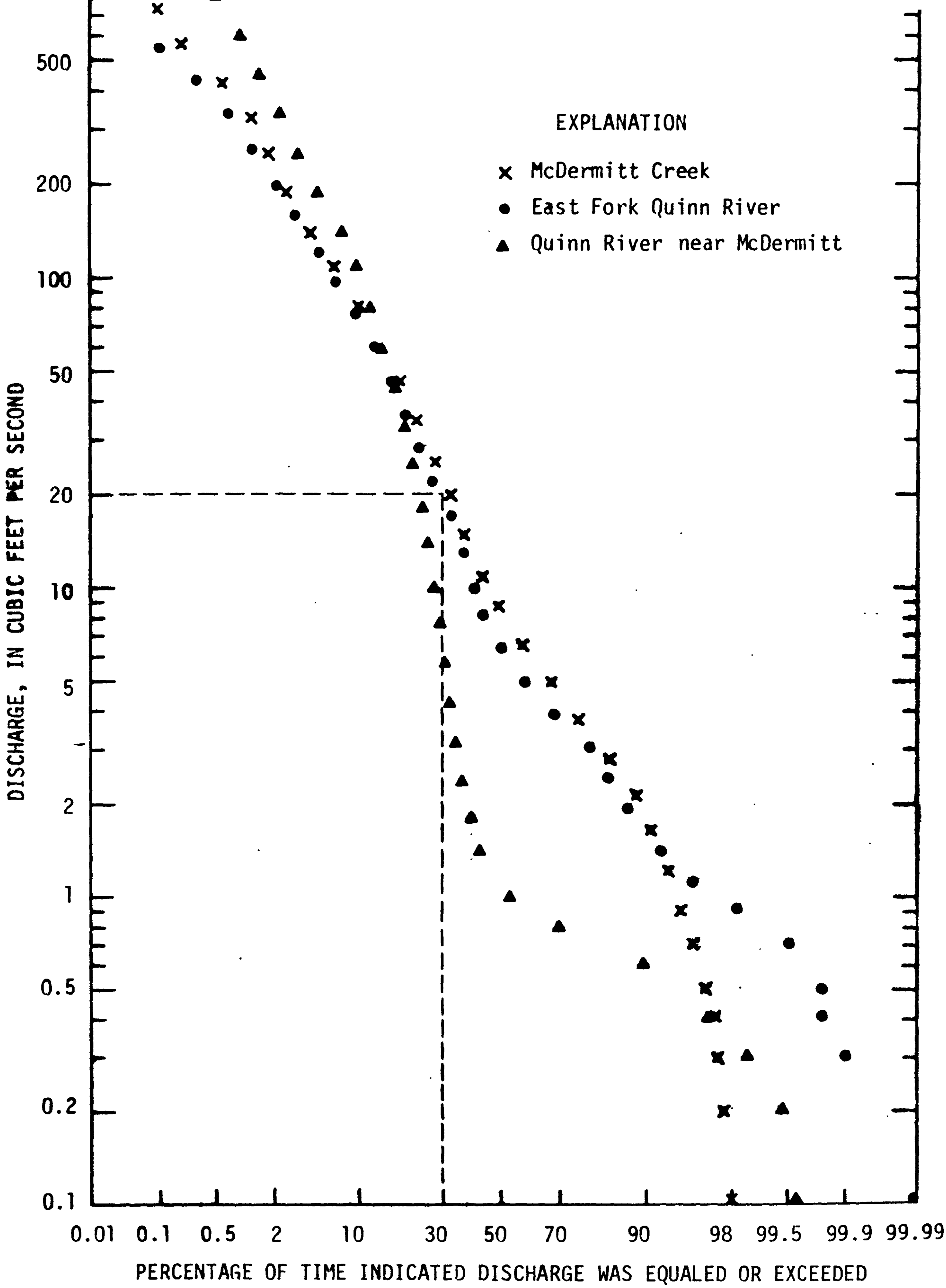

Figure 10.--Duration curves of mean daily flows for McDermitt Creek, East Fork Quinn River, and Quinn River near McDermitt, for period October 1948-September 1975.

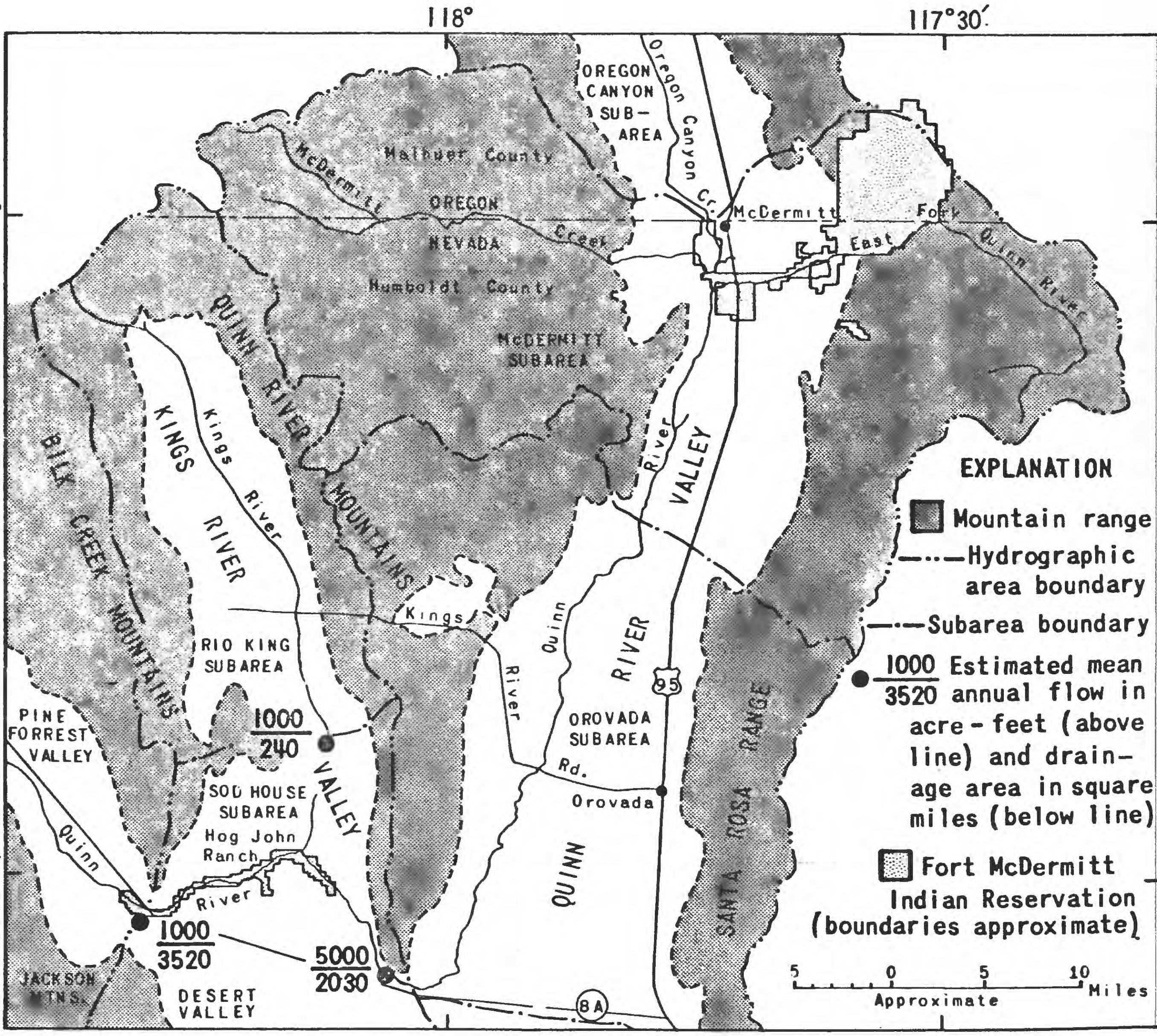

Figure 11.--Location of streamflow gaging sites used in water budget.

