STATE OF NEVADA

OFFICE OF THE STATE ENGINEER

WATER RESOURCES BULLETIN No. 5

Geology and Water Resources of Las Vegas, Pahrump, and Indian Spring Valleys, Clark and Nye Counties, Nevada

By

G. B. MAXEY and C. H. JAMESON

Prepared in cooperation with the

UNITED STATES DEPARTMENT OF THE INTERIOR

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FOREWORD

This report is the seventh in the series of Nevada Water Resources Bulletins, four of them dealing with ground water in Las Vegas Valley. It sets forth the results of a comprehensive and detailed geologic and hydrologic investigation in Las Vegas, Pahrump, and Indian Spring Valleys, in Clark and Nye Counties, Nevada. The report was prepared by the U. S. Department of the Interior, Geological Survey, in cooperation with the State Engineer.

A cooperative arrangement for a study of the ground-water resources in Las Vegas Valley was begun in July 1944 as the result of an agreement between the Director of the Geological Survey and the State Engineer of Nevada. The program for the State is under the supervision of Hugh A. Shamberger, Assistant State Engineer, and for the Geological Survey, under the direction of Thomas W. Robinson, District Engineer in Nevada for the Ground Water Division.

Prior to the present cooperative arrangement, a cooperative study was made of the underground leakage from artesian wells in the vicinity of Las Vegas. The findings of this investigation by Penn Livingston of the Ground Water Division, Geological Survey, are set forth in U. S. Geological Survey Water Supply Paper 849-D. As the result of the present cooperative arrangement the following reports on the ground water of the area have been prepared. The first, entitled "Progress report on the ground-water resources of the Las Vegas Artesian Basin, Nevada," was published in 1945. This was followed by "Water levels and artesian pressure in wells in Las Vegas Valley and in other valleys in Nevada, 1913–1945," Water Resources Bulletin No. 3 published in 1947; "Well data in Las Vegas and Indian Spring Valleys, Nevada," Water Resources Bulletin No. 4 published in 1946; "Ground water in Las Vegas, Pahrump, and Indian Spring Valleys, Nevada" (A summary), published in 1947, and the present report.

ALFRED MERRITT SMITH,
State Engineer.

June 28, 1948.

ABSTRACT

Las Vegas, Pahrump, and Indian Spring Valleys are situated in Clark and Nye Counties in southwestern Nevada. The city of Las Vegas, in the south-central part of Las Vegas Valley, is the chief commercial center for the three valleys. The Union Pacific Railroad and U. S. Highway 91, which pass through the southern part of Las Vegas Valley and the city of Las Vegas, are the main transportation routes to Los Angeles, California, about 300 miles south, and to Salt Lake City, Utah, about 450 miles north of Las Vegas. The population of Las Vegas Valley is chiefly dependent for its livelihood upon a resort and tourist trade, a limited chemical and mining industry, and the railroad. The people of Pahrump Valley are chiefly farmers and ranchers and the few people in Indian Spring Valley depend for their livelihood upon the tourist trade and the operation of one large ranch. The climate of the area is arid, for the average annual precipitation in the valleys is less than 10 inches, and there are no perennial surface streams. The water supply for the valleys is obtained from springs and wells, except at the town of Henderson in Las Vegas Valley, where a pumping station and pipe line supply water from Lake Mead.

A rapid increase in population in Las Vegas Valley, beginning in 1941, caused an apparently critical water shortage there, and in Pahrump Valley increased agricultural development resulted in further exploitation of ground-water supplies. The purpose of the study upon which this report is based was to determine the occurrence, source, and amount of ground water available in the three valleys.

The three valleys lie near the southwestern boundary of the Great Basin. They are bounded by high, rugged mountain masses with precipitous slopes which abut against relatively gently sloping alluvial aprons. The highest and largest mountains are the Spring Mountain and Sheep Ranges. The alluvial aprons usually terminate at their lower ends in playas. Remnants of the alluvial aprons extend far up the mountain canyons and, in many places, blanket the mountain slopes to elevations as high as 9,000 feet. In part of Pliocene and Pleistocene time, during and immediately following deposition of the sediments of the aprons, the mountains bounding the three valleys were probably buried deeply in alluvial materials which have since been partially removed by erosion.

The alluvial slopes are being eroded at the present time, although in some places they are sites of deposition. Sediments are being deposited in the lower parts of all the valleys. The mountains are everywhere being eroded.

Drainage in Pahrump and Indian Spring Valleys is interior, to playas that occupy the lowest portion of each valley. In effect, drainage in most of Las Vegas Valley is likewise interior, although if appreciable surface runoff occurred the water would drain to the Colorado River through Las Vegas Wash in the extreme southeastern part of the valley.

The rocks exposed in the area range in age from pre-Cambrian to Recent. Generally the older rocks of pre-Cambrian, Paleozoic, Mesozoic, and early Tertiary age form the mountains, and the rocks of Miocene (?), Pliocene, Pleistocene, and Recent age form the relatively unconsolidated materials within the valleys. Of the older rocks only the Sultan limestone of late (?) Devonian age and the Monte Cristo limestone of early and middle Mississippian age are important water-bearing formations, and usually they occur above the regional ground-water level. The other older rocks are relatively impermeable and are not important aquifers. They impede ground-water movement and act as barriers to form the boundaries of the ground-water reservoirs. The Esmeralda (?) formation of late Miocene (?) age and the Muddy Creek formation of Pliocene (?) age are thick deposits of chiefly fine-grained alluvial materials with a few thin sand and gravel lenses. They crop out in five widely separated localities in Las Vegas Valley and probably are present in the valley fill beneath the younger sediments in three valleys. These beds are not important as aquifers at the present time. Deeper drilling in the valleys may produce wells of moderate yield in the sand and gravel lenses in the sediments of the Esmeralda (?) and Muddy Creek formations. However, water from them may be highly mineralized.

The upper 700 to 1,000 feet of sediments in the valleys are the older alluvial deposits of gravel, sand, silt, and clay, chiefly of Pliocene (?) and Pleistocene (?) age. They are probably underlain by the Muddy Creek and Esmeralda (?) formations, and in some places they are overlain by a thin veneer of Recent playa and eolian sediments. These Pliocene (?) and Pleistocene (?) alluvial deposits form the alluvial apron and are typical alluvial-fan deposits. The upper part of the alluvial apron consists chiefly of gravel and sand beds, some of which grade into silt and clay toward the lower parts of the valley; others extend persistently toward the axes of the valleys and interfinger with the silt and clay beds. These persistent gravel layers are believed to represent periods when the streams had relatively great carrying power, probably periods of more humid climate. The silt and clay beds are inferred to represent periods when the streams had smaller carrying power, during times of aridity. The alluvial-fan materials are generally coarser and the deposits are much thicker and topographically higher in the valleys opposite the larger canyons in the mountains. In the valleys opposite the smaller canyons and along the mountain slopes, they consist chiefly of fine materials and are thinner and topographically lower. Numerous logs of the alluvial materials have been recorded from wells drilled in the southern part of Las Vegas Valley and in the central part of Pahrump Valley. They show that clay, sandy and silty clay, and caliche make up by far the largest part of the valley deposits near the lower ends of the alluvial fans. Layers of gravel and sand ranging from 1 to 20 feet in thickness occur infrequently there. The logs also show that these layers of gravel and sand are lenticular and thin rapidly toward the central parts of the valleys. Probably most of the gravel and sand lenses are limited in horizontal extent and are more or less imperfectly interconnected.

Most of the ground water used in the three valleys is obtained from wells and springs and is supplied by the gravel and sand lenses of the valley fill. In the Las Vegas Valley more than three-fourths of the wells draw water from aquifers ranging from 250 to 450 feet below land surface, designated as the Shallow Zone of aquifers. This zone is separated from the underlying Middle Zone of aquifers, which range from 500 to 700 feet in depth, by a persistent 10- to 50-foot-thick blue clay layer. Several wells of large yield draw water from aquifers in the Middle Zone. A few wells drilled to depths of more than 700 feet have encountered thin water-bearing beds as deep as 1,225 feet. All the water-bearing beds below 700 feet are included in the Deep Zone of aquifers. In Pahrump Valley confined water is encountered in wells at depths ranging from 165 feet to more than 900 feet. In Indian Spring Valley confined water has been found at depths ranging from 400 to 600 feet.

Ground water also occurs in the three valleys at shallow depths (100 feet or less). In parts of the valleys this water is under slight artesian pressure, in other parts of the valleys it occurs under water-table conditions. This water is referred to in this report as the "near-surface" water.

Playa and lacustrine deposits of Pleistocene age occur in the lower parts of the three valleys. These beds consist of superficial deposits of relatively impermeable silt and clay which are rarely thicker than 50 feet.

The playa, eolian, and wash deposits of Recent age consist chiefly of unconsolidated gravel, sand, silt, and clay. The deposits are usually less than 100 feet thick. They are only locally significant as aquifers. In the vicinity of Indian Springs and in the southeast part of Las Vegas Valley water, used chiefly for domestic purposes, is withdrawn from occasional thin gravel and sand lenses occurring in Recent deposits.

Outstanding geologic structural events include block faulting, which occurred previous to late Mesozoic time, and overthrusting and folding during Mesozoic and during early Tertiary and Quaternary time. Minor faulting and folding were probably synchronous with and related to both the overthrusting and the block faulting. Evidence that major faults and other large-scale structural activities displaced the older alluvial deposits was not observed anywhere in the three valleys. Small normal faults of probable Recent and late Pleistocene age were observed in the older alluvial deposits and in the Muddy Creek formation in Las Vegas Valley. These faults are probably a result of differential compaction in the younger relatively unconsolidated sediments, and probably do not cut the older bedrock, as do faults of Recent age in adjacent regions.

Movements of ground water in Las Vegas Valley are significantly affected by these faults. They act as partial barriers that impede the movement of water through the various aquifers. Moderately permeable beds in the valley fill were probably offset against less permeable beds, thus partly or wholly damming the flow of water through the permeable beds. Some of the ground water thus impeded moves upward along the fault zones and issues as springs near the traces of the faults. The location and origin of Kyle, Stevens, and Las Vegas Springs near the foot of the fault scarps in Las Vegas Valley are apparently a result of such faulting. The older structures in the indurated bedrock of the mountains also affect the movement of ground water. Most fault zones are cemented and generally form ground-water dams. Where the attitude and permeability of the rock strata are favorable, the water is brought to the surface as springs. When joints occur in soluble formations, they generally transmit large quantities of water.

The only source of ground water for the three valleys is precipitation on the higher areas of the Spring and Sheep Mountains. However, only a small part of the precipitation recharges the alluvial-fan and valley-fill materials that compose the ground-water reservoirs. The rest of the water from precipitation on the area is lost by evaporation and transpiration. The water that reaches the ground-water reservoirs is ultimately discharged through springs and wells and by evaporation and transpiration.

Estimates based on the available precipitation data, and checked with information from all available geologic and hydrologic data, show that the annual recharge of the ground-water reservoir in Las Vegas Valley is between 30,000 and 35,000 acre-feet.

The total annual discharge from the ground-water reservoirs in Las Vegas Valley probably never exceeded 35,000 acre-feet until 1946. Water levels have declined in the valley. They may be expected to continue to decline until the cones of depression in the piezometric or pressure-indicating surface, caused by withdrawal of water from wells and springs, have grown sufficiently to intercept the amount of recharge necessary to balance the total withdrawals of ground water. Locally, much of the excessive decline of water levels in Las Vegas Valley has been a result of local overdevelopment caused by close spacing and heavy pumping of wells. However, the available data indicate that ground water probably is now being pumped from storage; that is, more water is being taken from the reservoirs than is entering them from the recharge areas, and that therefore part of the water-level decline has resulted from overpumping. Thus, continued withdrawal of substantially more than 35,000 acre-feet of ground water annually will result in continued, and possibly increasing, decline of the water level and in overdevelopment of the ground-water supply in Las Vegas Valley.

Of the total discharge of ground water in Las Vegas Valley probably 5,000 to 8,000 acre-feet, or 12 to 15 percent, is lost by evaporation and transpiration. Also, it is estimated that possibly 15 percent of the total discharge is wasted through lack of conservation, mostly within the city of Las Vegas. It appears that at least half the water thus lost can be utilized by further development of wells in the near-surface reservoir and by increased, more efficient conservation of supplies now obtained from the Shallow, Middle, and Deep Zones of aquifers.

In Pahrump Valley approximately 23,000 acre-feet of water is annually available for recharge, and about 17,000 acre-feet is annually discharged from wells and springs. Water levels have declined during the short period of record and they may be expected to decline until the cones of depression have grown sufficiently to intercept the amount of recharge necessary to balance the total withdrawals of ground water. However, some ground water is available for additional development in Pahrump Valley.

Although sufficient data are not available to show whether there is a substantial unused supply in Indian Spring Valley, it appears that some additional ground water is available there also.

The chemical character of the ground water in Las Vegas Valley differs considerably from place to place. In general the quality is better in the vicinity of the city of Las Vegas than it is toward the lowest part of the valley to the south. The ground water in the vicinity of the city of Las Vegas is suitable and is used for both domestic and irrigation purposes. However, in the south part of the valley the water is not suitable for either domestic or irrigation use.

In Pahrump Valley the best water is found along the east side and poorer water in the central part. Although the water in the central part of the valley has a higher concentration of dissolved solids than that from the east side, it is suitable for domestic use and safe for irrigation.

PLATE 3—Well (S-21-54) 3cad1. Manse Ranch, Pahrump Valley, Nevada. Flowing 3,450 gallons per minute in February 1941

GEOLOGY AND WATER RESOURCES OF LAS VEGAS, PAHRUMP, AND INDIAN SPRING VALLEYS, CLARK AND NYE COUNTIES, NEVADA

By G. B. Maxey and C. H. Jameson

INTRODUCTION

LOCATION AND GENERAL FEATURES

The area described in this report covers about 3,100 square miles in the arid country of southwestern Nevada, in Clark and Nye Counties (see fig. 1). As is shown on plates 1 and 2, it comprises most of the drainage areas of Las Vegas, Pahrump, and Indian Spring Valleys. The chief communities are Las Vegas, North Las Vegas, and Henderson. The estimated population of these communities in 1946 was: Las Vegas 21,000, North Las Vegas 3,500, and Henderson 6,000. The first and last-named cities are, respectively, the second and third largest cities in Nevada (Reno is first). Las Vegas is the county seat of Clark County, a division point on the Union Pacific Railroad, and the main commercial center for Clark County and most of Southern Nye County. Las Vegas also is a lively pleasure resort and has a large tourist trade. A small chemical industry, which started with the construction of the Basic Magnesium Project at the beginning of World War II, is situated in Henderson. Agricultural activity in the area is mostly confined to Pahrump Valley, but there are a few scattered ranches in Las Vegas Valley. The people of Pahrump Valley depend partly upon nearby Shoshone, California, as a commercial point because adequate roads and other transportation facilities to Las Vegas are lacking. The few people who live in Indian Spring Valley depend upon the tourist trade and the operation of one large ranch for their livelihood.

TRANSPORTATION

The main line of the Union Pacific Railroad between Salt Lake City, Utah, and Los Angeles, California, crosses the southeast corner of the area and passes through Las Vegas. U. S. Highway 91 follows approximately the same route. Las Vegas is about 450 miles southwest of Salt Lake City and 300 miles northeast of Los Angeles. U. S. Highway 95 enters Las Vegas Valley in the south and traverses the central part of the valley northward through

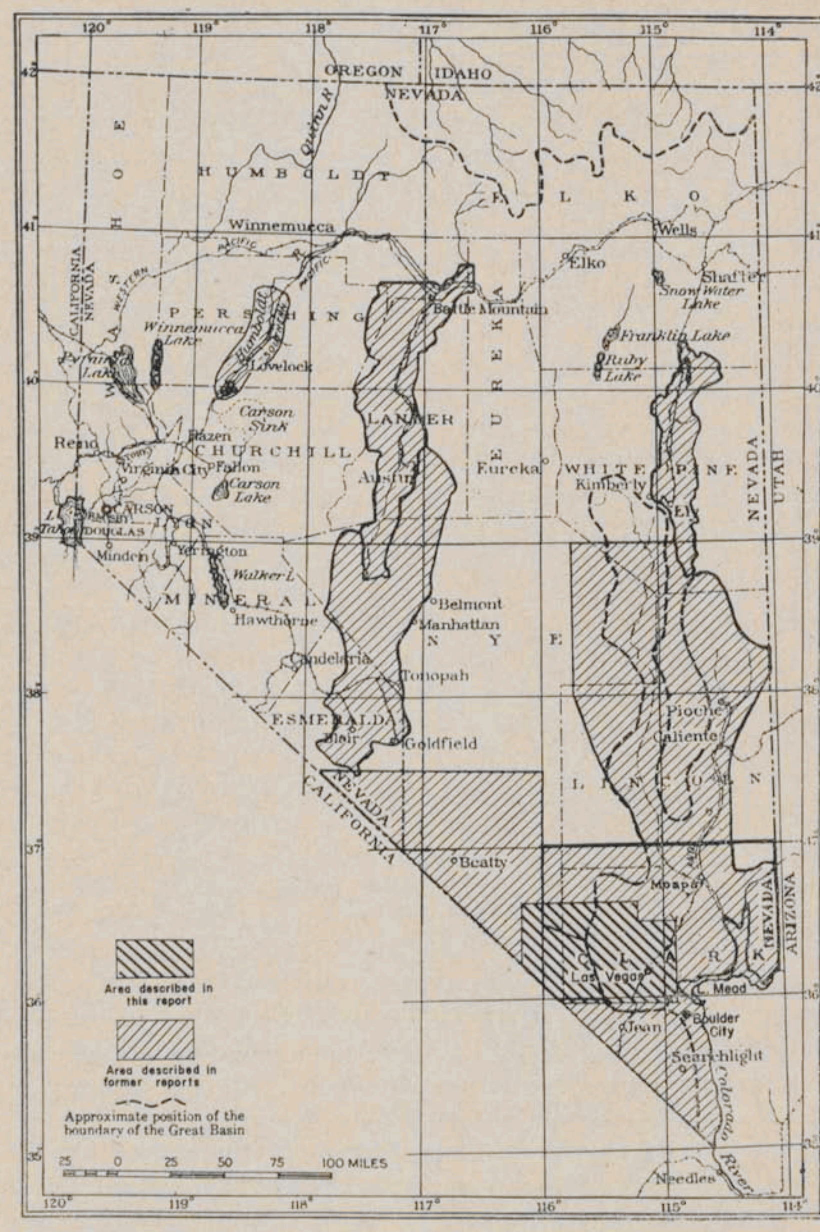

FIGURE 1—Map of Nevada showing areas covered by previous ground-water reports in Nevada and by the present report.

Las Vegas to Indian Springs, thence northwesterly to the cities in northern Nevada. An unimproved road, Nevada State Highway 16 (the "Johnnie Road"), traverses the central part of Pahrump Valley and connects with U. S. Highway 95 about 20 miles west of Indian Springs. Nevada State Highway 52 enters Pahrump Valley from the west, connecting the valley with Shoshone, California, and the West Coast. Many secondary roads and trails within the area have also been built. Thus, most parts of the area are readily accessible by automobile.

PURPOSE AND SCOPE OF THE INVESTIGATION

The purpose of the study upon which this report is based was to determine the sources and amount of ground water available to Las Vegas, Pahrump, and Indian Spring Valleys. This investigation was recommended by the State Engineer in part because of the danger of overdevelopment of the ground-water supplies in the area, and also to assist him in administration of the Nevada ground-water law and adjudication of rights to the use of ground water.

The investigation includes a study of the geology of the area in relation to the occurrence of ground water, a ground-water inventory for a 3-year period, and a determination of the chemical character of the water. The study necessarily involved collection of the existing records for past years relating to the various phases of the ground-water conditions in the three valleys. In addition, much time was spent in study of the relation of precipitation, runoff, and recharge to the occurrence of ground water. The field work was done by G. B. Maxey, who began an intensive study in July 1944. He was assisted in the ground-water studies by C. H. Jameson, Artesian Well Supervisor for Las Vegas and Pahrump Artesian Basins. The investigation was under the general supervision of O. E. Meinzer, Geologist in Charge, Division of Ground Water, U. S. Geological Survey, and T. W. Robinson, District Engineer, Ground Water Division for Nevada since June 1945. From July 1944 to June 1945 general supervision of the investigation was afforded by P. E. Dennis, Geologist in Charge of Ground-Water Investigations in Utah and Nevada during that period. Competent assistance was rendered by W. M. Clay, J. C. Fredericks, D. A. Phoenix, O. J. Loeltz, and Z. E. Bell.

The first seven sections of the present report—that is, those entitled Introduction, Climate, Vegetation and Soils, Physiography, Geology and Water-Bearing Characteristics of the Rock Formations, Springs and Streams, and Occurrence of Ground

Water—describe conditions in the area as a unit. The last three sections describe the detailed ground-water conditions in, respectively, Las Vegas, Pahrump, and Indian Spring Valleys. Preparation of the report, especially those sections dealing with the geology and the occurrence of ground water, was largely by Mr. Maxey. Mr. Jameson collected and compiled many of the data on water-level fluctuation, pumpage, and artesian flow. Mr. Robinson rendered valuable assistance in preparation of the report.

HISTORICAL SKETCH AND WATER-SUPPLY DEVELOPMENT

The large springs in Las Vegas, Pahrump, and Indian Spring Valleys were used as watering places by the aborigines long before the coming of the white man. The variety and abundance of discarded stone weapons and other artifacts, and evidences of primitive camp sites in the vicinity of these springs, indicate human utilization of ground water even before the coming of the Basket Makers and, later, the Paiute and Shoshone tribes. The springs were known by the Spaniards as early as 1770. Probably they were watering places for the Spaniards and other travelers before the Fremont[1] party stopped there in 1844, the first recorded visit of white men to Las Vegas Valley. Other early visitors and users of the springs were Jefferson Hunt, a Mormon missionary, who camped near Las Vegas Springs in 1847, and E. F. Beale and G. H. Heap,[2] who crossed Pahrump Valley, the Spring Mountains, and Las Vegas Valley in 1852, following the early trail past Las Vegas Springs and over Mountain Springs Pass.

By 1855 the existence of water in Las Vegas Valley was well-known and Brigham Young had assigned missionaries under the leadership of William Bringhurst to colonize and develop the valley. A community was built up at the Las Vegas Spring site and development of the land and water for producing agricultural crops was well under way by 1856. In 1857, because of troubles with the U. S. Government, the outlying missions of the Mormon Church were recalled by Brigham Young, and the Las Vegas mission was abandoned.

Further use of the ground water for agricultural purposes was made by O. D. Gass, and the Stewart and Kyle Ranches, from 1857 until the present time. The Stewart Ranch was purchased in 1903, during the construction of the San Pedro, Los Angeles,

[1]Fremont, J. C., Report of the exploring expedition to the Rocky Mountains, 1842–43–44, Washington, 1845.

[2]Beale, E. F., and Heap, G. H., Central route to the Pacific, pp. 101–108, 1854.

and Salt Lake Railroad, for a townsite, now the city of Las Vegas. In 1905, only small amounts of ground water were being used in the sparsely settled area, mostly by settlers whose ranches were way-stations on the southern route from Salt Lake City to the West Coast.

In 1905 the San Pedro, Los Angeles, and Salt Lake Railroad, now the Union Pacific Railroad, was completed and Las Vegas was selected as a division point, mainly because of its excellent water supply. A subsidiary of the railroad company, the Las Vegas Land and Water Company, built the townsite to attract workers and settlers to Las Vegas Valley. This was the beginning of the present city of Las Vegas. Most of the water used for the townsite came from the Las Vegas and Kyle Springs. Only a few shallow wells had been dug and there were no flowing wells. Las Vegas Spring was reported to flow approximately 3,000 gallons a minute, and Kyle Spring flowed approximately 300 gallons a minute. One deep well in which water stood approximately 65 feet below land surface was drilled, probably in 1905, by the Las Vegas and Tonopah Railroad Company for domestic supplies and construction at its Corn Creek station.

Late in 1905 the Vegas Artesian Water Syndicate was organized by residents of Las Vegas to prove by test-well drilling the existence of artesian water in Las Vegas Valley. The wells drilled by this organization were to be sold with adjacent areas of ground to responsible farmers to start agricultural development in the valley. The first flowing artesian well (S-20-61) 21abb1, in Las Vegas Valley was drilled by this organization in the spring of 1907, in the NW¼ NW¼ NE¼ sec. 21, T. 20 S., R. 61 E. At the present time it is owned by C. Gratz. Artesian aquifers were encountered at 176, 225, 260 and 293 feet below the surface, and a total flow of approximately 20 gallons a minute was reported. Following this successful venture, the Syndicate drilled two more artesian wells in 1907 and 1908. Several individuals also drilled wells during this period. In 1911, when Carpenter[3] made his study of ground water in Las Vegas Valley, he found that approximately 100 deep wells had been drilled, of which about 75 were flowing wells. Also, there were about 25 shallow wells, making a total of 125 wells in the valley at that time. Most of the water from the deep wells was being used for irrigation and about five ranches had become well established. About 1910 application of

[3]Carpenter, Everett, Ground water in southeastern Nevada: U. S. Geol. Survey Water-Supply Paper 365, pp. 39–40, 1915.

the Carey Act, enacted in 1894 by the U. S. Congress, further stimulated well drilling. Numerous organizations were formed to drill wells and make other improvements as required to obtain title to land under the provisions of this Act. In 1914 the South Nevada Land and Development Company, an organization backed by local and British capital, drilled several deep wells northwest of Las Vegas and, following this but before 1924, individuals drilled about 20 more deep wells.

During this early period of well drilling, flowing wells were not capped and water from them was wasted. This was undoubtedly due in large part to the belief of the residents that the valley was underlain by an inexhaustible supply of artesian water and that restricting the free flow from wells was a needless, expensive chore. However, as early as 1911, State Engineer W. M. Kearney[4] suggested that the artesian wells should be capped and that the water should be used "with economy instead of the lavish wasteful manner which has prevailed in the past." Carpenter[5] stated that allowing the water to run freely from the wells, and improper methods of casing the wells, had led to much waste of water and had diminished or completely stopped the natural flow of many wells. Although there are no recorded flow measurements between 1912 and 1924, it is known from many reports that the flow of individual wells had diminished and continued to diminish. The total yield from artesian wells and springs was approximately the same in 1924 as in 1912, notwithstanding the fact that more than 20 wells had been drilled during the period. Also, the flow of Las Vegas Spring had diminished from about 7 cubic feet per second in 1905 to about 4.5 cubic feet per second in 1924.

The population of the city of Las Vegas according to the 1910 census was 800, and probably a total of 1,000 people resided in all Las Vegas Valley. According to the 1920 census the city of Las Vegas had 2,304 people and the population of the valley was about 2,500. Most of these people were employed by the railroad and by various commercial concerns, and only a few were engaged in agricultural occupations. It is estimated that between 1910 and 1924 about 22,400 acre-feet of water a year was flowing from the artesian wells and springs. Of this total about 2,240 acre-feet of water a year was used for the municipal water supply and approximately 10,000 acre-feet a year was used for agricultural

[4]Kearney, W. M., in an article in the Las Vegas Age, Nov. 4, 1911.
[5]Carpenter, Everett, op. cit., pp. 40–41.

purposes. Thus, nearly half the water which issued from the ground-water reservoir was wasted throughout the period.

Between 1922 and 1936 the State Agricultural Experiment Station, under the immediate direction of George Hardman, made several studies of the wells in Las Vegas Valley to develop ground-water supplies for irrigation. Many measurements, pumping tests, and reconnaissance studies of the recharge areas were made. Hardman recognized early in the course of his studies that the artesian aquifers were recharged by precipitation on the neighboring mountain ranges. He stressed in his reports that the recharge was limited and that conservation of ground water should be practiced. He also pointed out the advisability of making a more detailed investigation of the water resources.

The most important industry in the Las Vegas Valley during the period 1922 to 1936 was the railroad division shop at Las Vegas. There were also a few farms and ranches. The population of the valley had increased to approximately 6,000. Hardman pointed out that any future development in the valley with an accompanying increase in population would be largely dependent upon the amount of water available from wells and springs, and that increased withdrawal of water from the aquifers would cause continued lowering of water levels and decreased yields of individual wells and springs. Beginning in 1930, and for several years thereafter, the population of the valley increased as a result of a growing tourist trade and the construction of Hoover Dam. Because of the demand for more water, wells were drilled and Hardman's prediction became fulfilled. For example, the flow of Las Vegas Springs, which was 4.5 cubic feet per second in 1924, diminished to about 3.75 cubic feet per second in 1936, and to only about 2.5 cubic feet per second early in 1944. Also, the head declined and flows decreased in all wells in the valley, particularly in the vicinity of the city of Las Vegas.

Following the completion of Hoover Dam, the construction of Army camps and training centers began, and later the Basic Magnesium Project was built and put into operation. These activities resulted in a large increase in the population and a consequent increase in the amount of water used. Continued declines of water levels and decreased yields of individual wells were noted. Since 1941 the largest supplies of water, which had previously been obtained from the free flow of artesian wells, have been pumped. The State Engineer's office has been actively interested in the ground-water resources of the State since 1938, and has been instrumental in having a law for the regulation of ground-water appropriation and use, written and passed in the State Legislature. Under this law the Las Vegas Artesian Basin

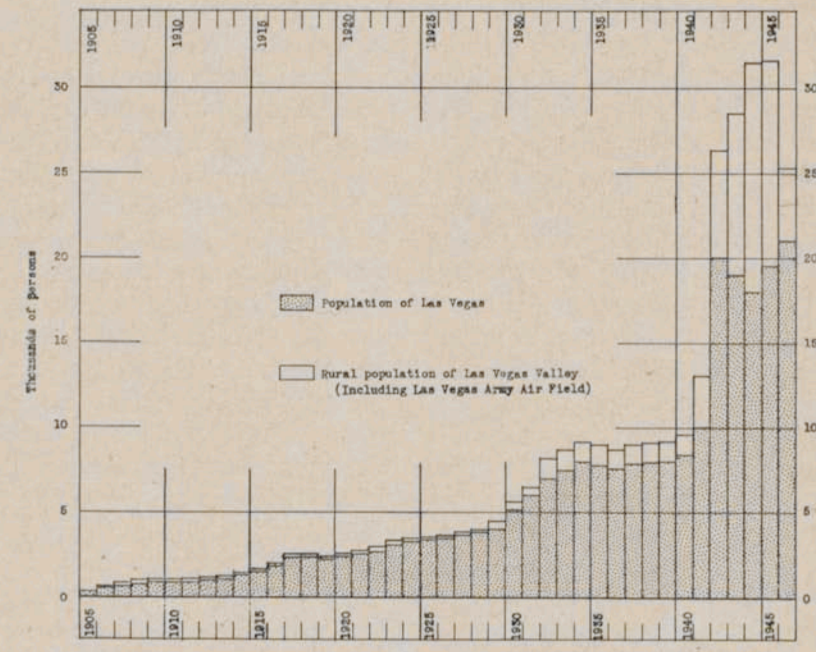

FIGURE 2—Population of Las Vegas Valley (Henderson and Basic Magnesium Project excluded).

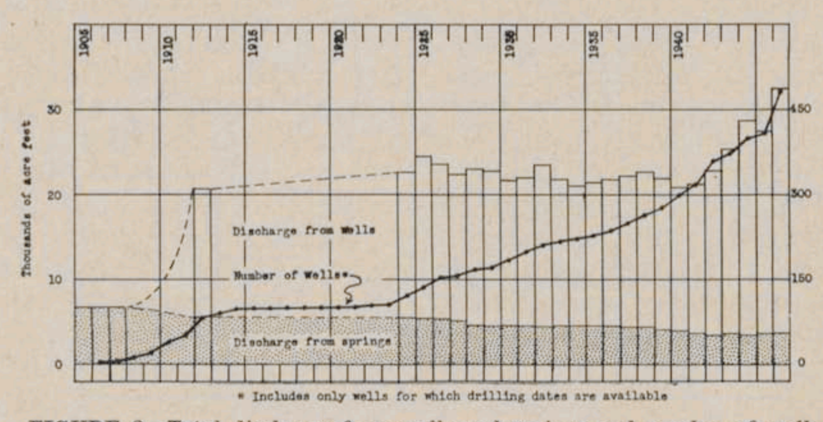

FIGURE 3—Total discharge from wells and springs and number of wells drilled in Las Vegas Valley, 1905–1946.

was designated, an Artesian Well Supervisor employed, and active steps taken to insure proper utilization and conservation of ground water.

Figures 2, 3, 4, and 5 illustrate the growth in population, the increase in the discharge of water and in the number of wells since 1907, and the general decline of water levels and flows of the ground water in Las Vegas Valley since about 1920, thus supplementing the above description. In the last 25 years the demand for water for domestic and cooling purposes has increased tremendously. More than 24,000,000 gallons of water a day (approximately 27,000 acre-feet a year) was used in Las Vegas Valley in 1945, and about 28,000,000 gallons a day (31,700 acre-feet a year) in 1946. Slightly more than one-fourth of this total is used by the city of Las Vegas. Probably not more than 2,500,000 gallons a day (about 2,800 acre-feet a year) was wasted in 1946 as a result of leaky casings and wells left flowing during

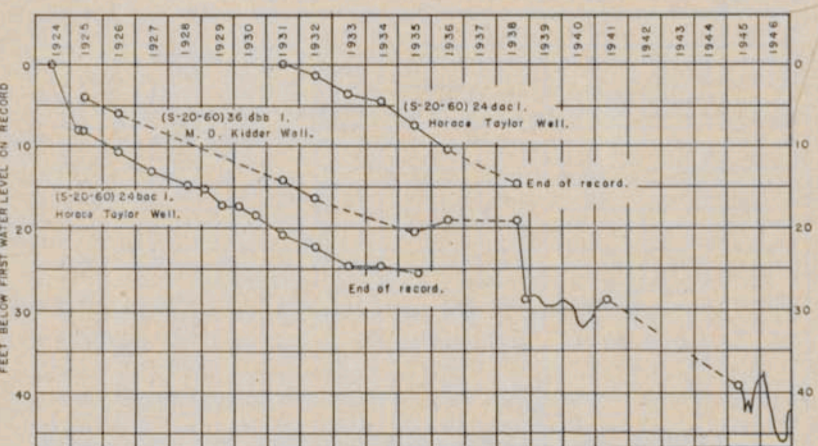

FIGURE 4—Decline of water levels in three wells in Las Vegas Valley, 1924–1946.

the nonuse period. In 1945 approximately 5,000,000 gallons of water a day (5,600 acre-feet a year) was used for agriculture, and nearly 16,000 acre-feet was used by establishments and domiciles not supplied by the city water system for domestic, industrial, railroad, and cooling purposes.

In 1942 a pipe line was constructed from Lake Mead to the Basic Magnesium Project, and for the first time Colorado River water was pumped into Las Vegas Valley. Thus, the town of Henderson and the industries in the Basic Magnesium Project did not use ground water throughout the war years and are still supplied by water pumped from Lake Mead.

In Pahrump Valley the first recorded organized attempt by white men to use ground water for irrigation was made by the Bennetts in 1875 at the present site of Pahrump Ranch. Joseph

Yount and Harsha White utilized spring water for irrigation at the Manse Ranch in 1877. Crops were grown successfully at both ranches. Bennetts Springs were reported to flow about 7½ cubic feet per second, and Manse Springs reportedly flowed approximately 6 cubic feet per second at about that time.

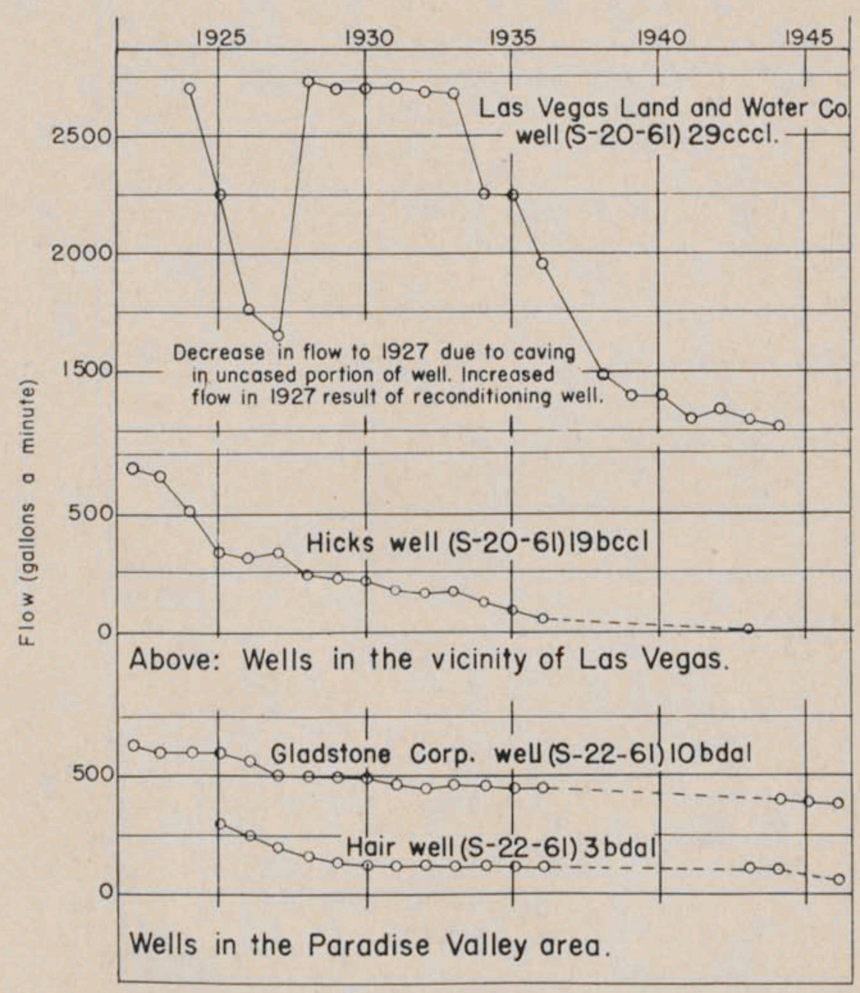

FIGURE 5—**Decline in discharge of representative flowing wells in Las Vegas Valley, 1922–1946.**

The first reported attempt to obtain artesian water from wells in Pahrump Valley was in 1910 when the Pahrump Valley Land and Irrigation Company drilled a well on the Pahrump Ranch in order to obtain more land under the Carey Act. This attempt was unsuccessful. In the spring of 1913 F. A. Buol drilled four wells just north of the Pahrump Ranch, and three of them encountered artesian water that flowed at the land surface. In 1916 Waring[6] reported 28 wells in Pahrump Valley. Of these wells, 15 were flowing, 7 were more than 150 feet deep but were nonflowing, and 6 were shallow nonflowing wells. Waring also measured the flow of Bennetts Springs (the two large springs), which he reported as 4.73 cubic feet per second, and the flow of Manse Springs, which he reported as 3.23 cubic feet per second.[7] He also measured the flows of many of the wells and other springs. From these measurements, and other reported measurements made at about the same time, it is estimated that approximately 12.5 cubic feet of water per second was flowing from artesian wells and springs in Pahrump Valley between 1915 and 1936. It is estimated that during this period not more than 1,000 acres of land were ever under cultivation at one time, and that probably no more than two-thirds of the total flow of water was ever put to beneficial use. Thus about 4.0 cubic feet of water per second was wasted.

Records of the development of ground water in Indian Spring Valley are few, although Indian Springs provided water for irrigation from the late nineties to the present time. The first attempts to secure water from wells for irrigation were made about 1910 and were unsuccessful. In the early twenties several shallow wells were dug and drilled for water for domestic supplies and many of these wells are still being used. In 1942, when the Indian Springs subbase of Las Vegas Army Air Field was built, two deep wells were drilled which encountered artesian water, but the head was not sufficient to force the water to the land surface. Pumps were installed and from 1943 to 1945 these two wells were heavily used. At the present time (1946) little water is used at the subbase. Mesquite Spring and one well about 4 miles west of Indian Springs are used for domestic and cooling purposes.

During the last 10 years several wells have been drilled in the vicinity of Manse and Bennetts Springs. Nearly all these wells yield large quantities of water (see pl. 3), and nearly 500 acres more land has been put under cultivation on the Manse and Pahrump Ranches. Recent exploratory drilling north of the Pahrump Ranch has so far developed no flowing wells of large yield. If good irrigation wells are developed here a large acreage of land

[6]Waring, G. A., Ground water in Pahrump, Mesquite and Ivanpah Valleys, Nevada and California: U. S. Geol. Survey Water-Supply Paper 450-C, pp. 76–79, 1921.

[7]Op. cit., p. 63.

will undoubtedly be cultivated. However, this acreage would be limited by the amount of ground water available.

PREVIOUS WORK AND BIBLIOGRAPHY

The general geologic and hydrologic features of the area were first described by Gilbert in 1875, and by Spurr in 1901 and 1903. Reconnaissance studies of the ground-water resources by the Geological Survey were made by Mendenhall in 1909, by Carpenter in 1915, and by Waring in 1921. A study of the occurrence and methods of utilization of ground water in Las Vegas was conducted by the Nevada State Agricultural Experiment Station under the immediate direction of George Hardman from 1922 to 1936. Results of this study were published, in part, in 1928 and 1934 and are contained in several unpublished manuscripts, two of which are listed below. In 1938 a survey of leaky wells in the area was made by the Geological Survey in cooperation with the Office of the State Engineer, the city of Las Vegas, and the Las Vegas Land and Water Company. A general geologic study of the area by C. R. Longwell has been in progress since 1921 and has not yet been completed. During the last 20 years papers on various features of the geology of the area have been prepared by Longwell, Nolan, Glock, Hewett, Hazzard and Mason, Hunt and others, and Miller. References to all reports mentioned above are listed in the following bibliography and proper credit by footnote is given when reports are referred to in the text.

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ACKNOWLEDGMENTS

Only 80 square miles of the area covered by the present report has been described in published geologic reports. The geology of most of the remainder of the area is the subject of a study by Professor Chester Longwell of Yale University, which is not yet ready for publication. Professor Longwell kindly allowed the use of his areal geologic map and offered many valuable suggestions based on his experience in mapping the Las Vegas quadrangle. Because Professor Longwell's work was not complete, many details have been generalized and some modifications have been made in compiling plate 1 of this report. The senior author assumes all responsibility for any errors or misinterpretations which may result from these modifications and trusts that they will not be attributed to Mr. Longwell. Also, he expresses at this time deep appreciation and gratitude for the valuable and generous assistance rendered by Mr. Longwell.

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The writers are also grateful to members of the Geological Survey who reviewed the manuscript and offered valuable suggestions and constructive criticism.

CLIMATE

Below the altitude of 6,000 feet Las Vegas, Pahrump, and Indian Spring Valleys are arid to semiarid, as the average annual precipitation is less than 10 inches. The rain falls chiefly during the winter months and in July and August. The relative humidity is low, evaporation is rapid, the percentage of sunshine is high, and the daily and seasonal range in temperature is unusually wide. Strong winds are common throughout the year and are especially prevalent during the spring. At higher altitudes in the surrounding mountain ranges the climate is less arid, as precipitation increases rapidly with elevation and storms are more frequent and of greater duration.

Over a 36-year period the average length of the frost-free period at Las Vegas has been 241 days. Generally the first killing frost in the fall occurs in the second week of November, and the latest killing frost in the spring occurs in March. However, in the fall and winter of 1942–1943 there was no killing frost, the only such occurrence on record, and in 1941 the latest spring frost occurred on January 20, the earliest of record. Thus, the growing season at Las Vegas is long. Although few data are available concerning the growing season in Pahrump Valley, it is believed to be of approximately the same duration as that in Las Vegas Valley. The growing season in Indian Spring Valley is probably somewhat shorter than in the other two valleys because Indian Spring Valley is considerably higher. Short records at Kyle Canyon Ranger Station (altitude 7,165 feet) indicate that killing frosts occur there in the latter parts of June and September, giving a frost-free period of only about 3 months.

METEOROLOGICAL RECORDS

Long-period records of precipitation obtained by the U.S. Weather Bureau at Las Vegas, and fragmentary records from other precipitation stations in Las Vegas, Pahrump, and Indian Spring Valleys, are available. In late 1944 the U. S. Weather Bureau, the Nevada Cooperative Snow Surveys, and the U. S. Forest Service cooperated with the Geological Survey in placing five snow-storage gages in the Spring and Sheep Mountains, and a rain gage at Pahrump. Also, two snow-survey courses were established by the Nevada Cooperative Snow Surveys.

The records show that the average annual precipitation at the lower altitudes in the area (1,870 to 3,150 feet) is less than 6 inches. The average annual precipitation at Las Vegas, according to the 42-year record, was 4.62 inches. The average annual precipitation at four other stations, where the record of each is less than 10 years, is: Las Vegas Airport, 4.26 inches; Desert Game Range, 4.99 inches; Indian Springs, 5.77 inches; Pahrump, 5.02 inches, and Kyle Canyon Ranger Station, 19.79 inches. All available precipitation records are summarized in the tables that follow and in figure 6. Except for the stations at Boulder City and Clay City the locations of all weather stations listed in the tables are shown on plate 2.

2

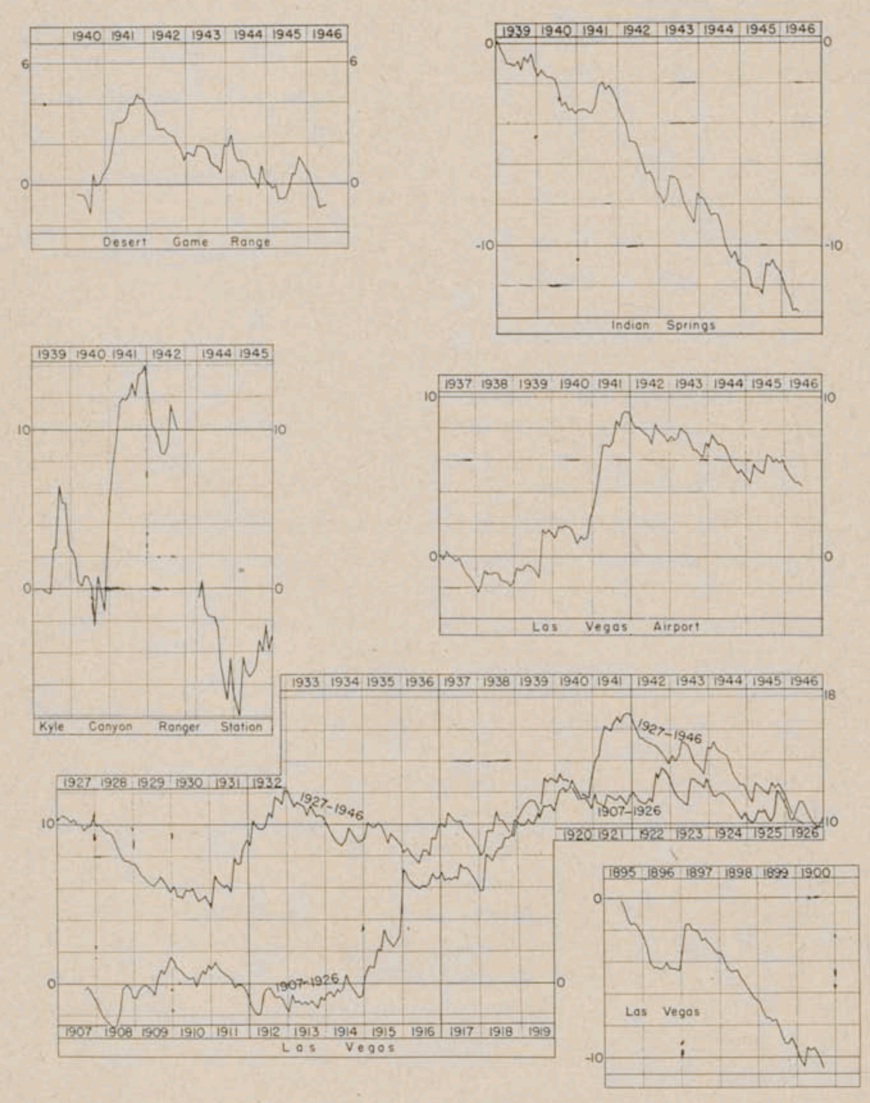

FIGURE 6—Cumulative departure, in inches, from normal precipitation at several precipitation stations in Las Vegas, Pahrump, and Indian Spring Valleys.

Annual Precipitation, in Inches, at 12 Stations in or near Las Vegas, Pahrump, and Indian Spring Valleys

(Data from Records of U. S. Weather Bureau)

Station	Las Vegas Airport	Las Vegas	Desert Game Range	Hidden Forest	Indian Springs	Cold Creek	Lee Canyon	Kyle Canyon Ranger Station	Boulder City	Roberts Ranch	Red Rock	Pahrump
No. on plate 2	1	2	3	4	5	6	7	8	—	10	11	12
Altitude (feet above sea level)	1,876	2,033	3,025	7,845	3,136	6,100	9,000	7,165	2,525	6,110	6,610	2,185
1896	——	3.24										
1897	——	5.35										
1898	——	1.64										
1899	——	2.03										
1908	——	4.73										
1909	——	7.05										
1910	——	4.11										
1911	——	3.41*										
1912	——	2.70*										
1913	——	4.96										
1914	——	4.98	——	——	——	——	——	——	——	——	——	4.90†
1915	——	8.41										
1916	——	8.11										
1917	——	4.33										
1918	——	8.63										
1919	——	4.95										
1920	——	4.74	——	——	——	——	——	——	——	——	——	7.26
1921	——	5.47	——	——	——	——	——	——	——	——	——	5.87‡
1922	——	5.81	——	——	——	——	——	——	——	——	——	5.58
1923	——	4.50	——	——	——	——	——	——	——	——	——	4.49‡
1924	——	2.49	——	——	——	——	——	——	——	——	——	2.20
1925	——	5.27										
1926	——	3.58										
1927	——	4.49										
1928	——	1.75										
1929	——	2.77										
1930	——	3.97										
1931	——	8.58										
1932	——	7.75	——	——	——	——	——	——	4.37			
1933	——	2.94	——	——	——	——	——	——	3.44			
1934	——	——	——	——	——	——	——	——	——			
1935	——	4.38	——	——	——	——	——	——	5.83			
1936	——	5.84	——	——	——	——	——	——	6.54			
1937	——	3.13	——	——	——	——	——	——	3.07			
1938	——	5.84	——	——	——	——	——	——	5.63			
1939	——	7.67	——	——	4.58	——	——	——	8.03			
1940	5.36	4.93	——	——	3.28	——	——	19.32	7.56			
1941	10.72	8.40	8.74	——	6.44	——	——	31.73	10.52			
1942	2.39	1.45	1.83	——	1.19	——	——	——	2.86			
1943	4.24	5.66	5.66	——	5.72	——	——	——	6.79			
1944	2.20	1.91	3.26	——	2.20	——	——	13.30	3.94			
1945	5.28	4.34	5.43	——	5.44	11.40†	28.81	21.33	6.88	13.08†	15.40	4.57
1946	3.29	3.58	4.33	15.0§	3.64	——	——	——	5.18	15.20	16.53	

*Estimated from surrounding stations.
†Three months of the year's record estimated from nearby stations.
‡One month of the year's record estimated from nearby stations.
§Two months of the year's record estimated from nearby stations.