WATER BUDGET

Water budgets are based on the premise that over the long term and for natural or near-natural conditions, the inflow to and outflow from an area are about equal. Thus, if reasonably accurate estimates or measurements of the elements of inflow and outflow can be made, the two totals should be about the same.

Huxel (1966, p. 27, 28) estimated recharge from precipitation and discharge from phreatophytes, in addition to runoff and subsurface flow into and out of the McDermitt subarea. Malmberg and Worts (1966, p. 33) presented a similar water budget for the Sod House subarea. These two budgets are listed in table 4. For the McDermitt subarea, the value for total runoff at the bedrock-valley-fill contact includes an estimate of about 16,000 acre-ft/yr from the East Fork Quinn River (pl. 1), which passes through the inhabited part of the Reservation. This estimate was derived by correlating the 10-yr (1948-64) record for the East Fork gage with the much longer-term (1922-64) record from Martin Creek in nearby Paradise Valley. Streamflow data for the East Fork gage during 1948-75 indicate an average annual runoff of 19,710 acre-ft for that 27-yr period.

The surface-water outflow to Pine Forest Valley, composed of runoff from the Sod House subarea and Desert Valley, plus inflow from Quinn River valley, must, at times, pass through most of the Ranch. The average quantity of runoff, an estimated 1,000 acre-ft/yr, is overshadowed by evapotranspiration losses estimated at 7,000 acre-ft for the Sod House subarea. As shown in table 4, about 80 percent of all inflow to valley fill of the Sod House subarea occurs as runoff (6,100 acre-ft/yr) but only 16 percent of this quantity (about 1,000 acre-ft/yr) leaves the area as surface-water outflow. Thus, about 5,000 acre-ft/yr would be potentially available for use along the flood plain at the Ranch. Lowering the water levels throughout the Sod House subarea by pumping could salvage some of this loss, and the water thus derived could be utilized more beneficially.

Table 4.--Water budgets for valley fill

(All estimates are in acre-feet per year)

Budget elements	McDermitt subarea 1/	Sod House subarea 2/
INFLOW:		
Surface water:		
Across bedrock-valley-fill contact	51,000	100
From Oregon Canyon subarea	1,000	--
From Quinn River valley	--	5,000
From Rio King subarea	--	1,000
Ground water:		
Across bedrock-valley-fill contact	5,000	100
From Oregon Canyon subarea	minor	--
From Quinn River valley	--	300
From Desert Valley	--	200
From Rio King subarea	--	1,000
Total inflow (1):	57,000	7,700
OUTFLOW:		
Evapotranspiration	17,000	7,000
Surface water:		
To Orovada subarea	17,000	--
To Pine Forest Valley	--	1,000
Diversions for irrigation	11,000	0
Ground water:		
To Orovada subarea	5,000	--
To Pine Forest Valley	--	200
Total outflow (2):	50,000	8,200
IMBALANCE: (1) - (2)	7,000	-500

1. Huxel, 1966, p. 32.

2. Malmberg and Worts, 1966, p. 33.

SUMMARY AND CONCLUSIONS

This appraisal of water resources on the Fort McDermitt Indian Reservation and surrounding lands suggests that water quality and availability are satisfactory for current needs.

In the McDermitt area, ground water is used for domestic purposes on the Reservation whereas on the Ranch, only one stock well exists and is used intermittently. The valley-fill reservoir in the McDermitt area is more than 1,225 ft deep in at least one place and at least 350 ft deep in the vicinity of the uninhabited Ranch. A test well drilled in the Reservation produced 360 gal/min (about 500,000 gal/day) and the water quality was suitable for irrigation, domestic, and industrial purposes. This will allow some flexibility in considering land-use management alternatives in that part of the Reservation. A pair of adjacent test holes drilled on the Ranch indicate an upward hydraulic gradient of about 0.07 ft/ft in the saturated zone at that site. Water quality in the Ranch area apparently improves generally with depth, at least to depths of about 250 ft for which data are available. This apparent trend implies that quantity, not quality, will be the deciding factor in implementing any management alternatives in that area. In the McDermitt area, measured transmissivities at seven wells ranged from 640 ft^2/day for the test well to as much as 11,000 ft^2/day.

Two short-term pumping tests made in the northern part of Desert Valley indicated transmissivity values of 620 and 1,650 ft^2/day, which are considerably less than the value of about 3,000 ft^2/day estimated by Zones (1963, p. 12) for the Sod House subarea.

RECOMMENDATIONS

Results of this study have implications for future geohydrologic investigations. In the main reservation near McDermitt, stream diversions for irrigation should be monitored to define their effect on areal variations in runoff. Continuous recorders might best be used at several shallow, unused domestic wells to monitor shallow water-level response, if any, to streamflow in the East Fork Quinn River. These new data could then be analyzed through the use of ground-water modeling techniques presently available.

Availability of ground water within the Hog John Ranch can best be determined by drilling and testing wells for yield and evaluating the water quality. Surface-water data in the vicinity of the Ranch must be collected before any quantitative analysis of the hydrologic system can be performed. A streamgaging network would be needed to evaluate the surface-water supply potential at the Ranch properly. This network would include continuous-recording streamgages at the mouth of Kings River, and at the eastern, western, and southern boundaries of the Ranch.

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DATA

The following tables provide hydrologic information for the Reservation, the Ranch, and adjacent areas. Included are well data (tables 5 and 6), well logs (table 7), and water-quality data (tables 6, 8, and 9). In addition, electric and drilling-time logs for test well 33B N47 E38 21DAA1 are shown on plate 4.