Snow-Course Data From Six Stations in the Spring Mountain Range

(Record from the Nevada Cooperative Snow Surveys)

Station and location	Elevation	Water Content of Snow Cover, in Inches: 1941	1942	1943	1944	1945	1946	6-yr. mean
Rainbow Canyon— T. 19 S.; R. 57 E.; sec. 31	7800	21.3	11.0	15.0	10.4	16.0	7.7	13.6
Kyle Canyon— T. 19 S.; R. 56 E.; sec. 26	8200	18.5	9.5	—	11.2	15.7	8.3	12.6
Lower Lee Canyon No. 1; T. 19 S.; R. 56 E.; sec. 10	8300	16.3	11.3	7.3	7.6	15.6	7.7	11.0
Upper Lee Canyon No. 2; T. 19 S.; R. 56 E.; sec. 9	9000	20.8	15.2	—	7.7	15.2	9.7	13.7
Trough Springs— T. 18 S.; R. 55 E.; sec. 23	8500	—	—	—	—	—	4.5	
Clark Canyon— T. 19 S.; R. 56 E.; sec. 8	9000	—	—	—	—	—	8.3	

Station and location	Percent of 6-Year Mean: 1941	1942	1943	1944	1945	1946
Rainbow Canyon— T. 19 S.; R. 57 E.; sec. 31	156.2	80.9	110.2	76.6	117.8	56.6
Kyle Canyon— T. 19 S.; R. 56 E.; sec. 26	146.6	75.2	—	88.9	124.2	65.9
Lower Lee Canyon No. 1— T. 19 S.; R. 56 E.; sec. 10	148.2	102.7	66.2	69.1	141.9	70.0
Upper Lee Canyon No. 2— T. 19 S.; R. 56 E.; sec. 9	152.1	110.7	—	56.3	111.0	70.8
Trough Springs— T. 18 S.; R. 55 E.; sec. 23	—	—	—	—	—	—
Clark Canyon— T. 19 S.; R. 56 E.; sec. 8	—	—	—	—	—	—

Normal Monthly and Annual Precipitation, in Inches, at Eight Stations in or Near Las Vegas, Pahrump, and Indian Spring Valleys

(Data from Records of U. S. Weather Bureau)

Station	No. on plate 2	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year	Length of record, years
Las Vegas Airport	1	0.62	0.41	0.34	0.26	0.18	0.14	0.53	0.53	0.33	0.58	0.22	0.42	4.26	10
Las Vegas	2	.52	.59	.43	.23	.19	.15	.54	.60	.37	.28	.31	.41	4.62	42
Desert Game Range*	3	.50	.57	.80	.75	.02	.05	.21	.63	.03	.52	.30	.61	4.99	7
Indian Springs†	5	.50	.66	.52	.82	.05	.09	.48	.91	.37	.37	.34	.66	5.77	8
Kyle Canyon Ranger Station*	8	1.93	3.53	2.07	1.55	.55	.06	.61	2.53	.86	1.38	1.74	2.98	19.79	7
Pahrump	12	.78	.57	.61	.39	.30	.20	.26	.38	.26	.28	.05	.94	5.02	8
Boulder City	...	.76	.81	.63	.43	.15	.04	.55	.45	.66	.55	.20	.63	5.86	15
Clay City‡	...	.16	.54	.34	.15	.24	.00	.00	.58	.00	.52	.19	.04	2.76	4

*Based on 5-year average. †Based on 7-year average. ‡Based on 4-year average.

Normal Monthly and Annual Air Temperature, in Degrees Fahrenheit, for Six Stations in or near Las Vegas and Indian Spring Valleys

(Data from Records of U. S. Weather Bureau)

Station	No. on plate 2	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Las Vegas Airport	1	42.2	47.9	53.8	61.6	70.5	80.6	87.1	84.8	75.4	63.7	51.3	43.4	63.6
Las Vegas	2	45.0	50.4	56.8	64.2	71.5	80.4	86.4	84.8	77.0	65.8	53.8	46.2	65.2
Indian Springs*	5	41.1	42.9	50.4	58.5	68.1	75.4	82.7	81.1	71.8	60.2	46.9	40.9	59.9
Kyle Canyon Ranger Station†	8	29.6	29.8	36.7	40.9	50.2	57.2	65.7	63.1	55.4	46.6	36.4	32.4	45.3
Boulder City	..	45.6	49.0	56.9	65.0	74.1	82.8	89.5	87.5	80.7	68.8	55.7	47.7	66.3
Clay City‡	..	41.6	47.3	51.4	58.7	67.6	75.5	85.0	82.5	74.5	62.3	50.9	42.7	61.8

*Based on 7-year-average. †Based on 5-year average. ‡Based on 4-year average.

Average Monthly Evaporation, in Inches, at Three Stations in or near Las Vegas, Pahrump, and Indian Spring Valleys

(Data from Records of U. S. Weather Bureau)

Boulder City, Nevada (1935–1946) Altitude 2,525

No. of years*	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
10–12	3.56	4.29	7.58	11.18	15.26	17.69	17.22	15.32	11.93	8.00	4.87	3.27	118.59

Clay City, Nevada (1926–1930) Altitude 2,185

No. of years*	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1–4	5.31	4.89	7.27	10.72	16.06	19.50	20.80	21.07	15.13	9.41	6.87	5.00	141.58

Pahrump, Nevada (1914–1925) Altitude 2,667

No. of years*	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
3–5	2.18	2.97	5.69	5.96	10.44	11.62	12.46	10.66	8.12	5.25	2.57	2.12	80.03

*Greatest and least number of years for any one month.

VEGETATION AND SOILS

The lowlands of Las Vegas and Pahrump Valleys are covered with a sparse to dense growth of vegetation. This vegetation may be classified largely as phreatophytes. Phreatophytes are plants that habitually grow where they can send their roots down to the water table or to the overlying capillary fringe and thus obtain a permanent water supply. Altogether seven species of plants known to be phreatophytes were observed. The most common were mesquite (*Prosopis velutina* and *Prosopis juliflora*), salt grass (*Distichlis spicata*), greasewood (*Sarcobatus vermiculatus*), and rabbit brush (*Chrysothamnus graveolens*). The three other species, usually localized in small areas, were pickleweed or iodine bush (*Allenrolfa occidentales*), saltbrush or quail brush (*Atriplex lentiformis*), and arrowweed (*Pluchea sericea*).

In other parts of the lowlands, and on the alluvial slopes where the "near-surface" water, or water table, is a considerable depth below the surface, creosote bush (*Covillea tridentata*) is by far the predominant plant and is associated with white bur-sage (*Franseria sp.*) and other less common species, such as saltbrush (*Atriplex sp.*), little rabbit brush (*Chrysothamnus stenophyllus*), sacaton (*Sporobolus wrighti*), and other southern desert shrubs and grasses. From the middle parts of the alluvial fans to the foothills the giant yucca or Joshua tree (*Yucca brevifolia*) and Spanish bayonet (*Yucca mohavensis*) abound, whereas creosote bush becomes scarce and blackbrush (*Coleogyne ramosissima*) becomes the prevalent small shrub. Many small cacti grow in this zone also. Above the lower foothills at elevations ranging from about 4,500 feet to the tops of the highest mountains, juniper (*Juniperus utahensis* and *Juniperus scopulorum*) and pinon pine (*Pinus monophylla*) grow, forming wooded areas over most of the higher slopes and ridges. Ponderosa pine (*Pinus ponderosa*), white fir (*Abies concolor*), and some foxtail pine (*Pinus aristata*) grow in the deeply shaded canyons and on north-facing slopes and ridges of the Spring and Sheep Mountain Ranges above an altitude of 7,000 feet. The undergrowth at this elevation is quite similar to undergrowth in other subalpine climates elsewhere in western United States.

The water table is only a short distance below the land surface where phreatophytes thrive. Here large quantities of water are discharged by the processes of soil evaporation and plant transpiration. Soil evaporation occurs when the capillary fringe extends to the land surface, and plant transpiration when the capillary fringe is within the reach of the roots of the plants. Generally the loss by transpiration is not large when the depth to the water table is greater than 20 feet.

In Las Vegas and Pahrump Valleys appreciable quantities of water are lost as the result of these processes (see p. 165). In the higher places, particularly in the mountains, the plant-cover undoubtedly increases the infiltration capacity of the drainage basin, and in this manner makes more water available for ground-water storage.

The soils in Las Vegas Valley were studied and reported upon by Carpenter and Youngs[8] in 1926, and the following discussion and most of plate 5, a map showing land classification and alkali concentration in part of the valley, are based on that report.

The soils of the valley are derived mainly from limestone and dolomite rocks with admixtures of materials derived from shale, sandstone, basalt, and other igneous rocks. The older soils of the alluvial fan have been modified to a large degree by weathering and accumulation of lime in the subsoils, with the result that a caliche hardpan underlies a large part of it. In places highly gypsiferous, subsoils have given rise to soils of the Bracken and Reeves series.[9] These soils consist of gypsiferous clay loam, generally with a high concentration of gypsum 1 foot to 3 feet below the surface. These types, together with other soils of a porous gravelly character, cover most of the area mapped on plate 5 as soils of limited and low agricultural value. Well-weathered old valley-filling soils having compact subsoils belong to the Spring, Arden, and Pond series[10], and make up most of the area mapped as soils with compact subsoils well-adapted to agriculture. Soils of recent deposition and slightly weathered soils with poorly compacted subsoils are referred to the Land of Gila series[11] and are considered the best soils in the valley. They make up, in large part, those mapped as soils with permeable subsoils well adapted to agriculture.

As Carpenter and Youngs have pointed out, "In the Las Vegas area there are three factors that have limiting effects on profitable agricultural development, and disregard of any of them could result in complete failure. Without water for irrigation, the

[8]Carpenter, E. J., and Youngs, F. O., Soil survey of the Las Vegas area, Nevada: U. S. Dept. Agr., Bur. Chemistry and Soils, Soil Survey Report No. 8, ser. 1923, 1928.

[9]Carpenter, E. J., and Youngs, F. O., op. cit., pp. 221–223.

[10]Idem., pp. 226–232.

[11]Idem., pp. 232–239.

profitable production of crops is impossible * * *. Of equal importance with water supply are the factors of alkali concentration and character and depth of soil. Other factors involved in the selection of a farm include location with respect to market, air drainage, and character of crop to be grown." In the foregoing paragraphs and on plate 5 the character and depth of soils have been briefly outlined, and alkali concentrations are also mapped.

In 1935 E. R. Fogarty of the Bureau of Reclamation made a detailed study of land classification in Las Vegas Valley below the 2,000-foot contour.[12] In this study 76,800 acres of land were classified, of which 10,174 acres were found suitable for irrigation. The standards used as a guide for classification of the lands were based upon soil character, depth, texture, alkali concentration, topography, and drainage conditions. Three classes of land were recorded:

Class 1—Irrigable.

Class 2—Irrigable (land with deficiencies in either soil, topography, or drainage).

Class 6—Nonirrigable (land which failed to meet the minimum requirements for Class 2, either in soil, topography, drainage, or a combination of such deficiencies).

The lands classified by Fogarty are shown on plate 5, on which Fogarty's classification is superimposed on the work by Carpenter and Youngs. The total of Class 1 land was determined to be 2,654.4 acres; of Class 2 land, 7,519.6 acres. All the Class 1 land is situated in secs. 1, 2, 12, and 13, T. 20 S., R. 61 E., and in secs. 1, 2, 11, 18, and 19, T. 20 S., R. 62 E. The Class 2 land is widely scattered and constitutes 74 percent of the irrigable land in Las Vegas Valley. The largest contiguous parcels of Class 2 land lie northeast of Las Vegas in T. 20 S., R. 62 E., and extend into adjacent townships.

The results of these two studies show that the largest tracts of land most suitable for agriculture are northeast and east of Las Vegas. Only small isolated tracts of arable land occur in other parts of the valley.

There are no published reports of soil studies in the north part of Las Vegas Valley and in Indian Spring and Pahrump Valleys. Parts of these valleys contain soils apparently similar to those in the south part of Las Vegas Valley. In Pahrump Valley an

[12] Kerr, John N., Report on Las Vegas pumping projects, Nevada; U. S. Bur. Reclamation mimeographed report, pp. 23–38, 1936.

area of about 14,000 acres lying along the west side of the "Johnnie" road, from a few miles south of the Manse Ranch to about 6 miles north of Pahrump, is apparently good agricultural land, and large tracts of it have been tilled successfully for many years.

PHYSIOGRAPHY

Las Vegas Valley is a northwest-trending trough bounded on the west by the lofty Spring Mountains, and on the northeast by the south parts of the north-south trending Pintwater, Desert, Sheep, and Las Vegas Ranges. The east part of the valley is bordered by Frenchman Mountain, locally called Sunrise Mountain, and a low range of unnamed hills extending southward to Las Vegas Wash, which drains southeasterly from Las Vegas Valley into the Colorado River. The River Mountains and the north extremity of the McCullough Range bound the south end of the valley.

Pahrump Valley lies at the west foot of the Spring Mountains. It is bounded on the north and west by a group of low-lying unnamed ridges that intersect the Spring Mountains in the vicinity of Johnnie and trend southward. The southern tip of these ridges and hills partially separate Pahrump Valley from Stewart Valley, a low-lying basin which receives drainage from the northern part of Pahrump Valley.

Indian Spring Valley is a crescent-shaped basin which trends north-south along the west foot of the Pintwater Range, then turns sharply west between the north end of the Spring Mountains and the Spotted Range, which bounds the north and west sides of the valley. Indian Spring Valley is separated from the north end of Las Vegas Valley by a low alluvial divide about 4 miles east of Indian Springs.

Thus, the area described in this report contains three topographically low basins with smooth gentle alluvial slopes, bounded by relatively high steeply sloping mountain ranges which trend north-south. These features are typical of the Great Basin section of the Basin and Range physiographic province. The poorly defined boundary between the Great Basin and the Sonoran Desert sections passes across the southern tip of Nevada near the south end of Pahrump Valley, Charleston Peak, and the north end of Las Vegas Valley. The northern boundary of the Mexican Highland section is formed by the Colorado River.[13] Therefore,

[13]Fenneman, N. M., and others, Physical division of the United States: Assoc. Am. Geographers Annals, vol. 6, pp. 19–98, map, 1927.

the area is partly within two sections of the Basin and Range province and is adjacent to a third section. However, the dominant physiographic features are, as Nolan[14] has stated, those of the Great Basin.

Most of Las Vegas Valley is tributary, through Las Vegas Wash, to the Colorado River. However, the northern part of Las Vegas Valley at the mouth of the Three Lakes Valley reentrant is an enclosed basin and is separated from the south part by a low alluvial divide. Drainage in Indian Spring Valley ends in a playa about 10 miles north of Indian Springs. The north part of Pahrump Valley drains westward into Stewart Valley, and the south part drains into a playa at the base of the Nopah Range about 12 miles southwest of the Manse Ranch. No perennial streams occur within the area and the intermittent streams have no regular seasonal flow. Surface water runs in washes only during, and for a short period following, infrequent and violent storms. Streams of water from even the larger springs and runoff from melting snows in the mountains disappear into the gravels or are dissipated by evaporation over short distances. Thus, most of the erosion at the present time occurs sporadically and violently, and conditions apparently are favorable for continued growth of alluvial fans and gradual filling of the present basins.

The area may be divided into three local physiographic provinces, one comprising the mountains, one the alluvial apron, and the third the basin lowlands. The mountains, having a relief of several thousand feet, consist largely of bare, well-consolidated sedimentary rocks. They are places of erosion where streams have cut and are continuing to cut deep ravines and canyons.

The alluvial apron has much less relief and the slopes are more gentle and regular than those in the mountains. It has been, in the geologically recent past, a place of deposition and still is in some localities. However, over most of the area the alluvial apron has been and is being eroded, and is considerably dissected. It consists of coarse, angular to poorly rounded, poorly assorted debris, which has been transported from the closely adjacent mountains.

The basin lowlands are underlain by fine-grained playa, lacustrine wash, and eolian materials deposited at the toe of the alluvial apron. The relief is low and the surface of the basins is smooth and apparently level in comparison to the alluvial apron and the mountains. The basins are sites of deposition and are

[14]Nolan, T. B., The Basin and Range province in Utah, Nevada, and California: U. S. Geol. Survey Prof. Paper 1917-D, p. 142, 1943.

gradually becoming filled. Even in the south part of Las Vegas Valley, where there is opportunity for materials to be transported through Las Vegas Wash, little erosion is taking place, and large quantities of fine material are deposited by floods during and following torrential storms.

MOUNTAINS

The Spring Mountains (pl. 1) occupy almost 1,000 square miles, approximately one-third of the area covered by this report. They trend northwesterly across it from the center of the south boundary to the northwest corner. They are a persistently high mountain mass, the crest of which is more than 7,500 feet above sea level from Potosi Mountain in the south to a point north of Mt. Stirling, a distance of more than 45 miles. A considerable part of the central section of the range in the vicinity of Charleston Peak and The Mummy, a long, high ridge east and north of Charleston Peak, is over 10,000 feet in altitude. Charleston Peak, the highest point in the range and one of the highest peaks in Nevada, reaches an altitude of 11,910 feet, which is about 9,700 feet above Las Vegas and more than 10,300 feet above the floor of Las Vegas Wash (see pl. 1). The width of the mountain mass ranges from about 5 miles in the southern part of the area to more than 25 miles in the central part of the range.

The main canyons on the east side of the range from north to south are: Lee Canyon, which drains north and northeasterly from Mt. Charleston and The Mummy; Deer Creek Canyon, which drains most of the east side of The Mummy; Kyle Canyon, which drains the south side of The Mummy, the east side of Charleston Peak and Ridge, and the north side of La Madre Mountain; Red Rock Canyon, which drains the south side of La Madre Mountain and the north part of Sharktooth Ridge; and Cottonwood Valley, which drains most of the east slope of the Spring Mountains south of Red Rock Canyon. On the west side of the range from north to south the main canyons are: Wheeler Canyon and its tributary Clark Canyon, which drain most of the Spring Mountains north of Charleston Peak and south of Wheeler Spring in sec. 20, T. 18 S., R. 55 E.; Carpenter Canyon, which drains the southeast side of Charleston Peak; Trout Canyon, which drains the south side of the peak and the west side of Charleston Ridge; and Lovell Canyon, which drains Sexton Ridge, the east side of the southward extension of Charleston Ridge, and the west side of Sharktooth Ridge. Most of the main canyons are formed along fault zones or areas of weakness caused by structural movements.

Many of the smaller washes and canyons also, are cut along faults and are topographic expressions of structural processes affecting the rocks. The general topography of the mountain region is rugged and is characterized by sharp peaks and ridges, steep and precipitous slopes, and deep, steeply sloping canyons.

The Spring Mountains are composed of Paleozoic and Mesozoic well-consolidated sedimentary rock masses of complex structure, which rise abruptly out of the alluvial apron. Conclusive evidence of the cause of elevation of the range has not yet been observed, and any statement concerning the methods of elevation must necessarily be general or based upon considerable speculation. Field evidence and observation to date indicate that the present elevation of the range must be, in part at least, the result of regional faulting accompanied or followed by extensive erosion of Las Vegas Valley.

The southern extremities of the Pintwater, Desert, Sheep, and Las Vegas Ranges are rugged, abruptly rising mountain masses partly buried by the alluvium. They are generally similar to the Spring Mountains except that they are lower and smaller. Of the four ranges only the Sheep Mountains reach an altitude over 8,000 feet. They all trend more or less east-west at the extreme southern ends, but within a few miles the trend swings sharply north. The Desert and Pintwater Ranges are only about 6 miles wide in the vicinity of Las Vegas Valley. The Sheep and Las Vegas Ranges are from 8 to 10 miles wide. Frenchman Mountain (Sunrise Mountain) east of Las Vegas reaches an altitude of about 4,000 feet, and the southward-extending ridge drops off rapidly toward the vicinity of Las Vegas Wash, where it is only about 2,500 feet above sea level. Likewise, the River Mountains and the McCullough Range are rugged low-lying masses. They differ from the other mountains in the area because they are formed of igneous rocks, largely of Tertiary age.

The mountains are flanked on all sides by the alluvial apron, which is composed of rock waste eroded from the mountains and deposited on the mountain flanks and in the valleys. Small remnants of such alluvial materials, now being eroded, are present in the mountains at altitudes as high as 9,500 feet. Three erosion terraces cut in the gravels are conspicuous in Kyle Canyon and can be recognized in other canyons in the range. They indicate at least three periods of erosion of the alluvial apron since the oldest alluvial materials were deposited. Therefore, during parts of Tertiary and Quaternary time the mountains must have been buried deeply in alluvial materials, which have been partially removed by subsequent erosion. The presence of the gravel deposits in all the major canyons high up in the mountains is a factor of paramount importance to the water supply of Las Vegas, Pahrump, and Indian Spring Valleys. The gravels are highly permeable and water enters them readily, with the result that no perennial streams exist in the mountains. Water from precipitation in the mountains enters the ground-water reservoirs directly and there is little or no surface runoff. This water then moves laterally into the lower-lying parts of the alluvial apron.

The central and northern parts of the Spring Mountains form the most important watershed in the area. More than three-fourths of the ground water used in Las Vegas, Pahrump, and Indian Spring Valleys originates in this watershed. The south part of the Spring Mountains, south of La Madre Mountain, and the Sheep Range also contribute small quantities of water to the ground-water reservoir.

ALLUVIAL APRON AND THE BASIN LOWLANDS

The boundary between the main alluvial apron and the mountains is conspicuously marked by an abrupt change in slope and rock material (see pl. 4A). It averages about 4,500 feet in altitude. However, the maximum altitude of the boundary is nearly 9,500 feet in the vicinity of Charleston Peak near the heads of Kyle, Lee, and Clark Canyons. The minimum altitude of this boundary on the land surface is about 1,600 feet in the vicinity of Las Vegas Wash. The boundary of the alluvial apron and the basin lowlands is obscure, for the change in slope and in the characteristics of the materials is gradual. In places the alluvial apron on one side of a valley joins the alluvial apron on the other side, and the typical basin lowland is absent. Only in localities where there are playa lakes or lacustrine deposits is the boundary well-marked by a change, both of slope and of the character of the sediments. The basin lowlands are nearly all sites of deposition, whereas the alluvial apron is now being dissected by erosion, especially near its upper margin. The boundary between the alluvial apron and the basin lowlands is never more than about 3,100 feet in altitude and is about 1,600 feet in altitude at its lowest point in Las Vegas Wash. The altitude of the boundary averages about 2,500 feet.

The materials that make up the alluvial apron are poorly assorted alluvial gravels, sand, silt, clay, and caliche, the coarser materials being in marked predominance. Near the mountains in

PLATE 4A—Kyle Canyon, Spring Mountain Range, about 25 miles northwest of Las Vegas. The distant peak, left of center, is Mt. Charleston. The foreground is a Pleistocene terrace cut on the older alluvial gravels.

the upper part of the alluvial apron, the materials are especially coarse, angular, and poorly assorted and dip away from the mountains at angles of 12° to 18° (see pl. 4B). Lower down on the alluvial apron the materials are not so coarse, are more rounded and better sorted, and dip at lower angles. The surface of the alluvial apron is cut by many drainage channels or washes of varying depth and width and, although from a distance it appears to be smooth, it has considerable relief. The "grain" of the topography of the alluvial apron is roughly normal to the mountains and the axes of the basins. The washes are generally

PLATE 4B—Section of the upper part of the alluvial apron in Kyle Canyon, showing coarse character and steep dip of the gravels.

dry and only during infrequent storms are they filled with water. However, little vegetation grows on the alluvial apron and it is poorly protected from erosion. When large storms occur, the washes are rapidly filled with swift torrents which cut deeply into the beds of the washes and transport large volumes of gravel, sand, and finer materials down the apron. After such storms, the detail of the drainage pattern of the alluvial apron is noticeably changed as a result of the channel shifting and rapid erosion which accompany the torrential flooding. Generally the desert storms follow a narrow path across the country or are localized over small areas, and washes which are filled with water in one part of the apron may be running only a small stream or be completely dry a few miles down the slope. Thus, the carrying power of the streams decreases rapidly, and the coarser materials are seldom carried far down the slopes. Mostly fine materials are deposited near the lower margin of the alluvial apron and in the basin lowlands.

The alluvial apron is made up of numerous coalescing fans which head high up in the mountains. The largest fans are always opposite the higher mountain masses at the mouths of the larger canyons and the smaller fans are opposite the mouths of the lower, smaller canyons. In Las Vegas Valley three high alluvial fans project far out into the valley from the mouths of Lee and Deer Creek Canyons, Kyle Canyon, and Red Rock Canyon. These fans are separated by low-lying interfan and small alluvial fan areas, and the lowest part of the valley swings sinuously out around the toes of the large fans and back toward the mountains in the interfan areas. In the north part of the valley the Lee-Deer Creek Canyon fan extends across the valley and joins the alluvial apron on the east side, forming an alluvial drainage divide, above which is the small playa lake at the mouth of Three Lakes Valley. Similarly, the Kyle Canyon fan extends far out into the valley and forms an alluvial dam which has been cut through by headward erosion of channels in the recent geologic past.

In Pahrump Valley similar conditions exist. The Pahrump and Manse fans (see pl. 1) at the mouths of Wheeler and Trout Canyons, respectively, are large, high fans extending far out into the basin and are separated by a low-lying interfan area. The character of the alluvial apron is of great significance to the occurrence of ground water because the larger alluvial fans contain the most productive and widespread sand and gravel aquifers.

The basin lowlands are sites of deposition. Generally fine sand, silt, and clay make up the surface deposits of the lowland and this surface is generally level. In Las Vegas Valley there are three such depositional areas. One of these is the playa at the mouth of Three Lakes Valley. Another is that part of the Las Vegas Valley southeast of the drainage divide formed by the Lee-Deer Creek fan, north of the Kyle fan and west of Corn Creek Ranch. The other is southeast of Las Vegas, from U. S. Highway 91 to Las Vegas Wash. The two latter areas were probably playas in the recent geologic past, although at the present time they drain southward into the Colorado River. The central part of Indian Spring Valley is a playa lake and there are playa lakes in the southwest and north parts of Pahrump Valley. Deposits of ancient lakes are present in the central parts of all three valleys (see pl. 1). These lakes left deposits of silt and clay, but no lake-shore features were observed and it is believed that the lakes were probably shallow and more or less ephemeral—similar to but larger than the present playa lakes.

Sand dunes and other wind-built features are present in several localities in the basin lowlands. They are particularly numerous in Las Vegas Valley north of Stevens and Mesquite Springs, between Whitney and the city of Las Vegas, a few miles north of the city, and northward in a long, wide arc from Corn Creek Ranch. Few of these dunes are active. Most of them are mounds of fine sediment built up around plants, generally mesquite trees, and are covered with a thick growth of mesquite. These mounds are prominent features in the vicinity of springs where ample water is available for plant growth. Some of the mounds have covered the vegetation growing around springs and have buried the springs as well, thus forming spring mound or knoll springs. Such spring mounds are common north and east of the Las Vegas Land and Water Company reservoir west of the city. Corn Creek and Tule Springs in Las Vegas Valley, Cottonwood and Mound Springs in Pahrump Valley, and Mesquite (Cactus) Spring in Indian Spring Valley are all typical knoll springs.

Many scarps are to be found in the south part of Las Vegas Valley in the vicinity of the city of Las Vegas and west of Whitney. They occur on the lower part of the alluvial apron and approximately along the boundary of the alluvial apron and the basin lowlands. They range from a few feet to nearly 150 feet high and are conspicuous topographic features. (See pl. 1.) All the larger springs and many small springs in the vicinity of Las Vegas, North Las Vegas, and Whitney issue from the ground near the base of these scarps.

The origin of some of the scarps is probably by differential compaction (see pp. 69–71), and undoubtedly they have been accentuated by erosion. In the north part of Las Vegas Valley, in the vicinity of Tule Springs and in Indian Spring and Pahrump Valleys, small erosional scarps have been formed in the soft, easily eroded Pleistocene lake beds.

GEOLOGY AND WATER-BEARING PROPERTIES OF THE ROCK FORMATIONS

PURPOSE AND SCOPE OF GEOLOGIC STUDIES

The geologic studies, which formed one phase of the investigation, were necessary for a basic understanding and interpretation of the ground-water conditions. The rocks of the area may be divided according to their hydrologic properties into two general groups: (1) the consolidated, relatively impervious rocks that form the mountains, and (2) the unconsolidated permeable sediments that make up the alluvial apron and underlie the valley floor. The ground-water reservoir, from which is withdrawn practically all of the ground water used, is composed of the unconsolidated sediments and is bounded by the relatively impervious consolidated docks. Consequently the geologic studies of the consolidated rocks in the mountains were largely of a reconnaissance nature, while detailed studies were reserved for the unconsolidated sediments of the valleys, with special attention to their water-bearing properties.

The geologic structure of the area has undergone modification in the relatively recent geologic past and has affected the occurrence and circulation of ground water. Considerable study, therefore, was made of the geologic structure, especially that of the sediments making up the ground-water reservoir.

The geologic information pertaining to the older rock formations and structures is based largely on studies by previous workers in the area (see Acknowledgments, pp. 15, 16.

GENERAL RELATIONS

Consolidated sedimentary and igneous rocks of Paleozoic, Mesozoic, and Tertiary age form the mountains adjacent to Las Vegas, Pahrump, and Indian Spring Valleys. Unconsolidated sedimentary rocks of Tertiary and Quaternary age form the alluvial apron and the valley floor. Pre-Cambrian rocks occur at only one place, near the base of Frenchman Mountain. No rocks of Cretaceous age are exposed in the area. Periods of time which are not represented by rocks were either periods of emergence, when no sediments were deposited in the area, or of deposition of sediments which were removed by later erosion or were buried by younger sediments. Block faulting occurred before last Mesozoic time, overthrusting occurred during Mesozoic and early Tertiary time, and block faulting again occurred during the Tertiary and Quaternary periods. Minor faulting and folding probably were synchronous with and related to both the overthrusting and block faulting.

Although the rocks are divided into many formations, several of these formations may be grouped together on the basis of the similarity of their water-bearing properties. This grouping has resulted in nine units. The sequence, physical character, and water-bearing properties of the units are summarized in the table that follows, in which are given the symbols used for the units shown on the geologic map, plate 1.

Generalized Stratigraphic Section in Las Vegas, Pahrump, and Indian Spring Valleys

Geologic age			Formation	Thickness within the area shown on plate 1 (feet)	Character and extent	Water-bearing properties
Cenozoic	Quaternary	Recent	Younger alluvial deposits (Valley fill and playa deposits) Qyal.	0 to unknown	Playa, eolian, and wash deposits locally derived from older rocks of the alluvial slopes and mountains; clean sand and gravel in washes on alluvial slopes in mountains, silty sand in dunes, and silty clay with little fine-grained sand and few sandy or gravelly lenses in playas and valley fill.	Wash deposits of sand and gravel are permeable and locally contain small quantities of unconfined ground water of good quality. Thin sand and gravel lenses of low permeability form aquifers in silty clay of playa and valley-fill deposits, and are the chief source of ground water east of U. S. Highway 91 and south of the Union Pacific R. R. in Las Vegas Valley, and in the central and western parts of Pahrump Valley. Feasibility for irrigation limited by low permeability; good for domestic and stock use where quality is suitable.
			—Unconformity—			
		Pleistocene	Lake and playa deposits Ql.	0 to 5 ±	Lacustrine and playa deposits of silt and silty clay, which crop out in the central parts of the valleys.	Thin, limited distribution and low permeability.
			—Unconformity(?)—			
	Late Tertiary(?) and Quarternary		Basalt series. Included in QTv.	(?)	Andesitic and basalt lava flows and associated deposits, which crop out near south margin of Las Vegas Valley.	Probably impermeable; act as a barrier to movement of ground water out of Las Vegas Valley.
			—Unconformity(?)—			

Cenozoic	Late Tertiary (?) and Quaternary (?)	Pliocene (?) and Pleistocene (?)	Older alluvial deposits QToa.	0 to unknown

Unconformity

Gravel, sand, silt, and clay forming the alluvial apron and much of the valley fill. Head of alluvial apron consists chiefly of gravel and sand deposits which grade into and interfinger with silt and clay deposits in the valleys.	Permeable beds are the layers of gravel and sand which finger between relatively impermeable beds of silt and clay. Permeable beds yield confined water and are the most important and practicable source of ground water in the valleys. Wells which bottom in this formation yield large quantities of water of good quality along the west side of Las Vegas Valley, the east side of Pahrump Valley, and the south side of Indian Spring Valley. Yields from wells drilled into this formation near the axes of the valleys yield smaller amounts of water of poorer quality. The gravel lenses in this formation are the source of the water which flows from Las Vegas, Tule, Manse Ranch, and Bennetts Springs, and probably much of the water from Indian Spring.

GENERALIZED STRATIGRAPHIC SECTION—*Continued*

Geologic age			Formation	Thickness within the area shown on plate 1 (feet)	Character and extent	Water-bearing properties
Cenozoic	Cretaceous to late (?) Tertiary	Miocene (?) and Pliocene (?)	Muddy Creek and Esmeralda(?) formations. Tme.	0–80	Lacustrine and playa deposits locally derived from older rocks in the area. Consist largely of silt and clay with a few thin lenses of sandstone and pebble conglomerate. Muddy Creek formation contains salt and gypsum beds in areas adjacent to Las Vegas Valley. Esmeralda (?) formation contains much volcanic ash. Gently folded locally and broken by block faults but not involved in thrust faulting.	Lenses of sandstone and conglomerate may be moderately permeable and may yield small quantities of water to a few deep flowing wells in Las Vegas Valley. Further drilling into these lenses may result in wells with larger yields. However, highly mineralized water may be encountered.
			Unconformity			
			Lavas of the River Mountains. Included in QTv.	0–1000	Porphyritic and latitic lava and flow breccia with glassy groundmass. Broken by numerous block faults but not involved in thrusting. Exposures limited to extreme southeast border of Las Vegas Valley and adjacent areas.	Forms a relatively impermeable barrier to ground-water movement southward out of Las Vegas Valley.
			Unconformity (?)			
		Eocene(?) to Miocene(?)	Black Canyon group of Ransome. Included in QTv.	(?)	Complex assemblage of andesitic lava flows, volcanic breccias, and related deposits. Probably unexposed in the area but crop out in Las Vegas Wash area closely adjacent. Cut by block faults and involved in thrusting.	May form impermeable barrier to movement of ground water southward and out of Las Vegas Valley.
			Unconformity			

Cenozoic	Cretaceous to Late Tertiary	Cretaceous to Miocene(?)	Horse Spring formation and Overton fanglomerate. Included in TKJTR.	(?)	Limestone, magnesite, clay, and sandstone deposits generally finer-grained and more indurated than the Muddy Creek formation. Locally intensely folded and cut by normal faults. Cut by thrust faults in adjacent areas. Unexposed in this area but possibly present as valley fill underlying more recently deposited sediments in Las Vegas Valley. Overton fanglomerate consists of well-indurated sandstone and fanglomerate.	Probably impermeable and unimportant as an aquifer.
Unconformity						
Mesozoic	Jurassic(?)	Upper Jurassic(?)	Aztec sandstone. Included in TKJTR.	2400 +	Buff, white, and red medium- to fine-grained massive, cross-bedded sandstone involved in both block faulting and thrust faulting. Locally well-developed joint systems are present. Crops out in south-central part of area.	Well-consolidated and generally impermeable, but transmits limited quantities of water where it is extensively jointed.
Unconformity(?)						
Mesozoic	Triassic	Upper Triassic	Chinle formation. Included in TKJTR.	700 ±	Red, pink, and lavender silty and shaly cross-bedded, thin-bedded sandstone.	Generally impermeable and forms a barrier to ground-water movement southward and out of Las Vegas Valley.
			Shinarump conglomerate. Included in TKJTR.	50–80	Light-gray and tan medium-grained thin-bedded to massive, well-consolidated sandstone with a few thin to thick beds of granule and pebble conglomerate.	Generally impermeable and well-consolidated but transmits limited quantities of water where extensively jointed.
		Unconformity				
		Lower Triassic	Moenkopi formation. Included in TKJTR.	1000–1500	Consists of a lower unit of reddish gypsiferous, sandy shale overlain by nearly 700 feet of buff sandy thin-bedded limestone, in turn overlain by about 500 feet of red shale, sandstone, and sandy shale.	Generally impermeable barrier to ground-water movement.
Unconformity						

GENERALIZED STRATIGRAPHIC SECTION—*Continued*

Geologic age			Formation	Thickness within the area shown on plate 1 (feet)	Character and extent	Water-bearing properties
Paleozoic	"Late Paleozoic" PCksb	Permian	Kaibab limestone.	0–700	Gray massive to thin-bedded fossiliferous, cherty limestone with a few thin interbedded layers of buff medium-grained sandstone. Locally faulted and jointed.	Generally impermeable and above the regional ground-water level. Small quantities of ground water transmitted through rocks where they are extensively faulted and jointed. Springs, generally with small flow, occur in the mountainous area in these rocks where they are much faulted and jointed, and where other conditions are favorable. Generally these rocks act as a barrier to movement of ground water.
			Supai formation.	1100 +	Red beds composed of sandstone, shale, and some gypsum, all well-consolidated.	
Paleozoic	Mississippian (upper) and Pennsylvanian		Bird Spring formation.	2500–5200 +	Gray thick- to thin-bedded limestone interbedded with dolomite. Many sandy and silty buff to tan beds interbedded with limestone near base of the formation. Crops out over an extensive area in south and central part of area. Thickens much from south to north.	
			Unconformity (?)			
"Middle Paleozoic" CDms	Mississippian (lower and middle)		Monte Cristo limestone.	800–1000	Light- to dark-gray massive to thin-bedded, moderately cavernous fossiliferous limestone. Formation contains sandy beds and is less cavernous in north part of area.	Generally above the regional ground-water level. Much water transmitted through solution channels along faults and joints. Many springs emerge from these formations in the mountains.
	Devonian (middle and upper)		Sultan limestone.	600 +	Light- to dark-gray massive to thin-bedded, moderately cavernous limestone.	

Paleozoic	"Early Paleozoic" D-C	Cambrian to Devonian (lower)	Limestone, shale, sandstone, and quartzite. (See text and fig. 7)	3000–18,000	Well-consolidated limestone and dolomite beds overlying shale, sandstone, and quartzite. The latter beds are very thin or not present in the south part of the area, but thicken northward. Much faulted and folded. (Includes pre-Cambrian gneiss in small area at base of Frenchman Mountain.)	Generally impermeable and above the regional ground-water level. Barrier to ground-water movement.

STRATIGRAPHY

PRE-CAMBRIAN ROCKS

A few small outcrops of reddish granite gneiss, unconformably overlain by hard dark-brown sandstone and green shale (Bright Angel shale), occur in a small area at the base of Frenchman Mountain. This gneiss has been assigned to the Archean by Longwell and Hewett,[15] and is the oldest known rock that crops out in the area.

These few outcrops have been mapped with the "Early Paleozoic" rocks on plate 1.

PALEOZOIC ROCKS

Rocks of Paleozoic age crop out in the mountains. For the purpose of the present report these rocks are arbitrarily divided on the basis of their water-bearing character into three groups designated "Early Paleozoic," "Middle Paleozoic," and "Late Paleozoic" rocks. Formations of Cambrian, Ordovician, Silurian, and Lower Devonian age are grouped together and whenever any or all of them appear they are designated "Early Paleozoic" rocks. As indicated above, the "Early Paleozoic" on the map also includes pre-Cambrian rocks at the base of Frenchman Mountain. Formations of Middle and Upper (?) Devonian age and the lower and middle parts of the Mississippian series are designated "Middle Paleozoic" rocks; and formations of the upper part of the Mississippian, the Pennsylvanian, and the Permian are referred to as "Late Paleozoic" rocks. The "Middle Paleozoic" rocks are important as water-bearing formations. The "Early" and "Late Paleozoic" rocks are not good aquifers and are important only as barriers to ground-water movements.

"EARLY PALEOZOIC" ROCKS

Outcrops of "Early Paleozoic" rocks are widely distributed throughout the area covered by this report. In the north and west parts of the area they underlie a preponderant part of the surface and are parts of huge thrust sheets that have moved over rocks deposited during later geologic time. Also, these formations are more numerous and thicker than they are in the south and east parts of the area, where unconformities exist in the lower part of the geologic section. Geologic sections showing the approximate thickness, type of rock, and geologic age of the various formations in and adjacent to the area are shown in figure 7.

[15] Longwell, C. R., and Hewett, D. F., Geology of the region near Arden, Clark County, Nevada, with reference to possible occurrence of oil and gas: U. S. Geol. Survey (manuscript report on file).

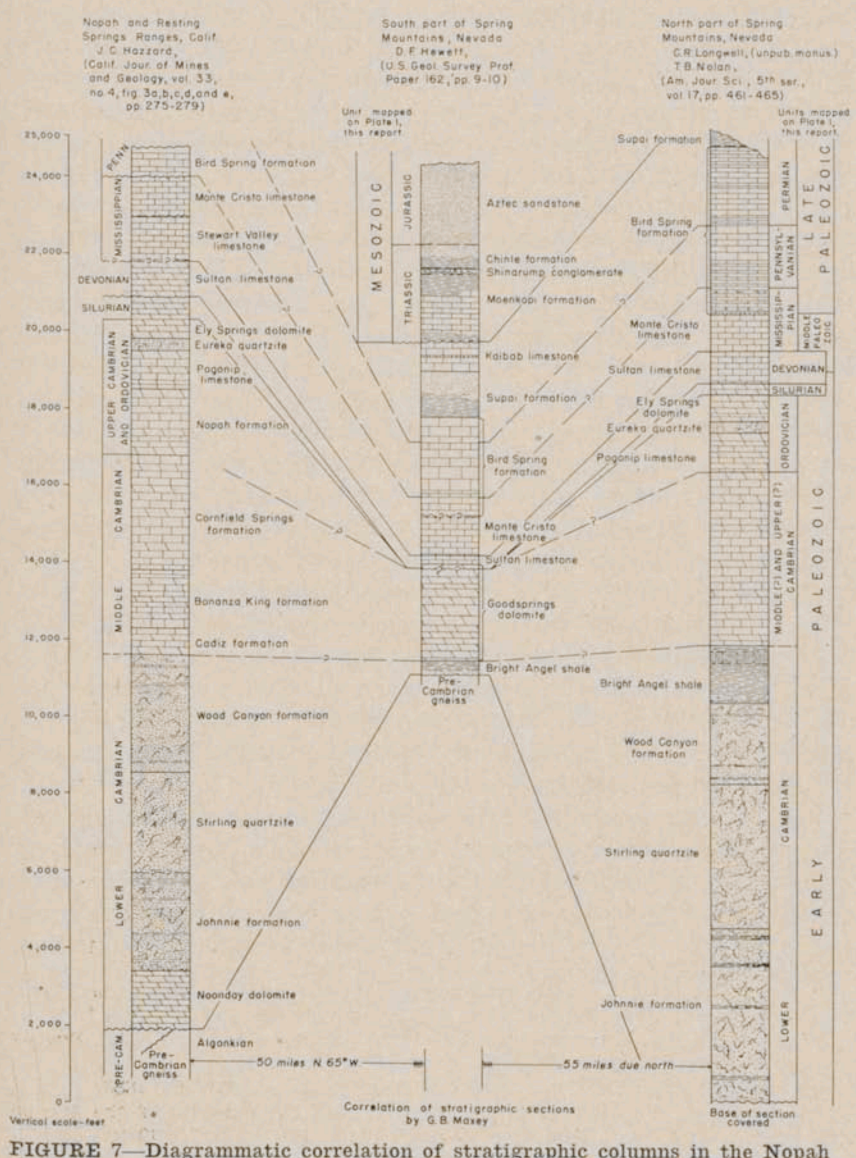

FIGURE 7—Diagrammatic correlation of stratigraphic columns in the Nopah and Resting Springs Ranges, California, and the Spring Mountains.

Nolan[16] has described the rocks of the lowest part of the geologic section in the vicinity of Johnnie, Nevada. These rocks include the Lower Cambrian Johnnie formation, more than 4,500 feet of grayish-green fine-grained quartzite, locally cross-bedded, and interbedded with layers of greenish shale and a little cream-colored dolomite; the Lower Cambrian Stirling quartzite, nearly 3,200 feet of pink and gray thick-bedded coarse-grained quartzite interbedded with reddish- or purplish-brown shaly cross-bedded quartzite; the Wood Canyon formation, 2,100 feet of brown micaceous shaly sandstone, dark quartzite, and sandy shale, with a few gray sandy limestone beds near the top; and the Bright Angel shale, 1,500 feet of greenish shale with minor amounts of white and reddish quartzite and much thin-bedded dark-gray limestone with shale partings, interbedded with the greenish shale layers toward the top of the formation. Fossils were found in the top of the Wood Canyon formation which were indicative of its Lower Cambrian age. Fossils found by Nolan in the Bright Angel shale are reportedly of Middle Cambrian age. The formations just described crop out near Johnnie and along the west side of Pahrump Valley, in the north part of the Spring Mountains, and in the Desert, Sheep, and Las Vegas Ranges.

Overlying the Bright Angel shale in the location just mentioned is about 7,000 feet of limestone and dolomite with a few interbedded shale and quartzite layers. Longwell[17] has divided these rocks into five formations. Three of the formations, the Pogonip limestone,[18] the Eureka quartzite,[19] and the Ely Springs dolomite,[20] all of Ordovician age, have been described and named in other regions. Of the two other formations, (1) a great thickness of limestone and dolomite overlying the Bright Angel shale and underlying the Pogonip limestone, has been tentatively assigned to the Middle and Upper Cambrian by Longwell and by others;[21] and (2) about 500 feet of dolomite and limestone overlying the Ely Springs dolomite and underlying the Sultan lime-

[16]Nolan, T. B., Notes on the stratigraphy and structure of the Spring Mountain Range: Am. Jour. Sci., 5th ser., vol. 17, pp. 460–465, 1929.

[17]Longwell, C. R., Geology of the Las Vegas quadrangle: U. S. Geol. Survey (manuscript report on file).

[18]Hague, Arnold, U. S. Geol. Survey 3d Ann. Rept., pp. 253–263, 1883.

[19]Westgate, L. G., and Knopf, A., Geology and ore deposits of the Pioche district, Nevada: U. S. Geol. Survey Prof. Paper 171, pp. 7, 15, 1932.

[20]Idem.

[21]Longwell, C. R., op. cit.: Mason, J. F., Longwell, C. R., and Hazzard, J. C., Sequence of Cambrian faunas in the southern Great Basin (abstract): Geol. Soc. America Proc., p. 366, 1936; Mason, J. F., Cambrian faunal succession in Nevada and California: Jour. Paleontology, vol. 12, pp. 287–297, 1938.

stone of Devonian age, has been assigned to the Silurian system.[22]

At the base of Frenchman Mountain and in the south part of the Spring Mountains the "Early Paleozoic" rocks consist of two formations, the Bright Angel shale and the Goodsprings dolomite. Here the Bright Angel shale crops out in only one limited locality, at the west base of Frenchman Mountain. It consists of a basal reddish dark-brown medium- to coarse-grained sandstone overlain by about 400 feet of micaceous green shale interbedded with a few thin layers of brown, mottled medium-crystalline dolomite. The total thickness of the formation is 525 feet. It rests unconformably upon reddish granite gneiss of pre-Cambrian age, and is conformably overlain by the Goodsprings dolomite which has been described in detail by Hewett.[23]

To the east of the southern part of the Goodsprings quadrangle a complete section of the Goodsprings dolomite, exposed on the southeast end of Sheep Mountain east of Jean, as measured by Hewett, was 2,500 feet thick. The thickness of the formation as measured by Longwell[24] on Frenchman Mountain is 2,000 feet.

The Frenchman Mountain section is the only location within the area covered by the present report where the total thickness of the formation is known to be exposed. The Goodsprings dolomite consists of gray crystalline thin-bedded mottled magnesium limestone layers interbedded with light-gray crystalline thick-bedded dolomite and some layers of dark-gray dolomite. Fossils collected by Hewett[25] indicate that the beds assigned to the Goodsprings may have been deposited during "Upper Cambrian, through Ordovician and Silurian, and possibly into the Devonian." According to Longwell[26] it is possible to identify beds in the Goodsprings dolomite exposed in the vicinity of Red Rock and La Madre Mountain that were probably contemporaneous with beds of Cambrian, Ordovician, and Silurian age that crop out in the northern part of the area. Thus, there is considerable northward thickening of the "Early Paleozoic" rocks.

Studies by Hazzard and Mason[27] of the faunal and stratigraphic relationships of the Goodsprings dolomite underlying Cambrian

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[22]Longwell, C. R., op. cit.

[23]Hewett, D. F., Geology and ore deposits of the Goodsprings quadrangle, Nevada: U. S. Geol. Survey Prof. Paper 162, pp. 11–13, 1931.

[24]Longwell, C. R., and Hewett, D. F., Geology of the region near Arden, Clark County, Nevada, with reference to possible occurrence of oil and gas: U. S. Geol. Survey (manuscript report on file).

[25]Hewett, D. F., op. cit., pp. 12–13.

[26]Longwell, C. R., personal communication, Dec. 1945.

[27]Hazzard, J. C., and Mason, J. F., "Goodsprings dolomite" of Nevada, and its faunas (abstract): Geol. Soc. America Proc. for 1935, p. 378, 1936.

formations in the Sheep Mountain section east of Jean, Nevada, have disclosed that the beds referred by Hewett to the Bright Angel shale are probably Lower Cambrian. Also, the lower 425 feet of beds included in the Goodsprings dolomite by Hewett has been tentatively referred by Hazzard and Mason to their Middle Cambrian Cadiz formation.[28] The upper 1,600 feet included in the Goodsprings by Hewett at Sheep Mountain and 460 feet of beds exposed near the Lincoln Mine in the Goodsprings quadrangle have been referred to their Bonanza King formation,[29] and an overlying 650 feet of dolomite has been referred to their Middle Cambrian Cornfield Springs formation.[30] Thus nearly all of the Goodsprings dolomite in the south part of the area is probably referable to the Middle Cambrian, and only 100 feet of dolomite beds at the top of the Goodsprings, separated from the beds of Cambrian age by an unconformity,[31] are of Devonian age. Beds of Upper Cambrian, Ordovician, and Silurian age are not present, at least in the vicinity of Goodsprings. It is probable then that some of the tremendous thickness of the "Early Paleozoic" beds in the north part of the area is represented in the south part by unconformities and is not altogether a result of northward thickening in the beds.

Water-Bearing Properties. In general the "Early Paleozoic" rocks are quartzite, well-indurated shale, noncavernous limestone, and dolomite which are relatively impermeable. Indeed, in some places ground water percolating through overlying permeable beds is brought to the surface along the upper contact of the "Early Paleozoic" rocks. Few springs occur except where the rocks have been brecciated or badly broken by faulting and other structural movements. Thus, the important hydrologic function of the "Early Paleozoic" rocks is as a barrier to ground-water movement from one basin to the other, or from the basins to the outside, rather than as an aquifer to transmit or store ground water.

"MIDDLE PALEOZOIC" ROCKS

The rocks classed in this report as "Middle Paleozoic" consist of two formations, the Sultan limestone and the Monte Cristo limestone, both of which were named and described in the report on the Goodsprings quadrangle by Hewett.[32] The rocks are widely distributed throughout the area and have outcrop attitudes similar

[28]Hazzard, J. C., Paleozoic section in the Nopah and Resting Springs Mountains, Inyo County, California: California Jour. Mines and Geology, vol. 33, No. 4, Oct. 1937, pp. 314–316, 1938.

[29]Hazzard, J. C., op. cit., pp. 316–318.