Table 5.--Records of selected wells

Use: A, abandoned; D, domestic well; I, irrigation; Ind, industrial; O, observation; PS, public supply; S, stock; T, test hole
Remarks: L, log is listed in table 7

Well location	Year drilled or dug	Depth of well (feet) and date measured	Casing: Diameter (inches)	Casing: Depth (feet)	Casing: Perforated interval (feet below land surface)	Use of well	Land-surface altitude (feet above mean sea level)	Water level: Depth below land surface (feet)	Water level: Date measured	Pumping data: Yield (gal/min) and drawdown (feet)	Pumping data: Date measured	Remarks
						RANCH AND VICINITY						
31 N41 E33 3BCD1	1963	102	2	43	--	O	4,118	13.63	6-21-63	--	--	USGS test hole KR-19; destroyed prior to 1976.
31 N41 E33 4BDD1	1943	48 (3-76)	6	86	--	S	4,103	2.62 5.70	11-07-60 12-[illegible]-75	87/--	4- -76	Reported original depth 94 ft. Previously a windmill; now uncapped.
29 N41 E33 6BDC1	1963	42 (4-76)	2	43	--	O	4,116	25.17 26.68	4-23-63 4-01-76	--	--	USGS test hole KR-20; reported original depth 102 ft.
31 N41 E33 10BCB1	1963	39 (4-76)	2	44	--	O	4,115	11.10 15.28	6-21-63 4-01-76	--	--	USGS test hole KR-17; reported original depth 45 ft.
31 N41 E33 22ACA1	--	--	--	--	--	S	4,127	21.35 26.91	4-04-61 5-12-76	--	--	Windmill.
31 N41 E34 6BDA1	1963	42 (3-76)	2	44	--	O	4,115	11.76 14.72	6-21-63 3-30-76	--	--	USGS test hole KR-18; reported original depth 43 ft.
31 N41 E34 8CAC1	1949	167 (3-76)	8	170	158-169	A	4,117	14. 13.03	8-19-49 3-02-76	141/79 26/--	8- -49 3- -76	L; reported original depth 181 ft; pumped with air compressor; no drawdown data obtained. Sod House #2.
31 N41 E34 8CC1	1961	14 (3-76)	4	18	15-18	O	4,118	13.60 dry at 14	6-04-61 3-02-76	--	--	Reported original depth 18 ft.
31 N41 E34 13DD1	1949	243 (3-76)	8	321	105-147 198-240	A	4,121	10. 10.38	9-06-49 3-18-76	35/--	3- -76	L; reported original depth 350 ft. Sod House #1.
30B N41 E35 17ABB1	1950	80	16	--	--	A	4,126	11.5	8-28-50	80/3	--	--
31B N41 E35 20A1	1951	112	16	--	--	A	--	--	--	--	--	--
30B N42 E33 10DDB1	1961	220	6	220	52-220	S	4,143	26.38 28.70	3-20-64 3-04-76	--	--	L; windmill.
30B N42 E33 21DBD1	1963	33 (3-76)	2	37	--	O	4,120	19.84 20.93	6-21-63 3-31-76	--	--	USGS test hole KR-1; reported original depth 52 ft.
30B N42 E33 27DBA1	1976	36 (3-76)	1½	39	36-39	O	4,108	4.69	3-30-76	--	--	L; USGS test hole; reported original depth 127 ft, caved into final depth of 36 ft.
30B N42 E33 27DBA2	1976	92 (3-76)	1½	92	89-92	O	4,108	3.67	3-30-76	--	--	USGS test hole.
29 N42 E33 32BAD1	1963	37 (5-76)	2	43.5	--	O	4,113	19.85 22.28	6-21-63 3-19-76	--	--	USGS test hole KR-21; reported original depth 88 ft.
30B N42 E34 4BAB1	1963	25 (5-76)	2	--	--	O	4,113	0.34 0.25	9-19-63 5-13-76	--	--	USGS test hole KR-4; reported original depth 102 ft.
30B N42 E34 12CCD1	1963	26 (4-76)	2	33.5	--	O	4,120	12.83 13.33	6-21-63 4-01-76	--	--	USGS test hole KR-7; reported original depth 34 ft.
31 N42 E34 20DBC1	1975	90 (3-76)	2	90	88-90	O	4,114	5.26	3-17-76	--	--	L; USGS test hole; reported original depth 92 ft.
31 N42 E34 20DBC2	1975	33 (3-76)	2	33	31-33	O	4,114	9.24	3-17-76	--	--	USGS test hole.
31 N42 E34 30ABC1	--	50 (3-76)	4	--	--	S	4,112	8.49	3-30-76	--	--	Well has small pump.
31 N42 E34 36BBB1	1945	230	6	--	--	S	4,124	12.52 11.95	9-26-47 3-09-76	--	--	L.
30B N42 E35 19ACD1	--	--	10	--	--	S	4,132	12.98 15.30	9-17-63 3-09-76	--	--	--
30B N43 E33 35DBA1	1962	80	6	--	--	S	4,160	41.98 47.96	9-17-63 5-13-76	--	--	Windmill pumping during water level measurement in 1976.
30B N43 E34 28CAA1	--	21 (4-76)	10	--	--	S	4,125	0.48 3.06	9-17-63 3-04-76	--	--	Windmill.
30B N43 E34 35ACD1	1963	21 (4-76)	2	25	--	O	4,123	8.42 9.45	6-21-63 4-01-76	--	--	USGS test hole KR-5; reported original depth 102 ft.
30B N43 E35 30BCB1	1963	23	2	--	--	O	4,133	11.57 13.80	6-20-63 3-09-76	--	--	USGS test hole KR-8.
30B N43 E35 31CDD1	1940	230 (3-76)	8	--	--	S	4,131	8.30 10.55	10-02-47 3-09-76	--	--	Windmill; reported original depth 236 ft.

Well location	Year drilled or dug	Depth of well (feet) and date measured	Casing: Diameter (inches)	Casing: Depth (feet)	Casing: Perforated interval (feet below land surface)	Use of well	Land-surface altitude (feet above mean sea level)	Water level: Depth below land surface (feet)	Water level: Date measured	Pumping data: Yield (gal/min) and drawdown (feet)	Pumping data: Date measured	Remarks
RESERVATION AND VICINITY												
33B N47 E37 2ABB1	--	--	--	--	--	S	4,460	7.60 5.85	10-29-63 12-16-75	-- --	-- --	Reported well diameter 8-10 ft; windmill.
33B N47 E37 13BAB1	--	--	--	--	--	S	4,443	4.53 4.70	6-19-64 12-16-75	--	--	Windmill.
33B N47 E37 21DAB1	1974	745	16	745	220-700	Ind	4,550	65.	7- -74	700/180 1200/285	7- -74 7- -74	L.
33B N47 E37 22BBB1	1974	600	16	600	200-600	Ind	4,527	58.24	12-16-75	340/335	10- -74	--
33B N47 E37 24BAB2	--	200	16	100	20-100	I	4,440	3.16	12-16-75	920/118	4-22-76	L, open hole from 100 to 200 ft
33B N47 E37 24BAC2	--	270	16	90	none	I	4,440	4.22	12-16-75	372/141	4-21-76	L, open hole from 90 to 270 ft.
33B N47 E38 5AACD1	1955	600	16	304	10-294	I	4,420	10.52 4.05	9-20-63 5-24-76	620/114 900/145 800/145	1955 1955 5-27-76	L, open hole 304 to 600 ft. Pumping test when well 340 ft. deep: 100 gal/min with 146-ft drawdown.
33B N47 E38 5BAC1	--	47 (5-76)	6	--	--	S	4,410	6.32 1.36	3-10-64 5-26-76	--	--	Windmill.
33B N47 E38 7ACA1	--	120	--	--	--	S	4,410	8.37 3.8	3-05-64 12-16-75	--	--	Windmill.
33B N47 E38 8ABA1	--	50 (6-76)	6	--	--	S	4,410	10.54 7.89	9-19-63 9-23-76	--	--	Windmill.
33B N47 E38 8CDCD1	1966	23	--	--	--	A	4,402	4. 2.4	7- -66 12-16-75	--	--	--
33B N47 E38 9BCBA1	1969	70	6 8	0-70 0-40	30-70	D	4,418	16.	5-29-69	8/48	5- -69	L.
33B N47 E38 12DCD1	1961	59	6	59	49-57	D	4,560	5.	11-16-61	--	--	L.
33B N47 E38 13ABA1	--	55	6	--	--	D	4,560	--	--	--	--	--
33B N47 E38 13BAAD1	1961	59	6	59	48-59	--	4,560	5	11-10-61	--	--	L; well destroyed.
33B N47 E38 13BACA1	1960	60	6	60	50-60	A	4,560	10	9-04-60	--	--	L.
33B N47 E38 13BCCD1	--	56	6	--	--	D	4,530	--	--	--	--	Well destroyed.
33B N47 E38 13CACA1	--	75	6	--	--	D	4,560	--	--	--	--	--
33B N47 E38 13CACB1	--	80	6	--	--	A	4,560	--	--	--	--	--
33B N47 E38 13CBCD1	1960	106	6	65	54-64	D	4,540	--	--	--	--	L.
33B N47 E38 13CBDC1	--	55	6	--	--	D	4,540	--	--	--	--	--
33B N47 E38 14CCB1	--	60	6	--	--	A	4,490	--	--	--	--	--
33B N47 E38 14CCC1	--	--	6	--	--	A	4,490	--	--	--	--	--
33B N47 E38 14CDD1	--	66	6	--	--	A	4,505	--	--	--	--	--
33B N47 E38 14CDD2	--	--	6	--	--	A	4,505	--	--	--	--	--
33B N47 E38 14DAD1	--	50	6	--	--	D	4,530	--	--	--	--	--
33B N47 E38 14DCA1	--	55	6	--	--	D	4,515	--	--	--	--	--
33B N47 E38 14DCD1	--	32 (3-64)	6-8	--	--	A	4,515	12.36	3-12-64	--	--	--
33B N47 E38 14DDD1	1960	56	6	56	46-56	A	4,544	20	7-14-60	--	--	L.
33B N47 E38 15CBA1	--	48	6	--	--	--	--	--	--	--	--	--
33B N47 E38 15DBCA1	--	82	6	--	--	--	4,480	--	--	--	--	--
33B N47 E38 15DCC1	1960	80	6	46	36-46	A	4,470	13 13.1	7-10-60 7-20-76	-- --	-- --	L, reported original depth 46 ft., deepened to 80 ft.
33B N47 E38 15DDBD1	--	85	6	--	--	A	4,480	8.3	7-20-76	--	--	--
33B N47 E38 15DDCD1	1960	77	6	77	57-77	--	4,480	16	7-06-60	--	7- -60	L; well destroyed.
33B N47 E38 16CABA1	1973	77	6	77	--	D	4,425	16	12- -73	12/5	12- -73	L.
33B N47 E38 17BBBA1	--	18	8	--	--	S	4,402	5.46 4.6	7-27-59 12-16-75	--	--	Windmill.
33B N47 E38 17CAD1	--	--	--	--	--	S	4,409	5.24	3-04-64	--	--	Windmill.
33B N47 E38 17DAA1	1955	701	16 12	0-200 220-500	50-200 400-500	I	4,418	19.47 16.65	3-05-64 12-16-75	660/192	6-16-76	L.
33B N47 E38 17DDD1	--	11 (6-76)	8	--	--	A	4,415	15.43 5.05	1-22-64 6-15-76	--	--	Abandoned windmill.
33B N47 E38 20ABB1	--	--	12	--	--	A	4,406	8.89 3.30	11-16-63 12-16-75	--	--	--

Table 5.--Record of selected wells--continued

Well location	Casing: Year drilled or dug	Casing: Depth of well (feet) and date measured	Casing: Diameter (inches)	Casing: Depth (feet)	Perforated interval (feet below land surface)	Use of well	Land-surface altitude (feet above mean sea level)	Water level: Depth below land surface (feet)	Water level: Date measured	Pumping data: Yield (gal/min) and drawdown (feet)	Pumping data: Date measured	Remarks
RESERVATION AND VICINITY												
33B N47 E38 20DBDB1	--	--	--	--	--	--	4,400	8.38 4.95	11-16-63 12-16-75	--	--	Windmill.
33B N47 E38 21CBAB1	1947	90	6	90	--	D	4,410	19	4- -74	12/6	4- -74	L.
33B N47 E38 21CBB1	--	30	--	--	--	--	4,408	12.8	3-05-64	--	--	Reported well diameter 36 inches.
33B N47 E38 21DAA1	1976	720 (9-76)	12	0-720	149-328 398-616	T	4,440	47.	9-28-76	360/150	9-30-76	L.
33B N47 E38 23AAB1	--	--	--	--	--	D	4,520	--	--	--	--	--
33B N47 E38 28BACB1	--	--	--	--	--	D	4,405	--	--	--	--	--
33B N47 E38 28BACB2	--	--	--	--	--	D	4,405	--	--	--	--	--
33B N47 E38 28BACB3	1947	90	6	0-90	--	D	4,405	21	4- -74	12/7	4- -74	L.
33B N47 E38 29AAC1	--	--	--	--	--	S	4,395	8.47 6.08	11-16-63 12-16-75	--	--	Windmill.
33B N47 E39 7ACDB1	1960	75	6	75	65-75	A	4,640	6.	7-21-63	--	--	L.
33B N47 E39 7ADA1	1960	105	6	105	95-105	D	4,680	--	--	--	--	L.
33B N47 E39 7ADAC1	--	59	6	--	--	A	4,640	--	--	--	--	L.
33B N47 E39 7ADC1	1966	404	8 6	0-360 360-400	60-404	PS	4,640	220 182.3	8- -66 6-15-76	--	--	L; reservation public-supply well.
33B N47 E39 7ADC2	1974	400	8 5-9/16	0-180 180-400	--	PS	4,640	179	6- -74	35/69	6- -74	L; reservation public-supply well
33B N47 E39 7BDD1	1960	65	6	65	55-65	--	4,630	--	--	--	--	L; well destroyed.
33B N47 E39 7CBBD1	--	105	--	--	--	--	4,600	--	--	--	--	L; well destroyed
33B N47 E39 7CDB1	1961	50	6	50	40-50	A	4,600	4	11-26-61	--	--	L.
33B N47 E39 7CDB2	--	46	6	--	--	D	4,600	6.6	7-21-76	--	--	--
33B N47 E39 8AACD1	--	46	6	--	--	--	--	--	--	--	--	--
33B N47 E39 8AAD1	--	52	6	--	--	--	--	--	--	--	--	--
33B N47 E39 8BCBD1	--	75	6	--	--	D	4,640	--	--	--	--	--
33B N47 E39 8BDB1	--	50	6	--	--	A	4,660	--	--	--	--	--
33B N47 E39 8BDB2	--	47	6	--	--	A	4,660	--	--	--	--	--
33B N48 E37 35DDD1	--	--	10	--	--	D	4,450	5.65	10-29-63	--	--	--
33B N48 E38 32DAA1	1955	144	8 12	0-136 0-63	106-136	D	4,424	23	10- -55	31/97	1955	--
33B N48 E38 32DB1	--	--	6	--	--	D	4,430	19.55	9-20-63	--	--	--
33B N48 E38 32DDB1	1966	609	12-3/4	609	189-209 230-400	PS	4,430	--	--	850/114	10- -66	L; McDermitt, Nevada's public-supply well.
OREGON												
33B S41 E42 22CDCD1	1961	615	16	198	100-198	I	4,455	17.63	5-26-76	1,800/136	5- -76	L; open hole from 198 to 615 ft.
33B S41 E42 23CCB3	1963	1,225	18 14	0-295 295-830	110-830	I	4,692	250.42	5-27-76	1,170/151	2- -63	L.