[30]Hazzard, J. C., op. cit., pp. 318–320.

[31]Hazzard, J. C., and Mason, J. F., op. cit., p. 378.

to those of the "Early Paleozoic" rocks. However, the "Middle Paleozoic" rocks are much thinner and therefore do not crop out in as large an area. Also, the Monte Cristo limestone is not everywhere present in the northern part of the area because it has been removed by erosion.

The Sultan limestone consists of a lower layer of dark-colored dolomitic limestone overlain by light-gray massive to platy limestone of porcelain-like texture. The light-gray limestone is moderately cavernous in many parts of the area. The formation is nearly 600 feet thick in the southern part of the area. However, like the underlying "Early Paleozoic" rocks, it thickens to the north. Fossils found in the Sultan limestone were reported to be of late Middle Devonian or early upper Devonian age.[33]

The Monte Cristo limestone consists of 800 to 1,000 feet of massive, light-gray to dark-gray finely crystalline limestone, overlain by massive light gray porcelain-texture cherty limestone, in turn overlain by a massive almost white coarsely crystalline dolomite, which underlies massive fossiliferous dark gray limestone. All the limestones are moderately cavernous in the southern part of the area. The formation thickens northward and some beds are sandy and less cavernous in the north part of the area. This condition is apparent in outcrops of limestone in the hills south of Indian Springs and along the west flank of the Sheep Range. Fossils found in the Monte Cristo limestone indicate that it is of early and middle Mississippian age.[34]

Water-Bearing Properties. Although the "Middle Paleozoic" rocks are well-consolidated, they are moderately cavernous, particularly in the south and central parts of the Spring Mountains, and they are capable of transmitting large quantities of water. In many places in the mountains, springs issue where the rocks are cut by faults and joints, and at the lower contact of these rocks where they are exposed above the relatively impermeable "Early" and "Late Paleozoic" beds. Much of the area of outcrop of "Middle Paleozoic" rocks is far above the regional groundwater level. However, these rocks serve to store and transmit water to the alluvial fan with which they are in contact in many places. In the valleys they probably occur at great depths, where their geologic and hydrologic character is unknown. Development of water at such depths is believed to be not economically feasible.

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[32]Hewett, D. F., Geology and ore deposits of the Goodsprings quadrangle, Nevada: U. S. Geol. Survey Prof. Paper 162, pp. 13–21, 1931.

[33]Hewett, D. F., op. cit., pp. 15–16.

[34]Hewett, D. F., op. cit., pp. 18–19.

"LATE PALEOZOIC" ROCKS

The "Late Paleozoic" rocks consist of the Bird Spring, Supai, and Kaibab formations. The Bird Spring formation was named and described by Hewett.[35] It was further described and its age was discussed by Longwell and Dunbar.[36] The Supai formation and Kaibab limestone were named and described near Grand Canyon in northern Arizona. Both formations are widely distributed in the southwest part of the United States.

The Bird Spring formation is a thick series of limestone, dolomite, shale, and silty sandstone which crops out in large areas of the Spring Mountains, the Las Vegas Range, and the Bird Spring Range. The formation is about 2,500 feet thick in the Bird Spring Range and on Frenchman Mountain. It thickens and changes in character considerably to the north. On the north side of La Madre Mountain, in the central part of the area, it is more than 5,200 feet thick and possibly becomes even thicker farther north.

The Bird Spring formation is divided into five members, one of which was named the Indian Springs member by Longwell and Dunbar. The basal member apparently is conformable with the Monte Cristo limestone north of La Madre Mountain. Hewett[37] suggests that it is unconformable with the Monte Cristo limestone in the vicinity of Goodsprings. The member is made up of tan and yellow shaly and sandy beds interbedded with light- to dark-gray fine- to medium-crystalline limestone. It is 400 to 600 feet thick in the south part of the area. Northward it apparently thickens and changes considerably in character. Near Indian Springs it is 700 feet thick. This member yielded many fossils which indicate an upper Mississippian or Chester age.

The Indian Springs member of Longwell and Dunbar is overlain by about 800 feet of alternating layers of resistant medium- to thick-bedded gray limestone and thin shaly, slightly sandy yellowish limestone. These beds are overlain by about 800 feet of thick-bedded limestone and dolomite, which form prominent cliffs. Fossils collected by Longwell and Dunbar[38] indicate that these beds are of Pennsylvanian age.

The cliff-forming member is succeeded by distinctive nonresistant slope-forming beds of platy limestone and gray, yellow, and orange calcareous shale. They range in thickness from 1,200 to 1,500 feet, and form the top of Charleston Peak.

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[35]Hewett, D. F., op. cit., pp. 21–30.

[36]Longwell, C. R., and Dunbar, C. O., Problems of Pennsylvanian-Permian boundary in southern Nevada: Am. Assoc. Petroleum Geologists Bull., vol. 20, No. 9, 1936.

[37]Op. cit., p. 22.

[38]Op. cit., p. 1207.

The uppermost member of the Bird Spring formation is a series of ledge-forming thick-bedded limestone and dolomite layers, with a few interbedded units of shaly and platy limestone which weather to slopes. This member is about 1,500 feet thick. The upper two members of the Bird Spring formation yield fossils which indicate a probable lower Permian age.[39]

The Supai formation consists of a basal member of gray calcareous shale interbedded with thin-bedded limestone, about 100 feet thick. Overlying the basal member is approximately 1,000 feet of typical red beds composed of sandstone, shale, and a few gypsum layers. Generally the red sandstones and shales give way to buff-colored sandstones near the top of the formation. Outcrops are widely distributed over the south part of the Spring Mountains. The formation is 1,000 to 1,100 feet thick. It also crops out in the hills south of Frenchman Mountain, where it reaches about the same thickness. In the area covered by this report the evidence for identification of the Supai formation is its lithologic character and stratigraphic position. However, the formation so identified must be of Permian age because it is overlain and underlain by rocks which were deposited during the Permian period.

The Kaibab limestone crops out usually in the same places as the conformably underlying Supai formation. It ranges in thickness from a feather edge to about 700 feet. This range in thickness is largely the result of widespread erosion during a period of emergence following the deposition of the formation. Where the formation is thickest it characteristically consists of a basal member, containing about 225 feet of gray massive fossiliferous limestone, with a few thin cherty layers of dolomite. These beds are succeeded by a middle member consisting of 30 to 80 feet of pale yellowish-brown and red medium-grained sandstone with a few interbedded zones of sandy shale. The sandstone interval is overlain by an upper member of gray massive cherty limestone with some interbedded fossiliferous layers of limestone and a few thin light-gray dolomite units. The upper member is about 300 feet thick. The lowest beds in the formation are apparently conformable with the upper part of the Supai formation. Fossils collected from the Kaibab limestone are of Permian age.[40]

Water-Bearing Properties. The foregoing description shows that the "Late Paleozoic" rocks consist of well-consolidated limestone, dolomite, sandstone, and shale. None of the rocks are cavernous, and therefore they are essentially impermeable and

[39] Longwell, C. R., and Dunbar, C. O., op. cit., p. 1207.
[40] Hewett, D. F., op. cit., pp. 31, 32.

do not transmit appreciable quantities of ground water, except where they are broken by structural movements and are much faulted, jointed, and brecciated. Like the "Early Paleozoic" rocks, the chief hydrologic function of these rocks is to act as a barrier to ground-water movement, and not as an aquifer or reservoir to transmit and store ground water.

MESOZOIC ROCKS

Rocks of Mesozoic age crop out south of the Spring Mountains and near Frenchman Mountain. They consist of four formations, three of which are widely distributed throughout the southwestern part of the United States and have been studied and described in many localities. These are the Moenkopi, Shinarump, and Chinle formations. The other formation, the Aztec sandstone, was named and described by Hewett[41] in his report on the Goodsprings quadrangle and is tentatively correlated with the Navajo sandstone of Jurassic age which occurs in Utah and Arizona. Rocks of Cretaceous age are not exposed in the area covered by this report, but they crop out in the Muddy Mountains about 50 miles east of the city of Las Vegas. Here early Upper Cretaceous ferns were found in beds referred to the basal part of the Overton fanglomerate of Tertiary age.[42]

In the south part of the Spring Mountains and near Frenchman Mountain the Moenkopi formation is 1,000 to 1,500 feet thick. A lower unit, about 150 feet thick, of red shale, generally gypsiferous, with a conglomerate of varying thickness and character, forms the basal member of the formation. Locally the conglomerate is absent. In some places it consists of well-rounded pebbles and gray cross-bedded sandstone, and in other places the pebbles are angular and tightly cemented in a calcium carbonate matrix. The middle unit of the formation consists of buff-colored sandy platy fossiliferous limestone and dolomite beds, which are separated by thin layers of greenish-gray shale. This member is 600 to 700 feet thick. It is succeeded by the upper member of the formation, which consists of interbedded layers of red shale, sandstone, red sandy shale, and a few gypsiferous beds. The Moenkopi formation is everywhere classed as Lower Triassic. It commonly rests disconformably upon the Kaibab limestone or older formations, and is probably disconformable with the overlying Shinarump conglomerate.

The Shinarump conglomerate consists of 50 to 80 feet of thin-

[41] Op. cit., p. 35.

[42] Hewett, D. F., and others, Mineral resources of the region around Boulder Dam: U. S. Geol. Survey Bull. 871, pp. 121–122, 1936.

bedded to massive light-gray and tan medium-grained sandstone that contains thin beds of granule and pebble conglomerate and some petrified wood. The pebbles in the conglomerate are well-rounded, and are composed largely of red, white, and purple quartzite. The beds weather to low rough dark-brown outcrops. South of Frenchman Mountain, the Shinarump conglomerate contains large pebble and boulder conglomerate, all the pebbles and boulders being well-rounded but much larger than is characteristic of the formation elsewhere in Nevada, and also in Utah. The age of the formation is classified at present by the Geological Survey as Upper(?) Triassic.[43]

The Chinle formation consists of cross-bedded, red, silty and shaly sandstones with a few interbedded layers of white and red sandy limestone and sandstone. It apparently is conformable with the underlying Shinarump conglomerate and the overlying Aztec sandstone. The Chinle is nearly 700 feet thick in the area covered by this report,[44] and is classified by the Geological Survey as being of Upper Triassic Age.

The Aztec sandstone consists of over 2,400 feet of massive, buff, tan, white, and red, medium- to fine-grained, cross-bedded, mottled sandstone. Wherever it crops out it forms imposing colorful cliffs and bluffs. The top of the formation is not exposed in the area. It is suggested by Hewett[45] that the formation is probably of Jurassic age.

Water-Bearing Properties. The Chinle and Moenkopi formations are impervious but they localize many small springs along contacts with other formations when the attitude of the beds and topography is favorable. Also these two formations act as barriers to movement of ground water out of Las Vegas Valley in the vicinity of Las Vegas Wash. The Aztec sandstone and Shinarump conglomerate are the only two Mesozoic formations capable of transmitting even small quantities of ground water. In most places they are well-consolidated and impermeable and transmit water only where they are faulted and jointed.

CENOZOIC ROCKS

The rocks of Cenozoic age fall into two classes, (1) older well-consolidated and tilted formations and much igneous flow rock, all definitely deformed by earth movements subsequent to their deposition, and (2) younger, poorly consolidated, relatively undeformed beds of gravel, sand, silt, and clay, and a few basalt flows.

There are only five known outcrops of the older rocks and these

[43] Hewett, D. F., op. cit., p. 34.
[44] Hewett, D. F., op. cit., p. 34.
[45] Op. cit., p. 35.

occur in limited and widely separated localities in the area. However, the older formations crop out in adjacent regions and many may be present in the valley fill. For the most part they have been buried by the younger alluvial sediments which form the major part of the surficial valley fill and alluvial apron. The older sedimentary formations are divided on plate 1 into two groups, designated, respectively, TKJTR and Tme. The igneous rocks are mapped together with the younger basalt flows and are designated QTv on plate 1.

The younger sediments of Cenozoic age are mapped as older alluvial deposits of Pliocene(?) and Pleistocene(?) age, lake and playa deposits of Pleistocene age, and younger alluvial deposits of Recent age. Wash deposits of Recent alluvium in the mountains and on the alluvial apron are not differentiated from the Pliocene(?) and Pleistocene(?) alluvial deposits because they are small, very thin, and only locally important as a source of ground water. The only deposits of Recent age differentiated on plate 1 are the valley fill and playa deposits in Indian Spring, Three Lake, and Las Vegas Valleys, designated Qyal on the map.

CRETACEOUS TO MIDDLE (?) TERTIARY ROCKS— UNEXPOSED FORMATIONS

Overton Fanglomerate and Horse Spring Formation. Longwell[46] has reported a thick section of Tertiary sediments that occurs in the Muddy Mountains several miles east of Las Vegas Valley. This section of Tertiary sediments has been further described by Hunt[47] in his report on geology in the vicinity of the Las Vegas Wash.

In summary, the section described by Longwell includes three formations: the Overton fanglomerate (which is now considered to be Cretaceous in part); the Horse Spring formation, which consists of limestone, magnesite, clay, and sand; and the Muddy Creek formation, which is largely composed of intermontane clay, silt, sand, and conglomerate deposits with some interbedded salt and gypsum. The Overton fanglomerate ranges from 20 to 3,500 feet in thickness, the Horse Spring formation ranges from 1,000 to 2,700 feet in thickness, and the Muddy Creek formation ranges from a feather edge to about 2,000 feet, making an aggregate maximum thickness of about 8,000 feet of these sediments in the Muddy Mountains. The Overton fanglomerate rests unconformably upon beds of early Upper Cretaceous age (see p. 50) and on

[46]Longwell, C. R., Geology of the Muddy Mountains, Nevada: U. S. Geol. Survey Bull. 798, pp. 68–96, 1928.

[47]Hunt, C. B., Reconnaissance geology of part of the Colorado River basin below Grand Canyon: U. S. Geol. Survey (manuscript report on file).

all other older sediments. It is apparently conformable with the beds of the Horse Spring formation. Its relation to the rocks of Ransome's Black Canyon group is unknown. Both the Overton fanglomerate and the Horse Spring formation occupy roughly the same outcrop area and were involved in similar structural movements: folding, thrust faulting, and block faulting. They are overlain by or interbedded with the middle-Tertiary(?) volcanics (lavas of the River Mountains). The Horse Spring formation may be the same age as the Artillery formation that crops out in the vicinity of Needles, Arizona, and which contains plant fossils assigned to the lower Eocene.[48]

According to Hunt, beds of considerable thickness of both the Horse Spring and the Muddy Creek formations are present in the vicinity of Las Vegas Wash and the Schumaker Gypsum Company claims, immediately east of Las Vegas Valley, but the Overton fanglomerate is not exposed.

In Las Vegas Valley the only part of these thick, widespread Tertiary deposits exposed at the surface is about 80 feet of the Muddy Creek formation (see page 55). However, it is possible that the lower part of the valley fill is made up of beds referable to the Horse Spring formation and Overton fanglomerate. At present sufficient evidence is not available to establish the presence of these formations in the basal part of the valley fill.

Black Canyon Group of Ransome. According to Longwell,[49] Ransome described a complex assemblage of andesitic lava flows, volcanic breccias, and related deposits, and called them the Black Canyon group in his report giving the results of geologic studies around the Black Canyon dam site. Although the stratigraphic relationship of these rocks with the Horse Spring formation is unknown, they are unconformably overlain and intruded by lavas of the River Mountains and have been involved in folding, thrust faulting, and block faulting.[50] Rocks of Ransome's Black Canyon group crop out near Las Vegas Valley but are not present in Pahrump and Indian Spring Valleys. Consideration of them and their stratigraphic relationships is important in the interpretation of the geologic history of Las Vegas Valley.

EXPOSED FORMATIONS

Lavas of the River Mountains. The northern extremities of the River Mountains and the McCullough Range that border Las

[48] op. cit.
[49] Longwell, C. R., Geology of the Boulder Reservoir floor, Arizona-Nevada: Geol. Soc. America Bull., vol. 47, p. 1417, 1936.
[50] Hunt, C. B., op. cit.

Vegas Valley on the southeast, east of U. S. Highway 91 and south of Las Vegas Wash, are composed of igneous flow rocks of Tertiary and Quaternary age. These volcanic rocks have been described by Hale; Jones; Hewett and Webber; Hunt, McKelvye, and Wiese; Longwell; and Hunt.[51] The following paragraph is a brief summary of the former descriptions of the Tertiary igneous formations, modified slightly by observations of the senior author, who made a study of the rocks in the vicinity of Las Vegas Wash and Railroad Pass.

The lavas of the River Mountains are porphyritic, latitic lava flows and flow breccias, with a more or less glassy groundmass, and containing some felsitic lava, white vitrophyre, and dense stony glasses. The River Mountains are composed, in large part, of these rocks. In some places the rocks have been altered, especially near the prominent faults. In the River Mountains about 1,000 feet of the lavas is exposed. However, they may be much thicker. The sequence of flows and flow breccias probably thins southward and westward. No outcrops of it have been observed south of Lake Mead or very far west of the River Mountains; however, in the latter places it may be concealed by younger rocks. Northeast of Las Vegas Wash the lavas are overlain unconformably by the Muddy Creek formation. North of Las Vegas Wash, dikes and irregular masses associated with the lava flows are intruded into the sandstone and shaly siltstone of the Chinle formation. Although the upper part of the lavas is known to be younger than the Horse Spring formation, the relationship of the two formations is not completely known. According to Hunt,[52] lavas of the River Mountains are strikingly similar to and probably correlative with the Needles volcanics and the eruptives in the Artillery Mountain region,[53] which are exposed about 150 miles south and east of Las Vegas Valley.

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[51]Hale, F. A., Jr., Manganese deposits of Clark County, Nevada: Eng. and Min. Jour., vol. 105, pp. 775–777, 1918; Jones, E. L., Jr., Deposits of manganese ore in Nevada: U. S. Geol. Survey Bull. 710, p. 222, 1920; Hewett, D. F., and Webber, B. N., Bedded deposits of manganese oxides near Las Vegas, Nevada: Univ. of Nevada Bull., vol. 25, No. 6, pp. 5–17, 1931; Hunt, C. B., McKelvey, V. E., and Wiese, J. H., The Three Kids manganese district, Clark County, Nevada: U. S. Geol. Survey Bull. 936-L pp. 300–302, 1942; Longwell, C. R., Geology of the Boulder Reservoir floor, Arizona-Nevada: Geol. Soc. America Bull., vol. 47, pp. 1417–1419; Hunt, C. B., Reconnaissance geology of part of the Colorado River basin below Grand Canyon: U. S. Geol. Survey (manuscript report on file).

[52]Hunt, C. B., op. cit.

[53]Lasky, S. G., and Webber, B. N., Artillery Mountains Manganese District, Mohave County, Arizona: Arizona Bur. Mines Bull. 145, pp. 133–139, 1938; Geology and manganese deposits in the Artillery Mountains: U. S. Geol. Survey Bull. (in preparation).

On plate 1, all the igneous rocks, that is, the Black Canyon group of Ransome, the lavas of the River Mountains, and the late Tertiary(?) and Quaternary(?) basalt series (see p. 58), are mapped as one unit because their water-bearing properties are similar. Moreover, they act as a barrier to movement of ground water from the valley fill south and east out of Las Vegas Valley.

Esmeralda(?) and Muddy Creek Formations. Outcrops of silty, sandy, tuffaceous light-colored beds occur on the north side of the Las Vegas Range in a locality just north of Gass Peak and 7 to 10 miles east of Corn Creek Ranch. Similar beds crop out in places in the Sheep and Spotted Ranges. These beds are relatively well consolidated, gently folded or tilted, and have been cut by normal faults. The beds lie unconformably on rocks of Paleozoic age. The structural and stratigraphic relationships of these beds are similar to those of the Muddy Creek formation, and although they may be older than the Muddy Creek they are probably younger than the Horse Spring formation. It is probable that these beds are synchronous with rocks belonging to the Esmeralda formation,[54] whose lithology and structural relationships are similar and which crop out in Nye County, Nevada, near Ash Meadows—localities not far from Indian Spring and Pahrump Valleys. Lack of diagnostic fossils in beds of probable early and middle Tertiary age in this area preclude more accurate correlation at the present time.

Beds assigned to the Muddy Creek formation crop out 1 to 2 miles west of Whitney, Nevada. At that location they consist of nearly 80 feet of medium- to thick-bedded siltstone in layers 1 to 5 feet thick, interbedded with thin, sandy and pebbly layers of siltstone. Most of the beds are well-consolidated and some are tightly cemented with caliche. The beds are essentially horizontal although they are locally distorted into low, gentle, undulating folds, and they are cut near the south border of the outcrop by small normal faults. The upper surface of the beds is partially covered by a thin (1 to 10 feet) veneer of later alluvial sediments. The alluvium is eroded in many places by small washes and the silty beds are undoubtedly present everywhere in the outcrop area mapped on plate 1. At nearby localities the Muddy Creek formation is overlain unconformably by the late Tertiary(?) and Quaternary basalt series. The base of the Muddy Creek beds in adjacent regions rests unconformably upon the older Tertiary formations and upon formations of Mesozoic and

[54]Turner, H. W., U. S. Geol. Survey 21st Ann. Report, pt. 2, pp. 197–208,1900; Ball, S. H., A geological reconnaissance in southwestern Nevada and eastern California: U. S. Geol. Survey Bull. 308, pp. 32–34, 1907.

Paleozoic age. Like the underlying lavas of the River Mountains, the beds of the Muddy Creek formation are not broken by thrust faults but are block faulted. The lithologic, stratigraphic, and structural relationships of these beds are similar to those of the Muddy Creek formation in other places as described by Longwell and Hunt.[55] Further, large areas of outcrop of the Muddy Creek formation exist in the vicinity of Las Vegas Wash, only a few miles east of Whitney. Therefore, the siltstone beds near Whitney are tentatively correlated with the Muddy Creek formation.

Fossils found in the Muddy Creek formation by Stock[56] and the structural and stratigraphic relationships of the beds indicate that they are possibly of Miocene or early Pliocene age.

The several widely distributed outcrops of rocks of approximate Miocene age indicate that these beds probably extended over a much larger region in the past than they do at the present time, and that they have been nearly all removed by erosion or covered by later alluvial deposits. Undoubtedly a large part of the valley fill consists of Muddy Creek and related deposits, particularly in Las Vegas Valley. The beds were probably deposited in great basins whose topography and geographic position rougly coincided with that of present-day basins. Much of the material in these formations resembles playa-lake deposits. However, as Longwell[57] has pointed out in his description of the Muddy Creek formation in the vicinity of the Muddy Mountains, "a playa of the extent represented by these intermontane deposits demands long bajada slopes adjacent, and the coarse sediments to be expected on such slopes are exposed very sparingly. In fact, except near the base of the series, the silt and fine sand extend without interruption to the slopes of high (mountain) masses * * * These relations * * * suggest deposition in a lake somewhat deeper than the ordinary playa." Longwell goes on to explain that the level of these lakes must have oscillated considerably but that for no extended time could there have been playa-lake and alluvial-fan deposition similar to that which existed later and which seems to exist at the present time. This description fits closely the conditions which must have been necessary to produce such widespread, uniformly deposited materials, and agrees with Hunt's statement[58] that the Muddy Creek formation in the vicinity of Las Vegas Wash seems to have been deposited under "very quiet, lacustrine conditions."

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[55]Longwell, C. R., op. cit., pp. 90–96; Hunt, C. B., op. cit.

[56]Stock, Chester, Later Cenozoic mammalian remains from the Meadow Valley Region, southeastern Nevada: Geol. Soc. America Bull., vol. 32, p. 146, 1921.

[57]Op. cit., (Geology of the Muddy Mountains, Nevada), pp. 95–96.

[58]Hunt, C. B., personal communication.

Water-Bearing Properties. The Overton fanglomerate and the Horse Spring formation consist of well-consolidated and tightly cemented gravels, sand, silt, clay, and limestone. If they are present in the valley they are probably impermeable and will not transmit large quantities of ground water.

Exposed rocks assigned to the Muddy Creek and Esmeralda(?) formations consist largely of fine-grained materials which are relatively impermeable and probably will not transmit much water. However, it is possible that in some places the fine-grained sediments are interbedded with sand and gravel tongues and lenses capable of transmitting appreciable quantities of water. Therefore, at least part of the early(?) and middle(?) Tertiary deposits may act as aquifers. A more detailed discussion of possible aquifers in the Muddy Creek formation is presented on page 68. The water-bearing properties of the Tertiary volcanic rocks have been discussed on page 55.

PLIOCENE (?) AND PLEISTOCENE (?) ALLUVIAL DEPOSITS

Exposed deposits of gravel, sand, silt, and clay, which form the alluvial apron and much of the valley fill, are much larger in extent than any other geological formation in Las Vegas, Pahrump, and Indian Spring Valleys. The contact of these deposits with the older, consolidated and highly deformed rocks composing the mountainous sections of the area is at an average altitude of about 4,500 feet. The minimum altitude of the alluvial deposits is about 1,500 feet in the vicinity of Las Vegas Wash. The maximum altitude in the vicinity of Charleston Peak and the heads of Kyle, Clark, and Lee Canyons is about 9,000 feet. Thus the bulk of these deposits is confined to the valleys and canyons and, by analogy, they form a "sea" in which numerous high "islands" of the older rocks occur.

The deposits range in thickness from a feather edge to several hundred feet, or even more. Near the mountains and the top of the alluvial apron where several exposures have been examined, they consist largely of massive beds of coarse, well-rounded to angular, poorly assorted gravel with some silt and sand, all of local derivation, which dip away from the mountains at angles of 12° to 18°. In many places the beds are well-cemented with caliche near the surfaces of the exposures, but in fresh exposures along road cuts and washes the beds were observed to be poorly cemented and essentially unconsolidated. Several of the well-cemented beds extend laterally for several miles. Lower down on the alluvial apron the beds become more silty and sandy and dip at lower angles. In this lower part of the alluvial apron the coarser materials finger out and are interbedded with thick deposits of silt and clay. The age of these alluvial materials is indicated only by their lithologic characteristics, stratigraphic position, and structural relationships, because no diagnostic fossils have been found in them. The deposits lie unconformably upon beds of the Muddy Creek formation and are unconformably overlain by lacustrine deposits of known Pleistocene age. The beds have not been involved in thrust-faulting or widespread folding, and were observed to be cut by normal faults in only one locality. Detailed descriptions of the physical characteristics and water-bearing properties of these beds are to be found in the section dealing with well logs of the valley fill. It is important to emphasize that the Pliocene(?) and Pleistocene(?) alluvial deposits contain the most productive aquifers and form the ground-water reservoir for nearly all the water used in Las Vegas, Pahrump, and Indian Spring Valleys.

LATE TERTIARY (?) AND QUATERNARY BASALT SERIES

This group of rocks is composed of andesitic and basalt lava flows and associated deposits, which overlie and are younger than the Muddy Creek formation and either overlie or are interbedded with the Pliocene(?) and Pleistocene(?) alluvial deposits in the vicinity of Las Vegas Wash. Most of the basalts are probably of late Pliocene age although some are probably younger. On plate 1 these rocks are mapped in the same unit (QTv) with the lavas of the River Mountains and the Black Canyon group of Ransome because their water-bearing properties are similar and because the rocks crop out only in a few places.

PLEISTOCENE LAKE BEDS

The deposits described in this report as Pleistocene lake beds crop out in the northern and central parts and in one place in the southern part of Las Vegas Valley, in the central part of Pahrump Valley, and in the central and eastern parts of Indian Spring Valley (see pl. 1). They range from a feather edge to probably not more than 50 feet in thickness and are approximately horizontal. In all the exposures examined the materials consist of light-colored somewhat calcareous, fossiliferous massive silt and clay beds, which lie unconformably upon the Pliocene(?) and Pleistocene(?) alluvial deposits. In general they are capped by a thin veneer of alluvium which, for the most part, has been removed in washes and other channels. This veneer is only 1 to 5 feet thick. The materials are weak, and thus great quantities of them have been removed by erosion.

Remnants of the deposits indicate that there were at least five different basins in the three valleys which were occupied by lakes during the Pleistocene epoch. The highest basin was in Indian Spring Valley, where the lake level reached an altitude of nearly 3,500 feet above sea level. In another basin, in Pahrump Valley, the maximum altitude of the water was between 2,800 and 2,900 feet. In Las Vegas Valley, at the mouth of Three Lakes Valley, the lake level stood at about 3,100 feet, and farther south, in the vicinity of Corn Creek Ranch, the level was about 3,000 feet. Southward, in the vicinity of Tule Springs, Las Vegas, and Warm Springs Ranch, remnants of the lake deposits indicate that the level of the water was about 2,600 feet above sea level. Although an intensive search was made for shore lines and other lake-cut or lake-built features, none were observed. This would indicate that the lakes probably were ephemeral, existing for only a short period of time. It is possible that the lakes were of the playa type and were at no time very deep. Invertebrate fossils collected from the lake deposits yield some evidence as to the nature and age of the lakes. The following statement by Frank C. Baker, Curator of the Museum of Natural History at the University of Illinois, to Professor C. R. Longwell, is quoted:

> The fresh water fauna would indicate a small lake into which the two species of land shells were washed. Such conditions prevail in this region at the present time, only the lakes are now mere pools which dry up more or less in the dry season. I think the deposit may be safely referred to the Pleistocene * * *. Some of the species listed * * * live in swampy places or ephemeral pools * * *. Others are known to live in larger lakes more or less permanent * * *. I may say that the two groups of species indicated * * * live in the same place, the mud-loving species along the shore or in sheltered places and the others in the more open part of the lake.

The following fossils collected by Professor Longwell from deposits near Corn Creek Ranch were identified by Mr. Baker:

FOSSIL	HABITAT
Valvatata humeralis californica Pils. Young.	Fresh water.
Physa virginia Gould. Young.	
Gyraulus similaris F. C. Baker	Fresh water.
Gyraulus vermicularis hendersoni (Walker)	Swampy places and ephemeral pools.
Stagnicola bulimoides techella (Hald.) Immature.	Swampy places and ephemeral pools.
Pisidium. Several species	Fresh water.
Fossaria species undet., possibly new	Swampy places and ephemeral pools.
Pupilla muscorum (Linn.) Spire of a shell	Land.
Succinea oregonesis gabbi Tryon? Immature.	

In addition to the above fossils, the remains of several vertebrates,[59] among them mammoths, camels, and horses, have been found and indicate the Pleistocene age of the lakes.

The lake beds consist of fine-grained relatively impermeable materials and are superficial deposits. As such they are unimportant either as aquifers or confining beds or as barriers to ground-water movement.

RECENT ALLUVIUM

The materials here described as Recent alluvium consist largely of surficial deposits of gravel, sand, silt, and clay and are present over large parts of three localities. They appear as playa-lake deposits in Indian Spring and Three Lake Valleys. The materials in the central part of the valley east and southeast of the city of Las Vegas are reworked silt and clay from the Muddy Creek formation, the Pliocene(?) and Pleistocene(?) alluvial deposits, and the Pleistocene lake beds. They vary from a feather edge to several feet in thickness. They are described in greater detail on pages 66–72. Other deposits of Recent alluvium occur as wash deposits, which range in thickness from a feather edge to about 50 feet, and form a thin veneer on the Pleistocene lake beds and the Pliocene(?) and Pleistocene(?) alluvial deposits. These deposits are not mapped in this report. Also, eolian deposits of Recent age occur in the larger valleys.

[59]Spurr, J. E., Descriptive geology of Nevada south of the fortieth parallel and adjacent portions of California: U. S. Geol. Survey Bull. 208, p. 157, 1903; Longwell, C. R., personal communication.

The water-bearing properties of the Recent alluvium are described in the general stratigraphic table.

GEOLOGIC STRUCTURE

The geologic structure within the area covered by this report is exceedingly complex, and the scope of this investigation limited study of the structure to its effect on ground-water conditions. Therefore, the following paragraphs describe only the general features of the structure and their relation to ground-water movements. Features of geologic structure are not mapped on plate 1 except as shown by the shape of the outcrops.

In the Spotted, Pintwater, Desert, and Sheep Ranges the "Early" and "Middle Paleozoic" rocks are folded in a huge anticline, the axis of which runs east along the south side of the Spotted Range to the south end of the Pintwater Range, where it turns abruptly and runs north along the east side of the latter range for several miles (see pl. 1). The anticline pitches to the north. The east limb is truncated by a huge thrust fault, the trace of which crops out along the west and north sides of the Las Vegas Range. The west limb is similarly broken by a thrust in the Spotted Range, which does not appear on plate 1. The anticline is broken also by at least two other thrusts of lesser magnitude and by numerous normal faults, some of which dip at very low angles. The low-angle normal faults in the Desert Range have been described in detail and their origin discussed by Longwell.[60] The thrust faults generally strike north-south but tend to swing west near the south ends of the ranges. The thrust planes of most of these faults dip west. Most of the major normal faults strike north, and several of them are probably responsible for the elevation of the ranges above the valleys in the north part of the area.

The most dominant structures in the Spring Mountains are a series of enormous thrust faults, some of which have been named and described by former workers. The most northern, or Johnnie, thrust was named and described by Nolan.[61] It occurs in the mountains a few miles east of Johnnie, Nevada, where great thicknesses of the Stirling quartzite and younger formations have been thrust over quartzite of the Johnnie formation. The trace of another thrust, the Wheeler Pass fault, crops out about 10

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[60] Longwell, C. R., Low-angle normal faults in the Basin and Range province: Am. Geophys. Union Trans., vol. 26, pt. 1, pp. 107–118, 1945.

[61] Nolan, T. B., Notes on the stratigraphy and structure of the northwest portion of Spring Mountain, Nevada: Am. Jour. Sci., 5th ser., vol. 17, pp. 461–472, 1929.

miles southeast of the Johnnie thrust in a small wash east of Horse Springs. The trace extends east of the Spring Mountains where it is buried by gravels and alluvium in the vicinity of Willow Spring. The upper plate of this thrust consists of "Early" and "Middle Paleozoic" strata which have been thrust over rocks of "Late Paleozoic" age. The stratigraphic displacement of the Wheeler Pass thrust ranges from 13,000 to 15,000 feet, according to Nolan. Detailed descriptions and discussions of these two thrusts are given by Nolan and Longwell.[62]

The trace of the Lee Canyon thrust fault[63] crops out in the vicinity of Lee Canyon where it strikes northeast. Northeast from Lee Canyon the thrust trace retains this strike; southwest from the head of Lee Canyon the trace swings abruptly south, continuing in this direction to a point about 1 mile south of the Red Rock road where it is covered by the alluvial apron. The upper plate of the fault consists of "Early Paleozoic" rocks which have been thrust over "Middle" and "Late Paleozoic" strata. About 2 miles south of the Lee Canyon thrust trace, another thrust crops out on the east side of the mountains. Southward, two smaller thrusts occur in the vicinity of The Mummy and Kyle Canyon. On the south slopes of La Madre Mountain, rocks of "Early Paleozoic" age have been thrust over the Aztec sandstone and other Mesozoic strata. This thrust fault, the trace of which trends east-west near La Madre Mountain and swings sharply south where the latter joins the main Spring Mountain Range, was named the Keystone thrust by Hewett.[64] Its general character and structural relationships in the Goodsprings quadrangle were discussed by him and it has been described by Glock and Longwell[65] farther north in the vicinity of La Madre Mountain. The average dip of the Keystone thrust is 8° west, and the fault has a stratigraphic displacement exceeding 12,000 feet. Several other thrust faults occur farther south in the Goodsprings quadrangle and have been described in detail by Hewett.[66] Also, numerous small thrust faults occur in other parts of the area.

In addition to thrust faulting, block faulting has occurred in

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[62]Op. cit., 465–471: Longwell, C. R., The mechanics of orogeny: Am. Jour. Sci., vol. 243-A, Daly Volume, pp. 420–423, 1945.

[63]Longwell, C. R., Structural studies in southern Nevada and western Arizona: Geol. Soc. America Bull., vol. 37, p. 566, 1926.

[64]Hewett, D. F., Geology and ore deposits of the Goodsprings quadrangle, Nevada: U. S. Geol. Survey Prof. Paper 162, p. 48, 1931.

[65]Glock, W. S., Geology of the east-central part of the Spring Mountain Range, Nevada: Am. Jour. Sci., 5th ser., vol. 17, pp. 335–337, 1927; Longwell, C. R., op. cit., pp. 564–566.

[66]Hewett, D. F., op. cit., pp. 48–51.

the Spring Mountains and also on Frenchman Mountain. In general, the block faults strike northwest, although several trend north and a few trend east. In most places where the thrust faults are intersected by block faults, the traces of the thrusts are offset. However, in a few places normal-fault traces do not seem to extend across the thrust planes, crop out on only one side of the thrust, and therefore are offset by the thrust fault. Block faulting is probably responsible for much of the present elevation of the Spring Mountains; however, thrusting and folding must also have contributed much to this end.

Numerous minor faults occur, particularly in the vicinity of the outcrops of the thrust faults, and probably major folds also exist which further detailed study may disclose. The older, well-consolidated rocks are cut by two main systems of joints. However, the attitude and the degree of development of joints in the rocks depends largely upon local structural conditions and the character of the rocks. Where the rocks are much disturbed by faulting and folding, the joint systems are well-developed. Where the rocks are relatively undisturbed, joints may be poorly developed and relatively scarce.

Tear faults occur with much horizontal displacement. Hewett[67] has mapped several faults having considerable horizontal displacement in the Goodsprings quadrangle and has described the faults briefly in his report. Also, Longwell mapped a large tear fault which passes into a thrust fault in the Spotted Range.

The sequence and age of structural events in parts of the area and in adjacent regions have been described by several geologists.[68] The following discussion is a brief summary of their findings. Block faulting may have occurred previous to or at the same time as extensive folding and thrusting, the first clearly recognized structural event in the area. The folding and thrusting involved strata of Mesozoic age in this area. In adjacent regions early Tertiary sediments were also involved in the thrust faults and in folds; thus the period of compression took place during the Laramide orogeny. Also, Longwell suggests that many of the normal faults in the region probably developed not later than early Cenozoic time. Following the development of folds and thrust faults, and previous to the deposition of the

[67]Hewett, D. F., op. cit., p. 52, pls. 1 and 2.

[68]Nolan, T. B., op. cit., pp. 460–465; Hewett, D. F., op. cit., pp. 53, 54; Glock, W. S., op. cit., pp. 335–337; Longwell, C. R., op. cit., pp. 551–584; also, The geology of the Muddy Mountains, Nevada: U. S. Geol. Survey Bull. 798; Low-angle faults in the Basin and range province: Am. Geophys. Union Trans., vol. 26, part 1, pp. 107–118, 1945; and Hunt, C. B., op. cit.

Muddy Creek formation, a period of extensive block faulting took place. Since middle (?) Tertiary time block faulting has continued on a relatively minor scale. Evidence that major faults and other large-scale structural activities displaced the Pliocene (?) and Pleistocene (?) alluvial deposits was not observed anywhere in the area. However, about 3 miles west of Whitney, Nevada, and in the vicinity of the city of Las Vegas in the south part of Las Vegas Valley, small normal faults of possible Recent or late Pleistocene age were observed in the Pliocene(?) and Pleistocene(?) alluvial deposits and in the Muddy Creek formation (see pp. 69–71). These faults are probably confined to the late alluvial and relatively unconsolidated sediments and probably do not cut the older bedrock as do faults of Recent age in adjacent regions.[69]

EFFECT OF GEOLOGIC STRUCTURE ON THE MOVEMENT OF GROUND WATER

Most fault zones in the area are cemented and therefore ground water is not ordinarily transmitted along them. Rather, water tends to be stopped by faults, and where the attitude and permeability of the rock strata are favorable, the water is brought to the surface as springs. Joints in the rocks undoubtedly transmit water, but not necessarily large quantities, unless the rock is susceptible to solution and large cavities and solution channels are present. The Goodsprings dolomite and most of the Bird Spring formation are good examples of much-jointed yet impervious rock. In many localities in the area, springs are localized at the upper contact of the Goodsprings dolomite even where it is much deformed and jointed. The Sultan and Monte Cristo limestones are relatively soluble and contain numerous solution openings, which generally are along joint planes. These two formations transmit considerable quantities of water where fault and joint systems are well-developed and enlarged by solution.

In summary, faults generally act as ground-water dams; joints generally do not transmit large quantities of water except where they occur in relatively soluble formations. The faults in the valley fill are of paramount importance to ground-water movement in Las Vegas Valley (see pp. 69–71).

SUMMARY OF GEOLOGIC HISTORY

The history of the area covered by this report seems to include the following stages:

(1) During most of Paleozoic time the area was a part of the

[69] Longwell, C. R., Faulted fans west of the Sheep Range, southern Nevada: Am. Jour. Sci., vol. 20, 5th ser., pp. 1–13.

Cordilleran geosyncline, and huge thicknesses of limestone, dolomite, shale, and sandstone were deposited. Clastic sediments characterized the earlier part of the Cambrian period and were succeeded by organic and chemical sediments which were deposited in the seas of medial Cambrian time and the succeeding periods. Clastic materials were not again the dominant type of deposit until Permian time, when a vast thickness of continental sandstone was deposited in the Supai formation. Unconformities in the Paleozoic rocks in the southern part of the area indicate periods of emergence and erosion during part of the Lower Cambrian epoch, part of the Middle Devonian epoch, and possibly during part of middle Mississippian time. Lack of deposits of Ordovician and Silurian sediments indicates possible emergence during those periods also, in some parts of the area.

(2) A period of emergence and extensive erosion occurred near the end of the Paleozoic era. This period of emergence and erosion is represented by the unconformity above the Kaibab formation. In some places in the Spring Mountains the Kaibab formation and part of the underlying Supai formation were removed by erosion.

(3) A period of oscillation between marine and continental conditions then occurred, during which the marine limestones and shales of the Moenkopi formation were deposited. This period culminated in complete emergence at the end of Lower Triassic time, with erosion of the Moenkopi and deposition of the continental Shinarump and Chinle formations and the Aztec sandstone.

(4) Following (3) was a period of erosion and uplift accompanied by tear and thrust faulting and probably preceded and accompanied by extensive block faulting. At least four great sheets of Paleozoic rocks were thrust southward, overriding other Paleozoic rocks and Mesozoic strata. This period of orogeny and erosion occurred after late(?) Jurassic time and probably extended well into Tertiary time, for in adjacent regions rocks deposited during the Tertiary period (the Overton and Horse Spring formations) were involved in folds. Probably extensive volcanic activity took place in the south part of the area which resulted in the extrusion of volcanic rocks (the Black Canyon group of Ransome). A topography similar to that of the present was the end result of the period of orogeny and erosion, and the present ranges and basins probably were outlined.

(5) Vast quantities of glassy lavas were extruded in the southern part of the area and in adjacent regions. The great thicknesses of sand, silt, and clay of the Muddy Creek formation were

deposited in oscillating lakes, which at times were rather deep and extensive. Deposition of these beds continued until late in Miocene time and were apparently accompanied by block faulting and local minor folding.

(6) Presumably near the end of Miocene time, deposition of the Muddy Creek sediments ceased and a period of erosion took place, during which large quantities of the Muddy Creek and allied formations were eroded from Las Vegas and Indian Spring Valleys and a surface of considerable relief was formed in the valleys. It is possible that the Colorado River had cut through southeast Nevada by this time and that Las Vegas Valley was tributary to it. Also, climatic conditions probably changed because at this time thick alluvial-fan deposits began to form and the quiet lacustrine conditions characteristic of Muddy Creek time had disappeared.

(7) The building of huge alluvial fans and aprons continued throughout the rest of the Tertiary period and well into the Quaternary period. While these thick deposits were forming, numerous basaltic and andesitic laval flows occurred in regions adjacent to Las Vegas Valley. Early in the Pleistocene epoch, the Spring Mountains and adjacent ranges were probably nearly buried in alluvial materials which extended in altitude within 3,000 feet of the top of Charleston Peak.

(8) After the period of alluviation, Las Vegas and Indian Spring Valleys were affected by lowering of the base level until the latter part of Pleistocene time, when the base level seems to have arisen and the two valleys were aggraded. This period of aggradation was brief and resulted only in the deposition of the thin deposits of the Pleistocene lake beds and thin supplementary deposits of gravels in the mountains. It was followed by a lowering of base levels and renewed erosion of the alluvial fans, a process which has resulted in the present-day landscape and which is going on today.

PHYSICAL CHARACTERISTICS AND WATER-BEARING PROPERTIES OF THE VALLEY FILL

Introduction—Many well-exposed sections of the valley fill are present on the higher parts of the alluvial aprons, but at lower altitudes in the valleys knowledge of the character of the alluvial sediments depends largely upon evidence obtained by the construction of wells. Approximately 235 logs of wells in Las Vegas, Pahrump, and Indian Spring Valleys are listed (see tables, appendixes I and II). Many of these logs may not be accurate because they were prepared from the drillers' memories, or because descriptions of the materials penetrated by the wells were inadequate and measurements of the thickness of the material were in error. The places where wells have been drilled cover only a small part of the total area of valley fill, and the character of the sediments underlying the undrilled fill must be interpreted from other data or from evidence furnished by logs from nearby wells. Moreover, the sediment occur in discontinuous, irregular, and lenticular beds typical of alluvial deposition in arid and semi-arid regions. In many instances, it is not possible to correlate the various water-bearing or other horizons encountered by the wells. However, the general character and extent of the aquifers and confining beds can be determined from these records and from supplementary geologic and hydrologic evidence.

The well records, geology, and hydrology show that permeable materials are most abundant in the higher parts of the alluvial apron in the form of widespread thick lenses of coarse gravel with some sand and small amounts of silt and clay. Farther down on the alluvial fans these lenses become thinner, more irregular, narrower, and discontinuous, and finger into thick deposits of silt and clay that underlie the central parts of the valleys. On the west side of Las Vegas Valley, south of La Madre Mountain, this change from a predominance of coarse materials to fine-grained sediments is especially abrupt. It largely occurs in a strip of land from 2 to 5 miles wide immediately west of a line from Tule Springs to the city of Las Vegas, thence south to a point about 3 miles west of Pittman. West of this strip the valley fill consists of gravel and sand with only a few thin fingers of silt and clay extending short distances west up the alluvial apron. East of this strip only thin beds of sand and gravel are interfingered with thick, widespread silt and clay layers. The beds of sand and gravel become progressively finer and better-assorted to the east, and most of them grade into silt and clay. Only a few sand and gravel beds, possibly only one bed (see pl. 6B) in the upper 1,000 feet of valley fill in Las Vegas Valley, extend east across the valley and are thus co-extensive with lenses of coarse material that are a part of the alluvial apron on the east side of the valley.

No wells are known to have reached the consolidated rocks of early Tertiary age or older anywhere in the valley. It appears that the deepest wells in the valley penetrate the beds of middle(?) or late(?) Tertiary age (the Muddy Creek formation), sediments that are considered a part of the valley fill. Therefore, the thickness of the valley fill is unknown.

Las Vegas Valley. The sand and gravel beds are the aquifers that transmit and store most of the ground water used in Las Vegas Valley. The silt and clay beds are confining layers that hold the water under pressure in the aquifers but transmit only small quantities of water. Part of the water stored in the confining beds probably drains slowly out of them when the head is lowered during periods of large discharge through wells.

Although it is difficult to recognize beds of marked horizontal extent in the valley fill, a persistent layer of light greenish-blue to dark-blue, plastic clay is penetrated by many wells in Las Vegas Valley (see pls. 6A and B). This blue clay ranges from 10 to 60 feet and averages about 20 feet in thickness. It occurs at depths ranging from 380 to 450 feet below land surface, at an altitude of about 1,550 feet in the vicinity of the city of Las Vegas and west of the large scarp that runs through the east part of the city and thence north to the vicinity of the Kyle Ranch. West of this scarp the blue clay is encountered in wells as far north as the Gilcrease Ranch, as far west as U. S. Highways 95 and 91, and as far south as secs. 20, 21, and 22, T. 22 S., R. 61 E. East of this scarp the blue clay bed is encountered at about the same depths below the land surface. However, here the beds are from 150 to 250 feet lower in altitude, or at altitudes ranging from about 1,300 to 1,400 feet. The clay has been penetrated by wells drilled as far north as U. S. Highway 91, as far south as Pittman, and as far east as sec. 32, T. 21 S., R. 62 E. It is a distinctive and persistent bed that was probably deposited in a lake, and that has been displaced by faulting since its deposition (see pls. 6A and B, and pp. 69, 70).

Several relatively thick sand and gravel lenses are present beneath the blue clay in the vicinity of the city of Las Vegas. They occur at depths ranging from 450 to 700 feet and west of the city are as much as 100 feet thick. To the south they grade into thinner lenses of fine- to medium-grained sand. These gravel lenses also thin to the east and most of them finger into the clays just east of Las Vegas and Whitney. Only a few wells have been drilled deeper than 450 feet north of Las Vegas and only two logs are available from this vicinity. These logs indicate that the sand and gravel lenses between depths of 450 and 700 feet thin toward the north.

A few wells drilled to depths of more than 700 feet have encountered thin water-bearing, medium- to fine-grained sand lenses, with a little fine gravel as deep as 1,255 feet. These materials differ considerably from the overlying sand and gravel beds, for they are finer-grained, better-assorted, and more thinly and evenly bedded. They are characteristically thin sand lenses with a little fine gravel interbedded with thicker beds of reddish silty clay. The sand and gravel lenses are rarely more than 5 feet thick and average about 2 feet. The clay beds are generally about 25 feet thick but range from 1 foot to about 100 feet in thickness. The sand and gravel lenses generally contain some silt and clay and consequently do not readily yield large quantities of water to the wells which penetrate them. The sediments making up the valley fill below about 700 feet in the vicinity of the city of Las Vegas are lithologically similar to beds of the Muddy Creek formation that are widespread in basins and valleys adjacent to Las Vegas Valley. As the Muddy Creek formation is present in parts of Las Vegas Valley also (see pp. 55, 56), these beds may belong to that formation, although diagnostic evidence is lacking.

In Paradise Valley, 5 to 10 miles south of the city of Las Vegas between Arden and Whitney, sedimentation was especially irregular. Apparently only the shallower beds in the upper 400 feet contain relatively widespread sand and gravel lenses and even these beds are poorly assorted and contain only irregular lentils of clean coarse-grained materials. The blue clay apparently is not present in much of Paradise Valley. The deeper sand and gravel beds that occur below 400 feet contain much silt and clay. Much gypsum is present in the bedrock in Cottonwood Valley, which lies about 15 miles west of and tributary to Paradise Valley. As a result, gypsum has been deposited with the sediments in this part of Las Vegas Valley.

Another conspicuous feature of the valley fill that is of paramount significance to the occurrence of ground water is the faults that occur near the city of Las Vegas and west of Whitney (see pls. 1 and 6A and B). The offset resulting from these faults is best shown by the displacement and slight tilting of the blue clay beds. In places this displacement has been as much as 150 feet. Other evidence of faulting near the scarps may be found west and southwest of Whitney, where the terrace surface of each scarp appears to tilt downward against the face of the next scarp west. Also, one scarp abuts beds of the Muddy Creek formation, which are flexured and probably broken at the point of abutment. West of the city of Las Vegas, brecciated caliche and caliche-cemented gravel were observed in excavations along one of the scarps in that vicinity. These faults are largely responsible for the scarps in the valley fill in the south part of Las Vegas Valley. The scarps roughly indicate the extent and number of faults in the valley fill. The faults nearly all occur within the narrow strip along the toe of the Red Rock fan, where the abrupt change from predominantly coarse to predominantly fine material takes place. It appears that they are the result of differential compaction of the sediments, the finer-grained beds having settled considerably more than the coarser-grained materials, thus causing faults in the beds where there is a rapid lateral change in the grain size of the sediments.