Table 6.--Data for domestic wells on the Reservation, July 1976

Well location	Owner	Reported well depth (feet)	Date	Depth to water (feet below LSD) 1/	Specific conductance 2/	Remarks
33B N47 E38:						
12DCD1	Vernon Horse	59	7-21-76	UTM	224	
13ABA1	Irene Jack	55	7-21-76	UTM	223	
13BAAD1	Albert Skedaddle	59	7-21-76	--	--	Destroyed.
13BACA1	Raymond Smart	60	7-20-76	UTM	--	Pump broken.
13BCCD1	Weiser Crutcher	56	7-20-76	--	--	Destroyed.
13CACA1	Leslie Smart	75	7-20-76	UTM	--	Pump broken.
13CACB1	Marjorie George	80	7-20-76	UTM	--	Do.
13CBCD1	Theadore Brown	106	7-20-76	UTM	599	Water rusty.
13CBDC1	Annie Barr	55	7-20-76	UTM	427	
14CCB1	Herman Crutcher	60	7-20-76	UTM	--	Pump broken.
14CCC1	Lloyd Crutcher	--	7-21-76	UTM	--	Do.
14CDD1	Hom Sam	66	7-20-76	6.5	--	Do.
14CDD2	do.	--	7-20-76	UTM	--	Do.
14DAD1	Glen Abel	50	7-20-76	UTM	462	
14DCA1	Flossie Missouri	55	7-20-76	UTM	198	
14DCD1	Ernest Crutcher	32	7-22-76	5.2	404	
14DDD1	Joe Silva	56	7-22-76	UTM	--	Pump broken.
15CBA1	C. Skedaddle	48	--	--	--	
15DBCA1	Art Cavanaugh	82	7-21-76	UTM	204	
15DCC1	Floyd Crutcher	80	7-20-76	13.1	--	Pump broken.
15DDBD1	Tom Grover, Sr.	85	7-20-76	8.3	--	Pump broken.
15DDCD1	Ben Crutcher	77	7-21-76	dry at 15 ft	--	Destroyed.
16CABA1 3/	Joyce Masters	77	7-20-76	UTM	200	Sample obtained from house tap.
21CBAB1 3/	Irene Tooke	90	7-20-76	UTM	242	Do.
23AAB1 3/	LDS Church	165	7-22-76	UTM	--	
28BACB1 3/	Gordon Abel	90	7-22-76	UTM	287	Sample obtained from house tap.
28BACB2 3/	Hazel Abel	--	7-22-76	UTM	290	Do.
28BACB3 3/	Corey Abel	90	7-22-76	UTM	275	Do.
33B N47 E39:						
7ADA1	Napoleon Sam	105	--	--	--	
7ADAC1	Ross Hardin	59	7-21-76	UTM	--	Pump broken.
7ACDB1	Lester Hinkey	75	7-21-76	6.0	--	Pump missing.
7BDD1	Kenneth Thomas	65	7-21-76	--	--	Destroyed.
7CBBD1	Elsie Sam	105	7-21-76	--	--	Do.
7CDB1	Fred Sam	50	7-21-76	UTM	--	Pump broken.
7CDB2	Josie Cracker	46	7-21-76	6.6	--	Do.

Table 6.--Data for domestic wells on the Reservation, July 1976--Continued

Well location	Owner	Reported well depth (feet)	Date	Depth to water (feet below LSD) 1/	Specific conductance 2/	Remarks
33B N47 E39;						
8AACD1	Orean George	46	7-22-76	--	--	Could not find.
8AAD1	Cato Dick	52	--	--	--	
8BCBD1	Ruby Snapp	75	7-21-76	UTM	276	
8BDB1	Stan Smart	50	7-22-76	UTM	--	Pump broken.
8BDB2	Eddie Smart	47	7-22-76	UTM	--	Do.

1. UTM: Unable to measure.
2. Field measurement, in micromhos. Samples were obtained from well with attached hand pump unless otherwise noted in remarks section. Samples collected after brief hand pumping of little-used or unused well may not represent chemical character of water yielded after appreciable pumping.
3. Electric submersible pump in use as of July 1976, and well is the only source of water supply.

Table 7.--Selected drillers' logs

Location/material	Thickness (feet)	Depth (feet)
RANCH AND VICINITY		
31 N41 E34 8CAC1		
Adobe, yellow	32	32
Clay, sandy, brown, water-bearing	13	45
Clay, blue	15	60
Gravel, blue	21	81
Gravel, blue, and clay	21	102
Clay, sandy, gray	21	123
Clay, sandy, blue	3	126
Sand, blue, water-bearing	15	141
Clay, blue	17	158
Sand, coarse, brown, water-bearing	11	169
Clay, blue	12	181
31 N41 E34 13DD1		
Adobe, yellow	30	30
Sand, brown, water-bearing	17	47
Clay, blue	16	63
Sand, blue	2	65
Sand, blue, water-bearing	22	87
Clay, gray	23	110
Sand, brown, water-bearing	7	117
Clay, brown, water-bearing	5	122
Sand, brown	21	143
Clay, brown	14	157
Clay, sandy, yellow	40	197
Clay, hard, brown	11	208
Clay, sandy, brown	35	243
Clay, brown	13	256
Clay, yellow	11	267
Quicksand, brown	29	296
Clay, yellow	6	302
Sand, gray	11	313
Clay, yellow	37	350
30B N42 E33 10DDB1		
Top soil	7	7
Lava, porous	32	39
Clay, gray, sticky	13	52
Water-bearing material, loose	3	55
Boulders and clay	125	180
Gravel	1	181
Lava with clay stringers	39	220
30B N42 E33 27DBA1		
Clay and silt	17	17
Sand	10	27
Clay and silt	20	47
Clay	25	72
Sand and clay	23	95
Clay, brown, sticky	32	127
31 N42 E34 20DBC1		
Silt	2	2
Clay	25	27
Clay, wet	5	32
Clay, sticky	25	57
Sand	5	62
Clay, sandy	20	82
Sand	5	87
Clay	5	92
31 N42 E34 36BBB1		
Topsoil and sand	10	10
Clay	90	100
Clay, sandy, and gravel	25	125
Clay	45	170
Clay and sand	35	205
Sand	25	230

Location/material	Thickness (feet)	Depth (feet)
RESERVATION AND VICINITY		
33B N47 E37 21DAB1		
Cobbles and clay	395	395
Clay, black	15	410
Cobbles and clay	290	700
Clay, blue, sticky	45	745
33B N47 E37 24BAB2		
Sand, gravel, and clay	80	80
Basalt	120	200
33B N47 E37 24BAC2		
Gravel	80	80
Basalt	190	270
33B N47 E38 5AACD1		
Topsoil	3	3
Clay and gravel	103	106
Gravel	10	116
Clay with stringers of gravel	154	270
Gravel	23	293
Clay and gravel	62	355
Clay, brown	217	572
Gravel and sand	8	580
Clay, brown	20	600
33B N47 E38 9BCBA1		
Topsoil	4	4
Gravel, coarse	4	8
Sand and gravel	4	12
Gravel, coarse, and large washed boulders	12	24
Sand, fine	5	29
Gravel, coarse, boulders, and washed gravel	9	38
Gravel, washed, and sand	6	44
Sand, fine, main water at 46 ft	12	56
Sand, coarse	8	64
Gravel, coarse, and sand	6	70
33B N47 E38 12DCD1		
Topsoil	6	6
Gravel, sand, and clay	10	16
Gravel, fine, sand, and clay	16	32
Gravel, cemented, and sand; first water at 36 ft	27	59
33B N47 E38 13BAAD1		
Topsoil	8	8
Gravel, some clay; first water at 12 ft	7	15
Clay, yellow, gravel and sand	9	24
Gravel, fine, sand and clay	12	36
Gravel, hard, cemented	8	44
Sand and clay	15	59
33B N47 E38 13BACA1		
Topsoil	10	10
Gravel, sand, and clay; first water at 16 ft	6	16
Clay, yellow, and gravel	2	18
Gravel, sand, and clay	6	24
Gravel, very hard cement	2	26
Gravel, softer cement	2	28
Sand and clay	32	60
33B N47 E38 13CBCD1		
Topsoil	4	4
Soil, gravelly	6	10
Gravel and sand	6	16
Clay, sand, and gravel	8	24
Sand and gravel; first water at 25 ft	2	26
Sand, cemented, and gravel	80	106
33B N47 E38 14DDD1		
Topsoil, sandy	3	3
Boulders, coarse sand	10	13
Gravel, coarse, and sand; slight seep of water at 24 ft	11	24
Gravel and sand; seep of water at 36 ft	13	37
Sand, some clay, slightly more water	19	56

Location/material	Thickness (feet)	Depth (feet)
33B N47 E38 15DCC1		
Topsoil	2	2
Boulders, gravel; slight seep of water at 8 ft	12	14
Gravel, coarse; first significant water at 18 ft, more water at 28 ft	14	28
Gravel and sand	10	38
Sand, coarse, some clay, more water	8	46
33B N47 E38 15DDCD1		
Topsoil	2	2
Boulders and gravel	10	12
Gravel and sand, seep of water at 28 ft	16	28
Sand, clay, slightly more water at 57 ft	29	57
Sand, mostly, some clay, more water	20	77
33B N47 E38 16CABA1		
Topsoil	2	2
Boulders and clay	27	29
Sand, fine; first water at 29 ft	4	33
Clay, gravel, and boulders	19	52
Gravel	3	55
Clay, hard	10	65
Sand and gravel	12	77
33B N47 E38 17DAA1		
Topsoil	4	4
Gravel	6	10
Gravel and clay	2	12
Gravel, water-bearing	16	28
Gravel, cemented	37	65
Clay, gravelly	2	67
Gravel, cemented	47	114
Clay, soft, sandy	6	120
Gravel, cemented	48	168
Clay, brown	11	179
Gravel, cemented	14	193
33B N47 E38 17DAA1--Continued		
Clay, gray, and gravel	26	219
Gravel, clayey	47	266
Clay, brown, sandy	21	287
Gravel, hard, cemented	14	301
Clay, gray, sticky	21	322
Gravel, cemented	78	400
Clay, gray, sandy	11	411
Gravel, cemented, and boulders	43	454
Clay, brown, sandy	7	461
Gravel, cemented	19	480
Clay, brown, sandy	11	491
Gravel, cemented	11	502
Clay, gravelly	24	526
Clay, sticky	2	528
Gravel, cemented	8	536
Clay, gravelly	25	561
Rock, volcanic	11	572
Clay, hard, gravelly	22	594
Rock, volcanic	8	602
Clay, brown, sticky, and thin sand streaks	42	644
Sandrock, porous	5	649
Clay, sandy, and water-bearing sand streaks	13	662
Sand and gravel, slightly cemented	7	669
Lava rock, volcanic	3	672
Gravel, hard, cemented	6	678
Sand and gravel, clayey	5	683
Clay, sticky	1	684
Sand and gravel	1	685
Clay, sticky, and thin sand streaks	16	701
33B N47 E38 21CBAB1		
Topsoil	3	3
Boulders and clay	27	30
Sand, fine, water	2	32
Clay, gravel, and boulders	45	77
Sand, water	2	79
Clay, hard	5	84
Sand and gravel	6	90

Location/material	Thickness (feet)	Depth (feet)
33B N47 E38 21DAA1		
Topsoil	2	2
Sand, fine to coarse, makes of matrix. Some grains are rounded, others are angular; gravel up to 1/2" is probably from cobbles and smaller rocks	156	158
Same as above, with clay streaks	29	187
Very hard material, probably rhyolite, sand and gravel, minor clay	14	201
Clay, gravel, fine to coarse sand	19	220
Gravel, very hard, some rounded grains, mostly angular chips, probably rhyolite; from 245 ft to 255 ft, lots of cave-in, very coarse material	60	280
Rhyolite, andesite, and some clay	55	335
Clay and gravel	10	345
Clay, gravel, boulders	40	385
Gravel and boulders, some sand	20	405
Clay, sandy, some gravel and boulders	60	465
Clay, sandy, no gravel	20	485
Clay, sandy	10	495
Sand, coarse, some clay	20	515
Sand, boulders	50	565
Sand, coarse, sandy clay, some rocks	30	595
Clay	10	605
Clay, sandy streaks, volcanics	95	700
Sand, coarse	20	720
33B N47 E38 28BACB3		
Topsoil	2	2
Boulders and clay	31	33
Gravel, water strata	3	36
Clay and gravel	35	71
Sand, water strata	3	74
Clay, hard	8	82
Sand and gravel, water strata	8	90
33B N47 E39 7ACDB1		
Topsoil	2	2
Gravel and sand	8	10
Gravel, clay, and sand	22	32
Sand and clay; seep of water at 48 ft	28	60
Gravel, fine, sand and clay	6	66
Gravel, sand, and clay	9	75
33B N47 E39 7ADA1		
Boulders and topsoil	18	18
Boulders and clay	7	25
Boulders, gravel, and clay	3	28
Gravel and clay	4	32
Boulders and gravel	8	40
Gravel and clay	16	56
Boulders and gravel; seep of water at 62 ft	6	62
Gravel, cemented, and sand; more water at 95 ft	43	105
33B N47 E39 7ADC1		
Silt	2	2
Boulders in size from pea gravel to 3 ft in diameter with interlayment of earth material	57½	59½
Gravel, large	1	60½
Boulders again	53½	113
Clay, brown-yellow, hard	17	130
Boulders, larger	20	150
Boulders and yellow-brown clay	50	200
Rocks, smaller, some clay, trace of black clay	58	258
Lava, volcanic, hard layers, and other hard rock	9	267
Rock, small, soft	38	305
Boulders with yellow-brown clay	95	400
Boulders	4	404