Comparison of the results of first-order leveling by the Geological Survey and the Coast and Geodetic Survey in the vicinity of the city of Las Vegas in 1915 and 1935 indicates some settlement. Two bench marks in the city settled about 3 inches, and two other bench marks settled more than 2 inches during that period. These four bench marks are in places underlain by predominantly fine-grained materials interbedded with thin strata of coarse-grained sand and gravel. Bench marks about 4 to 6 miles northwest of the city of Las Vegas settled less than 1 inch during the same period. The bench marks northwest of the city are underlain by valley fill that is predominantly coarse-grained and that contains only thin strata of fine materials. Bench marks farther from the valley axis showed little or no settlement during the period 1915 to 1935. In 1940 and 1941 levels were again run by the Coast and Geodetic Survey to some of the bench marks. These levels were part of a net that was established to determine the amount of settlement in the Lake Mead Basin above Hoover Dam.

Preliminary results from this leveling show that the south-central part of Las Vegas Valley settled from 1 to 3 inches during the period from 1935 to 1941. The maximum settlement took place in the vicinity of the city of Las Vegas. Very little settlement, less than one-half inch, occurred high up on the alluvial aprons. The amount of settlement near the city, a locality that is unaffected by the weight of the water and silt in Lake Mead, was over half the maximum settlement in the immediate vicinity of the loaded lake bed. The increase in the rate of settlement in the period 1935–1941 over that of the period 1915–1935 appears to be largely the result of increased discharge of the artesian water and the consequent release of upward pressure on the confining beds during the period 1930 to 1941. The settlement in Las Vegas Valley as a whole appears to be the result of compaction of the sediments of the valley fill, and the faults, as stated before, are probably caused by the differential compaction of the fine-grained and coarse-grained sediments.

These faults in the valley fill undoubtedly act as a partial barrier that impedes the movement of ground water through the various aquifers. The moderately permeable beds in many places were probably offset against the less permeable beds, thus wholly or part damming the flow of the water through the permeable beds. Some of the ground water thus impeded by the faults moves upward along the fault zones and issues as springs near the traces of the faults. The location and origin of Las Vegas, Kyle, Stevens, and several other such springs near the foot of the scarps in Las Vegas Valley is apparently a result of this faulting.

Most of these conditions of the valley fill in the vicinity of the city of Las Vegas are indicated in the diagrammatic sections, plate 6A and B. These sections are based on the logs of the wells indicated, supplemented by the logs of nearby wells and by interpretation of all available geologic and hydrologic data.

In the north part of Las Vegas Valley, north of Tule Springs Ranch, only a few wells have been drilled. Fragmentary records of the wells drilled at Corn Creek Ranch indicate that water-bearing sand and gravel lenses were encountered at depths of about 350 to 500 feet, but that mostly clay and caliche were penetrated by the drill. These wells were drilled to about 500 feet. Approximately 2½ miles northwest of Corn Creek Ranch, well (S-17-59) 20bc was drilled to a depth of over 300 feet. This well is reported to have penetrated thick beds of clay and caliche and only a few thin beds of sand and gravel. Wells drilled west of the Corn Creek Ranch in the central part of the valley are reported, by drillers and other interested persons, to have encountered very little sand and gravel. Thus, it appears that the east and central parts of the north half of Las Vegas Valley, north of the Tule Springs Ranch, are underlain by fine-grained materials with only occasional thin lenses of sand and gravel. The large alluvial fans that head in Kyle, Deer Creek, and Lee Canyons and that underlie most of the west side of the north part of the valley probably contain much thicker, more continuous, and more regularly deposited lenses of coarse materials. Their position, size, and slope are similar to those of the alluvial apron on the west side of the valley farther south. However, no wells have been drilled in this part of the valley and little information is available regarding the character of the sediments underlying it.

Pahrump Valley. In Pahrump Valley, the valley fill is probably similar to that in Las Vegas Valley. However, no conspicuous fault scarps cut the surface and evidence from the few available well logs is not complete enough to verify the presence of faulting in the valley fill. The logs and other data indicate that an abrupt change in grain size of the materials, similar to the change in the vicinity of Las Vegas and Tule Springs, occurs in the vicinity of Pahrump and Manse Ranches and in other places along the toes of the alluvial fans. The presence of the large Bennetts Springs at the toe of the Pahrump fan and the Manse Spring at the toe of the Manse fan may be an indication of faulting at these places. Logs of wells drilled in the vicinity of the springs and in localities to the north and east show a large proportion of coarse-grained materials. Logs of wells drilled west of the springs and in the basin lowlands along the lower margin of the alluvial apron show larger proportions of finer materials with only occasional thin gravel and sand strata. The sediments underlying the interfan areas, especially between the Pahrump and Manse fans, also appear to be relatively fine-grained, even near the upper margin of the alluvial fan. A few wells drilled in the vicinity of the Pahrump and Manse Ranches reach depths of about 900 feet. These are the deepest wells in Pahrump Valley. Logs of these wells indicate that only the younger sediments of late (?) Tertiary and Quaternary age were penetrated and that the older consolidated rocks were not encountered. Therefore, as in Las Vegas Valley, the maximum thickness of the valley fill is unknown. The deeper beds encountered by these wells are possibly of the same age as the Esmeralda (?) or Muddy Creek formations. No deep wells are known to have been drilled in the central part of the valley and little is known about the character of the valley fill. However, it probably corresponds to the central part of Las Vegas Valley, where the valley fill is largely silt and clay with very few interbedded sand and gravel lenses.

Indian Spring Valley. A complete record is available of only one deep well, (S-16-56) 8ab, in Indian Spring Valley. This well was drilled to a depth of 576 feet at the U. S. Army Air Field near Indian Springs. The logs of this well and of several other wells in the vicinity of Indian Springs indicate that water-bearing sand and gravel layers were encountered at depths of 22 feet, 45 feet, 70 feet, 165 feet, and 570 to 604 feet. These aquifers are interbedded with clay and caliche layers. Thus, the valley fill in Indian Spring Valley is probably similar to the valley fill in the other two valleys discussed in this report.

STREAMS AND SPRINGS

Perennial streams do not occur in Las Vegas, Pahrump, and Indian Spring Valleys and most of the intermittent streams have no regular seasonal flow. Surface water runs in the washes only during and following infrequent storms. Water from a few of the larger springs, such as those in Deer Creek, Cold Creek, and Clark Canyons, runs for a short distance in the washes below the springs and soon percolates into the gravels. Intermittent Spring, and the Pahrump Valley Springs in the central part of Pahrump Valley, discharge large quantities of water in the spring of the

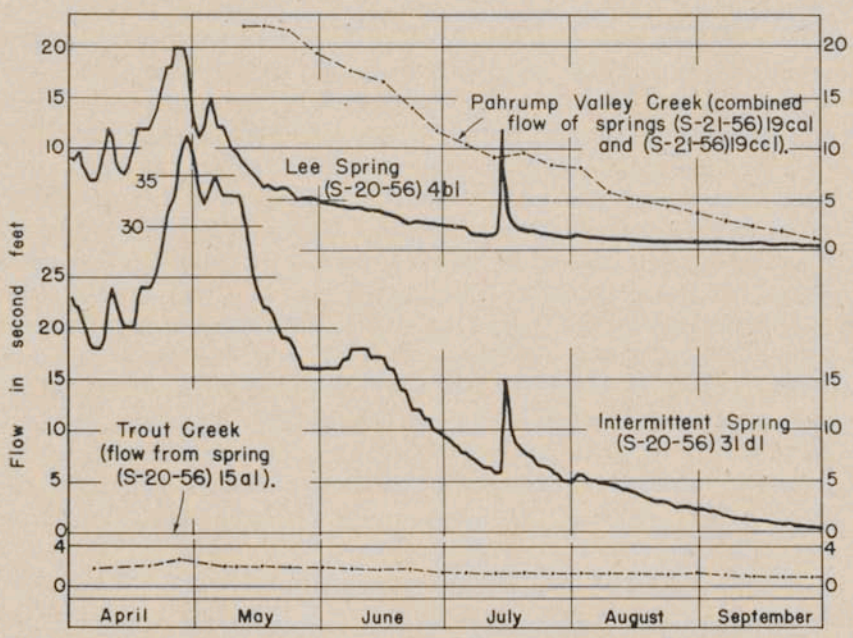

FIGURE 8—Graph showing flow of four springs in Pahrump Valley for the period April to September 1916. (Based on measurements by Albert Quill; see U. S. Geol. Survey Water-Supply Paper 450-C, pp. 61, 62, 1921.)

year (see fig. 8). The resulting streams flow for several miles below the springs but eventually percolate into the alluvial fan. During the rest of the year the water disappears into the gravels within a short distance of the springs. Ordinarily at least a few small streams would be present in a region where the mountains rise to altitudes ranging from 8,000 to 12,000 feet, and where the annual rainfall in the mountains is as much as 30 inches. Many high ranges in the Great Basin with approximately the same average annual precipitation do contain a few perennial and many intermittent streams that flow at regular intervals. The dearth of streams in the Spring Mountain and Sheep Ranges is largely the result of the highly permeable limestone bedrock and alluvial gravels that compose most of the surfaces of the ranges and the alluvial aprons. These formations are veritable "sponges" that soak up the water from precipitation before it can become concentrated in the larger gullies and washes as streams. Thus much of that part of the water from precipitation that ordinarily runs off as streams in regions similar to the Spring Mountain and Sheep Ranges, enters and recharges the ground-water reservoir in this area.

The largest and most important perennial springs in the area occur in the valleys and issue from the gravels of the alluvial apron. Most of these springs undoubtedly discharge water from the artesian aquifers of the valley fill and most of them are probably located along fault zones in the fill. Unlike the springs in the mountains, these valley springs discharge relatively steady flows of water throughout the year. Most of the fluctuation in discharge from these springs is caused by interference from nearby discharging wells. Typical examples of the large springs in the valleys are the Las Vegas, Tule, and Corn Creek Springs in Las Vegas Valley, and Bennetts and Manse Springs in Pahrump Valley. In addition to the artesian springs, many gravity springs are found in the valleys where the water table intersects the land surface. These gravity springs and seeps are especially numerous near the base of the scarps in Las Vegas Valley. Data for the well-known springs in the valleys are given in the tables on pages 76 to 80.

A few large and many small springs are found in the Spring Mountains. A few small springs occur in the other ranges in the area. Most of the springs are of the fifth or sixth magnitude, many are smaller, a few are larger, and none are of the first magnitude.[70] Most of the mountain springs are the contact type. Generally they occur along fault zones, where permeable water-bearing beds have been broken and the broken ends have been forced against impermeable beds as a result of movement along

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[70] Meinzer, O. E., Outline of ground-water hydrology, with definitions: U. S. Geol. Survey Water-Supply Paper 494, p. 53, 1923.

First magnitude, 100 second-feet or more; second magnitude, 10 to 100 second-feet; third magnitude, 1 to 10 second-feet; fourth magnitude, 100 gallons per minute to 1 second-foot (448.8 g.p.m.); fifth magnitude, 10 to 100 gallons per minute; sixth magnitude, 1 to 10 gallons per minute; seventh magnitude, 1 pint to 1 gallon per minute; eighth magnitude, less than 1 pint per minute.

the faults. Occasional springs are also found along the contacts of permeable and impermeable beds where favorable conditions of attitude and outcrop of the beds allow water under the force of gravity to come to the surface.

Discharge from most of the mountain springs fluctuates considerably. Many of the springs go dry in the late summer or fall and start flowing again during the spring melt of the following year. The discharge of some of the springs fluctuates greatly as a result of added recharge during local storms. Generally the discharge of springs that issue from cavernous limestone fluctuates most, and that from springs that are along fault zones appears to fluctuate least. Figure 8 illustrates the wide fluctuation of the discharge from Intermittent and Lee Springs, both of which issue from limestone rocks. It also shows the fluctuation of the Pahrump Valley Springs. These springs probably issue from limestone underlying the gravels near the contact of the alluvial apron and the mountains. Fluctuations of the flow of Trout Creek, which originates from springs along a fault zone, are also shown. The location of many of the springs is shown on plate 1. The name, location, discharge, and temperature, where available, are shown in the following table for the most important and best-known springs. The numbering system used for designating each spring is similar to that used for designating wells and is described in appendix I, pages 8 and 9. Available analyses of water from some of the springs are given in table 5, appendix II.

Discharge of Well-Known Springs in Las Vegas, Pahrump, and Indian Spring Valleys and the Adjacent Mountains

Location	Name	Discharge: Date	Discharge: Gallons per minute	Remarks
(S-15-60) 24	Wiregrass Spring	Apr.-July	.5±	Discharge estimated by the Desert Game Refuge Engineer, 1938-1940.
		Aug.-Mar.	.25±	
(S-16-55½) 11a	Mesquite (Cactus) Spring	7-30-46	.5±	Discharge estimated.
(S-16-56) 16b1	Indian Springs	12-15-12	405	See Water Supply Paper 365, table facing p. 30. T. 78° F. See analysis, Table 4, Appendix II.
		3-18-46	400	Discharge estimated.
(S-17-53) 27c	Horseshutem Spring	1916	8±	See Water Supply Paper 450, p. 76.
		7-14-45	10	Discharge estimated.
(S-17-59) 34a1	Corn Creek Spring	12- 8-12	90	See Water Supply Paper 365. See analysis, Table 4, Appendix II.
(S-18-54) 7	Rainbow Spring	1916	2±	See Water Supply Paper 450, p. 76.
(S-18-54) 1d	Cold Creek Spring	11- 9-44	690	
(S-18-55) 2a	Willow Spring	12-17-30	340	Discharge estimated—State Engineer of Nevada.
(S-18-55) 20c	Wheeler Spring	1916	1±	See Water Supply Paper 450, p. 76.
		7-14-45	1±	Discharge estimated.
(S-18-55) 23b	Trough Spring	9-13-45	30	Discharge estimated.
(S-18-55) 35	Buck Spring	1916	1±	See Water Supply Paper 450, p. 76.
		9-13-45	25	Discharge estimated.
(S-19-54) 14c	Horse Spring	1916	1±	See Water Supply Paper 450, p. 76.
(S-19-56) 3c	Scout Canyon Spring	6-26-42	4.7	Measurements by U. S. Forest Service.
		7-29-42	Dry	
		9-29-42	Dry	
		6-21-43	6.7	
		7-23-43	4.8	
		8-27-43	1.9	
		9-29-43	1.0	
		7-31-44	Dry	
		8-31-44	Dry	
		7- 9-46	10.9	
		8- 2-46	11.4	
		9- 2-46	9.3	
(S-19-56) 10c	Three Springs	6-26-42	44.0	Measurements by U. S. Forest Service.
		7-29-42	17.4	
		9-29-42	21.0	
		6-21-43	40.0	
		7-23-43	23.8	
		8-27-43	21.5	
		9-29-43	22.1	
		8- 4-44	15.5	
		8-31-44	12.4	
		7- 5-45	15.1	
		8- 1-45	11.3	
		9- 4-45	39.0	
		7- 9-46	27.3	
		8- 2-46	21.4	
		9- 2-46	13.5	

Location	Name	Discharge		Remarks
		Date	Gallons per minute	
(S–19–56) 25a	Stanley "B" Spring	6–27–42	20	Measurements by U. S. Forest Service.
		7–30–42	15	
		9–29–42	12.1	
		6–21–43	37	
		7–24–43	27.2	
		8–28–43	22.8	
		9–27–43	18.2	
		7–31–44	15.5	
		8–31–44	12.4	
		7– 4–45	24.4	
		8– 6–45	27.0	
		9– 3–45	34.0	
		7– 8–46	18.1	
		8– 3–46	21.2	
		9– 3–46	16.4	
(S–19–56) 35d	Rainbow Creek Spring	6–27–42	135.4	Measurements by U. S. Forest Service.
		7–30–42	79.2	
		9–29–42	29.0	
		6–22–43	282.0	
		7–24–43	192.4	
		8–28–43	101.7	
		9–26–43	61.0	
		7–31–44	105.0	
		8–30–44	90.0	
		7– 1–45	199.0	
		8– 4–45	121.0	
		9– 4–45	174.0	
		7– 6–46	110.5	
		8– 1–46	93.5	
		9– 3–46	69.7	
(S–19–57) 7c	Deer Creek Spring	6–27–42	54.1	Measurements by U. S. Forest Service.
		7–29–42	29.2	
		9–29–42	12.6	
		6–21–43	81.7	
		7–23–43	68.6	
		8–27–43	76.7	
		9–29–43	56.9	
		8– 5–44	78.8	
		8–31–44	34.1	
		7– 5–45	42.5	
		8– 1–45	74.2	
		9– 4–45	84.0	
		7–11–46	51.0	
		8– 3–46	50.9	
		9– 7–46	41.0	
(S–19–60) 9c1	Tule Spring	1912 (?)	210	Largest spring in group. See Water Supply Paper 365, p. 39. T. 69.5° F.
		12–21–12	180	Discharge estimated by J. T. McWilliams.
		4–20–29	270 to 450	See Agricultural Experiment Station Bull. 136, p. 24. See analysis, Table 4, Appendix II. See following table for additional measurements.
(S–20–52) 1c1	Buol Sixmile Spring	1916	.0	See Water Supply Paper 450, p. 76.
		8– 5–27	34	See Agricultural Experiment Station Bull. 136, p. 32. See analysis, Table 4, Appendix II.
		7–15–46	10	Discharge estimated.

Location	Name	Discharge: Date	Discharge: Gallons per minute	Remarks
(S-20-53) 14dc1	Bennetts Springs	1875	3,370	Reported by Mr. Bennett in 1905.
		9-30-16	2,125	Two larger springs. See Water Supply Paper 450, p. 63. T. 76.5° F. See analysis, Table 4, Appendix II.
		6-19-39	1,590	
		7-18-43	2,520	Two larger springs. Measurement by State Engineer of Nevada. Springs cleaned out.
(S-20-56) 4b1	Lee Spring	See Fig. 8	......	See Water Supply Paper 450, p. 61.
(S-20-56) 15a1	Trout Spring	See Fig. 8	......	See Water Supply Paper 450, p. 62.
(S-20-56) 31d1	Intermittent Spring	See Fig. 8	......	See Water Supply Paper 450, p. 62. See analysis, Table 4, Appendix II. T. 57° F.
(S-20-57) 1c1	Harris Spring	10- -35	50	Discharge estimated.
(S-20-61) 15dc1	Kyle Spring	5-29-09	315	Reported.
		9-16-12	405	See Water Supply Paper 365, p. 39. See analysis, Table 4, Appendix II. T. 76° F.
(S-20-61) 30ddc1	"Little" Las Vegas Spring	2-22-08	2,700-3,150	Reported by Judge M. S. Beal.
(S-20-61) 30ddd1	"Open" Las Vegas Spring	9-23-12	2,580	See Water Supply Paper 365, table facing p. 30. See analysis, Table 4, Appendix II. T. 73° F.
(S-20-61) 31aab1	"Big" Las Vegas Spring	12-21-12	2,390	Discharge estimated by J. T. McWilliams. See following table for other discharge measurements.
(S-21-54) 3bc1	Manse Springs	1877	2,700	Reported by Harsha White and Joseph Yount, 1905.
		9-30-16	1,445	See Water Supply Paper 450, p. 63. T. 75° F.
		8- 5-27	960	See Agricultural Experiment Station Bull. 136, p. 32. See analysis, Table 4, Appendix II. T. 75° F.
		1- -37	1,350	Measurements by State Engineer of Nevada.
(S-21-56) 19ca1 and 19cc1	Pahrump Valley Springs	See Fig. 8	......	See Water Supply Paper 450, p. 62.
(S-21-61) 1cc1	Red Spring	9-10-45	15	Discharge estimated.
(S-21-62) 29db1	Grapevine Spring	12- 2-46	10	See analysis, Table 4, Appendix II. Discharge estimated.
(S-21-62) 30dc1	Stevens (Mesquite) Spring	3-28-45	25	Discharge estimated.
(S-22-54) 14d1	Steve Brown Spring	8- 5-27	65	See Agricultural Experiment Station Bull. 136, p. 32. See analysis, Table 4, Appendix II.
		5- 5-46	20	

Location	Name	Discharge: Date	Discharge: Gallons per minute	Remarks
(S-22-56) 1b1	Robert's Lower Ranch Spring	5- 5-46	8	Discharge estimated.
(S-22-58) 20c1	Mountain Springs	1916	1±	See Water Supply Paper 450, p. 77. Probably only one spring.
		3- -22	40	Discharge estimated by Hewett.* Flow from six springs.
		5- 5-46	20	Estimated flow at trough below springs.
(S-22-59) 7c1	Cottonwood Spring	9-18-12	225	See Agricultural Experiment Station Bull. 136, p. 26.
		5- 5-46	225	Reported by users. See analysis, Table 4, Appendix II.
(S-23-55) 5b1	Stump Spring	1916	1±	See Water Supply Paper 450, p. 77.
		6-12-45	2±	Discharge estimated.
		5- 5-46	2±	Discharge estimated.

*Hewett, D. F., Geology and ore deposits of the Goodsprings quadrangle, Nev.: U. S. Geol. Survey Prof. Paper 162, p. 5, 1931.

Measurements* of the Discharge of Las Vegas Springs, 1924–46

Date	Discharge in Gallons Per Minute: (S-20-61) 30ddc1 "Little" Spring	(S-20-61) 30ddd1 "Open" Spring	(S-20-61) 31aab1 "Big" Spring	Combined flow of springs
1924	----	----	----	2,020†
1925	----	----	----	1,916†
1926	----	----	----	2,030†
March 3, 1927	668	354	1,009	2,031
September 5, 1928	660	290	674	1,624
July 23, 1929	740	411	830	1,981
December 28, 1929	655	306	740	1,701
April 30, 1930	633	323	668	1,624
June 27, 1930	695	323	695	1,713
July 14, 1931	623	306	712	1,641
1932	----	----	----	1,638†
1933	----	----	----	1,660†
July, 1934	569	230	663	1,462
June 6, 1935	719	285	749	1,753
April 6, 1936	611	246	725	1,582
June 22, 1936	689	246	749	1,684
February 24, 1938	695	212	725	1,632
1939	610	245	609	1,464
May 16, 1940	503	250‡	610	1,363
August 3, 1940	503	264	609	1,376
March 8, 1941	554	250‡	420	1,224
May 8, 1941	554	250‡	470	1,274
July 26, 1941	554	225‡	434	1,213
August 25, 1941	423	225	470	1,118
May 5, 1942	411	220‡	459	1,080
July 15, 1942	217	200‡	368	785
August 15, 1942	368	200‡	411	979
September 15, 1942	368	200‡	411	979
March 15, 1943	452‡	200‡	504	1,156
June 15, 1944	404	200‡	432	1,036
August, 1945	500	200‡	500	1,110
September, 1946	410	200‡	500	1,135

*By Las Vegas Land and Water Co., unless otherwise indicated.
†Measured by George Hardman, Nevada Agricultural Experiment Station.
‡Estimated.

Measurements* of the Discharge of Tule Springs, 1922–1946

Date	Discharge in gallons per minutes
1922	340
1923	476
1924	480
1925	530
1926	470
1927	470
1928	275
1929	311
1930	275
1931	243
1932	231
1933	228
1934	228
1935	205
1936	138
August 11, 1943	314†
December 17, 1943	277†
August 7, 1944	243‡
January 21, 1945	278‡
August 16, 1945	215‡
August 2, 1946	135‡

*Measurements by George Hardman, Nevada Agricultural Experiment Station, unless otherwise indicated.
†Measurements by Office of the State Engineer of Nevada.
‡Measurements by the U. S. Geological Survey.

OCCURRENCE OF GROUND WATER

GENERAL RELATIONS

Las Vegas, Pahrump, and Indian Spring Valleys are in the east-central part of the Southwestern Bolson ground-water province.[71] Features of ground-water occurrence in the valleys are similar to those typical of the province, because the main aquifers are sand and gravel lenses in the valley fill which is composed largely of sediments of late Tertiary age overlain by deposits of Quaternary age. As in many other valleys in the Southwestern Bolson province, precipitation is the source of the water that is taken from the aquifers in the valley fill. Most of the water comes from the higher mountains where precipitation is heavier. Only smaller and generally negligible amounts of water are derived directly from precipitation on the valley floor and the lower parts of the alluvial apron.

After the water falls as rain and snow, part of it percolates into the bedrock of the mountains and into the gravels of the higher parts of the alluvial aprons. It then moves into and through the valley fill. As the water moves down the alluvial aprons it becomes confined in the sand and gravel beds between the relatively impermeable silt and clay layers that thicken and become more numerous toward the axes of the valleys. Artesian pressure is created by the weight of the water held at higher

[71]Meinzer, O. E., Occurrence of ground water in the United States: U. S. Geol. Survey Water-Supply Paper 489, pp. 309–313, pl. XXXI, 1923.

levels on the alluvial aprons, and is maintained by these confining beds of silt and clay that prevent or impede upward movement of the water. In many instances the sand and gravel beds either grade into the fine silts and clays or are faulted off, thus impeding widespread lateral movement. When the confining beds are penetrated by wells or broken by faults the water rises in the wells or along the faults as a result of this pressure. In some places in Las Vegas and Pahrump Valleys the artesian pressure is above the land surface and the water flows at the surface.

The confining beds are not wholly impermeable, and appreciable quantities of water leak through the beds, especially in the vicinity of the fault zones. This water percolates upward and, with water from irrigation and leaky wells, maintains the water level in the shallow beds near the land surface in the central parts of the valleys.

THE "NEAR-SURFACE" WATER

The first water encountered in dug and drilled wells in the vicinity of the city of Las Vegas is at depths ranging from 1 to 50 feet below the land surface. Throughout Las Vegas Valley below altitudes of about 2,100 feet water is frequently near enough to the surface to support such plants as rushes, salt grass, willows, mesquite, and other phreatophytes (see pl. 7). Near Henderson, south of the city of Las Vegas along U. S. Highway 91, west of Tule Springs, north of La Madre Mountain in the north part of the valley, and on other high portions of the alluvial slopes, the first water is encountered at depths of 50 to 100 feet or more below the land surface. The upper surface of this first water encountered in wells is referred to in this report as the "near-surface" water level. The water is under artesian pressure in some places and is unconfined in other localities. It is locally referred to as the "surface water."

Near-surface water occurs at shallow depths in most of the central part of Pahrump Valley, also and in the vicinity of Mesquite (Cactus) Spring and Indian Springs, in Indian Spring Valley.

CONFINED WATER

Aquifers that yield artesian water when penetrated by wells are present at the toes of the Red Rock and Kyle Canyon fans in Las Vegas Valley. In the vicinity of Las Vegas and Tule Springs these aquifers are especially permeable and yield large flows of water to wells and springs. North of La Madre Mountain and the Tule Springs Ranch, in the north part of Las Vegas Valley, a few aquifers that yield only small quantities of water have been penetrated by wells. Ground-water occurrence north of Tule Springs Ranch has been discussed in a foregoing section of this report (see p. 71).

More than two-thirds of the wells in Las Vegas Valley, south of La Madre Mountain and Gass Peak, bottom in materials that lie below a depth of 200 feet and above the blue-clay horizon. They draw water from several sand and gravel lenses which occur at approximate depths of 250, 300, 350 to 400, and 450 feet. This group of aquifers is designated as the Shallow Zone of aquifers and supplies nearly two-fifths of the total quantity of water withdrawn from wells and springs in Las Vegas Valley. Until about 1940 it was the principal source of ground water in the valley.

Another zone of aquifers underlies the blue clay in Las Vegas Valley and occurs at depths ranging from 500 to 700 feet. This group is designated as the Middle Zone of aquifers. Many wells of large yield have tapped these aquifers since 1940. In the period 1940 to 1946 about one-half the ground water used in Las Vegas Valley was withdrawn from aquifers in this zone. Well logs show that the materials making up these aquifers are especially permeable in the southwest part of T. 20 S., R. 61 E., and in the northwest part of T. 21 S., R. 61 E. The materials grade into fine-grained sand south and east from this locality. Northward too few wells have been drilled into the Middle Zone to demonstrate adequately the water-bearing properties of the materials that compose the aquifers.

All the aquifers below about 700 feet have been included in the Deep Zone of aquifers. Only small quantities of water are withdrawn from the aquifers in this zone because they are thin and generally contain much silt and clay, and are penetrated by only a few wells.

In Pahrump Valley the most productive aquifers occur at the toes of the Pahrump and Manse alluvial fans. The area between these two large fans appears to be underlain by fine materials and no wells of large yield have been developed there. The Manse fan receives most of its recharge from Carpenter and Trout Canyons and the Pahrump fan receives its recharge from Wheeler and Clark Canyons. Water-level fluctuations in wells located on the two fans do not appear to be interrelated. Thus, the two fans can be treated as separate ground-water districts.

On the Pahrump fan wells drilled in the vicinity of the Raycraft, Buol, Kink, and Caton Ranches, 1 to 3 miles north of Bennetts Springs on Pahrump Ranch, penetrated aquifers that yielded flowing water at depths of about 175 to 200 feet, 285 to 350 feet, and 450 to 500 feet. At the Pahrump Ranch, aquifers were encountered at depths of 190 to 210 feet, 224 to 235 feet, 290 to 295 feet, and 332 to 495 feet. Two deeper wells drilled on the Pahrump Ranch are reported to have penetrated a few thin aquifers that yield only small quantities of water at depths ranging from 500 to about 900 feet. On the Caton property in sec. 27, T. 19 S., R. 53 E., aquifers were encountered at 98, 165, 285, 360, and 390 to 416 feet. The driller reported that the flow of the Caton well increased as the well was drilled from 416 to 480 feet, therefore additional aquifers were probably penetrated between these levels. About 1½ miles north, in the NE¼ sec. 22, the Van Horn well (S-19-53) 22ab1, penetrated no aquifers that yielded flowing water, but confined water was struck in aquifers at depths of 124 and 240 feet, and possibly at depths between 260 and 540 feet. In sec. 10, T. 19 S., R. 53 E., water-bearing beds were encountered between 90 and 250 feet. The water was probably confined in these beds but the water level in the well rose only within 90 feet of the land surface.

On the Manse fan, in the vicinity of the Manse Ranch, several wells that yield copious flows of water have penetrated aquifers at depths of about 220 to 280 feet, 325 to 350 feet, 400 to 480 feet, 570 to 580 feet, and 600 to 650 feet. The flow from two of the wells drilled to more than 700 feet was reported to have increased between the depths of 650 and 730 feet. Wells drilled to depths of more than 900 feet reportedly have not struck aquifers of large yield below 730 feet.

Waring[72] reports several test wells that were drilled during 1914–1916 in the vicinity of Mound Spring, about 2 miles south of Manse Ranch, by the Oasis Land Company. His description of these wells indicates the nature of the water-bearing materials underlying this locality and it is here quoted:

> Water under artesian pressure was encountered in all of (the wells), and in two (wells) * * * small flows were obtained. (One) was sunk to a depth of 135 feet a few yards from Mound Spring and in August, 1916, the water rose 15 feet above the surface. (In another well) flows were struck at depths of about 200 and 300 feet but were lost in gravel at 535 feet. After the well was filled to about 475 feet below the surface a slight flow was again developed. In August, 1916, the flow was about

[72] Waring, G. A., Ground water in Pahrump, Mesquite, and Ivanpah Valleys, Nev.-Calif.: U. S. Geol. Survey Water-Supply Paper 450, p. 65, 1921.

> one gallon a minute * * *. It is said that in the Spanker wells * * *, 3 miles southwest of Mound Spring (probably wells (S-21-54) 31dd1 and (S-21-54) 31dd2, water from the lower strata did not rise higher than 65 feet below the surface, and that the first struck at 23 feet, flowed down the well to the 65 foot level.

In 1946 the near-surface water level in a dug well adjacent to the cased wells was about 20 feet below the surface, and the deeper water level in the cased well was about 70 feet below the surface.

Farther south, at the old J. B. Yount Ranch, now known as the Hidden Ranch, at least two deep wells have been drilled in unsuccessful attempts to obtain flowing water. One of these wells was drilled to a depth of 320 feet, and Waring[73] reported that "a flow was not obtained, but at 225 feet water was struck in fine sand beneath clay under pressure that caused it to rise within 6 feet of the surface." This well is probably well (S-22-54) 25c1, listed in table 3 of appendix II of this report. The other well, (S-22-54) 25a1 in this report, was drilled to a reported depth of 888 feet. The driller reported that no sand and gravel lenses—only clay layers—were encountered. The water level in the well stood about 17 feet below the surface in September 1946. The Yount Ranch lies at the toe of the alluvial apron on the south side of the Manse fan and at the north edge of the alluvial fan that heads in Lovell Canyon. Thus it lies between two large fans, and confirms the expectation that deposits of fine materials would be thick and predominant, and coarse water-bearing materials would be scarce or absent in the valley fill.

Occurrence of ground water in Indian Spring Valley has been discussed in the section on physical characteristics and water-bearing properties of the valley fill (see p. 72).

GROUND WATER IN LAS VEGAS VALLEY

THE NEAR-SURFACE WATER

Many wells tap the near-surface water in Las Vegas Valley. Only a few of these wells are used for water supply because most of them are test holes or have been abandoned in recent years. Monthly measurements of water levels have been made in about 45 of these wells during all or part of the period 1944 to 1946. Water-level measurements made before December 31, 1945, have

[73] Op. cit.

been published[74] and measurements made in 1946 will be published in a forthcoming report. Most of these shallow wells were drilled in the valley south of the Tule Springs Ranch and it has been possible to determine by measurement and spirit leveling the altitude of the near-surface water level in much of this locality. Plate 7 illustrates by means of contours the shape and position of the ground-water surface of the near-surface water at the end of March 1946. The contours are lines along which the ground-water surface is the same altitude above sea level. The maximum hydraulic gradient and the direction of movement are perpendicular to these contours. In Las Vegas Valley high on the alluvial apron and in some other places, this ground-water surface is probably an unconfined water table, but in the lower parts of the valley the water is generally confined and is under slight artesian pressure. The map of the ground-water surface shows that it slopes steeply toward the city of Las Vegas from the vicinity of Tule Springs, and less steeply from the city to the lower part of the valley near Las Vegas Wash, where it intersects or is within a few feet of the land surface. The near-surface water level also intersects or is within a few feet of the land surface at the foot of and along the faces of the scarps near Las Vegas and west of Whitney. The contours show the effect of recharge to the near-surface water in the vicinity of Las Vegas Springs and the city of Las Vegas, where they bulge east toward the axis of the valley. The flattening of the water surface between the 2,100- and the 2,050-foot contours west of Las Vegas indicates that recharge to the near-surface water occurs there. The recharge has resulted in a high water level in this locality, and the high level has made difficult road building and construction of basements, sewers, and other excavations, especially within the city limits of Las Vegas.

DISCHARGE

Only a small quantity of near-surface water, probably not more than 200 acre-feet a year, is discharged by wells in Las Vegas Valley. Most of this water is withdrawn from wells in the central part of the valley east of the city of Las Vegas.

Most of the discharge from the near-surface water occurs by

[74] Robinson, T. W., Maxey, G. W., Fredericks, J. C., and Jameson, C. H., Water levels and artesian pressure in wells in Las Vegas Valley and in other valleys in Nevada, 1913–1945: State of Nevada, Office of the State Engineer, Water Resources Bull. 3, 1947.

transpiration and evaporation where the water level is at or within 10 feet of the land surface. No detailed studies of such loss have been made, although the places where the near-surface water level is within 10 feet of the surface, comprising about 5,000 acres, have been mapped (see pl. 7). Here the natural vegetation is largely salt grass and mesquite with some cottonwood and other phreatophytes. It is estimated that the natural discharge may range from 5,000 to 8,000 acre-feet a year.

A measurement of the sewage passing through the Las Vegas sewage-disposal plants in February 1947 showed a flow of about 3,600 gallons a minute. The amount of water supplied by the water company to the city, and from a few wells within the city, was about 2,700 gallons a minute. Thus about 900 gallons a minute of excess water was unaccounted for. As the sewer lines in parts of the city are below the near-surface water level, and as some sections of the lines leak, it appears that this excess water is supplied by the near-surface water. If this condition exists, the sewers are, in effect, acting locally as drains.

The sewage effluent is discharged onto the land surface east of Las Vegas, where it spreads over a considerable tract of relatively flat lying land. A large part of this effluent is undoubtedly disposed of by direct evaporation, and the remainder recharges the near-surface reservoir. No studies were made of this recharge, but tentative estimates indicate that it is probably about equal to the unaccounted-for excess sewage. Thus there probably is little net loss from the near-surface reservoir as a result of drainage by the sewerage system, and the total discharge from the near-surface water is between 5,000 and 8,000 acre-feet annually.

WATER-LEVEL FLUCTUATIONS

In Las Vegas Valley the greatest fluctuations of water levels in wells that tap the near-surface water are seasonal. It was not possible to obtain accurate long-period records of daily fluctuations resulting from evaporation and transpiration because no suitable observation wells were available. It is known from fragmentary records that such fluctuations do occur.

The hydrographs in figure 9 show typical seasonal fluctuations of the near-surface water level in several shallow wells in Las Vegas Valley. Nearly all these hydrographs show annual fluctuations that range from 1 to 3 feet. The water level is generally highest in April or May and lowest in September or October. Thus, the declines follow the yearly period of heavy draft on the artesian aquifers at which time hydrographs of the water levels

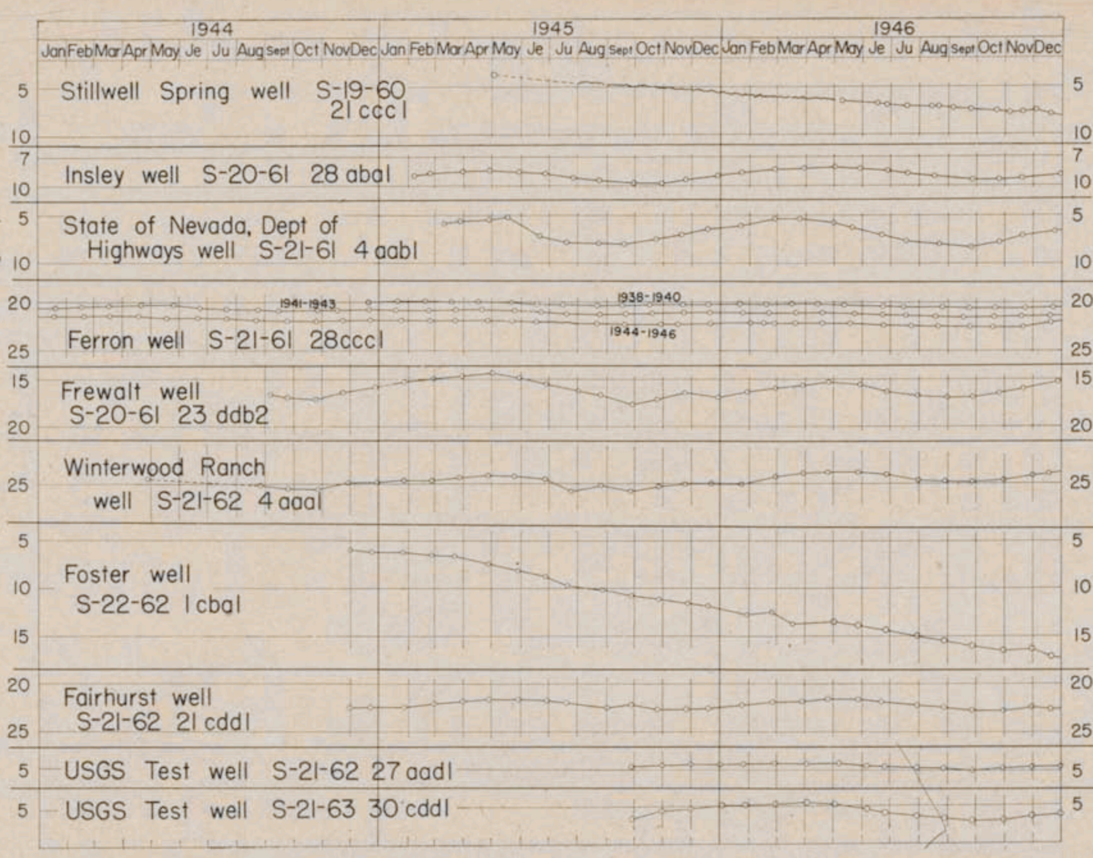

FIGURE 9—Hydrographs showing fluctuation of the level of the "near-surface" water in 10 wells in Las Vegas Valley.

in artesian wells also show declines. The declines of the near-surface water level lag about 2 months behind the declines of confined water levels. Apparently these fluctuations are the result of changes in the amount of recharge to the near-surface reservoir received from the artesian aquifers. These changes in the amount of recharge are caused largely by fluctuations in discharge from flowing wells, the lesser recharge occurring when the artesian wells are discharging. The annual fluctuations of the near-surface water level may also be partly a result of increased discharge of the water by evaporation and transpiration during the growing season.

The four upper hydrographs in figure 9 show the continuous yearly decline of the near-surface water level during the period of record in shallow wells that were drilled north and west of the scarps near Las Vegas and Whitney. This decline is especially large west of Tule Springs at Stillwell Spring well (S-19-60) 21ccc1. A small flow of water is reported to have issued from Stillwell Spring well during the early period of settlement in Las Vegas Valley, but in recent years the spring has dried up and a casing has been placed in the spring opening. The water level in this casing has continued to decline for several years. Although the decline of the near-surface water level has been smaller in the wells farther south, it has continued throughout the period of record. This decline is probably a result of the continual diminution of recharge from the confined water. In the vicinity of Las Vegas the near-surface water level has not declined appreciably in recent years (see hydrographs for wells (S-20-61) 28aba1 and (S-21-61) 4aab1, fig. 9), and is at about the same stage that it was reported to be between 1905 and 1944. East of Las Vegas in T. 20 S., R. 62 E., and in the north part of T. 21 S., R. 62 E., the near-surface water level has risen in the last few years (see hydrographs for wells (S-20-61) 23ddb2 and (S-21-62) 4aaa1, fig. 9). The rising water level in this vicinity is largely a result of increased recharge from the continually increasing amount of waste water and sewage effluent from the city. Also more recharge to the near-surface water has resulted from increased local irrigation.

Farther south, in the vicinity of Las Vegas Wash and Whitney, near-surface water levels apparently declined between 1928 and 1944. In 1928 at least and probably earlier, there was flow in Las Vegas Wash, because Hardman[75] measured 1 second-foot of

[75]Hardman, George, The quality of the water of southeastern Nevada; drainage basin and water resources: Nevada Agr. Exper. Sta. Bull. 136, p. 28, 1934.

water on March 5, 1928. He reported this to be about the normal summer flow in Las Vegas Wash at that time. No records are available to indicate the source of the flow. It may have been waste from flowing wells or local discharge of the near-surface water, or both. Early in 1944 the wash was dry, and apparently it had been for several years, although the near-surface water level intersected or was near the land surface in several places in the wash. Probably this cessation of flow and decline in water level resulted from better conservation and control of flowing wells in Las Vegas Valley during the period 1928 to 1944.

Between the spring of 1942 and the fall of 1943 waste water from the Basic Magnesium Project was discharged into ditches and tanks on the alluvial apron east of the plant and west and north of Pittman. It appears quite likely that some of this waste water recharged the near-surface water in the vicinity of Pittman, because the near-surface water levels rose a few months after the practice was started. On the east side of Pittman, basements and cesspools were flooded and small springs formed on the slope in late 1943 and early 1944. When this occurred the two large evaporation tanks south of Pittman were abandoned and the waste water from the magnesium plant was transported by ditches around Pittman, thence into Las Vegas Wash. After the tanks were abandoned the water level in the vicinity of Pittman declined rapidly (see hydrograph for well (S-22-62) 1cba1, fig. 9). Late in 1944 water, probably representing the waste from the Basic Magnesium Project, started flowing from springs in the old channel in Las Vegas Wash. From 1 to 2 second-feet of water was flowing in the wash in the fall of 1946. It appears that near-surface water levels north of the wash are little affected by this waste water because in three wells in that area they are still declining. (See hydrographs for wells (S-21-62) 21cdd1, (S-21-62) 27aad1, and (S-21-63) 30cdd1, fig. 9).

RECHARGE

An unknown quantity of confined water leaks upward along the fault zones in the valley fill in the vicinity of Las Vegas Springs and in Paradise Valley about 2 miles west of Whitney. Much of this water flows from the springs but undoubtedly a large part of it percolates laterally into the near-surface water reservoir, because the near-surface water level is high and the water-level contours indicate recharge in the vicinity of the springs. In many places the near-surface water level intersects the land surface and thus forms small seeps, springs, and marshy places. The water that leaks upward along the fault zones is probably the larger part of that recharged to the near-surface reservoir in Las Vegas Valley. Small quantities of water are apparently supplied to the near-surface reservoir by upward leakage through the confining beds of the deeper aquifers and from a few leaky deep wells. In wells far from and topographically above the faulted zones, the near-surface water level fluctuates more or less synchronously with the confined water levels. For example, when the Wick well, (S-22-61) 3dda1 was drilled to a depth of 335 feet it discharged approximately 1,400 gallons a minute for more than a month. Water levels were affected not only in the deeper wells in the vicinity but also in dug or other shallow wells as far as 2 miles away. The similarity in the seasonal and long-term fluctuations of water levels in the near-surface and artesian wells undoubtedly indicates that the two systems are at least imperfectly interconnected and that the near-surface water level is in large part maintained by water percolating upward from the artesian aquifers.

In the vicinity of the city of Las Vegas waste water from irrigation, cooling, and sewerage contributes greatly to the near-surface reservoir. Most of the waste water is discharged from the sewage-disposal plants east of the city and flows east and south toward Las Vegas Wash. In this vicinity the near-surface water level is rising from year to year because the amount of water discharged from the sewage disposal plant is also increasing. Waste water from a few uncontrolled wells and from irrigation contributes somewhat to the near-surface reservoir in the north part of T. 22 S., R. 61 E., and in the southeast part of T. 21 S., R. 62 E., in Paradise Valley. Since 1941 several large resort hotels and casinos have been constructed along U. S. Highway 91 south of Las Vegas, in secs. 9 and 16, T. 21 S., R. 61 E. These establishments dispose of waste water in cesspools and septic tanks. In recent years appreciable quantities of water have thus been discharged into the near-surface reservoir and locally this has resulted in a slight rise of the water level.

Most of the water-bearing material which transmits and stores the near-surface water is exposed at low altitudes in the valley where the average annual precipitation is less than 10 inches. Probably most of this precipitation is lost by transpiration and evaporation, and only small inappreciable quantities of water from direct precipitation on the land surface recharge the near-surface water.

Sufficient data are not available to estimate accurately the quantity of water annually available for recharge to the near-surface reservoir. Determination of the amount of leakage from the deeper aquifers would require a detailed study beyond the scope of this investigation. It is possible that the total annual recharge to the near-surface water now is approximately equal to or a little less than the total annual discharge, because the near-surface water levels have declined slightly.

QUALITY AND UTILIZATION

The foregoing discussion indicates that possibly as much as 8,000 acre-feet of near-surface water is available annually for development and use. However, the character and occurrence of most of the near-surface water limit its development and utilization for some purposes in most of the valley. The materials that transmit and store the water are generally thin and consist of poorly assorted, coarse- to fine-grained sediments that do not have a high transmissibility. Therefore, the wells that tap these aquifers yield only relatively small quantities of water when they are pumped from economically feasible depths. For example, the Marracci well, (S-20-62) 19bbb1, a shallow well typical of those east of Las Vegas, yields only 22 gallons of water a minute with a drawdown of 8 feet, or 2.75 gallons per foot of drawdown. Other wells in this vicinity yield about the same or lesser amounts of water at similar drawdowns. Therefore, these wells generally cannot be used in operations that require large quantities of low-cost water, such as irrigation of the ordinary field crops.

The chemical character of the near-surface water varies widely in the valley. Results of a few analyses of samples collected from shallow test holes and wells are given in table 4, appendix I. These analyses show only the dissolved mineral content and do not indicate the sanitary condition of the waters. They show that the near-surface water in the vicinity of Las Vegas and north and south of the city, west of the fault scarp that extends from the Kyle Ranch to about 3 miles west of Pittman, contains from 175 to 400 parts per million of dissolved solids, chiefly calcium and magnesium bicarbonates with some calcium sulfate. Locally the first water encountered in wells may contain as much as 1,000 to 2,000 parts per million of dissolved solids, principally calcium, magnesium, and sodium sulfate and bicarbonates. However, this highly mineralized water comes from only the extreme upper limits of the near-surface reservoir. At slightly greater depths the near-surface water is of better quality. East of the city of Las Vegas, in the lower part of the valley as far south as

Charleston Boulevard the near-surface water is similar to that in the locality described above. Farther south in Paradise Valley, in the vicinity of Whitney, and near Las Vegas Wash, the near-surface water contains from 650 to over 3,000 parts per million of dissolved solids, chiefly calcium, magnesium, and sodium sulfate with some bicarbonate and chloride.

Waters best fitted for domestic and stock purposes contain less than 500 parts per million of dissolved solids and, generally, waters with more than 1,000 parts per million are not satisfactory for these uses. Waters containing more than 2,000 parts per million of dissolved solids, especially when the predominating constituents are calcium, magnesium, and sodium sulfates and bicarbonates, are generally not satisfactory for irrigation (see p. 113). Generally water for either industrial or cooling use is satisfactory even when the dissolved-salt content is very high, although waters containing more than 4,000 parts per million may cause incrustation, corrosion, or other problems.

The evidence presented in the foregoing paragraphs indicates that the near-surface water cannot be widely developed for large-scale irrigation, and that in parts of the valley its chemical character is unsuited for both domestic use and irrigation. However, it appears that the near-surface water can be used satisfactorily for cooling nearly everywhere in the valley. The relatively low temperature of this water, which ranges from 60° to 70° F. throughout the valley, makes it even more satisfactory for cooling than the warmer confined waters. It is satisfactory for domestic and stock use where sanitary conditions are favorable except in most of Paradise Valley and in the vicinity of Whitney and Las Vegas Wash. Before the near-surface water is put to domestic use the sanitary condition should be carefully checked. In several places in Las Vegas, and east and south of the city, large quantities of untreated and poorly treated sewage waters undoubtedly percolate into the near-surface aquifers and probably render water from these aquifers unsuitable for human consumption.

CONFINED WATER

Most of the wells in Las Vegas Valley penetrate aquifers that yield water under sufficient pressure to cause it to flow at the land surface, or to rise within a short distance of the surface. The character, distribution, and number of aquifers and the occurrence of ground water in these aquifers have been discussed in some detail in earlier sections of this report. The following paragraphs describe the form and position of the generalized piezometric surface, the direction of movement, the fluctuations of the water levels, the discharge and recharge, and the quality of the confined water.

The piezometric or pressure-indicating surface of an aquifer—the surface to which water in wells penetrating the aquifer will rise under its full head—is defined by the static levels in the wells. The form and position of a piezometric surface gradually change, and such changes are indicated by the fluctuations of the water level in the wells. In Las Vegas Valley, as in many of the intermontane valleys and basins in the Great Basin, there are several aquifers at different depths (pl. 6A, and B). Each aquifer has its own piezometric surface; the deeper aquifers generally have the higher surfaces. As a result of irregular and locally limited deposition of the sediments that comprise the aquifers and confining beds, as well as faulting in the valley fill, leakage due to improper construction of wells, and other factors, pressures tend to become equalized by movement of water within the wells and formations. Thus, the measured shut-in pressure represents a composite effect of pressures in all aquifers tapped by a given well. Therefore, it is not possible to delineate separate piezometric surfaces for each of the aquifers encountered by wells drilled in Las Vegas Valley. However, numerous periodic measurements of water levels in certain wells separately cased in more than one aquifer indicate that such different piezometric surfaces do exist. This condition is illustrated by the hydrographs in figure 12.