Location/material	Thickness (feet)	Depth (feet)
33B N47 E39 7ADC2		
Topsoil	5	5
Boulders with some water	13	18
Rock, broken, with thin clay and sand streaks; possibly water	39	57
Basalt, with fractures; possible water in fractures	38	95
Basalt, black, very hard	23	118
Boulders and sand, water	6	124
Basalt, black, very hard	23	147
Basalt, black, with fractures	20	167
Sand and gravel with clay; possible water	30	197
Basalt, black, very hard	10	207
Basalt, black and red, broken; clean water	6	213
Basalt, black, very hard	18	231
Sand and clay; possible water	14	245
Basalt, black, very hard	20	265
Basalt, black and red, broken; clean water	11	276
Basalt, black, hard	23	299
Sand; clean water	15	314
Basalt, black, hard	33	347
Sand; clean water	14	361
Basalt, black, hard	13	374
Basalt, broken clean; possible water	13	387
Basalt, black, hard	4	391
Clay, red	5	396
Basalt, light red	4	400
33B N47 E39 7BDD1		
Topsoil	2	2
Boulders and gravel	12	14
Gravel, sand, and clay	16	30
Gravel and sand; first water at 34 ft	10	40
Gravel and sand, cemented	25	65
33B N47 E39 7CBBD1		
Topsoil, rocky	10	10
Sand, cemented, and gravel	14	24
Gravel and boulders	4	28
Gravel, fine, sand, and clay	32	60
Gravel, softer, sand and clay; no water	45	105
33B N47 E39 7CDB1		
Topsoil	6	6
Gravel, sand, and clay	12	18
Gravel and sand	6	24
Hardpan	3	27
Sand, cemented, and gravel	23	50
33B N48 E38 32DDB1		
Topsoil	3	3
Clay, yellow, sandy	4	7
Clay, yellow, sandy, and gravel	20	27
Gravel	13	40
Gravel, large	7	47
Clay, yellow, sandy, and large gravel	42	89
Clay, yellow, sandy, and gravel	11	100
Gravel	6	106
Clay, yellow, sandy, and gravel	27	133
Gravel and yellow clay streaks	44	177
Clay and gravel	12	189
Sand and gravel	20	209
Clay, yellow, sandy, and gravel	22	231
Gravel and yellow, sandy clay streaks	34	265
Sand and gravel	10	275
Gravel	20	295
Gravel and clay streaks	14	309

Location/material	Thickness (feet)	Depth (feet)
33B N48 E38 32DDB1--Continued		
Gravel, packed in yellow clay	22	331
Clay, red, silty	36	367
Clay, brown, sandy	30	397
Clay, brown, sandy, and gravel, hard streaks	76	473
Clay, brown, sandy, and gravel	87	560
Gravel	10	570
Clay, brown, sandy, and gravel	20	590
Sand and gravel	8	598
Clay, yellow, sandy, and gravel	11	609
33B S41 E42 22CDCD1 (Oregon)		
Topsoil	12	12
Gravel, coarse, and clay	34	46
Gravel, free	6	52
Gravel and clay	53	105
Gravel	5	110
Gravel and clay	82	192
Gravel, free, pea size	3	195
Gravel, hard, and clay	171	366
Boulders and clay	5	371
Clay and gravel	121	492
Gravel	4	496
Clay and boulders	16	512
Gravel, peas size, and rock	41	553
Clay and boulders	19	572
Gravel, free, and boulders	43	615

Location/material	Thickness (feet)	Depth (feet)
33B S41 E43 23CCB3 (Oregon)		
Topsoil, gravel, and clay	16	16
Sand and gravel	12	28
Gravel, cemented	52	80
Sand and gravel	30	110
Gravel, cemented, and boulders	30	140
Gravel and sand	25	165
Sand, gravel, and clay	58	223
Sand, gravel, and small boulders	52	275
Gravel and boulders	20	295
Sand, water-bearing	15	310
Rock	7	317
Sand, water-bearing	28	345
Sand, thin clay streak, and gravel	115	460
Sand, gravel, streak of clay	55	545
Gravel, streak of clay	89	634
Clay, sandy, gravel	46	680
Sand	20	700
Gravel and clay	30	730
Clay, sandy	31	761
Shale, blue	83	875
Log of deepening:		
Shale, blue	30	860
Rock	3	863
Clay, yellow	15	878
Shale, blue	32	910
Gravel, pea-sized	10	920
Shale, blue	60	980
Clay, brown, sandy, and sand	20	1,000
Clay and pea-sized gravel, mixed	50	1,050
Rock, black, soft	1	1,051
Clay, brown, sticky	5	1,056
Clay and gravel, mixed	74	1,130
Clay, blue, hard, and gravel	5	1,135
Clay, brown, sandy	65	1,200
Clay, sticky, and sand	25	1,225

Table 8.--Chemical analyses of selected ground waters

(Analyses by the U.S. Geological Survey, except as indicated)