The general direction of movement of the confined water can be determined from the measurements when they are referred to sea-level datum. For example, water levels in wells of approximately equal depth west and north of the city of Las Vegas reach higher altitudes than water levels in similar wells in the city and south and east of the city. Also, water levels in the west part of Paradise Valley reach higher levels than water levels in the vicinity of Whitney and in the east part of Paradise Valley.

Plate 8 shows contours on a composite piezometric surface for the spring of 1944, when water levels in the basin were at approximately the highest stage for the year. These contours connect points of equal altitude on the piezometric surface. The direction of movement and of maximum hydraulic gradient is at right angles to these contours. Thus, the contours in plate 8 show that north of the city of Las Vegas the general slope, and hence movement of the water, is southeast. In the immediate vicinity of and south of the city the movement is toward the east and northeast.

As a result of continued large withdrawal of ground water from wells two large cones of depression have been formed, one to the west of Las Vegas and the other in the east central part of the city. These cones appear on plate 9 as relatively flat areas of the piezometric surface because the large contour interval and the steeply sloping piezometric surface do not permit showing closed contours.

DISCHARGE

Wells

Most of the confined water used in Las Vegas Valley flows from wells. Only a few wells are pumped. Records of the discharge from wells are available for the year 1912 and the period of 1924–1946. There were no wells in the valley prior to 1906. The estimated annual discharge from wells is shown as part of the graph in figure 3 and is given, in acre-feet, in the following table for the years 1912 and 1924–1946:

Year	Amount	Year	Amount
1912	15,200	1935	17,100
1924	17,300	1936	17,400
1925	19,300	1937	17,800
1926	18,400	1938	18,200
1927	17,300	1939	17,900
1928	18,600	1940	16,900
1929	18,500	1941	18,700
1930	17,300	1942	19,600
1931	17,500	1943	22,100
1932	19,200	1944	25,300
1933	17,500	1945	23,900
1934	16,700	1946	28,500

NATURAL DISCHARGE

Confined water in Las Vegas Valley is also discharged from springs and by upward leakage. Geologic study of the southeast part of Las Vegas Valley has yielded no evidence that an appreciable amount of confined water escapes from the valley underground. Study of the valley margins indicates that escape of confined water by underground passage is unlikely in any part of the valley. Therefore, the total discharge of confined water from Las Vegas Valley is represented in the estimates of well discharge, spring discharge, and upward leakage.

Springs

Large quantities of water are discharged from the artesian springs in the vicinity of Las Vegas and the Tule Spring Ranch.

Smaller flows of water issue from Stevens, Kyle, and Corn Creek Springs. Estimates and measurements of the discharge of these springs are available for the years 1905–1907, 1912, and 1924–1946. The estimated annual discharge is shown as a part of the graph in figure 3 and is given, in acre-feet, in the following table for the years 1905–1907, 1912, and 1924–1946:

Year	Amount	Year	Amount
1905	6,400	1934	4,100
1906	6,400	1935	4,100
1907	6,400	1936	4,000
1912	5,300	1937	4,100
1924	5,100	1938	4,100
1925	5,000	1939	3,800
1926	5,000	1940	3,700
1927	4,800	1941	3,400
1928	4,200	1942	3,000
1929	4,100	1943	3,300
1930	4,200	1944	3,000
1931	4,200	1945	3,100
1932	4,100	1946	3,200
1933	4,100		

Upward Leakage

In addition to the water discharged from springs, appreciable quantities of confined water leak upward along the fault zones and into leaky wells, and through the confining beds of the aquifers. This water recharges the near-surface reservoir and is then largely discharged by evaporation and transpiration. The total amount of water lost by leakage from the artesian aquifers is unknown. It is not more than 8,000 acre-feet, the maximum estimated discharge from the near-surface water, and could be considerably less. In the discussion of the over-all safe yield of Las Vegas Valley on page 108 this water is taken into consideration as a part of the near-surface water.

Utilization

Most of the confined water discharged from wells and springs since 1942 has been used in four fairly distinct localities. The largest quantities of water, nearly three-fourths of the total amount used in the valley, are used in the vicinity of the city of Las Vegas in an area of about 22 square miles. Most of this water is used for cooling and domestic purposes and only a small quantity is used for irrigation. In Paradise Valley, south of the city of Las Vegas, and in the vicinity of Tule Springs most of the water withdrawn from wells and springs is used for irrigation. North and east of the city of Las Vegas, in the central and east parts of the valley, the Las Vegas Army Air Field has used large quantities of confined water for domestic purposes. The estimated annual discharge of confined water from wells and springs in each of these localities and in the valley for the years 1905, 1912, 1924, 1941, 1944, and 1946 is tabulated below:

Location	1905	1912	1924	1941	1944	1946
Vicinity of Las Vegas	5,200	9,700	17,800	17,400	20,100	23,200
Paradise Valley, south of Las Vegas	200	10,000	3,500	3,900	4,000	4,600
Tule Springs area	360	300	700	500	3,100	3,200
All others	640	500	400	300	1,100	700
Total	6,400	20,500	22,400	22,100	28,300	31,700

The discharge for 1905 was from springs only. This amount probably represents the total discharge of confined water from the springs for the period prior to settlement of the valley. The discharge figure for 1912 includes water from both wells and springs and shows the approximate increase of discharge of confined water during the early period of well development. From 1912 to 1941 approximately the same quantity of confined water was withdrawn from wells and springs each year, and from 1941 to 1946 there was a considerable increase in withdrawals. This information is also presented in figure 3.

Most of the ground water withdrawn between 1905 and 1946 has been used for domestic purposes, cooling, and limited irrigation. The amount of land irrigated has remained about the same since 1912, but from 1912 to 1940 the population increased about sevenfold. Thus, during the early part of the period 1912 to 1940, a considerable amount of water was not beneficially used. The tremendous increase in population in the valley between 1941 and 1946 (fig. 2), and greater conservation of water since 1939 have resulted in more complete utilization of the present discharge of water from wells and springs. Only about 15 percent of the total discharge ran to waste in 1946.

The maximum use of water occurs during August, and the minimum use during December or January. In the period 1938–1946 a daily average of about 34 acre-feet of water was withdrawn during the month of highest use (fig. 10).

Water Levels

Between 1920 and 1936, water levels in many of the wells that tap the confined water in Las Vegas Valley were measured from time to time by George Hardman of the State Agricultural Experiment Station. During the period 1938 to July 1944, monthly measurements were made in about 50 observation wells by the staff of the State Engineer of Nevada. Beginning in July 1944, monthly measurements were made by the U. S. Geological Survey in 65 wells and, in addition, five automatic water-level recorders were maintained on selected wells. During 1945 and 1946 monthly measurements were made on 56 wells, weekly measurements were made on two wells, daily measurements for part of the period were made on one well, and two pressure recorders and six automatic water-level recorders were maintained for all or nearly all of the period. Also during the years 1944 to 1946, several pumping tests were conducted that required many measurements of water levels in several wells for short periods of time. All water-level measurements made in the Las Vegas Valley prior to December 31, 1945, have been published.[76] Measurements made in 1946 will be published in a future report. Therefore, only measurements of water levels in selected wells are published in the present report. Conclusions reached in this report were based on computations involving all water-level measurements available. The altitude of the measuring points of all the wells in which water levels were measured were determined by instrumental leveling. The piezometric surface shown in plate 8 and the discussion on page 93 are based on these water-level data and, as will be shown in the succeeding paragraphs, data on the level of the confined waters are of paramount significance with regard to ground-water occurrence in Las Vegas Valley. They indicate the areas of recharge and discharge to the ground-water reservoir and the direction of movement of ground water.

SEASONAL AND LONG-TERM FLUCTUATIONS OF THE WATER LEVEL

Both seasonal and long-term fluctuations of the water levels in Las Vegas Valley indicate changes in the amount of storage in the ground-water reservoir. These fluctuations are illustrated by the hydrographs in figures 4, 10, 11, and 12 and are discussed in detail in the succeeding pages. Small daily fluctuations that result from changes in barometric pressure, earth tides, etc., are poorly shown in the hydrographs of automatic water-level recorders or are masked by the fluctuations of greater magnitude. These small fluctuations do not indicate substantial changes in the

[76]Robinson, T. W., Maxey, G. B., Fredericks, J. C., and Jameson, C. H., Water levels and artesian pressure in wells in Las Vegas Valley and other valleys in Nevada, 1913–1945: State of Nevada, Office of the State Engineer, Water Resources Bull. No. 3, 1947.

amount of storage in the reservoirs and are not discussed further.

Long-term records of water levels in wells penetrating the artesian aquifers are available for only a few wells in the valley. Hydrographs of water levels in three of these wells, the Kidder well, (S-20-60) 36dbb1, and the Horace Taylor wells, (S-20-60) 24bac1 and (S-20-60) 24dac1, are shown in figure 4. These wells are about 3 miles west and 4 miles northwest of Las Vegas, respectively, and are between the recharge area and the main discharge area in Las Vegas Valley. The hydrographs show a

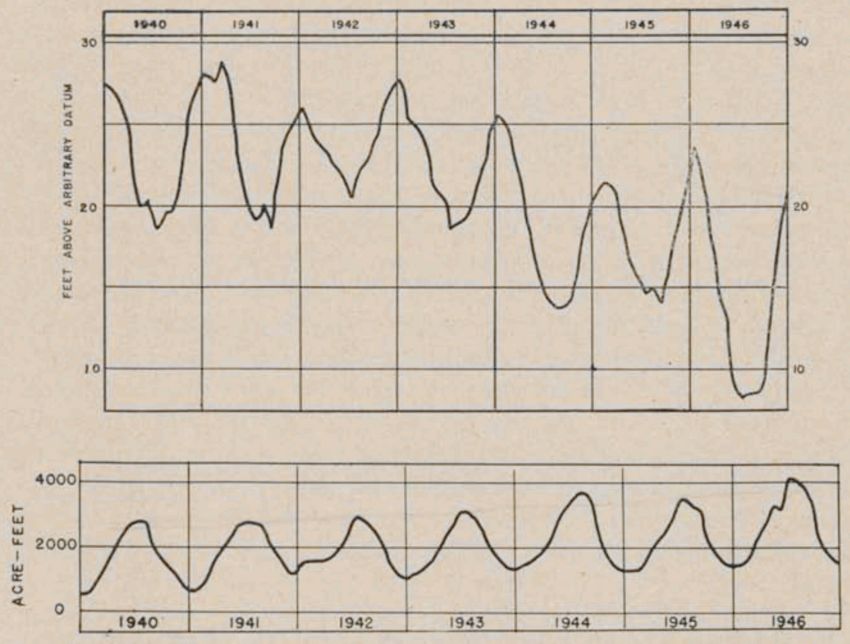

FIGURE 10—Upper graph shows mean monthly level in Las Vegas Valley, based on monthly measurements of water level in 15 selected wells. Lower graph shows estimated monthly discharge of wells and springs in Las Vegas Valley.

continuous decline in water level from 1925 to 1946. Other fragmentary records of water levels in the valley also show this decline. Some wells that flowed prior to and during the early part of the period of record have now ceased to flow. As mentioned before, the flow of artesian springs in the valley has also diminished during this period, as well as during the period 1905 to 1925 (see fig. 3).

Figures 11 and 12 show hydrographs of water levels for the period 1939 to 1946 in the Hicks, Caskey, Papus, Ellis, Lewis, Haggard, Allen, and Parks wells in the city of Las Vegas, where

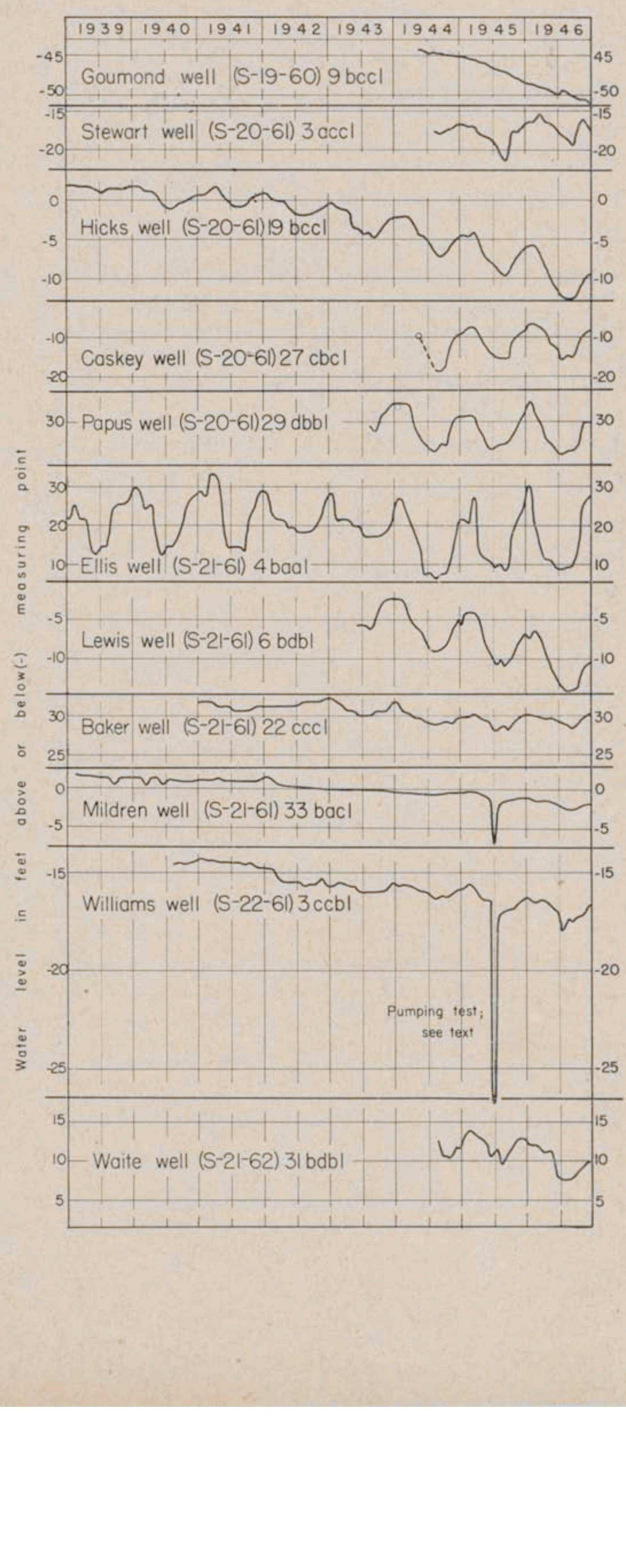

FIGURE 11—Hydrographs showing fluctuation of the level of the confined water in 11 wells in Las Vegas Valley.

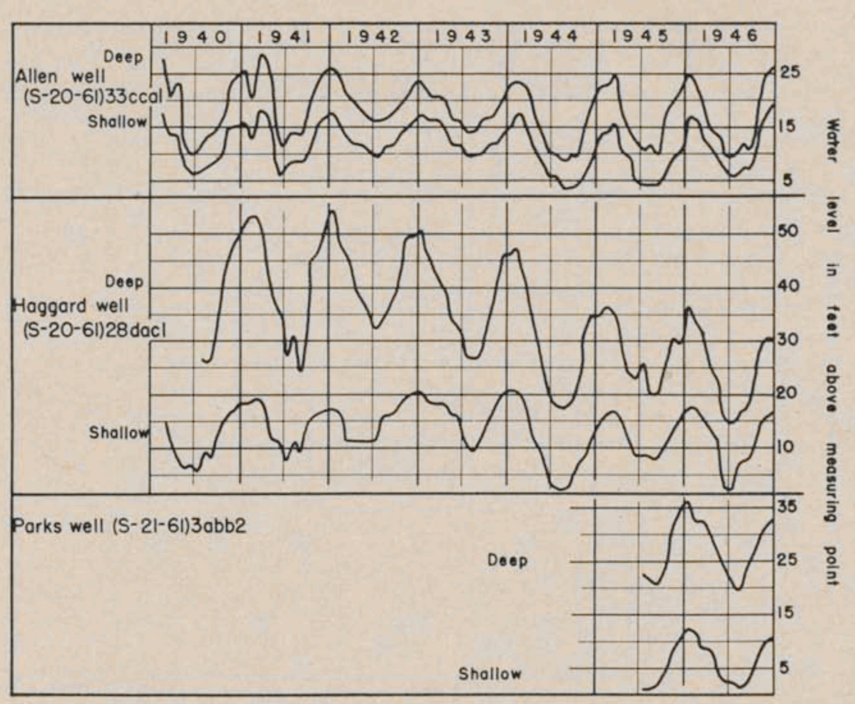

FIGURE 12—Hydrographs showing the fluctuation and difference in head of the water level in wells penetrating two aquifers, where the well is cased separately to the shallow and deep aquifer. (See Appendix I, table 2, for well construction.)

the water-level decline has been greatest, as much as 10 feet during the 8 years. The decline of water levels during the same period in wells south of Las Vegas in Paradise Valley, and north of the city in the vicinity of Tule Springs, has been much less. The water-level decline in these localities is best indicated by the hydrographs shown for the Baker, Mildren, Williams, and Waite wells in Paradise Valley, and for the Goumond well near Tule Springs. Figure 10, a graph showing the mean monthly water level in 15 selected wells in Las Vegas Valley for the period 1940–1946, also shows this progressive decline. The decline may be the result, in small part, of interference from nearby wells. However, the greater part is due to the development of a cone of depression caused by large withdrawals from closely spaced wells in the vicinity of the city of Las Vegas. Apparently this cone of depression has grown outward from the center of discharge in the vicinity of the city, resulting in a decline of water levels and a reduction in the area of flowing wells. The shrinkage in the area of flowing wells between 1912 and 1946 is shown on plate 2.

In several places near Las Vegas, especially in the eastern parts of secs. 4 and 9 and the western part of sec. 16, T. 21 S., R. 61 E., wells that are pumped heavily are also closely spaced. Heavy withdrawals from such small localities are producing excessive interference, resulting in an abnormally large decline in water levels.

The yearly rate of the decline of water levels in many wells has increased progressively since 1940 and the average water level in the valley declined rapidly from 1943 to 1944 and from 1945 to 1946. Water levels may be expected to decline until the cones of depression in the piezometric surface caused by the withdrawal of water from wells and springs have grown sufficiently to intercept the amount of recharge necessary to balance the total withdrawal of ground water. The discussion of the safe-yield indicates, however, that the discharge in the valley in 1946 exceeded the recharge. Therefore, if withdrawal of water from the aquifers is continued at the 1946 rate, water levels will decline continually, regardless of the magnitude of growth of the depression cones, because the recharge will be continually exceeded and no balance will be reached.

The major seasonal fluctuations of the confined water levels are caused by the seasonal draft. These fluctuations are shown by the hydrographs. The flowing wells are opened in the spring of the year and closed in the fall. There is no set time for opening or closing the wells, but the first wells are generally opened early in March or late in February and by late April most of the wells are flowing at their maximum discharge. In the fall the first wells are closed in the latter part of September and most of the wells are closed and discharge is at a minimum by November 1. The effects of this practice are clearly illustrated in the hydrographs. The highest water levels are generally reached in the early part of February and the lowest levels in September.

Seasonal fluctuations that occur as a result of recharge to the ground-water reservoir are not readily noted in the hydrographs, for they are masked by fluctuations of greater magnitude. However, in figure 10 the highest peaks of the hydrograph showing the average water level in the valley apparently lag about 12 to 18 months behind the years when the heaviest precipitation occurred. For example, the heaviest precipitation on record for Las Vegas occurred in 1941, and even though ground-water withdrawals were greater in 1942 than in 1941, water levels rose higher in the winter of 1942–1943 than in the winter of 1941–1942. There is considerable lag between the periods of heavy precipitation and the spring melt, and the effect of recharge from these sources to the ground-water reservoirs in the valleys is suggested on page 72 in the discussion of the springs in Pahrump Valley. Therefore, it appears possible that the high water levels reached in the winter of each year are partially caused by water percolating into the ground-water reservoir from the previous spring melt in the recharge areas. However, further observation and longer records are needed before more definite conclusions can be made concerning fluctuations resulting from recharge.

Permeability, Specific Capacity, and Interference Tests

The aquifers in Las Vegas Valley act both as storage reservoirs and as conduits to transmit the water from areas of recharge to points of withdrawal. The storage capacity of the aquifers depends upon their vertical and horizontal extent and upon the amount of effective pore space in the materials. Where the water is unconfined, the storage capacity is a measure of the amount of water that will drain from the material by gravity. Where the water is confined under pressure the storage capacity is very much smaller, as it is a measure of the compression of the water itself and of the expansion of the aquifer and associated beds caused by the artesian pressure. The rate at which the water moves through the materials of an aquifer depends upon the field coefficient of permeability (the rate of flow of water, in gallons per day, through a cross-sectional area of 1 square foot under a hydraulic gradient of 100 percent), the cross-sectional area, and the hydraulic gradient. It may be expressed in terms of the transmissibility, which is the field coefficient of permeability multiplied by the thickness of the aquifer in feet. The amount of ground water available for use, and therefore the yield of wells and springs, is limited by these factors and by the amount of recharge.

The specific capacity of a well is the discharge of the well in gallons of water per minute per foot of drawdown of the water level after several hours of flow or pumping. Although the specific capacity depends upon the construction of the well, it also reflects, more or less, the relative transmissibility and storage capacity of the materials from which the well withdraws water. In other words, wells tapping very permeable aquifers generally have large specific capacities, whereas wells tapping less permeable aquifers have low specific capacities. In Las Vegas Valley similar well-drilling methods have been used by the drillers and the construction of wells has been more or less uniform. Therefore, it is probable that the specific capacities of wells are reasonably good indicators of the relative transmissibility of the materials which compose the aquifers tapped by the wells.

Many tests of specific capacity were made on the wells in the valley, and plate 8 was prepared to show the approximate range in specific capacity and zones of differing specific capacity in the vicinity of Las Vegas. Specific capacities recorded for wells in the valley range from about 1 to 100. For wells in the vicinity of and west of Las Vegas Springs the specific capacity averages more than 50, whereas the average for wells east of the scarps is considerably less than 10. It is probable that the zones of high and low permeability are similar to the zones of large and small specific capacity, as shown in plate 8. Other pumping tests described in the following paragraphs and evidence from geologic studies of the valley indicate that this is true. Thus, the most permeable materials in the vicinity of Las Vegas are those of the west and north, and the least permeable are those in and east of the city.

During January and February 1946, when the piezometric surfaces were at their highest and most stable level, interference tests were made in three widely separated localities in the valley. Water levels within the suspected radius of influence of the test wells were stabilized as much as possible by securely capping or controlling the flow of all wells in the localities for at least 24 hours before the tests. The test wells were than allowed to discharge for a period of time during which their discharge and the pressures or discharge of the surrounding wells were measured at frequent intervals. After the discharge period, pressure measurements were made on the test wells and adjacent wells for at least 24 hours.

In test No. 1, the Sunrise Acres Water Association well (S-20-61) 36caa2 was pumped from 10:11 a. m. on January 24, 1946, until 4:10 p. m. of the same day. The average discharge during the period was 180 gallons per minute and the maximum drawdown of the water level in the well was 90 feet. Pressures in three adjacent wells were carefully measured. One of these wells, U. S. Geological Survey test hole (S-20-61) 36cbc1, is only 25 feet deep and penetrates none of the aquifers tapped by the pumped well. The other two wells, owned by William Clark, (S-20-61) 36ccd1, and by L. G. and M. C. Biel (S-20-61) 36ccb1, are 200 feet and 346 feet deep and about 1,200 feet south of and 1,100 feet west of the test well, respectively, and tap aquifers from which the pumped well also withdraws water. It appears that a cone of depression around the pumped well large enough to affect measurably the water levels in these wells was not formed during the short period the well was pumped, because the pressures of the observation wells were constant throughout the test period. The water level in the U. S. Geological Survey test hole also remained constant. The pressure-recovery data obtained when discharge from the well ended were used to calculate the permeability of the aquifer at the well by the Theis graphical method. The transmissibility is about 1,350 gallons per day per foot and, using 45 feet as the combined thickness of the aquifers, the permeability thus is about 30 gallons per day per square foot of cross-sectional area.

In test No. 2, the Henry Wick well (S-22-61) 3dda1, was opened at 3:30 p. m. on February 12, 1946, and closed at 11.05 a. m. on February 14. The average discharge during the period was 1,380 gallons per minute and the drawdown was 59.0 feet. The Wick well is 335 feet deep. The measurable pressure reduction in adjacent wells ranged from 6.5 feet in a well a mile away to 0.2 foot in wells nearly 3 miles away. However, the magnitude of the reduction effect observed at the wells is not always proportional to their distance from the discharging well. This may be because of differences in the depths of the wells and the horizons at which they are perforated, as well as lateral and vertical changes in permeability within the same aquifers. For example, the water level in the Dewey Williams well (S-22-61) 3ccb1, almost 1 mile from the discharging well, declined 6.3 feet. Water levels in the two Wick wells (S-22-61) 3ddb1 and (S-22-61) 2ccc1, about 400 feet and 1,000 feet from the discharging well, respectively, declined only 3.0 feet in the former and 0.6 foot in the latter. The water level in the Fitzpatrick well (S-22-61) 4bcc1, a well only 145 feet deep and nearly 2 miles from the discharging well, declined 3.45 feet, whereas the water level in the Reed well (S-22-61) 2cbc1, about 600 feet deep and 400 feet away, declined only 2.3 feet.

Other results of the effect on the adjacent wells were reductions in flow. The flow of the Nickerson well (S-22-61) 3caa1, about half a mile distant, declined from 171 to 133 gallons per minute or 22 percent. The flow of the Rohr Company well (S-22-61) 10bda1, about 1 mile away, was reduced by 100 gallons per minute, or 28 percent, and the flow of the Hair well (S-22-61) 3bda1, more than half a mile away, was reduced by 17 gallons per minute or 24 percent. These three wells are about the same depth and evidently tap the same aquifers as the discharging well. The permeability determined from the recovery data is about 5,000 gallons per day per square foot of cross-sectional area, using a thickness of 25 feet for the aquifer estimated from logs of nearby wells.

In test No. 3 the Las Vegas Land and Water Company well, (S-20-61) 31dac1, was opened at 11: 45 a. m. on February 20, 1946, and closed at 11:45 a. m. on February 21, 1946. The flow during the period was about 4.05 second-feet or 1,800 gallons per minute and the drawdown was 54.75 feet. The depth of the well is 940 feet and it is perforated from 548 to 750 feet and 800 to 904 feet. Most of the water discharged by the well issues from an aquifer 550 to 750 feet below the land surface, and only small quantities come from the aquifer at 800 to 904 feet. The pressure reduction in the adjacent wells that were measured ranged from 4.45 feet to 0.2 foot. In wells that tapped aquifers at depths ranging from about 500 feet to more than 700 feet in depth the magnitude of the reduction effect was approximately proportional to their distance from the discharging well. Water levels in wells tapping shallower aquifers declined, but not in proportion to the distance of the wells from the discharging well. For example, in the Kidder well, (S-20-60) 36dbb1, about 1.31 miles away from the discharging well, the water level declined 0.72 feet during the discharge period, whereas the water level in the Lewis well, (S-21-61) 6bdb1, 1 mile from the discharging well, declined only 0.58 foot in the same period. The flow from adjacent wells that were left open during the test was also reduced. In the R. B. Griffith well, (S-20-61) 32acc1, the flow decreased from 200 to 181 gallons per minute, a reduction of about 9.5 percent. The permeability at the discharging Las Vegas Land and Water Company well, (S-20-61) 31dac1, was determined by the Theis recovery method to be about 1,200 gallons per day per square foot of cross-sectional area, based on a logged thickness of 200 feet for the aquifers.

Two test holes were drilled during the summer of 1946 to determine the thickness and permeability of the aquifers in the vicinity of Tule Spring. One of these holes, well (S-19-60) 27bdc1, was drilled to a depth of 905 feet and the other, well (S-19-60) 33bba1, was drilled to 1,008 feet. Recovery tests run on these wells indicate that the average permeability of the aquifers to a depth of 1,000 feet in that part of Las Vegas Valley lying between the Gilcrease Ranch and La Madre Mountain is about 1,000 gallons per day per square foot of cross-sectional area, based on about 100 feet as the combined thickness of the aquifers. The log of the Gilcrease house well, (S-19-60) 23bbc1, shows largely clay and silt, and probably only inappreciable quantities of water move south through these materials toward the vicinity of Las Vegas. As previously stated, the consolidated rocks of which La Madre Mountain is composed are impermeable and transmit negligible quantities of water. Also, it appears that the materials lying deeper than 1,000 feet in the tested area are probably impermeable. Thus, it appears that most of the water that moves south from the high parts of the Spring Mountains, probably the source of most of the recharge to the ground-water reservoir in Las Vegas Valley, must pass through the narrow strip of permeable materials between the Gilcrease house well and La Madre Mountain. The average hydraulic gradient of the piezometric surface in this strip is about 50 feet per mile, and the width of the strip is estimated to be about 4.5 miles. Therefore, if the permeability is about 1,000 gallons per day per square foot of cross section and the section of permeable materials is 100 feet thick, the total amount of water transmitted through the aquifers is 22,500,000 gallons per day, or 25,000 acre-feet annually. Because of probable variations in the permeability and thickness of the aquifers, the actual figure may be considerably more or less, but at least it is of the correct order of magnitude.

Recharge

As has been mentioned previously, the area enclosed by the drainage boundary of Las Vegas Valley can be considered as a separate ground-water basin. Thus, the ultimate source of the ground water must necessarily be within this drainage boundary. However, only a small part of the water that falls as rain and snow on the watershed reaches the ground-water reservoir. Undoubtedly large quantities are lost by transpiration and evaporation before the water has deeply penetrated the soil and rocks that make up the surface of the basin. An appreciable fraction of the measured precipitation probably never reaches the soil but falls on trees and plants and evaporates following the storms. Studies of this problem have been made in other regions, the physical characteristics of which resemble, more or less, those of Las Vegas Valley. From the results of these investigations it can be safely assumed that in very dry places of low precipitation only negligible quantities of water reach the under-ground reservoirs, and most of the precipitation is dissipated by evaporation and transpiration. For this reason it appears probable that most of the basin beneath the 6,000-foot contour on the east slope of the Spring Mountains, and beneath 6,500-foot contour on the much more arid slopes of the Sheep Mountains, where the average annual rainfall is less than 10 inches, contributes negligible amounts of water to the ground-water reservoir in Las Vegas Valley.

Sufficient data are available to estimate the average quantity of water that falls annually as precipitation on the east slope of the Spring Mountains, tributary to Las Vegas Valley. It is estimated that between altitudes of 6,000 and 8,000 feet, an area of 61,000 acres, the quantity is 81,500 acre-feet; that between 8,000 and 10,000 feet, an area of 18,000 acres, the quantity is 33,000 acre-feet; and above 10,000 feet, an area of 5,000 acres, the quantity is 10,500 acre-feet. On the basis of fragmentary records, field observations, and comparison of conditions on the west and south slopes of the Sheep Mountains with the conditions in the Spring Mountains, it is estimated that between 6,500 and 8,500 feet on the Sheep Mountains, an area of 35,500 acres, the average quantity of water that falls as precipitation is 29,500 acre-feet, and that above 8,500 feet, an area of 5,375 acres, the quantity is 6,700 acre-feet.

Only a small part of the total water from precipitation percolates deeply enough to recharge the ground-water reservoir.

At present, estimates of this fraction must be based on inadequate knowledge of the process. Determination of the quantity of water that actually infiltrates to depth and enters the ground-water aquifers is a complex problem involving many fundamental factors, some of which have been incompletely studied. It requires lengthy, detailed studies far beyond the scope of this investigation.

In the Las Vegas Valley drainage basin, allowance must be made for two important conditions that differ from those in other regions where some study of the problem has been made. Most important of these is the permeability, exposed area, and surface slope of the aquifers where they crop out and where they consist of highly permeable sand and gravel strata that overlaps the more or less impermeable bedrock high up on the mountain slopes. This condition is conducive to infiltration and, therefore, materially reduces the runoff; thus much of that part of the water from precipitation that ordinarily leaves the recharge area as streams in other regions is caught by these permeable gravels and percolates into the aquifers in the recharge areas in Las Vegas Valley. Indeed, no perennial streams flow beyond the upper margin of the alluvial apron. The other condition important in this basin is the aridity of Las Vegas Valley. Most studies of recharge conditions have been made in less arid regions than the Las Vegas Valley. It appears that, although these two conditions tend to offset each other, the proportion of the water from precipitation that enters the ground-water reservoir in the mountains may be greater than that proportion in most other regions where detailed recharge studies have been made.

On this basis it is estimated that 20 percent of the water from precipitation between altitudes of 6,000 and 8,000 feet and 25 percent of that precipitation above 8,000 feet on the east slope of the Spring Mountains, and possibly 20 percent of that from precipitation above 6,500 feet in the Sheep Mountains, recharges the ground-water reservoir in Las Vegas Valley. These estimates are based on the best available data, largely from similar but less arid regions. Thus, the total average annual quantity of water available for recharge to the ground-water reservoir in Las Vegas Valley probably is between 30,000 and 35,000 acre-feet per year.

The Las Vegas Valley basin on the east side of the Spring Mountains is naturally divided by a long bedrock spur known as La Madre Mountain. As previously explained, the rocks composing this spur form a highly impermeable barrier around which ground water from the part of the basin north of La Madre Mountain must pass in order to reach that part of Las Vegas Valley south of Tule Spring Ranch. On the same basis as above, it is estimated that about 24,000 acre-feet of ground water a year originates north of the La Madre Mountain spur. Data based on the hydrologic properties of the aquifers, presented on page 106, indicate that the quantity of water passing through the permeable materials between Gilcrease Ranch and La Madre Mountain is about 25,000 acre-feet annually. This estimate, which was independently determined, is of the same order of magnitude as the estimate of recharge based on precipitation north of La Madre Mountain.

QUALITY

As a part of the investigation, 44 samples of the confined water from the various zones of aquifers were collected and analyzed. The results of the analyses, in addition to results from many analyses made during previous studies, are shown in table 4, appendixes I and II. The analyses were made by the University of Nevada Experiment Station, the United States Geological Survey, and the Nevada Department of Food and Drugs. The analyses show only the dissolved mineral content and do not indicate the sanitary condition of the waters.

As shown by the results of the analyses, the dissolved mineral matter in the confined water consists chiefly of bicarbonates and sulfates of calcium and magnesium, with smaller amounts of silica, sodium and potassium, carbonate, and chloride. A few of the samples were analyzed for fluoride and nitrate and both constitutents were found in small quantities. In the following paragraphs the chemical character of the waters is discussed in its relation to the location and stratigraphy and the use to which the water is put in Las Vegas Valley.

QUALITY IN RELATION TO LOCATION AND STRATIGRAPHY

The chemical character of the waters, as shown by the analyses, ranges considerably in Las Vegas Valley. The waters from wells and springs in the vicinity of the Las Vegas and the Tule Springs, in Tps. 19 and 20 S., Rs. 60 and 61 E., and in the north half of T. 21 S., R. 61 E., are similar in character and contain less dissolved solids than the waters from wells and springs elsewhere in the valley. These waters have a lower temperature than other confined waters in the valley. The waters from wells in the vicinity of Winterwood Ranch, Whitney, and Pittman, in Tps. 21 and 22 S., R. 62 E., contain more dissolved solids and have higher temperatures than other confined waters in the valley. The chemical character of the waters from wells in Paradise Valley, in the south part of T. 21 S., R. 61 E., in the southeast part of T. 21 S., R. 62 E., and in the north part of T. 22 S., R. 61 E., is more or less similar to that of the waters in the vicinity of the city of Las Vegas, but they contain considerably larger quantities of dissolved solids, mostly in the form of calcium sulfate, and the temperature of the waters is higher. The valley fill in the vicinity of and north of the city of Las Vegas was largely derived from carbonate rocks. The sediments composing the valley fill south and east of the city of Las Vegas were eroded from mountains containing many gypsum beds and some igneous rocks in addition to large amounts of limestone and dolomite. Therefore, the valley fill in Paradise Valley and near Whitney and Pittman contains much gypsiferous material. It appears that the larger concentrations of sulfate in the ground waters in these localities are due to solution of gypsum in the sediments of the valley fill as the water passes through them. The water-bearing beds in the vicinity of Whitney and Pittman, near the Winterwood Ranch, and in other sections of the lowest part of the valley are not very permeable and are farther from the source of the ground water. Thus the water travels farther through the sediments and there is much greater opportunity for it to become more highly mineralized. It is also possible that in some localities in this part of Las Vegas Valley some ground water has been trapped in the aquifers and there is little or no circulation. Such trapped water would undoubtedly become highly mineralized in aquifers containing large quantities of gypsum and other minerals. The following table, which is based on many of the analyses listed in tables 4 and 5 in the appendixes, shows the differences in the chemical character of the waters from wells and springs in the three localities discussed above.

It also shows that, in each of the three localities, the average concentration of the chemical constituents of the waters from the three zones of aquifers are quite similar. However, there are considerable differences from one locality to another. In some instances the true average character of the waters from the different aquifers may not be clearly shown because the quantities in the table are based on only a few samples and are probably not representative. Also, the apparent similarity of the waters from the different zones of aquifers may be a result of the mixing of these waters by natural leakage and leakage in the vicinity of improperly constructed wells, especially if it occurs at the wells from which the water samples were taken. Certain differences in the waters from the various aquifers are discernible. The

Average Concentration of Chemical Constituents and Average Temperature in the Shallow, Middle, and Deep Zones of Aquifers in Three Areas in Las Vegas Valley.

Zone of aquifers	Number of samples	Total solids	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na and K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Hardness	Percent Sodium (Na)	Temperature, °F.
Vicinity of Las Vegas and Tule Springs												
Shallow	26	322	18[1]	50	22	14	228	41	8	211	22	71[2]
Middle	11	328	......	45	25	8	225	32	7	215	8	72[1]
Deep	8	294	18[3]	39	20	26	206	45	7	180	24	75[4]
Paradise Valley												
Shallow	16	714	24[5]	120	44	24	204	315	28	481	10	79[6]
Middle	2	775	......	131	44	25	175	375	29	512	10	
Deep	1	580	36	79	39	33	195	232	20	357	18	
Vicinity of Whitney, Pittman, and Winterwood Ranch												
Shallow	6	2,922	59[7]	244	121	455	125	1,383	443	1,097	47	
Middle	7	3,122	50	240	89	602	115	1,678	303	963	58	76[8]
Deep	2	2,170	......	91	14	589	122	1,161	184	287	81	

[1]Average of 9 samples. [2]Average of 16 samples. [3]Average of 3 samples.
[4]Average of 6 samples. [5]Average of 8 samples. [6]Average of 10 samples.
[7]Average of 4 samples. [8]Average of 2 samples.

average temperature of water from wells tapping the Shallow Zone of aquifers in the vicinity of Las Vegas is 1 degree lower than that of the waters believed to be from the Middle Zone and 4 degrees lower than that of waters believed to be from the Deep Zone. Also, waters believed to be from the Deep Zone of aquifers in all three areas appear to contain less dissolved solids, are not so hard, and contain a greater proportion of sodium and potassium than waters from either the Shallow or Middle Zones in the same areas. Waters percolating through sediments below the land surface assume the temperature of the materials making up the aquifer. It is well known that a temperature gradient is established in the earth's crust and that under normal conditions the temperature of the materials beneath the surface of the earth increases with depth. Thus the higher temperature of the waters from the deeper aquifers of Las Vegas Valley, a common phenomenon in the intermontane valleys of the Great Basin, is due to warming of the waters as they percolate deeper beneath the land surface. It is not possible to explain completely why the waters from the Deep Zone of aquifers contain less dissolved solids than those from the upper aquifers; many factors of the problem are unstudied and possibly unknown. Possibly part of the water enters the deeper aquifers first, where they crop out at the highest elevations in the foothills, and leaks upward to the shallower aquifers. This would favor increased concentration of the dissolved solids in the upper aquifers, for the water would necessarily have to pass slowly through considerably more sediments and would thus have an opportunity to dissolve larger quantities of mineral matter.

QUALITY IN RELATION TO USE

In the following discussion the general statements concerning the quality of water in relation to use are adapted, in large part, from publications of the United State Geological Survey, the Nevada State Agricultural Experiment Station, and the Nevada Department of Food and Drugs.

Dissolved Solids. After a natural water has evaporated there is a residue consisting of a mixture of minerals, usually some organic matter, and some water of crystallization. This residue is composed of the solids that were dissolved in the water and is shown and referred to as "dissolved solids" in the tables and text of this report. Water containing more than 2,000 parts per million may be unsafe for agriculture, although such water is used in many places where no better is available. If it contains more than 1,000 parts per million it is generally unsuitable for domestic use, although, as for agriculture, inferior water is used in many places. Such water is likely to contain enough of certain constituents to lend an unpleasant taste to it or to make it unsuitable in other respects. In general, water containing less than 700 parts per million of dissolved solids is usually safe for irrigation and is quite satisfactory for domestic use, except for difficulties resulting from its hardness or corrosiveness.

The analyses in tables 4 and 5 in the appendixes show that only wells in the vicinity of Whitney and Pittman and near the Winterwood Ranch yielded waters unsatisfactory for domestic purposes or unsafe for irrigation. Most of the water from wells in the vicinity of Las Vegas and north shows a content of dissolved solids ranging from 200 to nearly 500 parts per million. A few miles south of Las Vegas in Paradise Valley the water contains from 400 to more than 800 parts per million.

Hardness. The hardness of water is most commonly recognized when soap is used with the water in washing. Calcium and magnesium cause nearly all of the hardness of ordinary waters. Water having a hardness of less than 50 parts per million is considered soft, and water with a hardness of 50 to 100 parts per million only slightly increases the consumption of soap when used for ordinary purposes. When water with more than 150 parts per million must be used for municipal supplies it is generally profitable to soften it, although water with a hardness of as much as 250 parts per million is widely used without treatment.

Calcium and magnesium are also the chief active agents in the formation of scale in steam boilers and in other vessels in which water is heated or evaporated. Water with less than 90 parts per million of scale-forming constituents (largely calcium and magnesium, with some suspended matter) is considered good; with 90 to 200 parts per million it is considered fair; with 200 to 430 parts per million it is poor; and with more than 430 parts per million it is bad for boiler use.

As shown by tables 4 and 5 of the appendixes, the hardness of the confined water in Las Vegas Valley ranges greatly. All the water is hard and none is good for use in boilers without treatment. In the vicinity of Las Vegas and north of the city the hardness ranges from 102 to about 300 parts per million. Farther south the water is harder and in the vicinity of Whitney, Pittman, and the Winterwood Ranch the hardness is as high as about 3,000 parts per million, and generally is more than 500 parts per million.

Sodium and Potassium. Sodium, in combination with the sulfate and carbonate radicals, forms the salts that are most commonly referred to as alkalies in agricultural and soil studies. Potassium occurs only in small concentrations in the ground waters of Las Vegas Valley and is calculated and reported with the sodium. The concentration of sodium is commonly expressed as a percentage rather than in parts per million in alkali studies. The percentage of sodium is calculated from analytical results expressed in milligram equivalents per kilogram. The results are obtained by dividing the parts per million of sodium, calcium, and magnesium by their chemical combining weights, 23, 20, and 12.24, respectively; then 100 times the milligram equivalents of sodium is divided by the sum of the milligram equivalents of sodium, calcium, and magnesium. In milligram equivalents $\frac{100\ Na}{Na + Ca + Mg}$ equals the percentage of sodium. Water containing a percentage of sodium of less than 50 is considered safe for irrigation, provided that other conditions, such as type of soil and drainage, are favorable. Water containing more than 60 percent of sodium is considered unsafe for irrigation.

Results of computations based on analyses of representative samples of water from wells in the vicinity of the city of Las Vegas and Paradise Valley are given in the table on page 111. They show that the water is safe for irrigation in these localities.

Results of similar computations for water from wells in Whitney, Pittman, and the Winterwood Ranch are also shown and indicate that the water is unsafe for irrigation.

Sulfate. Sulfate in water that contains much calcium and magnesium causes the formation of hard scale in boilers and increases the noncarbonate or so-called "permanent" hardness (hardness that cannot be mostly removed by boiling the water). Excessive quantities of sulfate are harmful to plants and usually water with more than about 500 parts per million is considered unsafe for irrigation. Also, high-sulfate water is laxative or purgative, especially when present with magnesium, and is therefore quite often unsatisfactory for domestic use. Water containing more than 400 parts per million of sulfate usually has a distinctive taste.

In the water of Las Vegas Valley sulfate ranges from 19 to more than 4,000 parts per million, as shown by the analyses. The water highest in sulfate is that in the vicinity of Whitney, Pittman, and the Winterwood Ranch, where the presence of sulfate and sodium renders the water unsuitable for both irrigation and domestic purposes. In the vicinity of the city of Las Vegas only a few wells yield water with more than 100 parts per million of sulfate and most of the water contains less than 60 parts per million. Most of the wells in Paradise Valley yield water with more than 400 parts per million of sulfate. As previously mentioned, the higher concentration of sulfate in the water in the south part of the valley is probably the result of solution by the ground water of gypsum from the gypsiferous sediments in this vicinity and adjacent localities to the west.

Chloride. Water that contains more than 250 to 300 parts per million of chloride is slightly brackish. Higher concentrations of chloride are correspondingly more salty to the taste, 1,000 parts per million being near the limit of potability. Excessive chloride concentration may result in corrosion, and it is also harmful to plants. Water containing more than about 400 parts per million of chloride may be unsafe for irrigation. Chlorides of calcium and magnesium also contribute to the hardness of water.

In Las Vegas Valley, the water from wells and springs in the vicinity of the city of Las Vegas contains chloride ranging from a trace to less than 30 parts per million. In Paradise Valley the water has a chloride concentration ranging from 10 to more than 100 parts per million. In the vicinity of Whitney, Pittman, and the Winterwood Ranch, concentrations of chloride are as high as 1,140 parts per million, most samples having 200 to 500 parts per million. Thus, in the last-named locality enough chloride is present in most of the water to give it a brackish taste and, in some places, to render the water unsafe for irrigation.

Fluoride. Fluoride in water has been shown to be associated with the dental effect known as mottled enamel, which may appear on the teeth of children who, during the formation of permanent teeth, drink water containing more than 1.5 parts per million of fluoride. If the water contains as much as 4 parts per million of fluoride, 90 percent of the children drinking the water are likely to have mottled enamel.

Only a few samples of water from wells in Las Vegas Valley were analyzed for fluoride, and all of the samples showed 0.6 part or less per million.

GROUND WATER IN PAHRUMP VALLEY

GENERAL RELATIONS

As in Las Vegas Valley, near-surface water is first encountered in wells in Pahrump Valley on the basin lowlands and near the lower margin of the alluvial apron at depths ranging from 1 to 50 feet. This water is usually under slight artesian pressure, but in many places it is unconfined. The near-surface water reservoir apparently is recharged in part by water from the deeper aquifers, although only small quantities of near-surface water are used in the valley or lost by transpiration and evaporation. It appears that most of it is of satisfactory quality for watering stock. Although it contains considerable quantities of dissolved minerals, in most places it is potable and, in a few places, is used for domestic purposes. As in Las Vegas Valley, shallow wells yield only small quantities of water (1 to 5 gallons per minute per foot of drawdown) when pumped and are, therefore, generally unsatisfactory for irrigation. At the present time there is little or no need for water for industrial or cooling purposes in Pahrump Valley. Therefore, the near-surface water is not especially important as a source of water supply in the valley and it was not studied in great detail and is not discussed further in this report. Beneath the near-surface water reservoir are several aquifers that contain confined water, which forms the main source of supply in Pahrump Valley.

DISCHARGE AND RECHARGE

Records of the discharge of wells and springs in Pahrump Valley are fragmentary and only a few measurements of the discharge have been made. Estimates based on these incomplete records are summarized in the following table:

Average Discharge in Pahrump Valley

Period	*Amount (acre-feet per year)*
1916 to 1937	9,600
1937 to 1940	7,000
1940 to 1946	17,500

During the period 1916 to 1937 most of the discharge was from springs. During that period about 7,300 acre-feet a year was discharged annually in the vicinity of the Pahrump Ranch. During the period 1937 to 1946 several wells that yielded large amounts of water were drilled. In the vicinity of the Manse Ranch about 9,700 acre-feet of water was discharged in 1946 and more than three-fourths of it came from wells. Almost 3,200 acre-feet was discharged from wells in the vicinity of Pahrump Ranch in 1946, and about 4,400 acre-feet flowed from Bennetts Springs. Thus the total discharge in the vicinity of the Pahrump Ranch in that year was about 7,600 acre-feet.

Pahrump Valley is an enclosed ground-water basin, and there is no loss of water from it by underflow. However, some water is discharged by evaporation and transpiration from places where the near-surface water level is close to the surface. Adequate study to determine the amount of water thus lost has not been made, and therefore an estimate of the total discharge of ground water from Pahrump Valley is not available; however, under natural conditions it must have equalled the recharge.

The valley is underlain and enclosed on all sides by impermeable bedrock. Therefore the source of ground-water must necessarily be the precipitation that occurs within the drainage boundaries of the valley. This drainage area is, in many respects, similar to that of Las Vegas Valley and, as in that valley, estimates of the amount of water available for recharge to Pahrump Valley can be made from precipitation data. As explained on page 107, most of the water for recharge comes from precipitation at the higher altitudes. The only areas high enough to contribute appreciable quantities of recharge are the west slopes of the Spring Mountains. These slopes however, are more arid than the east slopes and undoubtedly lose much larger quantities of water by evaporation and transpiration. The appearance of the vegetation indicates that there is considerably less precipitation on the west slopes. Thus, they correspond closely to the west slopes of the Sheep Range which border Las Vegas Valley.

The greater aridity of the west slopes is clearly shown by the distribution of vegetation. Along the east slopes of the Spring Mountains, in Las Vegas Valley, the juniper and pinon pine belt extends as low as 5,000 feet and species characteristic of this belt flourish at altitudes ranging from 6,000 to 7,500 feet. On the west slopes of the mountains, in Pahrump Valley, juniper, pinon pine, and associated plants do not ordinarily grow below an altitude of 6,000 feet, and in few places are thick growths observed below 6,500 feet. Higher up on the slopes on the east side of the range, fir and white pine grow as low as 7,100 feet and thick growths of these and associated plants are common at the higher altitudes. On the west slope of the range, fir and pine do not ordinarily grow beneath 8,000 feet, and even at higher altitudes thick growths of these trees are rare. This evidence, coupled with other evidence from field observation and fragmentary precipitation data, indicate that precipitation below 6,500 feet contribute only small, probably inappreciable, quantities of water to the ground-water reservoir. Thus, the recharge area contributing appreciable quantities in Pahrump Valley consists of 61,000 acres between the altitudes of 6,500 and 8,500 feet and 19,700 acres above the 8,500-foot contour. The area draining into the Pahrump fan and the north part of Pahrump Valley is 32,000 acres between 6,500 and 8,500 feet, and 10,700 acres above 8,500 feet. The remainder of the area drains into the Manse fan and the south part of the valley.