Location	Date of collection	Temperature (°C)	Silica (SiO_2) (mg/L)	Calcium (Ca) (mg/L)	Magnesium (Mg) (mg/L)	Sodium (Na) (mg/L)	Potassium (K) (mg/L)	Alkalinity as bicarbonate a/ (HCO_3) (mg/L)	Sulfate (SO_4) (mg/L)	Chloride (Cl) (mg/L)	Fluoride (F) (mg/L)	Nitrate (NO_3) (mg/L)	Arsenic (As) (ug/L)	Boron (B) (ug/L)	Iron b/ (Fe) (ug/L)	Hardness as $CaCO_3$ (mg/L)	Dissolved solids c/ (mg/L)	SAR	Specific conductance (micromhos)
RANCH AND VICINITY																			
31 N41 E33 22ACA1	10-20-60	13.0	--	48	29	326	18	305	--	280	--	--	--	--	--	240	1,250E	9.2	1,930
31 N41 E35 17ABB1	6-23-59	--	69	22	3.9	104	12	200	64	54	1.0	0.8	--	300	170T	70	431C	5.4	622
31 N41 E35 20A1	10-26-54	26.5	4.8	2.2	.8	197	18	264	70	106	1.4	.2	--	--	--	9	541C	29	941
30B N42 E33 10DDB1	2-13-64	15.0	--	27	6.0	d/ 101	--	231	44	55	--	--	--	--	--	92	420E	4.6	646
30B N42 E33 27DBA2	3-30-76	13.5	23	20	6.0	60	11	164	30	37	.7	.27	1	260	--	75	269C	3.0	412
31 N42 E34 20DBC1	3-30-76	11.5	2.2	14	3.3	56	9.4	149	25	25	.8	.04	0	160	--	49	209C	3.5	373
31 N42 E34 30ABC1	3-30-76	12.0	57	22	6.4	72	8.8	215	27	31	.9	.31	39	440	--	81	332C	3.5	481
31 N42 E34 36BBB1	4-01-76	14.5	59	26	4.3	110	19	161	40	110	.9	.62	24	400	--	83	450C	5.3	738
30B N43 E33 35DBA1	2-13-64	14.5	--	17	7.7	d/ 87	--	192	35	49	--	--	--	--	--	74	360E	4.4	559
30B N43 E34 35ACD1	2-13-64	--	--	38	10	d/ 79	--	190	88	45	--	--	--	--	--	138	420E	3.8	650
30B N43 E35 31CDD1	11-05-60	--	--	26	6.8	39	5.1	147	--	22	--	--	--	--	--	93	230E	1.8	357
RESERVATION AND VICINITY																			
33B N47 E37 2ABB1	2-12-64	8.0	--	23	6.0	d/ 38	--	144	27	14	--	--	--	--	--	82	213E	1.8	328
33B N47 E37 21DAB1 e/	8-20-75	--	--	63	6.0	60	5.0	185	83	66	0.71	1.6	200	--	20T	182	430C	--	--
33B N47 E37 24BAB2	4-23-76	26.5	56	7.8	1.8	69	3.4	178	49	19	5.3	.49	30	350	--	27	320C	7.5	458
33B N47 E37 24BAC2	4-23-76	26.0	56	7.7	1.0	88	3.2	176	49	19	5.3	.27	27	360	--	23	317C	7.9	449
33B N47 E38 5AACD1	5-27-76	22.5	77	24	3.0	48	8.0	128	39	22	1.1	4.2	12	150	20D	72	290C	2.5	389
33B N47 E38 8CDCD1 f/	1966	--	--	18	7.2	d/ 17	--	85	14	18	.45	--	--	--	100	70	--	--	--
3B N47 E38 14ddd1	3-08-64	8.0	--	28	6.8	d/ 29	--	145	18	16	--	--	--	--	--	98	203E	1.3	312
33B N47 E38 15DBC1 e/	2-17-64	--	--	22	3.0	d/ 29	--	95	24	18	.3	10	--	--	2,370T	70	150C	--	--
33B N47 E38 17CAD1	2-12-64	8.5	--	29	5.7	d/ 31	--	146	21	16	--	--	--	--	--	96	216E	1.4	333
33B N47 E38 17DAA1	6-16-76	33.5	110	5.8	.2	58	12	119	26	14	2.6	2.4	32	370	0D	15	290C	6.5	321
33B N47 E38 18CDB1 e/	8-13-64	--	--	11	1.0	d/116	--	246	48	25	--	.5	--	--	170T	32	435C	--	--
33B N47 E38 21CBB1	2-12-64	--	--	17	4.5	d/ 28	--	101	20	13	--	--	--	--	--	61	153E	1.6	236
33B N47 E38 21DAA1	9-30-76	21.0	69	13	2.8	21	8	79	13	13	.2	1.9	3	60	200D	44	182C	1.4	210
33B N47 E38 23AAB1 e/	5-18-62	--	--	27	6.8	d/ 83	--	232	48	25	.25	3.0	--	--	130T	96	347C	--	--
33B N47 E39 7ADC1 e/	4-23-74	--	--	40	11	46	9	222	31	25	.27	5.0	--	--	340T	145	339R	1.7	--
33B N48 E37 35DDD1	2-12-64	--	--	24	6.1	d/ 35	--	144	26	12	--	--	--	--	--	85	205E	1.7	315
33B N48 E38 32DAA1 e/	10-06-65	--	--	40	8.8	d/ 46	--	120	53	56	--	4.5	--	--	60T	136	295C	--	--
33B N48 E38 32DB1	10-15-54	--	67	103.	21	53	6.5	109	104	185	.2	5.0	--	--	30D	344	599C	1.2	955
33B N48 E38 32DDB1 e/	8-05-75	--	--	29	3.0	37	7	115	23	26	.66	5.1	15	--	0T	86	305R	1.7	--
OREGON																			
33B S41 E42 22CDCD1	5-27-76	16.5	48	16	2.4	36	3.4	114	18	10	2.2	.44	9	150	0D	50	193C	2.2	276
33B S41 E42 23CCB3	3-10-64	10.5	--	32	10	d/ 36	--	195	20	14	--	--	--	--	--	123	255E	1.4	393

Footnotes on following page.

Footnotes for table 8:

a. Laboratory determination.
b. Dissolved values indicated by "D"; total values indicated by "T."
c. Residues on evaporation indicated by "R"; estimated values (65 percent of specific conductance) indicated by "E." Calculated values (with bicarbonate multiplied by 0.492 to make results comparable with "residue" values) indicated by "C."
d. Sodium plus potassium, computed as milliequivalent-per-liter difference between determined negative and positive ions; expressed as sodium (concentration of sodium generally is at least 5-10 times that of potassium). Computation assumes that concentrations of undetermined negative ions--especially nitrate--are small.
e. Analysis by Nevada Bureau of Laboratories and Research.
f. Analyst unknown.

Table 9.--Temperature, specific conductance, and estimated dissolved-solids concentration of well water in the Hog John Ranch area

Well number 1/	Location	Well depth (ft)	Date sampled	Water temperature (°C)	Specific conductance (micromhos)	Dissolved solids 2/ (mg/L)	Source
1	31 N41 E33 4BDD1	48	4-01-76	12.0	1,360	880	Abandoned windmill.
2	29 N41 E33 6BDC1	42	4-01-76	11.0	3,380	2,200	USGS test hole KR-20.
3	31 N41 E33 10BCB1	39	4-01-76	13.5	12,900	8,400	USGS test hole KR-17.
4	31 N41 E34 6BDA1	42	3-30-76	14.0	37,000	24,000	USGS test hole KR-18.
5	31 N41 E34 8CAC1	167	3-19-76	--	1,200	780	Abandoned well used for highway construction.
6	31 N41 E34 13DD1	243	3-18-76	14.5	660	430	Abandoned well used for highway construction.
7	30B N42 E33 10DDB1	220	3-31-76	15.5	690	450	Windmill.
8	30B N42 E33 21DBD1	33	3-31-76	14.0	4,450	2,900	USGS test hole KR-1.
9	30B N42 E33 27DBA1	36	3-30-76	13.0	2,520	1,600	USGS test hole within Ranch.
10	30B N42 E33 27DBA2	92	3-30-76	13.5	412	270	USGS test hole within Ranch.
11	29 N42 E33 32BAD1	37	3-19-76	--	1,520	990	USGS test hole KR-21.
12	30B N42 E34 4BAB1	25	5-13-76	13.5	2,550	1,700	USGS test hole KR-4.
13	30B N42 E34 12CCD1	26	4-01-76	11.0	19,300	12,000	USGS test hole KR-7.
14	31 N42 E34 20DBC1	90	3-30-76	11.5	373	240	USGS test hole within Ranch.
15	31 N42 E34 20DBC2	33	3-30-76	11.5	5,840	3,800	USGS test hole within Ranch.
16	31 N42 E34 30ABC1	50	3-30-76	12.0	481	310	Stock well within Ranch.
17	31 N42 E34 36BBB1	229	4-01-76	14.5	738	480	Windmill.
18	30B N42 E35 19ACD1	--	4-01-76	20.0	438	280	Windmill.
19	30B N43 E33 35DBA1	80	3-31-76	11.0	511	330	Windmill.
20	30B N43 E34 28CAA1	21	5-13-76	12.0	408	260	Windmill.
21	30B N43 E34 35ACD1	21	4-01-76	11.0	1,250	810	USGS test hole KR-5.
22	30B N43 E35 31CDD1	230	4-01-76	13.5	361	240	Windmill.

1. Numbers correspond to those used in figure 8.
2. Estimated for sample whose specific conductance is 65 percent of that shown.