In a manner similar to that used for estimating water for recharge in Las Vegas Valley it is possible to estimate these quantities for Pahrump Valley. As previously noted, this method yielded estimates for Las Vegas Valley that closely checked independently derived estimates based on other data. Assuming that 20 percent of the precipitation beneath an altitude of 8,500 feet and 25 percent of the precipitation above 8,500 feet reaches the ground-water reservoirs, it appears that the annual increment to the ground water in Pahrump Valley is about 23,000 acre-feet. On the basis of the figures given above, it appears that about 12,000 acre-feet of water is annually available for recharge to the Pahrump fan and the north part of the valley and that about 11,000 acre-feet of water is annually available to the Manse fan and the south part of the valley.

WATER-LEVEL FLUCTUATIONS

During 1945 and 1946 the water levels in three wells in Pahrump Valley were measured periodically. During most of that period water-level recorders were maintained on these wells. Hydrographs based on the water-level records are shown in figure 13. They show that fluctuations of water levels in wells in the vicinity of both the Manse and Pahrump Ranches are closely related to changes in the amount of water used in the valley. Thus the highest water levels occur in January and the lowest levels occur in September or October. The hydrographs also show a continuous year-to-year decline in water levels in the observation wells. It appears that water levels are dropping at a rate of about 1 foot a year in the wells on the Manse fan and that the

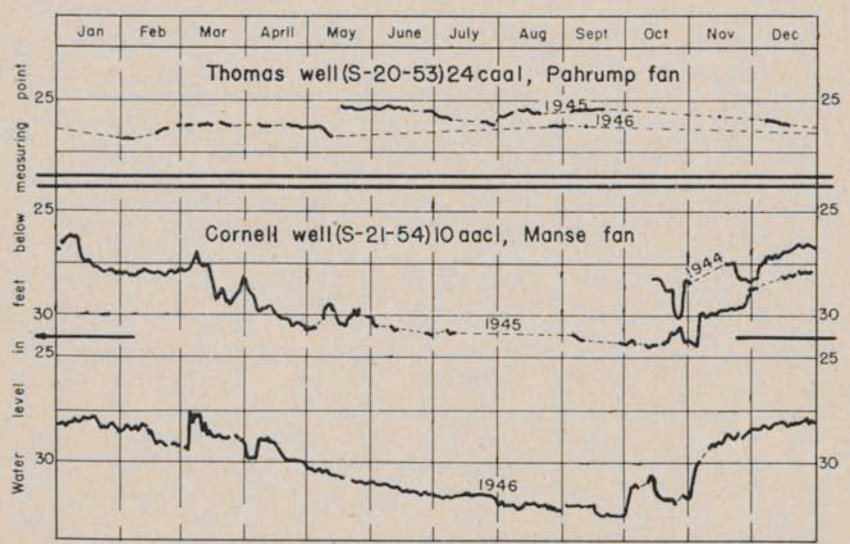

FIGURE 13—Hydrographs showing fluctuation of the level of the confined water in two wells in Pahrump Valley.

decline is less in the well on the Pahrump fan. The water-level decline is probably a result of the growth of two large cones of depression in the piezometric surfaces of the aquifers, which are caused by the large withdrawals of water in the vicinity of the Manse and Pahrump Ranches. Water levels in both localities may be expected to continue to decline until the cones have grown sufficiently to intercept the amount of recharge necessary to balance the total discharge of ground water.

Minor fluctuations caused by changes in barometric pressure and by earth tides are known to occur in wells in Pahrump Valley. The fluctuations are not discussed in this report because they do not reflect, or only temporarily reflect, substantial changes in the movement or storage of ground water.

QUALITY

Results of analyses of water from wells and springs in Pahrump Valley are given in table 4, appendix II. These analyses show that, although the water near the center and on the west side of the valley contains higher concentrations of dissolved solids, all the water is suitable for domestic use and is safe for irrigation. However, the water is hard and none would be classed as good for use in boilers, although most of it is fair for this use.

GROUND WATER IN INDIAN SPRING VALLEY

As in Las Vegas and Pahrump Valleys, the first or near-surface water is encountered by wells at depths of less than 100 feet in the lower parts of Indian Spring Valley. It is believed that this shallow water is recharged largely by the runoff from springs. Most of the wells in the valley are shallow and draw water from the near-surface reservoir and, according to reports by residents in the valley, this water is unconfined.

The few deep wells that penetrate aquifers containing confined water were drilled to depths ranging from 400 to 604 feet.

Most of the ground water discharged in Indian Spring Valley comes from Indian Springs. It is estimated that an average of approximately 800 acre-feet of water a year was discharged from the ground-water reservoir during the years 1905 to 1942 and in 1946. During the period 1943–1945 the total annual discharge increased to more than 1,450 acre-feet as a result of pumping of wells at the U. S. Army Air Field at Indian Springs.

No long-period records of water-level fluctuations are available for Indian Spring Valley. Reports by residents and well owners and occasional water-level measurements indicate that there has been little change in water levels in the valley in the last 20 years.

Recharge to the ground-water reservoir in Indian Spring Valley comes mostly from the north slopes of the Spring Mountains. Fragmentary records and the appearance of the vegetation indicate that the annual precipitation on these slopes below an altitude of 6,500 feet is less than 10 inches. The area tributary to the valley between the altitudes of 6,500 and 8,500 feet is about 20,000 acres, and that above 8,500 feet is about 350 acres. On the basis used for estimating the recharge to Las Vegas and Pahrump Valleys, from precipitation data, it appears that about 4,700 acre-feet of water is available to the ground-water reservoir in Indian Spring Valley; thus the discharge by evapo-transpiration must be substantial.

Results of analyses of water samples from two wells in Indian

Spring Valley are shown in table 4, appendix I. One of the samples from the Harnedy well, (S-16-56) 9bb2, is of water from the shallow aquifer of the near-surface reservoir and the other sample is from a deep well drilled by the U. S. Army. Results of several analyses of near-surface water were published by Hardman,[77] but it has not been possible to identify the wells from which the samples for his analyses were taken. An analysis of the water from Indian Springs is given in table 4, appendix II. All these analyses show that the water from the ground-water reservoir in the vicinity of Indian Springs is hard but suitable for domestic use and safe for irrigation. Although the near-surface water appears to contain a slightly higher concentration of sodium than the confined water, it has about the same character in other respects.

SUMMARY

From the foregoing discussion the following conclusions may be drawn: The only source of ground water for the three valleys is precipitation on the higher areas of the Spring and Sheep Mountains. However, only a small part of this precipitation recharges the alluvial fan and valley fill materials that compose the ground-water reservoirs. Estimates based on the available precipitation data show that the annual recharge to the ground-water reservoir in Las Vegas Valley is between 30,000 and 35,000 acre-feet, and it is approximately 23,000 acre-feet to the ground-water reservoir in Pahrump Valley.

The discharge from wells and springs in Las Vegas Valley was less than 30,000 acre-feet through 1945 and that figure was exceeded for the first time in 1946. Discharge from wells and springs in Pahrump Valley through 1946 never exceeded 17,500 acre-feet. In the vicinity of Las Vegas there are areas of local overdevelopment, as a result of close spacing and heavy pumping of wells. Water levels have been declining and are continuing to decline in Las Vegas Valley. In Pahrump Valley water levels have also declined during the short period of record. In both valleys, the ground-water levels may be expected to continue to decline until the cones of depression in the piezometric or pressure indicating surface caused by the withdrawal of water from wells and springs have grown sufficiently to intercept the recharge necessary to balance the total withdrawals of ground water. In Las Vegas Valley, where the withdrawal from wells approaches

[77] Hardman, George, and Miller, M. R., The quality of the waters from southeastern Nevada: drainage basins and water resources: Univ. of Nevada Agr. Exper. Sta. Bull. 136, p. 29.

the total annual recharge, this may be expected to take longer than in Pahrump Valley. The available data indicate that continued withdrawal of substantially more than 35,000 acre-feet of ground water annually will result in overdevelopment of the ground-water supply in Las Vegas Valley. Some ground water appears to be available for additional development in Pahrump Valley. Sufficient data are not available to show whether a substantial unused supply is available in Indian Spring Valley.

the total annual recharge, this may be expected to take longer than in Pahrump Valley. The available data indicate that continued withdrawal of substantially more than 35,000 acre-feet of ground water annually will result in overdevelopment of the ground-water supply in Las Vegas Valley. Some ground water appears to be available for additional development in Pahrump Valley. Sufficient data are not available to show whether a substantial unused supply is available in Indian Spring Valley.

APPENDIX I

STATE OF NEVADA
OFFICE OF THE STATE ENGINEER

❖

WATER RESOURCES BULLETIN No. 4

❖

WELL DATA IN LAS VEGAS AND INDIAN SPRING VALLEYS, NEVADA

By
G. B. MAXEY and C. H. JAMESON

Prepared in cooperation with the
UNITED STATES DEPARTMENT OF THE INTERIOR
Geological Survey
1946

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FOREWORD

This report is the fourth in the series of Nevada Water Resources Bulletins prepared by the U. S. Department of Interior, Geological Survey, in cooperation with the State Engineer.

A cooperative arrangement for a study of the ground-water resources in Las Vegas Valley was begun in July 1944 as the result of an agreement between the Director of the Geological Survey and the State Engineer of Nevada. Expansion of this arrangement for a State-wide investigation of the ground-water resources was made possible by the action of the Forty-second Session of the Legislature in appropriating $35,000 for the biennium, to be matched by an equal amount by the Geological Survey.

The program for the State is under the supervision of Hugh A. Shamberger, Assistant State Engineer. The program of the Geological Survey is under the direction of Thomas W. Robinson, District Engineer in Nevada for the Ground Water Division, Geological Survey.

The need for a systematic collection, tabulation, and recording of well data in Las Vegas Valley was recognized by Mr. Shamberger in 1938 when Penn Livingston of the Ground Water Division, Geological Survey, at the request of the State Engineer, made a brief investigation of the underground leakage from artesian wells in the vicinity of Las Vegas. The results of this investigation are set forth in U. S. Geological Survey Water-Supply Paper 849–D. The local field numbers established at that time were expanded by the State Engineer to include all of the wells in the Valley.

A systematic collection of well data (which was beyond the scope of the State Engineer's office) was begun in July 1944 by George B. Maxey, Associate Geologist assigned to the Las Vegas Valley investigation, and by C. H. Jameson, Artesian Well Supervisor. Some of the well data, together with the more important results of this investigation, were summarized in a report by them entitled, "Progress Report on the Ground-Water Resources of the Las Vegas Artesian Basin, Nevada," published in 1945. This report, by the same authors, includes the results of their systematic work on the collection of well data.

ALFRED MERRITT SMITH,
July 19, 1946. State Engineer.

WELL DATA IN LAS VEGAS AND INDIAN SPRING VALLEYS, NEVADA

By G. B. Maxey and C. H. Jameson

INTRODUCTION

The need for detailed information on wells in Las Vegas Valley has long been felt by the State Engineer, by local residents, and by the many other individuals and organizations interested in the ground-water resources of the valley. The purpose of this report is to satisfy, at least in part, that need, and to record information and data which might otherwise be lost to posterity. The report includes all available data on 570 wells in Las Vegas Valley that have been collected and compiled by the Geological Survey and the Office of the State Engineer as of April 30, 1946. In addition, data on 15 wells in Indian Spring Valley, northwest of Las Vegas Valley, are included.

The table is not complete in that data for many of the wells are missing. Most of these missing data are probably lost or destroyed. The compilation was conducted with great care and every effort was made to avoid possible errors.

The large amount of information and data presented in the following tables could not have been collected without the assistance and cooperation of many organizations and individuals in Las Vegas Valley. Much of the data in Tables 2 and 3 were collected through the courtesy of the local well-drillers from their records of well-drilling operations, often at inconvenience to them. The writers are especially grateful for the valuable assistance rendered by the well-drillers, the many individuals, and organizations who through their efforts have made available more complete records than would otherwise have been possible. Special thanks are due Zaida E. Bell who collected and compiled much of the information on wells.

EXPLANATION OF THE TABLES

TABLE 1

Table 1 is an index showing the various numbers used to identify individual wells since the Office of the State Engineer began active study of the wells in 1938. The first column lists, in consecutive order, the State Engineer's local field number which was used by him for several years prior to the present investigation to designate individual wells on his field records and map, several editions of which have been released to the public since

1938. The third column lists the State permit number which is the State Engineer's official record in designating the permit held by the owner of a well or spring to appropriate the public waters of the State of Nevada.[1]

Each State permit number in the table is opposite the State Engineer's local field number for the well on which the permit applies.

The second column lists the numbers used by the Geological Survey to designate individual wells and their locations. Each number in the table is opposite the State Engineer's local field number for the well on which both numbers apply. The Geological Survey numbers are not in consecutive order in this table. However, they are in consecutive order in Table 2. A description of the Geological Survey system of numbering wells in Las Vegas Valley is given below so the reader can make complete use of the well numbers.

The numbering system is based on the network of surveys by the General Land Office and serves to locate the well in the township, range, and section. In order to locate the well within an area of 10 acres, the sections have been subdivided into quarters, the northeast quarter being designated by the letter a, the northwest by the letter b, the southwest by the letter c, and the southeast by the letter d. The quarter sections have similarly been subdivided and designated and these 40-acre subdivisions further divided and similarly designated in 10-acre tracts. The wells in a 10-acre tract are numbered consecutively in the order in which they are recorded, beginning with 1. Thus, each well is designated by eight units if it can be located within a 10-acre tract. The first unit in the designation, either the letter N, or the letter S, indicates that the well is either north or south of the Mt. Diablo baseline. The second and third units in the designation indicate the Township and Range in which the well is located. These first three units are separated by hyphens and enclosed by parentheses. The fourth unit is the number of the section; the fifth, sixth, and seventh units indicate the 160-acre tract, the 40-acre tract, and the 10-acre tract, respectively, in which the well is located. The eighth unit in the expression designates the well within a 10-acre tract. Thus the first well in the southeast quarter of Section 31, Township 20 South, Range 60 East, would be numbered (S-20-61)31aad1, the second would be (S-20-61)31aad2,

[1]For a description of laws relating to ground water in Nevada, see "An Act Relating to Underground Waters," approved March 25, 1939, Nevada State Legislature. (Available from Office of the State Engineer, Carson City, Nevada.)

and so forth. A graphical illustration of the numbering system is shown on the accompanying map. Plate 1.

In some cases, the boundaries of the 40-acre and 10-acre tracts are unknown. The numbering system is then modified to include only the designations for the subdivisions of the section which are known. If more than one well is recorded in that particular subdivision, the wells are numbered consecutively in the order in which they are recorded, beginning with 1. Thus, if a well can be located only to the northeast 160-acre tract of Section 31, Township 20 South, Range 61 East, the number would be (S-20-61)31a, or if other wells are located in the same 160-acre tract, the number would be (S-20-61)31a1. Similarly, if a well can be located only in the northeast 40-acre tract of the northeast 160-acre tract of Section 31 of the same Township, the number would be (S-20-61)31aa or (S-20-61)aa1.

TABLE 2

Table 2 is a list of all the known wells in Las Vegas and Indian Spring Valleys, 585 in all. The wells are listed consecutively by their respective Geological Survey numbers in the first column on the left side of the table. The State Engineer's local field numbers and permit numbers are listed in the second and third columns, respectively. The "Remarks" column lists miscellaneous information which does not properly fit in the other columns, the headings of which are self-explanatory. It should be particularly noted that when records of well logs and casing data, pumping data, and analyses of water from the wells are available, this fact is noted in the "Remarks" column. The records of well logs and casing data are listed under consecutive well numbers in Table 3 and available water analyses are listed in the same manner in Table 4. The use of water from each well is indicated by the following abbreviations: DI, domestic and irrigation; Ind, industrial; N, unused; O, observation; P, public supply; and S, stock. In many instances water from the well is used for more than one purpose and is so indicated in each case. Blank spaces in the columns opposite each well indicate that the information is either unavailable, or unknown. All of the wells listed in this table are also located on the accompanying map. (Plate 1).

The well data were compiled and most of it was collected by the Office of the State Engineer and the Geological Survey between 1938 and April 30, 1946. In some instances, data were reported orally by reliable individuals, but in most cases, the data were taken from written records or collected in the field. All altitudes of measuring points are referred to sea-level datum and were determined by third order instrumental leveling. Artesian pressures were measured with a mercury manometer and water levels were determined with a steel tape. A complete record of all significant measurements of water levels in wells in Las Vegas Valley may be found in another publication.[2] The flow of each well measured was determined either volumetrically with the aid of a stop watch, or by means of a weir.

TABLE 3

Table 3 lists all available well logs and casing records from well drilling operations in Las Vegas and Indian Spring Valleys. This information is listed in consecutive order according to Geological Survey number. A total of 168 logs are included in the table. Many of the well logs were reported by well-drillers or well-owners and are accordingly marked "driller's log." The descriptions of the materials have generally been copied *verbatum* from the drillers' logs, but in a few instances have been edited for clarity and consistency.

The remaining well logs are those described by the Geological Survey from samples taken by the driller or by the staff of the Geological Survey at the time of drilling, and supplemented by the drillers' written logs. The terms in the descriptions of materials in these logs are those suggested by Wentworth[3] and by Allen.[4]

The altitudes of land surface listed in this table were determined by altimeter or by instrumental leveling. The diameter of the well is given as its diameter at land surface. All well logs and casing records in this table are also mentioned in the "Remarks" column in Table 2.

TABLE 4

Table 4 is self-explanatory. It contains available significant analyses of well and spring waters, 96 in all, in Las Vegas and Indian Spring Valleys and refers the reader to a few other analyses not included in this report. Authorities for the analyses are shown at the beginning of the table.

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[2] Water Levels and Artesian Pressure in Wells in Las Vegas Valley and in Other Valleys in Nevada, 1913–1945: State of Nevada, Office of the State Engineer, Water Resources Bulletin No. 3, 1946.

[3] Wentworth, C. K., A Scale of Grade and Class Terms for Clastic Sediments: Journal of Geology, vol. 30, 1922, pp. 377–392.

[4] Allen, V. T., et al., Terminology of Medium-Grained Sediments: National Research Council, Division of Geology and Geography, Annual Report 1935–1936, Exhibit B, Appendix 1.

TABLE 1

Index for State Engineer's Local Field Numbers, Permit Numbers, and U. S. Geological Survey Numbers of Wells in Las Vegas Valley, Nevada.

(State Engineer's local field numbers are arranged in consecutive order)

State Engineer's local field No.	Well No.	Permit No.	State Engineer's local field No.	Well No.	Permit No.
1	(S-20-60) 24dac1		31	(S-21-61) 17dbc1	10183
2	(S-20-60) 24adb1		32	(S-21-61) 16bcc1	9832
3	(S-20-61) 19bcb2		33	(S-21-61) 15bdc1	
4	(S-20-61) 19bcc1		34	(S-21-61) 22bca1	10624
5	(S-20-61) 19abd1		35	(S-21-61) 27cbb1	
6	(S-20-61) 20cbb1		36	(S-21-61) 27cbb2	
7	(S-20-61) 20cbc1	9389	37	(S-21-61) 34abc1	
8	(S-20-61) 20caa1	11165	38	(S-21-61) 27ccc1	11080
9	(S-20-61) 21dbc1		39	(S-21-61) 33bac1	
10	(S-20-61) 22dcd1	9992	40	(S-21-61) 28ccc1	
11	(S-20-61) 22dcd2	9992	41	(S-22-61) 4bcc1	
12	(S-20-61) 28cbd1	10293	42	(S-22-61) 9cbb1	
13	(S-20-61) 33dad1		43	(S-20-61) 20cbc2	9389
14	(S-20-61) 33ccb1	10035	44	(S-20-61) 19bcb1	
15	(S-20-61) 33ccb2		45	(S-20-61) 19bdb1	
16	(S-20-61) 32acb1		46	(S-20-61) 22dcb1	10181
17	(S-20-61) 32dcb1	11166	47	(S-20-61) 34adc1	
18	(S-20-60) 36dbb1		48	(S-21-61) 4baa1	
19	(S-21-61) 6acb1	11283	49	(S-21-61) 4abb1	
20	(S-21-61) 6acb2	10757	50	(S-20-61) 35ddc1	10152
21	(S-21-61) 6acc1	10409	51	(S-21-61) 2cbb1	
22	(S-21-61) 6acc2	10409	52	(S-20-61) 29dca1	10434
23	(S-21-61) 6adc1		53	(S-21-61) 28bcc1	10854
24	(S-21-61) 5bac1	10987	54	(S-21-61) 3abb1	
25	(S-21-61) 5caa1		55	(S-22-61) 11bac1	
26	(S-21-61) 4bcb1	10988	56	(S-22-61) 11bac2	
27	(S-21-61) 4acb1		57	(S-22-61) 1dac1	2303
28	(S-21-61) 7ddd1		58	(S-22-61) 1dab1	2303
29	(S-21-61) 18bbc1		59	(S-22-61) 1cda1	
30	(S-21-61) 18dbd1		60	(S-22-61) 1cda2	

TABLE 1—*Continued.*

State Engineer's local field No.	Well No.	Permit No.	State Engineer's local field No.	Well No.	Permit No.
61	(S-22-61) 1cdc2		92	(S-21-61) 35ccb1	9498
62	(S-22-61) 1bdb1		93	(S-21-61) 29dda1	9516
63	(S-22-61) 1bdb2		94	(S-21-61) 29dac1	9516
64	(S-21-61) 4bcc1	10988	95	(S-20-61) 35dcb1	9520*
65	(S-21-61) 4bda1	10986	96	(S-20-61) 23cba1	9522*
66	(S-21-61) 4bca1	10988	97	(S-20-61) 23cba2	9522*
67	(S-21-61) 3bcc1	10392	98	(S-20-61) 23cbc1	9522*
68	(S-20-60) 11b		99	(S-20-61) 29dac1	9525
69	(S-22-61) 10bda1	4374	100	(S-20-61) 26cad1	9601
70	(S-22-61) 10acc1	4374	101	(S-20-61) 27dcd1	9602
71	(S-21-61) 36abb1		102	(S-20-61) 26bbb1	9614
72	(S-21-61) 34dbc1		103	(S-20-61) 26bbb2	9614
73	(S-21-61) 34dcb1		104	(S-21-61) 36ccc1	9652
74	(S-21-61) 34dcc1		105	(S-20-61) 27acc1	9653
75	(S-21-61) 4abc1		106	(S-21-61) 2ddc1	9885
76	(S-21-61) 4bad1		107	(S-20-61) 27aaa1	9914
77	(S-20-61) 29ccc1	7201	108	(S-20-61 27dcc1	9939
78	(S-20-61) 35dbd1		109	(S-20-61) 30bbb1	8173
79	(S-22-61) 3bda1	7593	110	(S-20-61) 30bbb2	9940
80	(S-20-61) 19cdc1	7930	111	(S-21-61) 16bdb1	10013
81	(S-20-61) 29cbb1	10720	112	(S-21-61) 16bda1	10019
82	(S-20-61) 29cbc1	10721	113	(S-20-61) 20ccb1	10066
83	(S-20-61) 29cbc2	10722	114	(S-20-61) 31aad1	10127
84	(S-21-61) 1cdc1		115	(S-20-61) 30baa1	10182
85	(S-21-61) 26bbb1	9239	116	(S-20-61) 20cab1	10241
86	(S-21-61) 26bba1	9239	117	(S-21-61) 22ccc1	10243
87	(S-21-61) 27baa1	9243	118	(S-20-61) 28cad1	10245
88	(S-21-61) 4ddb1	9323	119	(S-20-61) 23cbd1	10260
89	(S-20-61) 14ddd1		120	(S-20-61 32ddd1	10301
90	(S-21-61) 2dcc1	10830*	121	(S-22-61) 3caa1	10321
91	(S-20-61) 33bcc1		122	(S-22-61) 3acc1	10321

*Canceled.

TABLE 1—*Continued.*

State Engineer's local field No.	Well No.	Permit No.	State Engineer's local field No.	Well No.	Permit No.
123	(S-21-61) 21bbb1	10820	154	(S-20-61) 22ddd4	
124	(S-21-61) 21aaa1	10821	155	(S-21-61) 7acc1	
125	(S-21-61) 35dcc1		156	(S-20-61) 22acd1	11131
126	(S-21-61) 23ccb1	10608	157	(S-20-61) 27add1	
127	(S-21-62) 31bdb1		158	(S-20-61) 27adc1	
128	(S-21-62) 30dbb1		159	(S-20-61) 34bcb1	
129	(S-21-62) 30dbb2		160	(S-21-61) 21cbb1	
130	(S-21-62) 19acd1		161	(S-20-61) 22ddd1	
131	(S-21-62) 31bdc1		162	(S-20-61) 22ddd5	
132	(S-21-62) 31bdc2		163	(S-20-61) 34aab1	
133	(S-21-62) 29ccb1		164	(S-20-61) 23ccb1	
134	(S-21-62) 29ccc1		165	(S-20-61) 22ddc1	
135	(S-21-61) 36cdc1		166	(S-20-61) 20cac1	11158
136	(S-22-62) 6bbc1		167	(S-20-61) 22ddd6	
137	(S-22-62) 6bac1		168	(S-22-61) 1cdc1	
138	(S-21-61) 9dcd1	10813	169	(S-20-61) 27abc1	10612
139	(S-22-61) 2cbc1	10579	170	(S-20-61) 22ddd3	
140	(S-20-60) 13dcc1		171	(S-20-61) 29dab1	
141	(S-20-60) 24bac1		172	(S-21-61) 3bcc2	10392
142	(S-21-61) 33bbc1		173	(S-20-61) 27ada1	
143	(S-22-61) 8aba1		174	(S-20-61) 34acd1	10391
144	(S-19-60) 35cc		175	(S-22-61) 2abd1	
145	(S-22-61) 3ccb1		176	(S-21-61) 27acc1	
146	(S-21-60) 1ab		177	(S-21-61) 33ccc1	
147	(S-20-61) 22dcc1		178	(S-21-61) 3cbb1	10643
148	(S-21-61) 6acc3	10409	179	(S-20-61) 30dda1	10458
149	(S-21-61) 25cab1		180	(S-20-61) 27daa1	10439
150	(S-22-61) 2aca1	10367	181	(S-20-61) 27aaa2	
151	(S-21-61) 6acb3		182	(S-20-61) 34dbb1	10466
152	(S-20-61) 22ddd2		183	(S-20-61) 33ccc1	
153	(S-20-61) 22dab1		184	(S-20-61) 21abb1	

TABLE 1—*Continued.*

State Engineer's local field No.	Well No.	Permit No.	State Engineer's local field No.	Well No.	Permit No.
185	(S-20-61) 21ddb1		216	(S-21-61) 4aba1	
186	(S-20-61) 21ddb2		217	(S-21-61) 4bbb1	
187	(S-20-61) 22dac1		218	(S-21-61) 4bbb2	
188	(S-20-61) 23bdc1		219	(S-21-61) 1bbb1	
189	(S-20-61) 23dad1		220	(S-21-61) 17dbc2	
190	(S-20-61) 23cbc2		221	(S-21-61) 18dbc1	
191	(S-20-61) 22dcb2		222	(S-21-61) 17dad1	
192	(S-20-61) 22cdb1		223	(S-21-61) 27bbb1	
193	(S-20-61) 22dca1		224	(S-21-61) 27dcb1	
194	(S-20-61) 22dca2	11130	225	(S-21-61) 2aba2	
195	(S-20-61) 28cac1	10474	226	(S-22-61) 2aba1	
196	(S-20-61) 28dbd1		227	(S-22-61) 2bab1	
197	(S-20-61) 28dbc1		228	(S-22-61) 2bbc1	
198	(S-20-61) 28dbd2	11143	229	(S-22-61) 34adb1	
199	(S-20-61) 28dac1		230	(S-20-61) 34aaa1	
200	(S-20-61) 28dac2		231	(S-20-61) 35bcb1	
201	(S-20-61) 32ddb1	11271	232	(S-20-61) 34add1	
202	(S-20-61) 33ccd1		233	(S-20-61) 35cbb1	
203	(S-20-61) 33cbc1		234	(S-21-62) 1aab1	10623
204	(S-20-61) 33cba1		235	(S-21-61) 3bac1	
205	(S-20-61) 33cca1	10471	236	(S-21-61) 3bab1	
206	(S-20-61) 33cca2		237	(S-21-61) 3baa1	
207	(S-20-61) 33cdb1		238	(S-21-61) 3abb2	
208	(S-20-61) 16bdb1		239	(S-21-61) 3abb3	
209	(S-20-61) 27acd1		240	(S-21-61) 4ddc1	
210	(S-20-61) 35dca1		241	(S-21-61) 4ddd1	
211	(S-20-61) 27add2		242	(S-21-61) 16bab1	10497
212	(S-20-61) 22cdd1		243	(S-21-61) 16cbb1	
213	(S-20-61) 27adb1		244	(S-21-61) 16cbb2	
214	(S-20-61) 4dcc1		245	(S-21-61) 16cbb3	
215	(S-21-61) 4abd1		246	(S-21-61) 16cbc1	10792

TABLE 1—*Continued.*

State Engineer's local field No.	Well No.	Permit No.	State Engineer's local field No.	Well No.	Permit No.
247	(S-21-61) 17dcb1		278	(S-20-61) 25ccb1	
248	(S-20-61) 17aac1		279	(S-20-61) 25ccc1	
249	(S-21-61) 33bca1		280	(S-20-61) 36bbb2	
250	(S-22-61) 3adb1		281	(S-20-61) 36bdb1	11095
251	(S-22-61) 3dcb1		282	(S-20-61) 36bdc1	11100
252	(S-22-61) 10aab1		283	(S-21-62) 7bad1	
253	(S-22-61) 10aac1		284	(S-21-62) 7bac1	
254	(S-22-61) 10adc1		285	(S-21-62) 7bad2	
255	(S-22-61) 10adc2		286	(S-21-62) 7bac2	
256	(S-22-61) 10add1		287	(S-21-62) 7bab2	
257	(S-22-61) 10dab1		288	(S-21-62) 7bab1	
258	(S-22-61) 10dad1		289	(S-21-61) 12dac1	
259	(S-22-61) 10dad2		290	(S-21-61) 12dca1	
260	(S-22-61) 2cdd1		291	(S-21-61) 12dcd1	
261	(S-22-61) 11bac3		292	(S-21-61) 13dbd1	
262	(S-22-61) 11bdb1		293	(S-21-62) 28aad1	
263	(S-22-61) 11bdb2		294	(S-21-62) 28ada1	
264	(S-22-61) 11bdc1		295	(S-21-62) 21ddd1	
265	(S-22-61) 2ddc1		296	(S-21-62) 27cba1	
266	(S-22-61) 12bbb1		297	(S-21-62) 28acd1	
267	(S-22-61) 1cdd1		298	(S-21-62) 30dbb3	
268	(S-22-61) 1dcb1		299	(S-21-62) 30dbb4	
269	(S-22-61) 1bcb1		300	(S-21-62) 30dbb5	
270	(S-22-61) 1bcb2		301	(S-21-62) 29bcc1	
271	(S-22-61) 1bcb3		302	(S-21-62) 30dcc1	
272	(S-22-61) 1bcb4		303	(S-20-61) 28bbd1	
273	(S-22-61) 1cbb1		304	(S-20-61) 28bca1	
274	(S-22-61) 1cbb2		305	(S-20-61) 21bdb1	
275	(S-22-61) 1cbb3		306	(S-20-61) 21bdc1	
276	(S-20-61) 27cdd1		307	(S-20-61) 17cdb1	
277	(S-20-61) 31ada1	10508	308	(S-20-61) 17cdc1	

TABLE 1—*Continued.*

State Engineer's local field No.	Well No.	Permit No.
309	(S-20-61) 22aaa1	
310	(S-20-61) 15dcc1	
311	(S-20-61) 15dcb1	
312	(S-20-61) 15dca1	
313	(S-20-61) 15dcb2	
314	(S-20-61) 3dab1	
315	(S-20-61) 3adc1	
316	(S-20-61) 3acc1	
317	(S-20-61) 3acb1	
318	(S-20-61) 4add1	
319	(S-20-61) 27abb1	
320	(S-20-61) 27acc2	
321	(S-20-61) 27bad1	
322	(S-20-61) 27caa1	
323	(S-20-61) 20dba1	
324	(S-20-61) 20dba2	
325	(S-20-61) 36cca1	10503
326	(S-20-61) 34adc2	
327	(S-20-61) 34adc3	
328	(S-20-61) 33cdc1	10580
329	(S-21-61) 10cdc1	
330	(S-21-61) 11bbb1	10520
331	(S-21-62) 8cca1	
332	(S-20-61) 29ada1	
333	(S-20-61) 27cbd1	
334	(S-20-61) 27cac1	
335	(S-20-61) 27cba1	
336	(S-20-61) 27cbc1	
337	(S-21-62) 4aaa2	
338	(S-21-62) 4aaa1	
339	(S-21-62) 3bac1	
340	(S-21-62) 3bac2	
341	(S-21-61) 9aac1	10553
342	(S-21-62) 27bcb1	10559*
343	(S-20-61) 20ccb2	10066
344	(S-21-61) 16bac1	10528
345	(S-21-61) 26bbc1	10573
346	(S-21-61) 32dda1	10574
347	(S-21-61) 4dac1	10582
349	(S-21-61) 3baa2	
350	(S-22-62) 1cba1	10602*
351	(S-20-61) 27adb2	
352	(S-22-61) 11bac2	
353	(S-20-61) 34dbb2	10717*
354	(S-20-61) 19ddc1	10630
355	(S-21-62) 27bcd1	10635
356	(S-21-61) 3cbb2	10660
357	(S-20-61) 29dad1	10669
358	(S-20-61) 22dda1	10670
359	(S-20-61) 28cdb1	10675
360	(S-20-61) 20cdc1	10679
361	(S-21-61) 6aca1	10680
362	(S-20-61) 35cac1	10697*
363	(S-20-61) 35cbb2	10702
364	(S-20-61) 21aba1	10958
365	(S-22-61) 16ccc1	10705
366	(S-20-61) 30dda2	10706
367	(S-20-61) 31aad2	10707
368	(S-20-61) 35ddc2	10713
369	(S-21-61) 29ddb1	11051
370	(S-21-61) 9aab1	10718
371	(S-20-62) 4acb1	10734

*Canceled.

TABLE 1—*Continued.*

State Engineer's local field No.	Well No.	Permit No.
372	(S-21-61) 16bcc2	10740*
373	(S-22-61) 3ddb1	10745
374	(S-21-62) 17ddc1	
375	....	
376	(S-21-61) 1aab2	10753*
377	(S-21-61) 9acd1	10754
378	(S-21-61) 16bcd1	10758
379	(S-21-61) 6aca2	10761
380	(S-20-61) 29dbb1	10781
381	(S-20-61) 20cba1	10784
382	(S-22-62) 9dcc1	10785
383	(S-20-61) 33cca3	10786
384	(S-19-60) 27aab1	10795
385	(S-21-62) 21cbc1	10802
386	(S-21-61) 4aad1	10818
387	(S-21-61) 16bab2	11039
388	(S-20-61) 34aab2	10725
389	(S-21-61) 6adc2	10787
390	(S-20-61) 32acb2	10791
391	(S-20-61) 23ddb1	10823
392	(S-21-61) 17cac1	11325
393	(S-20-61) 36bbb1	10844
394	(S-20-61) 32ddb2	10847
395	(S-21-61) 1aba1	10848
396	(S-20-61) 19dab1	10858
397	(S-21-61) 4bab1	10860
398	(S-20-61) 31add1	10867
399	(S-20-61) 31dab1	10868
400	(S-20-61) 31ddb1	10869
401	(S-20-61) 31ddc1	10870
402	(S-21-61) 9aad1	10885
403	(S-20-61) 28cda1	10951
404	(S-22-61) 2ccc1	10894
405	(S-20-61) 36bcb1	10919
406	(S-20-61) 19cdd1	10930
407	(S-21-62) 20ddd1	10948
408	(S-21-62) 20ddd2	10949
409	(S-21-61) 6bdb1	
410	(S-20-61) 28cdb2	
411	(S-20-61) 20cdb1	11144
412	(S-20-61) 20cca1	10990
413	(S-21-61) 27baa2	10969
414	(S-21-61) 1bba1	
415	(S-21-61) 1bda1	
416	(S-20-62) 4add1	
417	(S-20-62) 4dca1	
418	(S-20-61) 3adc3	
419	(S-20-61) 3adc2	
420	(S-21-61) 4dac2	10942
421	(S-20-61) 20bdb1	10952
422	(S-20-61) 36bbc1	10996
423	(S-22-62) 9cdb2	10961
424	(S-22-62) 9cdb1	10961
425	(S-21-61) 4acc1	
426	(S-19-60) 9bdd1	10917
427	(S-19-60) 9bcc1	10931†
428	(S-19-60) 9abb1	10991
429	(S-19-60) 9cda1	10940
430	(S-21-62) 21cbc2	10971
431	(S-22-62) 1ccc1	10826
432	(S-22-62) 1bdc1	10825
433	(S-20-61) 20cbb2	10970

*Canceled. †Withdrawn.

TABLE 1—*Continued.*

State Engineer's local field No.	Well No.	Permit No.	State Engineer's local field No.	Well No.	Permit No.
434	(S-22-61) 3dda1	11054	466	(S-21-62) 30dcb1	11341
435	(S-20-61) 20bcc1	11101	467	(S-21-62) 30bd	11347
436	(S-21-61) 12cdb1	11102	468	(S-20-61) 13adc1	11379
437	(S-21-61) 9dcc1	11227	469	(S-21-61) 4aca1	11302
438	(S-20-61) 30adb1	11103	470	(S-21-61) 4abd2	11091
439	(S-20-61) 20ccc1	11155	471	(S-20-61) 19cdd2	11380
441	(S-20-61) 25cca1	11233	472	(S-21-61) 9dcb1	11300
442	(S-20-62) 19cba1	11277	473	(S-20-61) 36bac1	11241
443	(S-20-62) 19bcc1		474	(S-21-61) 7ddb1	11138
444	(S-20-62) 19bbb1		475	(S-20-61) 20bdd1	11309
445	(S-20-62) 19bab1		476	(S-19-60) 9aba1	11337
446	(S-20-62) 19bdd1		477	(S-20-61) 28bca2	11421
447	(S-20-62) 19bda1		478	(S-21-61) 15bcc1	11327
448	(S-20-62) 19dbb1		479	(S-20-61) 22acd2	11437
449	(S-19-60) 23bbc1	11024	480	(S-21-61) 6adc3	11175
450	(S-19-60) 4dab1	11142	481	(S-21-61) 16bbd1	11157
451	(S-21-61) 9cdc1	11156	482	(S-22-61) 3cab2	11388
452	(S-21-61) 4bbb3	11198	483	(S-20-61) 22ccb1	
453	(S-21-61) 20aaa1	11226	484	(S-21-61) 36adc1	
454	(S-21-61) 27baa3	11231	485	(S-21-62) 7baa1	
455	(S-21-61) 12cdc1	11244	486	(S-22-61) 2daa1	
456	(S-20-61) 32acc1	11246	487	(S-21-61) 17cab1	
457	(S-20-61) 31dac1	11249	488	(S-20-61) 14ddd2	
458	(S-21-61) 26bbb2	11255	489	(S-20-62) 32bbb1	
459	(S-20-61) 36ccb1	11263	490	(S-21-62) 3bac3	
460	(S-20-62) 18bbc2	11340	491	(S-21-62) 27ccc1	
461	(S-20-61) 22cbc1	10985	492	(S-22-62) 1bcc1	
462	(S-20-61) 36cca2	11284	493	(S-22-62) 1cab1	
463	(S-20-61) 36ccd1	11207	494	(S-22-62) 1cbc1	
464	(S-20-61) 32cdd1	11306	495	(S-22-62) 1cbd1	
465	(S-20-61) 32cdc1	11323	496	(S-22-62) 12abc1	

TABLE 1—*Continued.*

State Engineer's local field No.	Well No.	Permit No.	State Engineer's local field No.	Well No.	Permit No.
497	(S-20-61) 34add2		506	(S-20-60) 13ddc1	
498	(S-20-61) 34ddb1		507	(S-20-61) 32dbd1	
499	(S-22-61) 1bca1		508	(S-20-61) 32dac1	
500	(S-22-61) 1bca2		509	(S-20-61) 32dac2	
501	(S-22-61) 1bca3		510	(S-20-61) 32dab1	
502	(S-22-61) 1bca4		511	(S-20-61) 32dab2	
503	(S-22-61) 1ccb1		512	(S-20-61) 13adb1	
504	(S-22-61) 1bcb5		513	(S-20-61) 13aac1	
505	(S-20-61) 18bcc1		514	(S-20-62) 18bbc1	

TABLE 2

Record of wells in Las Vegas and Indian Spring Valleys, Nevada. (Use of Water—DI, Domestic and irrigation; Ind., Industrial; N, Unused; O, Observation; P, Public supply; S. Stock.)

Well No. and Location	State Engineer's Local Field No.	State Permit No	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Measuring Point: Altitude	Measuring Point: Above (+) or Below (—) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (—) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
INDIAN SPRING VALLEY																		
(S-16-55½) 11ad	....	....	Charles Kielhofer	....	....	8	400	....	....	....	....	....	....	....	5	DI,S		
(S-16-56) 5dd	....	....	Las Vegas Army Air-field—Indian Springs sub-base	....	1942	8	604	....	....	....	....	....	....	....	....	P	....	Analysis; 300 G. M. pumped in 1942.
(S-16-56) 8ab	....	....	Las Vegas Army Air-field—Indian Springs sub-base	....	1942	6	576	....	....	....	0.0	Land surface	—54.0	9-15-1942	....	P	....	Log; 185 G. M. pumped, draw-down 30 feet in 1942.
(S-16-56) 8da	....	....	S. C. Schenck	....	....	60	25	....	....	....	0.0	Top of 8-in. by 8-in. timber cribbing, east side	—23.79	3-18-1946	....	N		
(S-16-56) 9ac	....	....	Unknown	....	....	60	74	....	....	....	+1.2	Top of 8-in. by 8-in. timber cribbing	—69.62	3-18-1946	....	N		
(S-16-56) 9bb1	....	....	State of Nevada, Department of Highways	....	....	60	35	....	....	....	....	....	....	....	....	DI		
(S-16-56) 9bb2	....	....	Tim Harnedy	Tim Harnedy and O. G. Hairgrove	....	60	50	....	....	....	+0.2	Top of con-crete curb	—25.42	3-18-1946	....	DI	....	Analysis; 5 G. M. pumped in 1945.
(S-16-56) 9bb3	....	....	Tim Harnedy	Tim Harnedy	....	17	30	....	....	....	+0.4	Top of con-crete floor around well	—25.62	3-18-1946	....	DI		
(S-16-56) 9bc1	....	....	Tim Harnedy	O. G. Hairgrove	....	6	45	....	....	....	+0.5	Top of casing	—13.52	3-18-1946	....	DI		
(S-16-56) 9bc2	....	....	Tim Harnedy	O. G. Hairgrove	....	8	582	....	....	....	+0.2	Top of casing	—4.07	3-18-1946	....	DI		
(S-16-56) 9bd	....	....	Mrs. R. Ridge	....	....	60	22½	....	....	....	+2.5	Top of 8-in. by 8-in. timber cribbing	—17.01	3-18-1946	....	N		
(S-16-56) 16bc	....	....	Mrs. Alice MacFarland	....	....	60	19½	....	....	....	0.0	Top of 8-inch by 8-in. timber	—9.05	3-18-1946	....	DI		
(S-16-56) 17a1	....	....	S. C. Schenck	....	....	60	27	....	....	....	0.0	Top of 8-in. by 8-in. timber	—22.37	3-18-1946	....	DI		
(S-16-56) 17a2	....	....	S. C. Schenck	....	....	60	25	....	....	....	0.0	Top of board well cover	—21.79	3-18-1946	....	N		
(S-16-56) 17a3	....	....	S. C. Schenck	....	....	60	16½	....	....	....	0.0	Top of 8-in. by 8-in. timber cribbing	—15.12	3-18-1946	....	N		

TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Altitude	Measuring Point: Above (+) or Below (—) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (—) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
LAS VEGAS VALLEY																		
(S-16-57) 24c	......	......	Unknown	U. S. Grazing Service	......	4	151	......	......	......	+2.0	Top of casing	—126.09	3-18-1946	......	N		
(S-17-59) 20bc	......	......	Grazing Service	......	......	6	300	......	......	......	+0.3	Top of casing	—31.31	9-12-1944	......	S,O	67	Windmill well; 15 G. M. pumped during 1944.
(S-17-59) 32b	......	......	Desert Game Refuge	......	......	12	250	......	......	......	0.0	Top of 12-in. casing	—86.61	5-11-1945	......	N,O	....	Well flooded and filled with silt Nov. 9, 1945.
(S-17-59) 34a	......	......	Desert Game Refuge	......	......	12	150	......	......	......	+0.7	Top of 8-in. by 8-in. tie	—24.33	5-11-1945	......	N	....	No casing in well.
(S-17-59) 34b	......	......	Desert Game Refuge	......	......	8	365	......	......	......	......	......	......	......	......	DI		
(S-18-59) 4b1	......	......	Desert Game Refuge	......	......	60	61½	......	......	......	+3.0	Top of wood platform under cross-ties	—57.90	8-14-1944	......	N,O		
(S-18-59) 4b2	......	......	Desert Game Refuge	......	......	10	......	......	......	......	......	......	......	......	......	N	....	Plugged at 65 feet.
(S-19-60) 4dab1	450	11142	P. J. Goumond	Brockman Drilling Co.	1945	16	780	......	......	......	+0.4	Top of 14-in. plate	+30.2	4- 5-1946	70	DI	69	Log.
(S-19-60) 9aba1	476	11337	P. J. Goumond	Thomas Miller	1945	14	716	......	......	......	......	......	......	......	413	DI	....	Log.
(S-19-60) 9abb1	428	10991	P. J. Goumond	Brockman Drilling Co.	1943	16	706	......	......	......	0.0	Top of 14-in. casing	+17.0	12-30-1944	705	DI	....	Analysis; log.
(S-19-60) 9bcc1	427	†10931	P. J. Goumond	Brockman Drilling Co.	1943	10	830	190-275	......	......	+0.5	Top of casing	—43.0	5- 1-1944	......	N,O	....	Log.
(S-19-60) 9bdd1	426	10917	P. J. Goumond	Brockman Drilling Co.	1943	8	1001	425-520	270-287 533-552 565-570 587-593 690-705 745-750 797-810	......	—6.0	Top of 8-in. welded cap	+2.33	5- 1-1944	308	DI	....	Log.
(S-19-60) 9cda1	429	10940	E. A. and J. T. Gilcrease	Brockman Drilling Co.	1943	8	612	......	......	......	......	......	......	Fall, 1945	651	DI	69	Analysis; log.
(S-19-60) 21ccc1	......	......	Stillwell Springs	......	......	36	8	......	......	......	—2.0	Top of culvert pipe casing	—3.75	5- 3-1945	......	S,O	....	Analysis; Old spring known as "Stillwell Spring;" 10 G. M. pumped during 1945.
(S-19-60) 23bbc1	449	11024	E. A. and J. T. Gilcrease	Brockman Drilling Co.	1944	12	910	550-570	......	......	0.0	Land surface	+9.0	8——1944	50	DI	....	Analysis; log.
(S-19-60) 27aab1	384	10795	H. M. Dixon	Thompson and Brockman	1943	8	605	......	......	......	+0.5	Top of 8-in. collar on casing	+16.5	9-19-1944	340	DI	69	Analysis.
(S-19-60) 35cdc1	......	144	Engler	......	1930	12	......	......	......	2,319.79	0.0	Top of casing	—49.57	3-22-1945	......	N,O	....	Well bridged at 55 feet.
(S-20-60) 11b	68	......	Southern Nevada Land and Development Co.	......	1911	....	628	......	......	......	......	......	......	......	......	......	....	Well destroyed.

†Withdrawn.

TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Measuring Point: Altitude	Measuring Point: Above (+) or Below (—) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (—) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-20-60) 13dcc1	140		Thayer Coon		1915	8	260					Top of casing				DI	70	450 G. M. pumped during 1945.
(S-20-60) 13ddc1	506		C. E. Smoke	J. L. Filby	1944	10					+1.0	Top of casing	—13.49	11-20-1944		N,O		This was an old well which was redrilled in 1944.
(S-20-60) 24adb1	2		George Curtis	Floyd Francis	1912	8	270	155-232			+2.0	Top of casing	—5.45	1-22-1939		DI		Analysis.
(S-20-60) 24bac1	141		Horace Taylor		1924	8	315			2,211.50	+2.0	Top of casing	—14.70	8-15-1938				Well destroyed.
(S-20-60) 24dac1	1		Horace Taylor		1913	6	315				+0.5	Top of casing	—18.50	8-18-1930		N		Well bridged at 6 feet; dry in July, 1944.
(S-20-60) 36dbb1	18		M. D. Kidder	Floyd Francis	1925	8	385			2,229.2	+1.0	Top of casing	—38.32	5- 4-1945		N,O		Log.
(S-20-61) 3acb1			Woods	Woods	1946	8	50				0.0	Top of 8-in. terra cotta pipe	—42.72	3-30-1946		N		
(S-20-61) 3acb2	317		S. U. Stewart		1934	2					—1.0	Bottom of lip of 2-in. ell	—19.11	4-25-1946		N		
(S-20-61) 3acc1	316		S. U. Stewart		1934	8	300				+1.0	Top of casing	—17.60	8-23-1944		N,O		
(S-20-61) 3adc1	315		Las Vegas Army Airfield	Joe Evans	1939	$7\frac{5}{8}$	340				+2.3	Inside bend of 4-in. ell	—11.75	8-11-1944		N,O		
(S-20-61) 3adc2	419		Las Vegas Army Airfield	Joe Evans	1941	$6\frac{1}{4}$	400									N	71	
(S-20-61) 3adc3	418		Las Vegas Army Airfield	Brockman Drilling Co.	1943	12	500									P		Log; 200 G. M. pumped during 1945.
(S-20-61) 3dab1	314		Las Vegas Army Airfield	Floyd Francis	1933	8	242				+3.3	Top of 8-in. tee	+2.05	8-23-1944	185	P		Analysis.
(S-20-61) 4add1	318		George Craig		1912	10	900									N		Analysis.
(S-20-61) 5b			Armstrong			10	267				+0.3	Top of casing	—39.52	11-15-1944		DI,O		15 G. M. pumped during 1944.
(S-20-61) 12cda1			John Greenfield			60	53				0.0	Top of plank well-cover	—48.25	4-19-1946		DI		5 G. M. pumped during 1946.
(S-20-61) 13aac1	513		F. H. Callahan			8	80					Measurement of water level not possible					67	15 G. M. pumped during 1946.
(S-20-61) 13adb1	512		J. R. Cannon	John Frewalt		8	120				+1.0	Hole in casing	—39.95	4-19-1946		DI		2 G. M. pumped during 1946.
(S-20-61) 13adc1	468	11379	L. and M. Van Der Meer	Las Vegas Drilling Co.	1946	8	930				+1.0	Top of casing	—42.53	4-19-1946		DI	74	Log; 6 G. M. pumped during 1946.
(S-20-61) 13adc2			L. and M. Van Der Meer	Las Vegas Drilling Co.	1946	10	400				+1.0	Top of 10-inch casing	—39.94	4-19-1946		DI		
(S-20-61) 14ddd1	89		Las Vegas Home Building Investment Co.		1938	8	402				+0.5	Top of casing collar	+5.8	4- 6-1946	8	DI	72	

TABLE 2—*Continued.*

											Measuring Point		Pressure Head or Water Level					
Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Altitude	Above (+) or Below (—) Land Surface (feet)	Description	Above (+) or Below (—) Measuring Point (feet)	Date of Measurement	Yield (gallons a minute) Flow	Use	Temperature (°F)	Remarks
(S-20-61) 14ddd2	488	....	J. D. Tate	....	....	6	....	....	....	....	+0.8	Top of 4-in. welded cap	+4.2	4-19-1946	10	DI	71	
(S-20-61) 15dca1	312	....	Taylor Estate	Floyd Francis	....	....	....	....	....	....	....	....	....	....	15	DI		
(S-20-61) 15dcb1	311	....	Taylor Estate	Floyd Francis	1925	6	805	....	....	....	....	Top of casing	....	....	15	DI	....	Log.
(S-20-61) 15dcb2	313	....	Taylor Estate	Floyd Francis	1925	6	935	....	....	....	—6.0	Top ½-in. nipple on 6-in. cap	—9.15	8-23-1944	....	N	....	Log.
(S-20-61) 15dcc1	310	....	Taylor Estate	Floyd Francis	1925	8	500	....	....	....	+0.8	Top of casing	—4.35	8-23-1944	....	N	....	Log.
(S-20-61) 16bdb1	208	....	E. C. Osborne	....	1930	8	386	....	....	....	+1.8	Top of casing	—1.17	8-23-1944	....	DI,O	....	10 G. M. pumped during 1944.
(S-20-61) 17aac1	248	....	Pickwick Oil Co.	....	1931	....	500	....	....	....	....	....	....	....	....	N	....	Well not found in 1946.
(S-20-61) 17cdb1	307	....	Town of Vegas Heights	Floyd Francis	1928	8	....	....	....	....	....	Cannot measure water level	....	1-31-1944	50	P	74	
(S-20-61) 17cdc1	308	....	Town of Vegas Heights	Floyd Francis	1928	8	....	....	....	....	+1.5	Top of casing	+18.2	1-31-1944	50	P	74	
(S-20-61) 18bcc1	505	....	Sky Haven Airport	O. G. Hairgrove	1944	6	412	....	....	....	+0.7	Top of casing	—3.22	11-27-1944	....	DI,O	....	Analysis; 10 G. M. pumped during 1944.
(S-20-61) 19adb1	5	....	Splane Estate	....	1914	10	260	....	....	2,175.96	+0.5	⅛-inch. plug in casing	+13.3	8-22-1944	75	DI,O	....	Analysis.
(S-20-61) 19bcb1	44	....	Splane Estate	Floyd Francis	1913	9	300	....	....	2,201.91	+3.25	Top of casing	—2.03	3- 3-1944	....	N,O	....	Log.
(S-20-61) 19bcb2	3	....	Splane Estate	....	1914	....	234	....	....	2,203.16	+1.8	Top of tee	+0.93	8-26-1938	....	N		
(S-20-61) 19bcc1	4	....	R. S. Hicks	Floyd Francis	1914	12	244	....	....	2,201.66	+1.75	Top of 8-in. tee	—1.56	3-17-1944	....	N,O		
(S-20-61) 19bdb1	45	....	Splane Estate	....	1914	12	....	....	....	2,189.96	+0.7	Top of casing	+9.24	3- 3-1944	15	N	69	
(S-20-61) 19cdc1	80	7930	B. V. Provenzano	Floyd Francis	1926	8	275	240-265	151	2,193.50	+1.3	Top of collar on 8-in. casing	+2.84	8-15-1944	....	DI	....	20 G.M. pumped during 1944.
(S-20-61) 19cdd1	406	10930	J. F. and F. Haakie	O. G. Hairgrove	1943	8	262	200-262	....	2,180.66	+1.9	Top of welded cap on casing	+0.55	3- 3-1944	....	DI	....	Log; 20 G. M. pumped during 1944.
(S-20-61) 19cdd2	471	11380	J. F. and F. Haakie	A. W. House	1946	8	325	....	....	....	+2.1	Top of 8-in. tee	+9.1	3-23-1946	160	DI	....	Log.
(S-20-61) 19dab1	396	10858	Southern Nevada Industries Ltd.	J. L. Filby	1942	8	286	230-286	....	2,154.26	+1.0	Top of 8-in. tee	+32.34	2-24-1944	60	Ind	71	Log.
(S-20-61) 19ddc1	354	10630	E. B. Coram	Pat Thompson	1941	8	280	255-280	....	2,161.64	+2.0	⅛-in. plug in casing	+24.9	3-28-1944	....	DI,O	72	Analysis; log.
(S-20-61) 20bcc1	435	11101	R. J. Kaltenborn	Bert Hairgrove	1944	8	283	258-283	110-130	2,129.42	+1.0	Top of 10-in. casing	+28.87	9-20-1944	162	DI	70	Log.
(S-20-61) 20bdb1	421	10952	M. C. Oglesby	Joe Evans	1944	8	450	365-377	417-420	2,116.70	+1.8	Top of 6-in. reducer	+14.5	3-16-1944	40	DI	69	Log.

TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Measuring Point: Altitude	Measuring Point: Above (+) or Below (—) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (—) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S–20–61) 20bdd1	475	11309	J. A. Griffin	Claude Shell and E. Bowman	1945	10	325	292–303	275–283	......	+1.1	Top of 8-in. welded cap	+5.55	1–23–1946	15	DI	....	Log.
(S–20–61) 20bdd2	......	......	J. A. Griffin	Claude Shell and E. Bowman	1945	8	50	......	......	......	+2.5	Top of casing	—10.96	1–14–1946	......	N,O		
(S–20–61) 20caa1	8	11165	J. W. and Mae Cook	John Frewalt	1937	10	300	......	......	2,110.58	+2.0	Top of casing	+3.1	4–17–1944	5	N	70	Log.
(S–20–61) 20cab1	116	10241	C. Richardson	......	......	6	386	......	......	2,116.22	+2.0	Top of 6-in. tee	+15.0	2–23–1944	50	DI	72	
(S–20–61) 20cac1	166	11158	E. O. Underhill	......	1932	9	347	......	......	2,114.49	+1.3	Top of casing	+13.0	8–11–1944	75	DI	71	Analysis.
(S–20–61) 20cba1	381	10784	Louis Pisetta Estate	John Frewalt	1942	7	300	......	......	2,122.69	+1.6	Top of welded cap on casing	+8.2	8–11–1944	21	DI	70	
(S–20–61) 20cbb1	6	......	Brundy	......	......	8	268	......	......	2,128.84	+2.0	Top of casing	+25.6	4–27–1944	93	DI	71	
(S–20–61) 20cbb2	433	10970	J. W. and Mae Cook	John Frewalt	1944	6	255	175–180	180–245	2,127.07	+2.0	Top of casing	+11.5	5–25–1944	15	N	66	Log.
(S–20–61) 20cbc1	7	9389	Oppedyk Estate	Diskin	1930	6	278	......	......	2,128.66	+1.0	⅛-in. plug in casing	+27.0	8–11–1944	185	N,O	72	Analysis.
(S–20–61) 20cbc2	43	9389	Oppedyk Estate	Diskin	1930	7⅝	318	......	......	2,126.72	+2.0	⅛-in. plug in casing	+9.9	8–11–1944	46	N,O	72	
(S–20–61) 20cca1	412	10990	T. W. Allen and D. Campbell	Joe Evans	1942	9	358	300–358	285–300	2,119.16	+1.3	Top of casing	+37.5	3–22–1944	150	DI	70	Log.
(S–20–61) 20ccb1	113	10066	W. R. Smith	......	1926	6	300	......	......	2,126.88	+2.5	⅛-in. plug in casing	+16.17	2–25–1944	......	DI	71	20 G. M. pumped during 1944.
(S–20–61) 20ccb2	343	10066	W. R. Smith	Joe Evans	1940	9	300	260–295	......	2,127.64	+0.87	⅛-in. plug in casing	+30.1	8–11–1944	170	DI	71	Log.
(S–20–61) 20ccc1	439	11155	S. P. James	John Frewalt	1945	8	350	315–325	285–290	......	+1.8	Top of welded cap on casing	+26.9	5–28–1945	130	DI	71	Log.
(S–20–61) 20cdb1	411	11144	M. D. and F. Butler	Bert Hairgrove	1941	8	340	300–340	......	2,110.77	+1.6	Top of 8-in. casing	......	2– 7–1945	75	N	72	Log; well leaks around casing.
(S–20–61) 20cdc1	360	10679	M. D. Butler	Bert Hairgrove	1942	8	325	300–325	......	2,109.42	+1.0	⅛-in. plug in casing	+27.8	8–24–1944	120	N,O	71	Analysis; log.
(S–20–61) 20dba1	323	......	J. Masek	......	1936	....	325	......	......	......	......	......	......	9——1945	10	DI		
(S–20–61) 20dba2	324	......	J. Masek	......	......	....	......	......	......	......	......	......	......	9——1945	10	DI		
(S–20–61) 21aba1	364	10958	L. W. Noblett	John Frewalt	1945	8	346	280–300	......	......	+1.5	Top of casing	—8.22	2– 9–1945	......	N	....	Log.
(S–20–61) 21abb1	184	......	C. Gratz	......	1912	12	316	......	......	......	......	......	......	......	1	N	63	Log; well cleaned out and deepened to 316 feet in 1946 by John Frewalt.
(S–20–61) 21bdb1	305	......	B. Owens	Floyd Francis	1925	8	525	......	......	......	+1.75	Top of lower flange on pump	+2.55	3–30–1944	5	DI	68	
(S–20–61) 21bdc1	306	......	Floyd Francis	Floyd Francis	1925	8	500	......	......	......	......	......	......	......	......	DI		

TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Altitude	Measuring Point: Above (+) or Below (—) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (—) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S–20–61) 21dbc1	9	......	Las Vegas Building and Loan Co.	......	1913	10	......	......	......	......	+1.3	Top of casing	—1.65	3–30–1944	......	N	....	Log; well bridged at 2.0 feet.
(S–20–61) 21ddb1	185	......	Oppedyk Estate	......	1912	8	490	......	......	......	+0.35	Top of cement block around well	—5.35	3–30–1944	......	N		
(S–20–61) 21ddb2	186	......	Oppedyk Estate	......	1912	6	410	......	......	......	+1.0	Top of casing	—8.00	3–30–1944	......	DI	....	20 G. M. pumped during 1944.
(S–20–61) 22aaa1	309	......	Taylor Estate	Floyd Francis	1912	8	418	......	......	......	......	......	......	......	......	....	....	Log; well destroyed.
(S–20–61) 22acd1	156	11131	City of North Las Vegas	Joe Evans and O. G. Hairgrove	1931	6	752	......	......	1,938.00	+0.6	⅛-in. plug in casing	+45.00	2–19–1944	43	P	69	Log; 150 G. M. pumped during 1944.
(S–20–61) 22acd2	479	11437	City of North Las Vegas	Las Vegas Drilling Co.	1946	10	828	......	......	......	......	......	......	......	......	P	....	Log.
(S–20–61) 22cbc1	461	10985	Jack Moore and C. E. Bell	John Frewalt	1944	8	385	......	......	......	—0.5	Bottom of 3-in. outlet pipe	—5.00	7–30–1944	......	N,O	....	Log.
(S–20–61) 22ccb1	483	......	L. A. and F. C. Malone	......	1938	10	812	......	......	......	+1.8	Top of 8-in. casing	+11.4	4–13–1944	18	DI	78	10-in. casing to unknown depth. 8-in. casing to unknown depth.
(S–20–61) 22cdb1	192	......	L. A. and F. C. Malone	J. L. Filby	1923	6	320	......	......	......	+1.8	Opening in pump base	—9.10	4– 8–1946	......	DI	....	5 G. M. pumped during 1946.
(S–20–61) 22cdd1	212	......	M. Man-kiewicz	......	......	6	......	......	......	......	+0.46	Top of casing	—1.77	4–13–1944	......	DI	....	5 G. M. pumped during 1944.
(S–20–61) 22dab1	153	......	M. N. Martin	......	......	6	425	......	......	......	......	......	......	......	......	N	....	Capped in 1946.
(S–20–61) 22dac1	187	......	Russell	......	1931	....	......	......	......	......	+2.4	......	......	......	......	DI		
(S–20–61) 22dca1	193	......	City of North Las Vegas	Joe Evans	1939	8	......	......	......	......	......	Top of 4-in. valve flange	+16.3	4–24–1943	......	P	72	
(S–20–61) 22dca2	194	11130	City of North Las Vegas	Joe Evans	1939	8	......	......	......	......	+0.7	Top of 8-in. tee	+17.7	4–10–1946	......	P	72	
(S–20–61) 22dcb1	46	10181	City of North Las Vegas	Joe Evans	1936	12	740	......	......	......	+1.8	Top of 6-in. valve flange	+1.9	4–24–1943	......	P		
(S–20–61) 22dcb2	191	......	H. Sakai	Anderson	1918	8	450	......	......	......	......	......	......	......	......	DI	....	Well inaccess-ible in 1946.
(S–20–61) 22dcc1	147	......	C. Stocker	......	......	5	169	......	......	......	0.0	Top of 4-in. tee	+7.4	4–10–1946	27	DI	71	
(S–20–61) 22dcc2	......	......	G. Lopez	......	......	6	400	......	......	......	......	......	......	......	5	DI		
(S–20–61) 22dcd1	10	9992	City of North Las Vegas	Joe Evans	1936	8	600	......	......	......	+2.0	Top of 4-in. tee	......	......	......	P		
(S–20–61) 22dcd2	11	9992	City of North Las Vegas	Joe Evans	1933	8	250	......	......	......	+0.5	Top of center of tee	+34.6	1–28–1939	......	P,O	74	
(S–20–61) 22dda1	358	10670	Arthur Arnold	Bert Hairgrove	1944	8	300	280–290	......	......	0.0	Land surface	—2.1	5–31–1944	......	DI	....	Log.
(S–20–61) 22ddc1	165	......	Dimmick	......	......	4	210	......	......	......	......	......	......	......	......	DI	72	

TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Altitude	Measuring Point: Above (+) or Below (—) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (—) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-20-61) 22ddd1	161	....	Mayer	....	....	8	361	....	....	....	....	....	....	....	....	DI	....	2 G. M. pumped in 1945.
(S-20-61) 22ddd2	152	....	J. W. Woodard	....	....	10	4	....	....	....	+1.25	Top of casing	+9.2	4-11-1944	....	DI		
(S-20-61) 22ddd3	170	....	Harry Miller	Floyd Francis	1925	6	525	245-248	....	....	....	....	....	....	....	N	....	Log; well plugged with concrete in 1946.
(S-20-61) 22ddd4	154	....	Harry Miller	....	1931	4	415	....	....	....	+0.1	Top of 6-in. bushing	+6.3	4-10-1944	....	DI		
(S-20-61) 22ddd5	162	....	M. E. Barker	....	....	8	415	....	....	....	+0.4	Top of 8-in. casing	+0.19	4-10-1946	....	N		
(S-20-61) 22ddd6	167	....	The Five Point Service Station	....	1940	....	165	....	....	....	....	....	....	....	....	DI		
(S-20-61) 23bdc1	188	....	Cox	....	1934	4	......	....	....	....	....	Cannot measure water level	....	....	....	DI	....	2 G. M. pumped in 1945.
(S-20-61) 23cba1	96	*9522	Patio Court	Joe Evans	....	....	310	....	....	....	....	....	....	....	....	DI	....	10 G. M. pumped in 1945; well inaccessible in 1946.
(S-20-61) 23cba2	97	*9522	G. R. Wait and S. M. Pahor	Joe Evans	....	6	265	....	....	....	....	....	....	....	....	DI	72	
(S-20-61) 23cbc1	98	*9522	Tom Williams	Joe Evans	....	8	417	....	....	....	+0.35	Top of 8-in. plug	—2.03	4-12-1946	....	DI		
(S-20-61) 23cbc2	190	....	Tony Bruno	Joe Evans	1936	8	210	....	....	....	....	....	....	....	....	DI	73	
(S-20-61) 23cbd1	119	10260	R. F. Watson	Joe Evans	1938	$5\frac{5}{8}$	210	200-210	....	....	....	....	....	....	....	DI	....	Log.
(S-20-61) 23ccb1	164	....	Paris Auto Court	....	....	2	180	....	....	....	....	....	....	....	....	DI		
(S-20-61) 23cad1	189	....	Coleman	....	1937	12	440	....	....	....	+1.2	Top of 6-in. to 2-in. bushing	+19.3	4-12-1946	....	DI	71	12-in. casing to unknown depth; 6-in. casing to unknown depth.
(S-20-61) 23ddb1	391	10823	Mary Gaddis	John Frewalt	1943	8	420	318-324	370	....	+2.0	Top of welded 8-in. cap	+17.4	4- 6-1944	15	DI,O	....	Log.
(S-20-61) 23ddb2	......	....	John Frewalt	John Frewalt	1944	8	50	....	....	....	+0.8	Top of casing	—16.61	9- 5-1944	....	DI,O		
(S-20-61) 25cca1	441	11233	O. A. Effinger	Bert Hairgrove	....	6	......	....	....	....	....	....	....	....	....	DI	....	Well not finished in 1946.
(S-20-61) 25ccb1	278	....	Hampton	....	1932	....	530	....	....	....	+2.5	Top of 4-in. tee	+25.41	3-10-1944	30	DI		
(S-20-61) 25ccc1	279	....	Hampton, Davis and Dial	....	1940	8	330	....	....	....	....	....	....	....	....	DI		
(S-20-61) 26bbb1	102	9614	City of Las Vegas	Joe Evans	1936	8	812	808-812	....	....	+1.2	Top of cement block	+19.3	4-10-1944	....	DI		Log.
(S-20-61) 26bbb2	103	9614	City of Las Vegas	....	....	8	490	....	....	....	+1.3	Top of cement block	+24.25	4-10-1944	....	DI		

*Canceled.

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TABLE 2—*Continued.*

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(S-20-61) 26cad1	100	9601	City of Las Vegas	......	1932	8	352	......	......	......	+0.2	Top of 4-in. to 8-in. bushing	+43.8	4-26-1944	......	DI		
(S-20-61) 27aaa1	107	9914	Elmer Baxter	......	1932	6	198	......	......	......	+0.8	Top of concrete pump base	+8.0	4-12-1944	......	DI	72	122 feet of 6-in. casing.
(S-20-61) 27aaa2	181	......	R. B. Saunders	J. L. Filby	1940	4	200	190–200	114–118	......	+1.0	Top of 4-in. collar	+4.7	4-13-1944	......	DI	....	Log.
(S-20-61) 27abb1	319	......	P. A. Simons	......	1930	4	310	......	......	......	......	......	......	......	......	DI		
(S-20-61) 27abc1	169	10612	U. S. Department of Interior, Bureau of Indian Affairs	......	1931	8	553	......	......	......	......	......	......	......	13	DI	76	No flow in summer.
(S-20-61) 27acc1	105	9653	Wilson and Mikkelsen	......	1928	6	900	......	......	......	+0.0	Top of 6-in. casing	+71.61	4-10-1944	......	P		
(S-20-61) 27acc2	320	......	P. P. Young	......	......	....	320	......	......	......	......	......	......	......	......	....	....	Well destroyed.
(S-20-61) 27acd1	209	......	Oppedyk Dairy	Joe Evans	1937	....	1000	......	......	......	......	......	......	......	......	DI		
(S-20-61) 27ada1	173	......	Harold Case	......	1933	8	280	......	......	......	+1.4	Top of 8-in. welded cap	+7.4	5-29-1944	......	DI		
(S-20-61) 27adb1	213	......	State of Nevada, Department of Highways	......	1912	....	......	......	......	......	......	......	......	......	......	....	....	Analysis; well destroyed.
(S-20-61) 27adb2	351	......	Gay Myers	......	1940	....	265	......	......	......	......	......	......	......	......	DI		
(S-20-61) 27adc1	158	......	State of Nevada, Department of Highways	......	......	6	270	......	......	......	......	......	......	......	......	....		Well destroyed.
(S-20-61) 27add1	157	......	Mina Stewart	Anderson	......	8	265	......	......	......	+1.1	Top of 8-in. casing	+18.7	4-12-1946	46	DI	71	
(S-20-61) 27add2	211	......	V. Richardson	......	......	4	......	......	......	......	......	......	......	......	......	DI		
(S-20-61) 27bad1	321	......	Fred Remick	......	......	6	......	......	......	......	......	......	......	......	......	DI		
(S-20-61) 27bbb1	......	......	Cal Henry	......	......	6	......	......	......	......	+0.5	Top of cap on casing	+26.8	4-13-1946	17	DI		
(S-20-61) 27caa1	322	......	Matt Kelly	Floyd Francis	1924	6	283	......	......	......	+2.0	Top of 1-in. pipe	—7.54	4- 8-1946	......	N		
(S-20-61) 27caa2	......	......	Jack Reynolds Estate	......	1923	10	300	......	......	......	+1.0	Top of 1-in. pipe in cap	—7.40	4- 8-1946	......	N		
(S-20-61) 27cac1	334	......	Steve Tibbitts	......	1922	6	385	......	......	......	......	......	......	......	......	N		
(S-20-61) 27cba1	335	......	Baldwin	......	1923	8	......	......	......	......	+1.0	Top of 8-in. collar on casing	—9.00	4- 8-1946	......	N		
(S-20-61) 27cbc1	336	......	Clyde Caskey	......	1923	8	......	......	......	......	+1.1	Inside of valve seat	—9.51	4-19-1944	......	N,O		
(S-20-61) 27cbd1	333	......	M. E. Ward	......	1924	4	472	......	......	......	......	Top of 4-in. casing	......	......	......	N		

TABLE 2—*Continued.*

										Measuring Point			Pressure Head or Water Level		Yield (gallons a minute)			
Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Altitude	Above (+) or Below (—) Land Surface (feet)	Description	Above (+) or Below (—) Measuring Point (feet)	Date of Measurement	Flow	Use	Temperature (°F)	Remarks
(S-20-61) 27cdd1	276	......	William Goodwin	Floyd Francis	1924	6	357	......	......	......	+1.2	Hole in well cap	—5.00	4- 9-1946	......	N	....	Analysis.
(S-20-61) 27daa1	180	10439	Las Vegas Land and Water Co.	John Frewalt	1939	8	323	......	......	......	......	......	......	......	80	DI	73	Log.
(S-20-61) 27dcc1	108	939	City of Las Vegas	Joe Evans	1936	8	925	......	......	......	+1.8	2-in. to 1-in. reducer	+61.21	2-29-1944	......	DI		
(S-20-61) 27dcd1	101	9602	City of Las Vegas	......	1932	8	626	......	......	......	+1.4	Top of 6-in. tee	+27.2	5- 5-1944	......	DI		
(S-20-61) 28aba1	......	......	......	......	......	60	10	......	......	......	0.0	Top of plank well cover	—8.95	2- 8-1945	......	S,O		
(S-20-61) 28bbd1	303	......	E. H. Thomas and H. W. Polk	Floyd Francis	1912	8	690	......	......	......	+1.25	Top of 8-in. tee	+25.3	4-19-1944	54	DI	74	
(S-20-61) 28bca1	304	......	E. H. Thomas and H. W. Polk	......	......	4	......	......	......	......	+1.5	Top of 4-in. tee	—3.85	4-19-1944	......	....	....	Plugged in 1946 and replaced by (S-20-61) 28bca2.
(S-20-61) 28bca2	477	11421	E. H. Thomas and H. W. Polk	Las Vegas Drilling Co.	1946	10	710	......	......	......	+2.35	Top of 10-in. tee	+26.8	2-26-1946	70	P	....	Log.
(S-20-61) 28cac1	195	10474	Robert Bunker	......	1932	8	820	......	......	2,065.56	+1.1	Top of collar on casing	+43.0	3-28-1944	150	DI	76	
(S-20-61) 28cad1	118	10245	E. A. Honrath	Bert Hairgrove	1940	6	650	636-650	320-385 404-450 540-550	2,059.19	+2.3	Top of 2-in. cap on line 16.2 feet south of well	+50.82	2-29-1944	......	DI	74	Log.
(S-20-61) 28cbd1	12	10293	T. J. Thebo	John Frewalt	1938	8	650	635-650	284-332	2,068.13	+1.65	⅛-in. plug in casing	+24.1	7-20-1944	50	DI,O	74	Analysis; log.
(S-20-61) 28cda1	403	10951	V. K., M. G., L. V. Clement and Lee Waite	Joe Evans	1944	8	690	685-690	440-455 508-509 634-635	2,057.04	+1.12	Top of 8-in. collar on casing	+23.8	8- 8-1944	50	N	76	Analysis; log.
(S-20-61) 28cdb1	359	10675	E. and J. Bunker	Bert Hairgrove	1941	8	350	......	......	2,062.02	+3.1	Top of 8-in. welded cap	+11.6	2-24-1944	8	DI	72	
(S-20-61) 28cdb2	410	......	E. and J. Bunker	Bert Hairgrove	1942	6	350	......	......	2,061.43	+2.5	Top of 6-in. welded cap	+12.7	2-29-1944	8	DI	72	
(S-20-61) 28dac1	199	......	J. A. Haggard	Floyd Francis	1916	6	805	600-685	......	2,047.07	+3.8	⅛-in. plug in casing	+46.2	1-17-1944	75	DI,O	....	Analysis.
					1916	8	368?	......	?-368	2,045.16	+1.0	⅛-in. plug in 1-in. line 10 ft. from well	+20.8	1-17-1944	30	N,O	72	Analysis.
(S-20-61) 28dac2	200	......	J. A. Haggard	......	1928	6	320	......	......	2,043.74	+1.0	Top of bolt on 6-in. pump flange	+5.9	5-29-1944	30	DI	74	
(S-20-61) 28dac3	......	......	J. A. Haggard	J. A. Haggard	1928	60	18	......	......	2,043.74	+1.0	Top of bolt on 6-in. pump flange	—4.94	4-23-1945	......	N,O		
(S-20-61) 28dbc1	197	......	Hutchinson	......	1924	8	323	......	......	2,056.20	+1.4	Top of 6-in. to 8-in. bushing	+6.93	2-25-1944	10	DI	70	Cleaned out by O. G. Hairgrove, June 17, 1943.

TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Measuring Point: Altitude	Measuring Point: Above (+) or Below (—) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (—) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-20-61) 28dbd1	196	.....	A. Hermen-get	.....	1924	10	390	.....	.....	2,050.56	.....	Top of 6-in. to 4-in. reducer on casing	.....	.....	.....	DI	72	No flow in summer.
(S-20-61) 28dbd2	198	11143	Lola Buck	.....	1920	6	420	.....	.....	2,047.81	+1.5	Top of 6-in. valve connection	+5.25	4-28-1944	5	DI	72	
(S-20-61) 29ada1	332	.....	Arthur Lyon	.....	.....	8	.....	.....	.....	.....	0.0	Top of 8-in. casing	+6.4	4-19-1944	47	DI		
(S-20-61) 29cbb1	81	10720	T. E. Sharp	.....	.....	8	375	.....	.....	2,140.68	0.0	Top of 4-in. tee	+6.4	4-19-1944	30	DI	72	Cleaned out by Floyd Francis in 1921.
(S-20-61) 29cbc1	82	10721	T. E. Sharp	Floyd Francis	1921	7⅝	495	.....	.....	2,139.07	+1.0	Top of 6-in. plug on 4-way tee	+7.9	4-19-1944	108	DI	72	Log.
(S-20-61) 29cbc2	83	10722	T. E. Sharp	Floyd Francis	1928	8	.....	.....	.....	2,119.96	+1.0	Top of 8-in. valve connection	+33.2	4-19-1944	340	DI	73	Analysis.
(S-20-61) 29ccc1	77	7201	Las Vegas Land and Water Co.	.....	1924	12	.....	.....	.....	.....	.....	.....	.....	1-15-1944	1252	P	....	Composite analyses; table 4.
(S-20-61) 29dab1	171	.....	Masek and Hennon	.....	1932	8	.....	.....	.....	2,086.39	+0.8	Top of welded cap on 8-in. casing	+20.8	2-29-1944	75	DI	69	
(S-20-61) 29dac1	99	9525	Julia Russell	Floyd Francis	1915	8	780	.....	.....	2,083.29	+1.4	Top of hose bib 40-ft. north of well	+34.7	2-21-1944	160	DI	....	Log.
(S-20-61) 29dad1	357	10669	Louis Perozzi	John Frewalt	1941	9	430	.....	.....	2,078.86	+1.25	Top of 6-in. tee	+40.0	3-22-1944	.....	DI	72	Log.
(S-20-61) 29dbb1	380	10781	John Papus	Joe Evans	1942	7⅝	475	.....	.....	2,095.26	+1.6	⅛-in. plug in casing	+21.8	8- 8-1944	160	N,O	....	Analysis; log.
(S-20-61) 29dca1	52	10434	Julia Russell	John Frewalt	1938	8	664	.....	.....	2,083.87	+0.5	⅛-in. plug in casing	+42.8	1-31-1945	170	DI,O	....	Analysis; log.
(S-20-61) 29dca2	.....	.....	Geological Survey Test Well	Geological Survey	1946	2	30	.....	.....	.....	+0.9	Top of casing	—6.34	4-23-1946	.....	O		
(S-20-61) 29ddb1	369	11051	Joe S. Ronnow	John Frewalt	1944	6	.....	.....	385-390	2,079.38	+0.9	Top of 6-in. collar on casing	+8.5	10-18-1944	15	DI	....	Log.
					1944	4	412	421-431	.....	2,079.38	+0.9	Top of 6-in. collar on casing	+16.3	10-18-1944	15	DI	....	Log.
(S-20-61) 30adb1	438	11103	L. H. Tritle	Bert Hairgrove	1945	10	322	264-318	180-200	.....	+2.5	Top of welded cap	+17.6	6-22-1945	175	DI	72	Log.
(S-20-61) 30baa1	115	10182	City of Las Vegas	Joe Evans	1937	9⅝	680	380	200 670	2,182.79	+2.9	Top of 12-in. tee	+9.5	4-18-1944	.....	P,DI		
(S-20-61) 30bbb1	109	8173	City of Las Vegas	Joe Evans	1927	8	322	.....	.....	2,202.51	—1.0	Top of 2-in. tee	—5.19	2-20-1945	.....	P,DI	....	Analysis.
(S-20-61) 30bbb2	110	9940	City of Las Vegas	Joe Evans	1937	7⅝	830	750	250 440 470 665	2,199.00	+2.0	Top 8-in. casing	.....	.....	.....	N,O		

TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Measuring Point: Altitude	Measuring Point: Above (+) or Below (−) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (−) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute) Flow	Use	Temperature (°F)	Remarks
(S-20-61) 30bcc1	......	....	Geological Survey Test Well	Geological Survey	1946	2	33	....	....	....	+0.5	Top of casing	—14.85	4-19-1946	....	O	....	Log.
(S-20-61) 30dda1	179	10458	Las Vegas Land and Water Co.	Hall-Baker Exploration Co.	1940	16	800	650-734	290-360 770-790	2,123.67	+3.0	Top of ⅛-in. valve on check valve	+64.7	2-18-1944	650	P	....	Composite analysis, table 4; log.
(S-20-61) 30dda2	366	10706	Las Vegas Land and Water Co.	Hall-Baker Exploration Co.	1941	13⅜	489	300-383	445-477	2,124.50	+4.2	Top of ¼-in. tee on air line	+31.2	2-18-1944	225	P	....	Composite analysis, Table 4; log. 840 G. M. pumped during 1944.
(S-20-61) 31aad1	114	10127	Las Vegas Land and Water Co.	Roscoe Moss Co.	1936	12	802	575-802	325-407	2,149.02	0.0	Top of 12-in. discharge pipe	+38.2	2-18-1946	844	P	....	Composite analysis, Table 4.
(S-20-61) 31aad2	367	10707	Las Vegas Land and Water Co.	Hall-Baker Exploration Co.	1942	13⅜	500	280-490	....	2,140.42	+3.22	Top of ¼-in. ell on air line	+30.0	2-18-1946	388	P	....	Composite analysis, Table 4; log. 840 G. M. pumped during 1946.
(S-20-61) 31ada1	277	10508	Las Vegas Land and Water Co.	Hall-Baker Exploration Co.	1940	16	801	535-801	285-475	2,137.61	+3.2	Top of ⅛-in. plug on air line	+49.7	2-18-1946	264	P	....	Composite analysis, Table 4; log. 480 G. M. pumped during 1946.
(S-20-61) 31add1	398	10867	Las Vegas Land and Water Co.	Hall-Baker Exploration Co.	1942	13⅜	485	360-400	270-320	2,128.88	+3.5	Top of upper flange on 12-in. 4-way tee	+50.8	2-18-1946	480	P	....	Composite analysis, Table 4; log. 809 G. M. pumped during 1946.
(S-20-61) 31dab1	399	10868	Las Vegas Land and Water Co.	Hall-Baker Exploration Co.	1942	13⅜	766	560-680	320-380 730-750	2,132.18	+3.2	Top of 12-in. flange on 4-way tee	+54.9	2-18-1946	575	P	....	Composite analysis, Table 4; log.
(S-20-61) 31dac1	457	11249	Las Vegas Land and Water Co.	Hall-Baker Exploration Co.	1945	10¾	940	550-750	230-365 800-904	2,131.90	0.0	Top of concrete platform at NW corner of sump	+56.3	2-18-1946	1800	P	....	Log.
(S-20-61) 31ddb1	400	10869	Las Vegas Land and Water Co.	Hall-Baker Exploration Co.	1942	13⅜	472	280-350	....	2,135.47	+2.9	Top of 12-in. flange on 4-way tee	+50.8	2-18-1944	786	P	....	Composite analysis, Table 4; log.
(S-20-61) 31ddc1	401	10870	Las Vegas Land and Water Co.	Hall-Baker Exploration Co.	1942	13⅜	1250	500-800	290-390 840-920 1100-1150	2,140.92	+3.85	Top of 8-in. to 12-in. flange	+48.3	2-18-1944	2023	P	....	Composite analysis, Table 4; log.
(S-20-61) 32acb1	16	....	R. B. Griffith	J. L. Filby	1930	8	363	....	....	....	+4.5	Top of casing	—1.10	12-21-1940	....	N,O	....	Plugged in 1944.
(S-20-61) 32acb2	390	10791	R. B. Griffith	Joe Evans	1942	8	660	640-660	400	....	+1.8	⅛-in. plug in casing	+71.5	8-22-1944	340	DI,O	77	Analysis; log.
(S-20-61) 32acc1	456	11246	R. B. Griffith	Las Vegas Drilling Co.	1946	10	695	....	....	2,096.02	+3.1	Top of cap on 12-in. casing	....	2-27-1946	150	P	76	Log.
(S-20-61) 32cdc1	465	11323	Kenneth Searles	Joe Irwin	1946	10	585	....	....	2,102.14	+1.5	Top of 10-in. tee	+79.8	2-27-1946	360	DI		
(S-20-61) 32cdd1	464	11306	E. W. and L. Cragin	Tommy Miller	1946	10	575	....	....	2,094.46	+1.4	Top of 10-in. welded cap	+68.8	3-25-1946	....	DI	....	Log.
(S-20-61) 32dab1	510	....	J. L. Filby	J. L. Filby	1946	8	100	....	....	....	+1.2	Top of casing	—8.11	4-18-1946	....	DI		

TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Altitude	Measuring Point: Above (+) or Below (—) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (—) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-20-61) 32dab2	511	....	J. L. Filby	J. L. Filby	1946	8	100	....	....	....	+0.3	Top of casing	—7.93	4-18-1946	....	DI		
(S-20-61) 32dac1	508	....	J. L. Filby	J. L. Filby	1946	8	100	....	....	....	+1.2	Top of casing	—8.56	4-18-1946	....	DI		
(S-20-61) 32dac2	509	....	J. L. Filby	J. L. Filby	1946	8	....	....	....	....	....	....	....	....	....	....	....	Well not finished in April, 1946.
(S-20-61) 32dbd1	507	....	J. L. Filby	J. L. Filby	1946	8	100	....	....	....	+0.4	Top of casing	—4.05	4-18-1946	....	DI		
(S-20-61) 32dcb1	17	11166	R. H. Morrison	J. L. Filby	1928	8	616	....	....	....	0.0	Top of casing	+70.5	8- 4-1944	....	DI	72	
(S-20-61) 32dda1	346	10574	Adrian Kuffer	J. L. Filby	1940	5⅝	418	370-408	....	2,071.29	+1.9	Top of 6-in. tee	+18.5	3- 9-1944	120	DI	72	Log.
(S-20-61) 32ddb1	201	11271	M. R. Russell	....	1932	8	....	....	....	2,075.62	+0.8	Top of 4-in. ell	+27.7	2-19-1946	....	DI		
(S-20-61) 32ddb2	394	10847	M. R. Russell	Joe Evans	1943	10	644	500-644	400-410 496-500	2,075.02	+0.3	Top of 12-in. casing	+32.7	8- 4-1944	75	DI	72	Log.
(S-20-61) 32ddd1	120	10301	H. D. Gerken	J. L. Filby	1939	5⅝	407	345-410	332-342	....	+1.9	Top of 6-in. valve	+19.6	3- 6-1944	....	DI	....	Log.
(S-20-61) 33bcb1	....	....	Freeman Rogers	....	....	8	75	....	....	....	....	Cannot measure water level				N		
(S-20-61) 33bcc1	91	10797	H. A. Studwell	J. L. Filby	1925	6	525	375-400	330-335	2,068.51	+2.0	Top of 6-in. ell	+13.3	8-12-1944	44	DI	72	Log; 375 feet of casing.
(S-20-61) 33bcc2	....	....	....	....	....	6	75	....	....	....	+0.2	Top of casing	—4.61	4-18-1946	....	N		
(S-20-61) 33cba1	204	....	J. L. Filby	J. L. Filby	1938	8	426	....	....	2,061.91	....	Top of 8-in. casing leading from ell	....	....	....	DI		
(S-20-61) 33cbc1	203	....	J. L. Filby	Floyd Francis	1913	8	400	338-376	....	2,068.27	0.0	End of ¾-in. line 20 feet south of well	+18.5	3- 6-1944	....	DI	72	Log.
(S-20-61) 33cca1	205	10471	E. H. Allen	E. H. Allen	1938	3	400	390-400	320-340	2,059.59	+1.0	¾-in. hose bib	+17.2	10-30-1945	15	DI,O	71	Analysis; log.
					1938	1	200	200-210	....	....	+1.0	¾-in. hose bib	+6.4	10-30-1945	....	DI,O	70	Analysis; log.
(S-20-61) 33cca2	206	....	Ed Strong	Ed Strong	1938	4	226	....	....	2,055.97	+1.7	Top of 1-in. tee on suction pipe of pump	—0.2	5-12-1944	....	DI	....	Analysis.
(S-20-61) 33cca3	383	10786	Margaret Folsom	J. L. Filby	1942	5⅝	400	390-400	280-290	2,056.04	+2.5	1-in. line by garage	+32.3	2-21-1944	....	DI	....	Log.
(S-20-61) 33ccb1	14	10035	A. W. Blackman	....	1936	6	400	....	....	2,062.97	+2.4	Top of 6-in. tee	+23.1	3- 3-1944	60	DI	72	
(S-20-61) 33ccb2	15	....	Myrtle Tate	....	1912	8	425	....	....	....	+2.4	Top of 8-in. to 4-in. reducer	+13.9	3- 3-1944	25	DI	72	Analysis; well leaks around casing.
(S-20-61) 33ccc1	183	....	Woodland Park	....	1912	8	360	....	....	2,063.85	0.0	4-in. pump flange	+23.1	3- 3-1944	....	P		
(S-20-61) 33ccd1	202	....	Clark County Hospital	Diskin	1926	8	386	....	....	....	+0.8	Top of 8-in. welded cap	+7.8	6- 6-1944	12	N	....	Tools lost in well when drilled.

TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Measuring Point: Altitude	Measuring Point: Above (+) or Below (−) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (−) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-20-61) 33cdb1	207	....	John Ullom	....	1912	8	401	....	....	2,057.37	+3.0	Top of pump	....	....	....	DI		
(S-20-61) 33cdc1	328	10580	G. C. Blaine and Clifford A. Jones	Pat Thompson	1940	5⅝	492	432–450	....	....	+0.9	Top of 2-inch welded outlet	+30.0	3- 6-1944	20	DI	69	Log.
(S-20-61) 33dad1	13	....	Mrs. Frank Beam	J. L. Filby	1938	8	600	....	....	....	+1.0	Top of casing	+27.7	3-27-1944	....	DI	....	Log.
(S-20-61) 34aaa1	230	....	Tom Keeler	....	1926	6	600	....	....	....	+2.4	Top of collar on casing	+17.6	4-12-1946	....	N	73	
(S-20-61) 34aab1	163	....	Ralph Stone	....	1925	8	....	....	....	....	+1.3	Top of casing	+20.9	4-12-1946	....	N	72	
(S-20-61) 34aab2	388	10725	J. Sigurdson	Pat Thompson	1941	6	480	....	....	....	+1.0	Top of pump base	+5.03	4-12-1946	....	DI	75	
(S-20-61) 34acd1	174	10391	Richard Clough	Joe Evans	1940	6⅝	290	....	....	....	....	....	....	....	....	DI		
(S-20-61) 34adb1	229	....	W. B. Mundy	....	1913	8	160	....	....	....	+1.0	Top of 4-in. tee	+6.0	3- 7-1944	....	N		
					1913	4	814	530	....	....	....	....	+5.5	3- 7-1944	....	N		
(S-20-61) 34adc1	47	....	S. W. Craner	Floyd Francis	1913	8	354	....	....	....	+1.0	Top of 8-inch cap on casing	+32.3	3-19-1944	....	DI,O	69	Analysis; log.
(S-20-61) 34adc2	326	....	S. W. Craner	....	1913	8	....	....	....	....	+1.5	Top of 8-in. to 4-in. bushing	+20.8	4-29-1944	....	N		
(S-20-61) 34adc3	327	....	S. W. Craner	....	1926	8	....	....	....	....	+1.3	Top of 8-in. to 2-in. bushing	+4.05	4-29-1944	....	N		
(S-20-61) 34add1	232	....	J. H. Ladd Estate	....	1912	....	370	....	....	....	+2.0	Top of 4-in. ell	+18.8	5-29-1944	....	DI		
(S-20-61) 34add2	497	....	Sam Mikulich															
(S-20-61) 34bcb1	159	....	Union Pacific Railroad	....	....	....	....	....	....	....	....	....	....	....	....	DI	....	Analysis.
(S-20-61) 34dbb1	182	10466	P. J. Goumond	Joe Evans	1940	5⅝	638	....	....	....	....	Land surface	+42.0±	4- 2-1940	66	DI	....	Log.
(S-20-61) 34dbb2	353	*10717	Max Tenesch	Pat Thompson	1941	....	350	....	....	....	....	....	....	....	....	DI		
(S-20-61) 34ddb1	498	....	Unknown															
(S-20-61) 35bcb1	231	....	Jake Garehime	Floyd Francis	1926	4	820	....	....	....	+3.45	Top of 2-in. tee	+24.0	3-25-1944	30	DI	72	Sanded up to 430 ft.; 4-in. casing to unknown depth; 3-in. casing to unknown depth.
(S-20-61) 35cac1	362	*10697	E. A. Clark	Pat Thompson	1941	8	470	407–438	146–150 258–263	....	....	....	....	....	....	DI	68	Log.
(S-20-61) 35cbb1	233	....	J. H. Ladd Estate	O. G. Hairgrove	1940	6	410	410–420	....	....	+2.72	⅛-in. plug in casing	+27.7	3-10-1944	....	N,O	....	Log.
					1940	4	795	600–650	....	....	+2.72	⅛-in. plug in casing	+49.7	3-10-1944	....	N,O	....	Log.
(S-20-61) 35cbb2	363	10702	H. & G. Stocker	Pat Thompson	1941	8	460	400–460	....	....	+1.7	Top of 8-in. collar on casing	+9.6	9-19-1945	12	DI	....	Analysis.

*Canceled.

TABLE 2—*Continued.*

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(S-20-61) 35dbd1	78	....	Mrs. Frank Beam	....	....	6	475	....	....
(S-20-61) 35dca1	210	....	Pat's Patio	....	1931	8	412	....	....
(S-20-61) 35dcb1	95	*9520	E. A. Clark Estate	....	1925	4	290	....	....
(S-20-61) 35ddc1	50	10152	Marie O. Lawton	Joe Evans	1937	8	350	....	....
(S-20-61) 35ddc2	368	10713	Estella Beam	John Frewalt	1941	8	418	....	....
(S-20-61) 36bac1	473	11241	C. K. and A. M. Ryerse	John Frewalt	1946	8	470	....	....
(S-20-61) 36bbb1	393	10844	A. C. Delkin	Bert Hairgrove	1942	7⅝	325	300-325	....
(S-20-61) 36bbb2	280	....	Charles Haller	....	1934	4	340	320-340	....
(S-20-61) 36bbc1	422	10996	W. M. Metzer	John Frewalt	1944	6	365	265-271	171-175 340-344 354-365
(S-20-61) 36bcb1	405	10919	K. G. Speirs	John Frewalt	1943	7	340	330-340	170-180
(S-20-61) 36bdb1	281	11095	Odd Johnson	Jennings	1929	.6	235	....	....
(S-20-61) 36bdc1	282	....	Thomas M. and Anne Metcalf	....	1929	6	....	....	....
(S-20-61) 36cbc1	......	....	Geological Survey Test Well	Geological Survey	1945	1	25	....	....
(S-20-61) 36cca1	325	10503	E. A. Clark Estate	Bert Hairgrove	1940	5⅝	637	220-225	....
(S-20-61) 36cca2	462	11284	Sunrise Acres Water Association	Bert Hairgrove	1946	8	500	....	....
(S-20-61) 36ccb1	459	11263	L. G. and M. C. Biel	J. E. Metz	1945	10	346	270-282	135-145 158-167 341-342
(S-20-61) 36ccc1	104	9652	E. A. Clark Estate	....	1932	8	465	....	....
(S-20-61) 36ccd1	463	11207	William Clark	A. W. House	1945	10	200	....	....
(S-20-62) 3bbd1	......	....	Las Vegas Army Air Field	Joe Evans	1941	8	242	120-260	....
(S-20-62) 4acb1	371	10734	Aeroville Corporation	....	1942	6	680	....	....

*Canceled.

Well No. and Location	Measuring Point: Altitude	Measuring Point: Above (+) or Below (—) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (—) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-20-61) 35dbd1	....	+1.2	Top of 6-in. well cap	+50.5	3-30-1944	....	DI		
(S-20-61) 35dca1	....	+1.0	Top of 8-in. welded tee	+41.6	3-10-1944	....	DI		
(S-20-61) 35dcb1	....	+1.88	Top of 4-in. tee	+37.0	3-10-1944	....	DI		
(S-20-61) 35ddc1	....	0.0	⅛-in. plug in casing	+38.1	3-21-1943	....	DI,O	68	
(S-20-61) 35ddc2	....	+1.7	Top of 8-in. tee	+29.7	9-19-1945	46	N,O	71	Analysis; log.
(S-20-61) 36bac1	....	+1.3	Top of 8-in. welded cap	+13.0	3- 6-1946	11	DI	....	Log.
(S-20-61) 36bbb1	....	+2.5	Top of 8-in. welded cap	+24.3	3-27-1945	35	DI,O	69	Analysis; log.
(S-20-61) 36bbb2	....	+3.0	¾-in. stand pipe 45 feet east of well	+27.7	3-10-1944	....	DI		
(S-20-61) 36bbc1	....	+1.6	Top of 6-in. welded cap	+8.3	3-25-1944	37	DI	68	Log.
(S-20-61) 36bcb1	....	+2.1	Top of 6-in. welded cap	+34.7	3-10-1944	35	DI	69	Log.
(S-20-61) 36bdb1	....	0.0	Top of 1-in. ell	+7.2	3-28-1944	7	DI	....	225 feet of 6-in. casing
(S-20-61) 36bdc1	....	+2.5	Top of 6-in. bushing	+18.5	3-28-1944	....	DI		
(S-20-61) 36cbc1	....	+1.0	Top of casing	—7.84	4-25-1946	....	O	....	Log.
(S-20-61) 36cca1	....	+2.0	Middle point of 6-in. tee	+27.7	3-16-1944	32	P	....	Log.
(S-20-61) 36cca2	....	+2.0	Top of 2-in. valve east side of well	+19.8	1-24-1946	23	P	72	Log.
(S-20-61) 36ccb1	....	+0.3	Top of 10-in. casing collar	+15.0	9——1945	34	P	....	Log.
(S-20-61) 36ccc1	....	+2.6	Top of 8-in. to 4-in. welded reducer	+32.3	2-16-1944	....	DI	70	
(S-20-61) 36ccd1	....	+2.3	Top of 8-in. welded cap	+11.35	1-24-1946	4	P	....	Log.
(S-20-62) 3bbd1	....	+1.35	Top of casing	—61.35	7-27-1945	....	N	....	Log.
(S-20-62) 4acb1	....	+0.80	Top of casing	—65.80	4-25-1946	....	DI		

TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Altitude	Measuring Point: Above (+) or Below (—) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (—) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-20-62) 4add1	416	....	Las Vegas Army Air Field	Joe Evans	1942	16	800	....	....	....	0.0	Land surface	—20.0	4-19-1942	....	P	....	Analysis; log. 400 G. M. pumped with 180 ft. of draw-down in 1942.
(S-20-62) 4dca1	417	....	Las Vegas Army Airfield	Brockman Drilling Co.	1942	16	795	....	....	....	0.0	Land surface	—51.0	8——1942	....	P	....	Log; 200 G. M. pumped with 80 feet of draw-down in 1942.
(S-20-62) 18bbc1	514	....	A. L. Simpson	A. L. Simpson and O. G. Hairgrove	1944	8	700	....	....	....	+1.0	Top of 6-in. by 6-in. timber across well	—41.05	8-23-1944	....	N,O		
(S-20-62) 18bbc2	460	11340	G. W. and Inez Rittenhouse	John Frewalt	1946	8	203	180-203	....	....	0.0	Land surface	—42.0	8- 9-1945	....	P	....	Log.
(S-20-62) 19ab	....	....	William Hardin	....	....	60	32	....	....	....	0.0	Top of 2-in. by 6-in. timber across well	—30.5	3-29-1946	....	N,O		
(S-20-62) 19acc1	....	....	J. E. Metz	J. E. Metz	1944	8	125	....	....	....	+3.0	Metal pump base	—27.03	5- 5-1945	....	DI	....	2 G. M. pumped during 1945.
(S-20-62) 19bab1	445	....	Joe Hannig	J. E. Metz	1944	8	140	....	....	....	....	....	....	....	....	DI	....	Log; 2 G. M. pumped during 1945.
(S-20-62) 19bbb1	444	....	C. C. Maracci	Joe Evans	1940	12	289	....	....	....	+0.5	Top of cement block	—28.38	11-24-1945	....	DI	....	Analysis; 22 G. M. pumped during 1945; 8 feet of draw-down when pumping 22 G. M. 60 ft. of 12-in. casing.
(S-20-62) 19bcc1	443	....	Byron Thornton	J. E. Metz	1945	8	150	....	....	....	+1.0	Top of casing	—31.12	3-29-1946	....	DI,O	....	Log; 2 G. M. pumped during 1946.
(S-20-62) 19bdd1	446	....	J. E. Hardin	J. E. Metz	1944	....	125	....	....	....	+0.5	Top of wooden platform	—27.28	5- 5-1945	....	DI,O	....	Log; 2 G. M. pumped during 1945.
(S-20-62) 19cab1	442	11277	W. E. Sayler	J. E. Metz	1944	6	200	....	....	....	+0.5	Top of metal pump base	—30.34	3-29-1946	....	DI,O	....	Log; 2 G. M. pumped during 1946.
(S-20-62) 19dba1	447	....	I. H. Ault	J. E. Metz	1944	9	128	....	....	....	+1.0	Top of metal pump base	—26.23	5- 5-1945	....	DI,O	....	Log; 2 G. M. pumped during 1945.
(S-20-62) 19dbb1	448	....	William Hardin	J. E. Metz	1944	8	120	....	....	....	+0.8	Top of pump base	—27.18	3-29-1946	....	N,O	....	2 G. M. pumped during 1946.
(S-20-62) 20cb	....	....	....	....	....	60	35	....	....	....	0.0	Top of wooden stake south-side of well	—31.00	3-29-1946	....	N,O		
(S-20-62) 32bba1	....	....	Walter Mansfield	....	....	60	23	....	....	....	0.0	Top of plank well cover	—13.48	3-29-1946	....	N,O		
(S-20-62) 32bbb1	489	....	E. B. and Margie Grubb	A. W. House	1944	8	500	....	....	....	+1.7	Top of casing	—16.97	3-29-1946	....	S, DI,O	67	Log; 2 G. M. pumped during 1946.

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TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Altitude	Measuring Point: Above (+) or Below (−) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (−) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-20-62) 33ccc1	......	....	Geological Survey Test Well	Geological Survey	1946	1	32	....	....	....	+0.6	Top of casing	—23.82	4-25-1946	......	O	....	Log.
(S-21-61) 1aab1	234	10623	H. J. Scott, Trustee, Meadows Addition	....	1930	8	510	....	....	....	+2.0	Top of 4-in. tee 4-ft. from well house	+4.0	4- 3-1944	12	DI		
(S-21-61) 1aab2	376	*10753	C. B. Henderson	....	1935	....	......	....	....	....	......	....	......	....	......	DI		
(S-21-61) 1aba1	395	10848	R. J. Kaltenborn	Joe Evans	1942	10	810	....	....	....	......	....	......	....	......	DI	....	Log.
(S-21-61) 1bba1	414	....	Colony Club	Bert Hairgrove	1942	6	345	....	....	....	......	....	......	....	......	DI	....	Log.
(S-21-61) 1bbb1	219	....	J. C. Fisher	....	......	8	......	....	....	....	+1.0	Top of 8-in. to 4-in. bushing	+32.3	3- 7-1944	......	DI		
(S-21-61) 1bda1	415	....	R. J. Kaltenborn	Joe Evans	1942	8	760	....	....	....	......	....	......	....	......	DI	....	Log; leak on outside of casing.
(S-21-61) 1cdc1	84	....	S. Whitehead	....	1926	6	......	....	....	....	0.9	Top of 6-in. to 3-in. bushing	+3.6	4- 3-1944	14	DI	70	
(S-21-61) 2cbb1	51	....	Henry Hunt	Floyd Francis	1926	6	1120	....	....	1,997.15	+1.0	Top of 6-in. to 4-in. bushing	+38.4	8-21-1944	75	N,O	83	Analysis; log.
(S-21-61) 2cbb2	......	....	Geological Survey Test Well	Geological Survey	1946	1½	20	....	....	....	+1.0	Top of casing	—10.27	4-24-1946	......	O	....	Log.
(S-21-61) 2dcc1	90	*10830	R. J. Kaltenborn	Floyd Francis	1913	8	398	....	....	....	+1.0	Top of 4-in. to 8-in. bushing	—50.7	4- 3-1944	......	DI	74	Log.
(S-21-61) 2ddc1	106	9885	B. Dennison	Joe Evans	1828	8	260	....	....	....	......	....	......	5-31-1943	20	DI	72	Log; leak on outside of casing.
(S-21-61) 3abb1	54	....	....	....	1907	....	442	....	....	....	......	....	......	....	......	N	....	Well not located in 1945.
(S-21-61) 3abb2	238	....	W. S. Sparks	....	1912	12-8	......	Shallow	....	....	+2.3	Top of 4-way tee	+8.9	3-26-1946	......	DI,O	70	Analysis.
					1912	4	807	Deep	....	....	+2.3	....	+32.9	3-26-1946	......	....	....	Analysis.
(S-21-61) 3abb3	239	....	Dutton	....	1924	6	......	....	....	....	+1.4	Top of 4-in. tee	+0.6	4-25-1944	......	N	70	
(S-21-61) 3baa1	237	....	S. J. Lawson	Floyd Francis	1925	4	403	365-400	....	....	+0.7	Top of 1½-in. valve 39 feet south of well	+13.9	3- 6-1944	10	DI	73	Log.
(S-21-61) 3baa2	349	....	Al Corradetti	....	1923	6	......	....	....	....	+3.0	Top of 4-inch 4-way tee	—2.10	9-17-1945	......	N,O	70	
(S-21-61) 3bab1	236	....	James Fulcher	....	1927	6	400	....	....	....	......	Cannot measure water level........				DI	73	10 G. M. pumped during 1946.
(S-21-61) 3bac1	235	....	Home Auto Court	....	1926	6	400	....	....	....	......	....	......	....	......	DI		
(S-21-61) 3bcc1	67	10392	Michael Paps	....	1912	6	725	....	....	....	......	....	......	....	......	DI	74	
(S-21-61) 3bcc2	172	10392	Michael Paps	Mizer	1933	10	810	....	....	....	......	....	......	....	......	DI	74	Analysis.

*Canceled.

TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Altitude	Measuring Point: Above (+) or Below (−) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (−) Measuring Point (feet)	Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-21-61) 3cbb1	178	10643	Otto and Loriene Underhill	Joe Evans	1939	4	512	....	....	....	+1.7	Top of 2-inch tee	+41.6	3- 2-1944	....	N	....	Log.
(S-21-61) 3cbb2	356	10660	Wilson-Mikkelsen	Pat Thompson	1931	5⅝	666	430-432	390-398 562-582	....	+1.25	¾-in. tee 2 ft. west of well	+20.8	3- 2-1944	....	DI	....	Log.
(S-21-61) 4aab1	....	....	State of Nevada, Department of Highways	....	....	8	20	....	....	....	0.0	Top of spike at edge of well southside	—5.64	3-27-1945	....	N,O	....	Well uncased.
(S-21-61) 4aad1	386	10818	Opaco Lumber Co.	Pierce-Anderson	1942	10	793	550-780	300-310	....	+3.0	Top of plug in casing	+14.2	8-19-1944	50	N,O	74	Analysis; log.
(S-21-61) 4aba1	216	....	Peter Clos	....	....	8	....	....	....	....	....	....	....	....	....	DI		
(S-21-61) 4abb1	49	....	T. L. Roberts	....	1910	6	403	....	....	....	....	Cannot measure pressure	....	4- 9-1946	4	DI,S	71	
(S-21-61) 4abc1	75	....	Art Harris	....	1910	8	480	....	....	....	+1.35	Top of 8-in. to 4-in. bushing	+12.2	4- 9-1946	20	DI	71	
(S-21-61) 4abd1	215	....	Peter Clos	....	1913	8	750	....	....	....	+3.12	Top of ⅛-in. plug in casing	+41.6	3- 2-1944	....	DI		
(S-21-61) 4abd2	470	11091	Stoner and Myers	Joe Irvin	1946	10	400	....	....	....	....	....	....	....	....	DI	....	Well unfinished in 1946.
(S-21-61) 4aca1	469	11302	E. F. and M. Nelson	Joe Irvin	1946	10	900	882-890	550-560 595-615	....	+3.0	Top of 8-in. nipple	+33.3	1- 3-1946	184	P	77	Log.
(S-21-61) 4acb1	27	....	J. South	....	1936	8	341	....	....	....	0.0	Top of 8-in collar on casing	+15.6	4-18-1944	120	DI	72	
(S-21-61) 4acc1	425	....	David Stearns	Joe Evans	1941	8	740	....	....	....	+1.4	Top of 8-in. welded cap	+16.2	9-18-1945	75	DI	74	Small leak in valve during measurement.
(S-21-61) 4baa1	48	....	William Ellis	....	1911	8	381	....	....	....	+1.0	Top of 8-in. casing	+26.4	1-17-1944	260	DI,O	72	Analysis.
(S-21-61) 4bab1	397	10860	Nick Pahor and Martin	John Frewalt	1942	8	....	....	....	....	+1.0	Top of 8-in. to 4-in. ell	+25.4	3- 3-1944	....	DI		
(S-21-61) 4bad1	76	....	Art Harris	....	1911	8	750	....	....	....	+1.6	Top of 8-in. valve	+34.7	3- 2-1944	190	DI	74	
(S-21-61) 4bbb1	217	....	G. Heffner	....	1926	6	....	....	....	2,071.37	+0.9	Top of 4-in. tee	+18.5	3- 7-1944	130	DI	74	
(S-21-61) 4bbb2	218	....	G. Heffner	....	1926	8	710	....	....	2,068.75	+2.15	Top of 4-in. tee	+17.1	8- 4-1944	90	DI	74	
(S-21-61) 4bbb3	452	11198	E. A. Honrath	O. G. Hairgrove	1945	8	492	380-385	295-297	2,070.13	+1.3	Top of 8-in. welded cap	+18.5	12-29-1945	250	DI,S	70	Log.
(S-21-61) 4bca1	66	10988	L. G. McNeil	....	1911	8	372	....	....	....	+1.25	Top of 6-in. valve	+14.5	4-18-1944	....	DI		
(S-21-61) 4bcb1	26	10988	L. G. McNeil	....	1914	7	354	....	....	....	+1.65	Top of 7-in. casing	+9.5	4-18-1944	....	DI	....	Log.
(S-21-61) 4bcc1	64	10988	L. G. McNeil	....	1911	8	378	....	....	....	0.0	Top of 4-in. valve flange	+7.1	4-18-1944	75	DI	70	
(S-21-61) 4bda1	65	10986	L. G. McNeil	....	1913	....	430	....	....	....	....	....	....	....	....	DI	....	10 G. M. pumped during 1945.

TABLE 2—*Continued.*

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(S-21-61) 4dac1	347	10582	Theodore Michelas	Joe Evans	1940	7⅝	810	....	....	....	+3.0	Top of 4-in. ell	+46.2	3- 2-1944	66	DI		
(S-21-61) 4dac2	420	10942	Theodore Michelas	A. W. House	1944	7	650	370-391	643-647	....	+1.5	Top of welded cap	+6.9	6-19-1944	43	DI	74	Analysis; log.
(S-21-61) 4dcc1	214	....	W. McLellen	....	1912	6	382	....	....	....	....	....	....	Spring, 1945	2	DI	....	Casing rusted off at surface.
(S-21-61) 4ddb1	88	9323	Boulder Dam Insurance Co.	....	....	8	400	....	....	....	+1.75	Top of west 2-in. valve	+11.6	3- 2-1944	....	N	....	Analysis.
(S-21-61) 4ddc1	240	....	Dr. Stevenson	John Frewalt	1939	....	350	....	....	....	....	....	....	....	....	DI	....	10 G. M. pumped during 1945.
(S-21-61) 4ddd1	241	....	Tower Auto Court	....	....	8	....	....	....	....	0.0	Top of casing	+24.2	3-31-1944	37	DI	72	
(S-21-61) 5bac1	24	10987	L. G. McNeil	....	1934	8	555	....	....	2,113.13	+2.0	Top of valve	+54.6	8- 4-1944	576	DI,O	72	Well leaks 100 G. M. throughout year.
(S-21-61) 5caa1	25	....	Splane Estate	Floyd Francis	1914	8	585	....	....	....	....	....	....	8-30-1944	260	DI	72	Log; well leaks 225 G. M. throughout year.
(S-21-61) 6aca1	361	10680	J. and A. Edmonds	Pat Thompson	1941	8	288	255-288	....	2,170.65	+1.5	Top of 6-in. to 2-in. bushing	+13.2	8-31-1944	43	DI	72	Log.
(S-21-61) 6aca2	379	10761	Sebastian Mikulich	Pat Thompson and John Frewalt	1942	9	329	....	....	2,175.00	+1.5	Top of 8-in. casing	+10.4	8-30-1944	120	DI	74	Log.
(S-21-61) 6acb1	19	11283	G. D. Corey	John Frewalt	1937	6	326	....	....	2,178.04	+1.0	⅛-in. plug in casing	+16.2	11-18-1942	40	DI,O	72	20 G. M. pumped during 1942.
(S-21-61) 6acb2	20	10757	L. M. Pinjuv	....	1938	6	292	....	....	2,176.94	+0.5	Top of 4-in. valve	+16.2 +8.0	3- 2-1944 8-21-1944	47	DI	72	
(S-21-61) 6acb3	151	....	Artesian Acres	....	1931	....	259	....	....	2,176.94	0.0	Top of 1-in. line 6 feet south of well	+16.2	3- 2-1944	....	DI		
(S-21-61) 6acb4	......	....	G. D. Corey	....	....	60	31	....	....	....	0.0	Top of board well cover	—19.36	3-10-1945	....	N,O		
(S-21-61) 6acc1	21	10409	J. D. Porter	....	1937	10	394	....	....	2,179.87	+1.25	Top of 10-in. welded cap	+12.7 +5.8	3- 7-1944 8-23-1944	133	DI	73	
(S-21-61) 6acc2	22	10409	J. D. Porter	....	1934	6	224	....	....	2,176.92	+2.5	Top of 4-in. tee	+16.2 +8.6	3- 7-1944 8-23-1944	50	DI	73	
(S-21-61) 6acc3	148	10409	J. D. Porter	....	....	4	274	....	....	2,178.63	+3.0	Top of 3-in. welded ell	.... +13.9	3- 7-1944 8-23-1944	20	DI	73	
(S-21-61) 6adc1	23	....	Fred Gobeli	....	1928	6	229	....	....	2,170.03	+4.0	Top of 6-in. welded ell	.... +13.9	3- 7-1944 8-30-1944	20 12	DI	72	
(S-21-61) 6adc2	389	10787	Leo Pahor	John Frewalt	1942	6	318	292-318	....	2,166.16	+2.6	Top of 6-in. welded cap	.... +23.1	3- 7-1944 8-30-1944	36	DI	72	Log.
(S-21-61) 6adc3	480	11175	E. M. and A. M. Ladd	O. G. Hairgrove	1946	8	360	348-360	....	....	+1.0	Top of 8-in. casing collar	+18.8	4- 2-1946	62	DI	72	Log.
(S-21-61) 6bdb1	409	....	J. R. Lewis	Pat Thompson	1942	8	350	305	....	2,196.21	+5.0	Top of casing	—8.37	3-22-1946	....	N,O	....	260 feet of 8-in. casing.
(S-21-61) 7acc1	155	....	Kimball-Williams	....	....	8	....	....	....	2,180.41	+1.0	⅛-in. plug in casing	+8.9	3-18-1944	15	DI,O	72	Analysis.
					....	6	355	355	....	2,180.41	+1.0	....	11.2	3-18-1944	10	DI,O	73	Analysis.

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TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Measuring Point: Altitude	Measuring Point: Above (+) or Below (−) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (−) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-21-61) 7dda1	...	11218	Robert and Josie Russell	A. W. House	1946	8	400	...	...	...	+1.0	Top of 8-in. welded cap	+9.2	3- 1-1946	16	DI		
(S-21-61) 7ddb1	474	11138	F. T. Roberts	...	1946	...	400	...	...	...	...	...	...	...	16	...	...	Log.
(S-21-61) 7ddd1	28	...	W. M. Sweet	...	...	8	360	...	...	...	+2.5	Top of 4-in. valve	+20.6	9- 1-1938	35	DI	72	6-in. casing inside.
(S-21-61) 9aab1	370	10718	T. E. Hull	Joe Evans	1941	8	...	...	...	...	...	...	...	10-10-1944	...	DI	...	210 G. M. pumped during 1944.
(S-21-61) 9aac1	341	10553	T. E. Hull	...	1940	8	550	...	...	...	+2.8	Top of 8-in. tee	+18.4	10-10-1944	160	DI		
(S-21-61) 9aad1	402	10885	M. D. Close	Joe Evans	1942	10	555	...	...	...	+2.6	Top of 10-in. tee	+30.4	3-31-1944	20	N	70	Cleaned out by Joe Irvin in 1946.
(S-21-61) 9acd1	377	10754	Vegas Valley Development Co., Ltd.	Joe Evans	1942	7⅝	550	540-550	...	...	+2.1	Top of 4-in. ell	+25.3	8-15-1944	75	N,O	70	Analysis; log.
(S-21-61) 9cdc1	451	11156	Hotel El Rancho, Inc.	Joe Irvin	1945	10	585	...	...	...	+4.1	Top of welded pump base	+15.3	7-16-1945	50	P	...	Log.
(S-21-61) 9dcb1	472	11300	L. M. and L. L. Woods	Joe Irvin	1946	10	688	...	...	...	+0.5	Top of 10-in. casing	+26.3	3-27-1946	10	P	74	Log.
(S-21-61) 9dcc1	437	11215 11227	Pacific States Theatres	O. G. Hairgrove	1945	10	600	540-580	310-315	...	+1.0	Top of 10-in. casing	+10.0	2-14-1945	50	DI	74	Log.
(S-21-61) 9dcd1	138	10813	Thomas A. Campbell	...	1928	8	530	...	...	...	+0.3	Top of 8-in. casing	+31.8	3-31-1944	30	DI		
(S-21-61) 10cdc1	329	...	Ridgeview Estate	...	1912	...	...	...	...	...	...	...	...	...	...	DI		
(S-21-61) 11bbb1	330	10520	Nevada Hotel Co.	J. L. Filby	1940	8	650	480-582	...	...	+2.3	Top of 8-in. welded cap	+16.0	8- 7-1944	25	N,O	76	Log.
(S-21-61) 12cdb1	436	11102	C. R. Martin	Bert Hairgrove	1944	8	333	...	...	...	+1.3	Top of casing	+32.0	12- 7-1944	66	DI	73	
(S-21-61) 12cdc1	455	11244	C. M. and D. M. Martin	Bert Hairgrove	1945	6	...	...	...	...	...	...	...	...	...	DI	73	
(S-21-61) 12dac1	289	11432	H. C. and N. M. Harris	Joe Evans	1939	8	310	...	...	...	...	...	...	9-17-1945	15	N	71	
(S-21-61) 12dca1	290	...	W. B. Brown	John Frewalt	1937	6	284	...	...	...	...	...	...	9-17-1945	20	DI	71	
(S-21-61) 12dcd1	291	...	F. C. Creighton	John Frewalt	1937	8	284	...	...	...	...	...	...	9-17-1945	66	DI	69	
(S-21-61)* 13bdb1	292	...	John Lisle	Joe Evans	1939	8	260	...	...	...	...	...	...	9-17-1945	72	DI	71	
(S-21-61) 14cdd1	...	...	Geological Survey Test Well	Geological Survey	1946	1½	35	...	...	...	+1.0	Top of casing	...	...	...	O	...	Log.
(S-21-61) 15bb	...	...	T. T. Schofield	...	...	60	9	...	...	...	+1.0	Top of 2-in. frame set in cement block	—7.42	3-26-1945	...	DI,O	...	2 G. M. pumped during 1945.

TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Measuring Point: Altitude	Measuring Point: Above (+) or Below (−) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (−) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-21-61) 15bcc1	478	11327	T. A. Wells	O. G. Hairgrove	1946	10	892	485-495	310-333 362-370 390-400 550-555 666-685	......	+1.0	Top of 10-in. collar on casing	+6.9	3-20-1946	133	P	....	Log.
(S-21-61) 15bdc1	33	......	L. H. Rockwell	......	1924	8	386	......	......	......	0.0	Top of 8-in. casing	+24.2 +9.5	3-30-1944 8- 7-1944	75	N	72	
(S-21-61) 16bab1	242	10497	Hotel Last Frontier	......	1930	8	600	......	......	......	......	......	......	......	......	P		
(S-21-61) 16bab2	387	11039	Hotel Last Frontier	......	......	....	......	......	......	......	......	......	......	......	......	P		
(S-21-61) 16bac1	344	10528	F. Dio Date	Joe Evans	1940	8	550	......	......	......	+2.1	Top of 6-in. well	+38.2	3-31-1944	......	DI	72	
(S-21-61) 16bbd1	481	11157	Hotel El Rancho, Inc.	Joe Irvin	1946	10	972	......	......	......	+2.5	Top of casing	+47.4	2- 6-1946	46	P	....	10-in. casing to 610 ft.; 803 ft. of 8-in. casing from 169 to 972 ft.
(S-21-61) 16bcc1	32	9832	State of Nevada, Department of Highways	Joe Evans	1935	10	900	460-470	544-547 764-?	......	+1.7	Top of 10-in. cap on casing	+36.4	4- 5-1944	......	DI	....	Log.
(S-21-61) 16bcc2	372	*10740	R. A. Coffman	......	1941	8	......	......	......	......	......	......	......	......	......	N		
(S-21-61) 16bcd1	378	10758	F. W. Somerville	......	1942	6	535	......	......	......	......	......	......	......	......	DI		
(S-21-61) 16bda1	112	10019	Burton Weller	Joe Evans and Bert Hairgrove	1929	6	565	......	......	......	+0.9	Top of casing	+19.5	4-24-1944	26	DI	72	6-in. casing to unknown depth; 4-in. casing from surface to 565 ft., perforated from 465 to 565 ft.
(S-21-61) 16bdb1	111	10013	John Stafford	Joe Evans	1936	5⅝	559	......	......	......	+1.18	Top of 6-in. collar on casing	+37.2	3-31-1944	......	DI	72	Log.
(S-21-61) 16cbb1	243	......	Miller and Smith	......	......	....	700	......	......	......	......	......	......	......	......	DI		
(S-21-61) 16cbb2	244	......	T. A. Wells	Joe Evans	......	....	......	......	......	......	......	......	......	......	......	N		
(S-21-61) 16cbb3	245	......	T. A. Wells	Joe Evans	......	....	700	......	......	......	......	......	......	......	......	N		
(S-21-61) 16cbc1	246	10792	Jack Weisberger	......	1936	8	700	......	......	......	+1.3	Top of 8-in. tee	+16.9	3-31-1944	......	DI		
(S-21-61) 17aca1	......	......	Geological Survey Test Well	Geological Survey	1946	2	35	......	......	......	......	......	......	......	......	O	....	Log.
(S-21-61) 17cab1	487	......	O. T. and M. I. Edgell	......	......	6	......	......	......	......	+1.2	Top of 6-in. collar on casing	+9.5	4- 6-1944	......	DI		
(S-21-61) 17cac1	392	11325	F. V. and W. L. Somerville	Pat Thompson	1942	10	325	300-325	......	......	+2.35	Top of cement pump base	+27.6	4- 6-1944	......	Ind.		

*Canceled.

TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Measuring Point: Altitude	Measuring Point: Above (+) or Below (—) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (—) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-21-61) 17dad1	222		Woodward	Woodward							+2.0	Top of ⅛-in. plug	+20.9	4- 5-1944	25	N	74	
(S-21-61) 17dbc1	31	10183	City of Las Vegas	Woodward	1928	6	400				+3.0	Top of 6-in. cap	+18.7	3-31-1944		Ind.	74	
(S-21-61) 17dbc2	220		City of Las Vegas	Woodward		2					+0.9	Top of cement block around well	+19.5	3-31-1944	25	N	74	2-in. casing to 2 ft.; 8-in. casing to unknown depth.
(S-21-61) 17dcb	247		F. Munson		1937		540									Ind.	74	
(S-21-61) 18bbc1	29		Henry Deadrich		1912	8	292				+0.65	Top of casing	—30.35	3-22-1942		N,O		Well bridged at 29 feet.
(S-21-61) 18dbc1	221		C. A. Bryant		1930											DI		
(S-21-61) 18dbd1	30		C. A. Bryant	Floyd Francis	1925	6	225				+1.0	Top of casing	—6.16	9- 1-1938		N		Analysis; well not located since 1938; 6-in. casing to 80 ft.; 4-in. casing to 275 feet.
(S-21-61) 20aaa1	453	11226	Murray and Agnes Wollman	O. G. Hairgrove	1945	10	710	705–710	440–447 560–570		+1.0	Top of casing	+27.8	7-20-1945	25	DI	78	Log.
(S-21-61) 21aaa1	124	10821	Murray Wollman and H. Mack	O. G. Hairgrove	Repaired 1944	6	784				+2.0	Top of 6-in. tee	+27.5	11-10-1944	65	P		
(S-21-61) 21bbb1	123	10820	Moe Sedway		1930	6	850				0.0	Top of ⅛-in. plug in casing	+49.7	3-18-1944	25	DI,O	74	Analysis; 600 feet of 6-inch casing.
(S-21-61) 21cbb1	160		Morris Rose			8	520				+1.4	Top of 8-in. cap	+14.3	3-25-1944	5	N	72	
(S-21-61) 21dcd1						60	22				0.0	Head of nail in south 6x6-in. timber across well	—19.2	3-16-1945		N,O		
(S-21-61) 22bca1	34	10624	E. C. Wilbourne		1930	6	690				+1.0	⅛-in. plug in casing	+31.2	2-24-1945	37	DI,O	77	
(S-21-61) 22ccc1	117	10243	A. P. Baker		1933	6	500				+1.0	⅛-in. plug in casing	+27.8	8-21-1944	46	N,O	72	
(S-21-61) 23ccb1	126	10608	Murray Wollman		1929	6					+6.0	Top of 6-in. ell	+67.0	4-13-1944		DI		
(S-21-61) 25cab1	149		C. Beckwith			6					+3.7	Top of 6-in. plug	+17.3	12- 8-1944	55	N	75	
(S-21-61) 26bba1	86	9239	V. O. Eastland			6	500				+1.0	Top of 6-in. welded cap	+27.7	3- 9-1944		N		
(S-21-61) 26bbb1	85	9239	A. J. and L. C. Wood				610				+1.7	¼-in. plug 4.5 ft. from well	+37.0	3- 9-1944		DI		
(S-21-61) 26bbb2	458	11255	A. J. and L. C. Wood	J. E. Metz	1945	10	595	565–595	197–215 277–280 309–310		+0.8	Top of 10-in. casing	+49.9	11-13-1945	135	P	78	Log.

TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Altitude	Measuring Point: Above (+) or Below (—) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (—) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-21-61) 26bbc1	345	10573	J. L. and Rena Hunter	Joe Evans	1940	6	290	......	......	......	+2.0	Top of 3-in. tee 3.0 ft. north of well	+27.7	3- 9-1944	40	DI	68	
(S-21-61) 27acc1	176	......	Martin Kisiwor	......	1912	2	230	......	......	......	+0.5	Top of 2-in. casing	+1.15	4-12-1944	......	DI		
(S-21-61) 27baa1	87	9243	Bell Telephone Co.	......	1930	6	625	......	......	......	......	......	......	......	......	....	....	Well plugged.
(S-21-61) 27baa2	413	10969	Lawrence Henz	Joe Evans	1943	8	338	140–145	......	......	+0.5	Top of 8-in. welded cap	+7.0	4-12-1944	5	DI	....	Log.
(S-21-61) 27baa3	454	11231	Bell Telephone Co.	O. G. Hairgrove	1945	10	605	604–605	300–330	......	+1.0	Top of 8-in. by 8-in. by 4-in. tee	+40.7	9-18-1945	52	DI	78	Log.
(S-21-61) 27bbb1	223	......	Walter Butterly	......	1931	6	360	......	......	......	+2.8	Top of 4-in. tee	+25.5	2-22-1945	15	DI		
(S-21-61) 27bbb2	......	......	Walter Butterly	......	......	60	17	......	......	......	0.0	Top of wood door across well	—14.93	3-22-1945	......	N,O		
(S-21-61) 27cbb1	35	......	Armstrong	......	1912	8	400	......	......	......	+0.9	Top of casing	+20.5	4-17-1945	12	DI	....	Analysis.
(S-21-61) 27cbb2	36	......	Armstrong	......	1912	8	346	......	......	......	+0.9	Top of casing in well (S-21-61) 27cbb1	+26.3	4-17-1945	12	DI		
(S-21-61) 27ccc1	38	11324	W. L. and B. Jenison	......	......	6	263	......	......	......	+1.5	Top of ⅛-in. plug in casing	+28.2	8-21-1944	30	N,O	74	Analysis.
(S-21-61) 27dcb1	224	......	Bell	......	......	....	......	......	......	......	+4.0	Top of 4-in. ell on pump flange	+16.5	4-12-1944	......	DI	75	
(S-21-61) 28bcc1	53	10854	Public Service Commission of Nev.	......	......	6	176	......	......	2,140.70	+1.0	Top of casing	—22.42	3-22-1942	......	DI,O		
(S-21-61) 28ccc1	40	......	W. E. Ferron	......	......	8	103	......	......	2,158.15	—0.5	Top of casing	—21.42	3-18-1944	......	N,O		
(S-21-61) 29dac1	94	9516	F. M. Ferguson	......	1931	6	280	......	......	......	+3.2	Top of casing	+0.09	4- 6-1944	1	N,O		
(S-21-61) 29dda1	93	9516	F. M. Ferguson	......	1931	6	260	......	......	......	+2.1	Top of tee	+0.45	4- 6-1944	5	N,O	70	Analysis.
(S-21-61) 33bac1	39	......	F. R. Mildren	......	1927	6	222	......	......	......	+1.0	Top of casing	—0.37	3-22-1945	......	N,O	....	Analysis.
(S-21-61) 33bbc1	142	......	McIntyre	......	1931	4	351	......	......	......	0.0	Top of casing	—12.67	4- 6-1944	......	N		
(S-21-61) 33bca1	249	......	C. R. Mildren	......	......	8	......	......	......	......	+0.4	Top of casing	—4.67	4- 4-1944	......	DI		
(S-21-61) 33ccc1	177	......	Las Vegas Irrigation, F. L. Co.	......	1912	....	550	......	......	......	......	......	......	......	......	....	....	Well never found.
(S-21-61) 34abc1	37	......	Tallackson	......	......	6	246	......	......	......	+1.0	Top of 4-in. valve flange	+8.6	4-12-1944	......	DI	75	
(S-21-61) 34ccc1	......	......	......	......	......	60	25	......	......	......	0.0	Top of wood well cover	—23.06	3-26-1945	......	N,O		
(S-21-61) 34dbc1	72	......	Fred Nagamatsu	......	1912	8	......	......	......	......	+2.0	Top of cement block	+4.44	4-28-1944	5	N		

TABLE 2—*Continued.*

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(S-21-61) 34dcb1	73	....	Fred Nagamatsu	....	1912	8	......	....	....	....	+1.0	Top of casing	—0.57	2-11-1946	......	DI		
(S-21-61) 34dcc1	74	....	Fred Nagamatsu	....	1912	6	......	....	....	....	0.0	Top of casing	—3.73	4-28-1944	......	N,O		
(S-21-61) 35ccb1	92	9498	Roy Wood Martin Estate	....	1931	8	300	....	....	....	+0.8	Top of casing	+10.4	4-28-1944	......	N	77	
(S-21-61) 35dcc1	125	....	Vail Pittman	Floyd Francis	1925	6	465	....	....	....	+4.65	Top of 4-in. tee	+13.6	4-13-1944	12	DI	76	Analysis; log.
(S-21-61) 36abb1	71	....	A. F. McCarter	....	......	8	......	....	....	....	+4.0	Top of casing	+8.7	12- 8-1944	9	N	76	
(S-21-61) 36adc1	484	....	Unknown	....	......	4	......	....	....	....	+3.0	Top of 3-in. globe valve	+23.2	3-28-1945	......	N,O		
(S-21-61) 36adc2	......	....	Geological Survey Test Well	Geological Survey	1946	1½	20	....	....	....	+1.1	Top of 1½-in. pipe	—11.71	4-24-1946	......	O		
(S-21-61) 36cdc1	135	....	Bailey	....	......	......	......	....	....	....	......	....	......	....	......	DI	....	Well inaccessible.
(S-21-62) 3bac1	339	....	Winterwood Ranch	....	1912	8	......	....	....	....	+0.7	Top of cement block around casing	—19.76	4-26-1944	......	N,O	....	Analysis.
(S-21-62) 3bac2	340	....	Winterwood Ranch	....	1912	8	......	....	....	....	+1.5	Top of casing	—9.48	3-27-1945	......	N,O		
(S-21-62) 3bac3	490	....	Winterwood Ranch	....	......	10	......	....	....	....	0.0	Top of casing	—19.78	3-27-1945	......	N,O		
(S-21-62) 3ccc1	......	....	Geological Survey Test Well	Geological Survey	1946	1	30	....	....	....	+1.1	Top of casing	—22.19	4-25-1946	......	O	....	Log.
(S-21-62) 4aaa1	338	....	Winterwood Ranch	....	......	12	......	....	....	....	+0.7	Top of cement base around casing	—24.40	4-26-1944	......	N,O		
(S-21-62) 4aaa2	337	....	Winterwood Ranch	....	1912	12	......	....	....	....	......	Cannot measure water level.........				N,O	....	Analysis.
(S-21-62) 7baa1	485	....	Unknown	....	......	4	......	....	....	....	......	....	......	....	......	DI	65	2 G. M. pumped during 1946.
(S-21-62) 7bab1	288	....	Mabel Finlayson	....	......	6	325	....	....	....	+2.4	Top of 2-in. tee	—4.19	4-11-1946	......	DI	....	5 G. M. pumped during 1946.
(S-21-62) 7bab2	287	....	Jack Carter	....	1926	6	......	....	....	....	......	....	......	....	......	DI	67	
(S-21-62) 7bac1	284	....	G. H. Murphy	....	......	6	183	....	....	....	......	Cannot measure water level.........			3	DI	68	
(S-21-62) 7bac2	286	10709	S. Barbee	John Frewalt	1929	8	225	....	....	....	+0.95	Top of welded cap	+2.42	3-27-1946	......	DI,O	....	10 G. M. pumped during 1946.
(S-21-62) 7bad1	283	....	S. Barbee	....	......	6	......	....	....	....	......	....	......	....	2	DI	71	
(S-21-62) 7bad2	285	....	Bernard Clark	....	......	6	700	....	....	....	+1.5	Top of 6-in. tee	—8.74	....	......	DI	....	20 G. M. pumped during 1946.
(S-21-62) 8cca1	331	....	Gladys L. Splane	....	......	8	......	....	....	....	......	Cannot measure water level.........			3	S	71	Log.

TABLE 2—*Continued.*

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(S–21–62) 15bca1	......	....	Geological Survey Test Well	Geological Survey	1946	1	22	....	....	....	+1.3	Top of casing	—21.06	4–25–1946	......	O	....	Log.
(S–21–62) 17ddc1	374	....	Whitney Taxpayer's Association	P. Conn	1942	8	540	....	....	....	+0.85	Top of casing	+52.0	3–28–1945	5	N,O	....	Analysis; log.
(S–21–62) 19acd1	130	....	A. Parks	....	1934	6	......	....	....	....	......	....	....	....	5	DI	76	
(S–21–62) 20ddd1	407	10948	J. Bunch, L. Netherton and L. Thurman	P. Conn	1942	6	458	412–415	430–458	....	+1.6	Top of 4-in. to 3-in. bushing	+30.0	2– 5–1944	30	P	76	Analysis; log.
(S–21–62) 20ddd2	408	10949	J. Bunch, L. Netherton and L. Thurman	Bert Hairgrove	1943	6	500	....	....	....	+1.0	⅛-in. plug in casing	+40.4	3– 7–1944	30	P	76	Log.
(S–21–62) 21cbc1	385	10802	L. E. Billman	P. Conn	1942	8	650	....	....	....	+2.2	Top of 8-in. tee	+47.4	3– 7–1944	85	N	76	Log.
(S–21–62) 21cbc2	430	10971	L. E. Billman	Bert Hairgrove	1944	8	500	....	....	....	+2.36	Top of 8-in. tee	+58.8	12–22–1944	44	N,O	....	Log.
(S–21–62) 21dcd1	......	....	Frank Fairhurst	....	......	60	23	....	....	....	+0.5	Top of wood well cover	—21.82	3–28–1945	......	N,O		
(S–21–62) 21ddd1	295	....	George Dolan	....	......	6	......	....	....	....	+1.0	Top of casing	+14.6	3–28–1945	1	S,O	....	Analysis.
(S–21–62) 27aad1	......	....	Geological Survey Test Well	Geological Survey	1945	4	12	....	....	....	+1.0	Top of casing	—4.25	4– 2–1946	......	O		
(S–21–62) 27bcb1	342	*10559	J. H. Bunch	....	1940	6	......	383	407 420 525	....	......	....	....	....	......	DI	....	Analysis.
(S–21–62) 27bcd1	355	10635	R. R. Stadelman	Pat Thompson	1941	7⅝	450	....	....	....	......	....	....	....	......	DI	....	Log.
(S–21–62) 27cba1	296	....	R. M. Snider	....	1933	....	400	....	....	....	......	Cannot measure water level....................				DI	....	Analysis.
(S–21–62) 27ccc1	491	....	Unknown	Floyd Francis	......	8	375	....	....	....	0.0	Top of collar on casing	—23.13	4– 9–1946	......	N	....	Equipped with pump; formerly known as the "Anna Taugher well;" analysis.
(S–21–62) 28aad1	293	....	C. Gribble	....	......	....	420	....	....	....	......	....	....	....	......	....	....	Analysis; well destroyed.
(S–21–62) 28acd1	297	....	Clark and Ronnow	....	......	8	......	....	....	....	......	Cannot measure water level	....	4– 9–1946	1	DI	72	Analysis.
(S–21–62) 28ada1	294	....	J. H. Bunch	....	1931	8	570	....	....	....	+1.0	Top of casing	—18.67	5–10–1944	......	DI,O	....	Analysis.
(S–21–62) 29bcc1	301	....	J. R. Bond	....	1935	8	......	....	....	....	......	....	....	....	10	DI	74	Analysis.
(S–21–62) 29ccb1	133	....	J. R. Bond	Floyd Francis	1912	2	1165	....	....	....	+0.8	Top of cement block	+25.3	3–28–1945	10	DI,O	....	Analysis; log; 6-in. casing below surface.
(S–21–62) 29ccc1	134	....	J. R. Bond	....	1912	6	404	....	....	....	+3.2	Top of cement block	+9.9	3–28–1945	1	DI,O	80	Analysis.

*Canceled.

TABLE 2—*Continued.*

											Measuring Point		Pressure Head or Water Level		Yield (gallons a minute)			
Well No. and Location	State Engineer's Local Field No.	State Permit No	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Altitude	Above (+) or Below (—) Land Surface (feet)	Description	Above (+) or Below (—) Measuring Point (feet)	Date of Measurement	Flow	Use	Temperature (°F)	Remarks
(S-21-62) 30bd	467	11347	L. H. Hamp	A. W. House	1946	8	400	......	......	......	+2.3	Top of 8-in. welded cap	+33.2	12-21-1945	170	DI	74	Log.
(S-21-62) 30dbb1	128	......	U. G. Campbell	Floyd Francis	1926	4	390	......	......	......	......	......	......	8-24-1944	40	DI	77	Analysis.
(S-21-62) 30dbb2	129	......	U. G. Campbell	Floyd Francis	1926	4	405	......	......	......	......	......	......	8-24-1944	20	S	77	
(S-21-62) 30dbb3	298	......	U. G. Campbell	......	......	....	......	......	......	......	......	......	......	......	......	....	....	Well not found in 1946.
(S-21-62) 30dbb4	299	......	U. G. Campbell	......	......	4	......	......	......	......	......	Cannot measure water level or flow......				DI	73	
(S-21-62) 30dbb5	300	......	U. G. Campbell	......	......	1½	......	......	......	......	......	......	......	......	......	DI	75	1½-in. casing to unknown depth; 4-in. casing to unknown depth.
(S-21-62) 30dcb1	466	11341	C. A. and Una Stewart	A. W. House	1946	8	400	......	......	......	+2.0	Top of cap on 8-in. casing	+79.8	1-29-1946	150	DI	....	Log.
(S-21-62) 30dcc1	302	......	Una Stevens	......	1910	6	415	......	......	......	—2.0	Top of 1½-in. ell	+16.0	8-24-1944	20	DI,O		
(S-21-62) 31bdb1	127	......	Ed Waite	......	1931	6	......	......	......	......	......	Top of 6-in. welded ell	+12.5	8-29-1944	32	DI,O	76	Analysis.
(S-21-62) 31bdc1	131	......	J. Sheppard	......	1911	6	250	......	......	......	+1.0	Top of 4-in. tee	+6.7	8-29-1944	12	DI		
(S-21-62) 31bdc2	132	......	J. Sheppard	......	......	8	600	......	......	......	......	Cannot measure water level	......	4- 9-1946	2	DI	74	Analysis.
(S-21-63) 30cdb1	......	......	Geological Survey Test Well	Geological Survey	1945	4	10	......	......	......	+0.4	Top of casing	—4.64	4- 2-1946	......	O		
(S-22-61) 1bca1	499	......	J. K. Houssels	......	......	6	......	......	......	......	......	Cannot measure water level......				DI	72	
(S-22-61) 1bca2	500	......	J. K. Houssels	......	......	6	......	......	......	......	......	Cannot measure water level......				DI	74	
(S-22-61) 1bca3	501	......	J. K. Houssels	......	......	6	......	......	......	......	......	Cannot measure water level......				DI	74	
(S-22-61) 1bca4	502	......	J. K. Houssels	......	......	2	......	......	......	......	......	Cannot measure water level......				DI		
(S-22-61) 1bcb1	269	......	J. K. Houssels	......	1938	6	225	......	......	......	......	Cannot measure water level......				DI	78	
(S-22-61) 1bcb2	270	......	J. K. Houssels	......	1912	6	455	......	......	......	......	Cannot measure water level......				DI	78	Log.
(S-22-61) 1bcb3	271	......	J. K. Houssels	......	1912	10	340	......	......	......	......	......	......	......	......	DI	78	10-in. casing to unknown depth; 8-in. casing to unknown depth.
(S-22-61) 1bcb4	272	......	J. K. Houssels	......	1912	4	......	......	......	......	......	Cannot measure water level......				DI	....	Analysis.
(S-22-61) 1bcb5	504	......	J. K. Houssels	Bert Hairgrove	1943	6	310	......	......	......	......	Cannot measure water level	......	12- 5-1943	15	DI,S	78	
(S-22-61) 1bdb1	62	......	J. K. Houssels	......	1912	2	......	......	......	......	......	Cannot measure water level......				DI	....	Analysis; well cemented over at surface.

TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Altitude	Measuring Point: Above (+) or Below (−) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (−) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-22-61) 1bdb2	63	....	J. K. Houssels	....	1912	2	....	....	....	....	....	Cannot measure water level........				DI	74	Well leaks near surface.
(S-22-61) 1cad1	59	....	John Graham and Tip Rowe	Floyd Francis	1910	10	505	....	....	....	....	Cannot measure water level	....	4- 9-1946	3	DI	78	
(S-22-61) 1cbb1	273	....	J. K. Houssels	Floyd Francis	1912	8	700	....	....	....	....	Cannot measure water level........				DI	79	Log.
(S-22-61) 1cbb2	274	....	J. K. Houssels	Floyd Francis and Bert Hairgrove	1912	6	340	225–230	....	....	....	Cannot measure water level........				DI	78	Log; well deepened in 1944 by Bert Hairgrove.
(S-22-61) 1cbb3	275	....	J. K. Houssels	....	1912	8	....	....	....	....	....	Cannot measure water level........				DI	78	8-inch casing to unknown depth; 6-inch casing to unknown depth.
(S-22-61) 1ccb1	503	....	J. K. Houssels	....	....	12	....	....	....	....	+1.7	Top of casing	—1.90	4- 9-1946	....	N		
(S-22-61) 1cda1	60	....	John Graham and Tip Rowe	Floyd Francis	1912	8	230	....	....	....	....	Cannot measure water level	....	4- 9-1946	20	DI	78	
(S-22-61) 1cdc1	168	....	John Graham and Tip Rowe	....	1936	10	....	....	....	....	....	Cannot measure water level	....	4- 9-1946	25	DI	80	
(S-22-61) 1cdc2	61	....	John Graham and Tip Rowe	....	1912	....	335	....	....	....	....	....	....	....	....	....	....	Well destroyed.
(S-22-61) 1cdd1	267	....	John Graham and Tip Rowe	....	1914	8	536	....	....	....	....	Cannot measure water level	....	4- 9-1946	3	DI	77	
(S-22-61) 1dab1	58	2303	Y. Tomiyasu	Floyd Francis	1911	8	....	....	....	....	....	....	....	....	....	....	....	Well filled to surface.
(S-22-61) 1dac1	57	2303	Y. Tomiyasu	Floyd Francis	1911	8	203	....	....	....	....	Cannot measure water level	....	9- 2-1945	429	DI	....	Analysis; log.
(S-22-61) 1dcb1	268	....	John Graham and Tip Rowe	....	1911	2	503	....	....	....	....	Cannot measure water level	....	4- 9-1946	15	DI	78	2-inch casing to unknown depth; 6-inch casing to unknown depth.
(S-22-61) 2aba1	226	....	L. H. Irvin	....	1924	4	200	....	....	....	+2.5	Top of casing	+18.4	4-13-1944	35	S,O	74	Analysis; log.
(S-22-61) 2aba2	225	....	Nate Mack	....	....	4	200	....	....	....	+2.75	Top of 4-in. collar	+15.7	4-13-1944	30	N	74	
(S-22-61) 2abd1	175	....	Lawrence Warden	....	1912	8	290	....	....	....	+5.6	Top of 8-in. terra cotta pipe	—2.86	4- 9-1946	15	DI	77	
(S-22-61) 2aca1	150	10367	L. P. Leavitt	....	1940	8	....	....	....	....	+1.7	Top of casing	—0.9	4-13-1944	10	DI		
(S-22-61) 2bab1	227	....	M. M. Sweeney	....	....	4	350	....	....	....	+3.7	Top of 3-in. to 2-in. reducer	+1.2	4-13-1944	10	DI	76	
(S-22-61) 2bbc1	228	....	Smythe	....	1910	....	....	....	....	....	....	....	....	....	....	DI	....	Inaccessible.
(S-22-61) 2cbc1	139	10579	H. F. Reed	....	....	8	600	....	....	....	+3.1	Top of 6-in. ell	+36.6	8-15-1944	52	DI	79	
(S-22-61) 2ccc1	404	10894	Henry Wick	Joe Evans	1943	10	600	....	....	....	+0.0	Top of casing	+12.5	2- 7-1946	10	DI,S	84	Log.
(S-22-61) 2cdd1	260	....	F. W. Leadbetter	....	1912	8	....	....	....	....	....	Cannot measure water level or flow........				N	80	

TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Measuring Point			Pressure Head or Water Level		Yield (gallons a minute)	Use	Temperature (°F)	Remarks
										Altitude	Above (+) or Below (−) Land Surface (feet)	Description	Above (+) or Below (−) Measuring Point (feet)	Date of Measurement	Flow			
(S-22-61) 2daa1	486	....	Painton	....	....	4	....	....	....	....	....	Cannot measure water level	....	4- 9-1946	15	DI	72	
(S-22-61) 2ddc1	265	....	R. R. Stadelman	....	....	5	....	....	....	....	+1.8	Top of casing	+16.3	6-22-1944	12	DI	84	
(S-22-61) 3acc1	122	10321	H. Nickerson	....	1912	6	....	....	....	....	....	....	....	....	....	DI	....	Analysis; inaccessible.
(S-22-61) 3adb1	250	11338	T. P. and G. G. Walker	....	....	6	565	....	....	....	+0.2	Top of 6-in. casing	+50.5	2-11-1946	30	DI	84	Well cleaned out and repaired by O. G. Hairgrove in 1946.
(S-22-61) 3bda1	79	7593	H. H. Hair	Floyd Francis	1925	8	374	....	....	....	+1.9	Top of 4-in. tee	+18.5	8-15-1944	109	DI	82	Log.
(S-22-61) 3caa1	121	10321	H. Nickerson	....	1924	6	395	....	....	....	....	Cannot measure water level	....	1-15-1944	170	DI	84	Analysis; log.
(S-22-61) 3cab1	......	....	N. L. White	....	....	60	32	....	....	....	−5.0	Top of 2-in. by 4-in. timber frame	−17.21	3-20-1946	....	DI,O		
(S-22-61) 3cab2	482	11388	N. L. and M. S. White	....	1946	6	435	380-382	....	....	+0.8	Top of 6-in. casing	−3.0	5- 1-1946	....	DI	....	Log.
(S-22-61) 3ccb1	145	....	Dewey Williams	Joe Evans	1935	10	575	....	....	2,154.30	+1.0	Top of 10-in. casing	−16.48	3-20-1946	....	N,O	....	Log.
(S-22-61) 3dcb1	251	....	Rufus Johnson	....	....	4	....	....	....	....	0.0	Top of 4-in. valve	+9.6	2- 7-1946	....	DI		
(S-22-61) 3dcc1	......	....	Geological Survey Test Well	Geological Survey	1946	1¼	30	....	....	....	+1.0	Top of casing						
(S-22-61) 3dda1	434	11054	Henry Wick	N. Tomiyasu and Henry Smith	1945	10	335	335	....	....	+3.5	Top of 10-in. cap on tee	+59.9	2-11-1946	160	DI	84	Analysis; log.
(S-22-61) 3ddb1	373	10745	Henry Wick	Pat Thompson	1942	6	....	....	....	....	+1.4	Top of welded 6-in. cap	+34.2	2-11-1946	40	DI	86	
(S-22-61) 4bcc1	41	....	Fitzpatrick	....	1926	8	355	....	....	....	+3.8	Top of casing	−81.88	3-20-1946	....	N,O		
(S-22-61) 5ad	......	....	....	....	....	8	....	....	....	....	....	....	....	....	....	....	....	Well filled to 18 feet in 1946.
(S-22-61) 8aba1	143	....	Mrs. Frank Beam	....	1931	....	115	....	....	....	....	....	....	....	....	....	....	Well filled to 37 feet in 1944.
(S-22-61) 8dad1	......	....	William Strable	....	....	....	....	....	....	....	....	....	....	....	....	DI		
(S-22-61) 9bbb1	......	....	F. W. Leadbetter	....	....	8	....	....	....	....	0.0	Top of casing	−96.0	4-10-1944	....	DI		
(S-22-61) 9cbb1	42	....	Daisy Bell	....	1925	10	127	....	....	....	+0.6	Top of casing	−94.44	3-20-1946	....	N,O		
(S-22-61) 10aab1	252	....	J. Fox	....	1912	6	....	....	....	....	+0.5	Top of 4-in. valve	+32.0	2-11-1946	....	N,O	86	
(S-22-61) 10aac1	253	....	J. Fox	....	1912	60	....	....	....	....	−3.0	Top of wooden frame	−11.5	4- 8-1944	....	....	....	Well caved and filled in.
(S-22-61) 10acc1	70	4374	Gladstone Corporation	Floyd Francis	1926	12	715	....	....	....	....	....	....	....	....	N	....	Log.

TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Measuring Point: Altitude	Measuring Point: Above (+) or Below (−) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (−) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-22-61) 10adc1	254		Arnold Zaugg			8												Filled in.
(S-22-61) 10adc2	255		Arnold Zaugg			8												Filled in.
(S-22-61) 10add1	256		Arnold Zaugg			8										N		Well leaks at 6.0 feet below surface.
(S-22-61) 10bda1	69	4374	Gladstone Corporation		1909	8	325					Cannot measure water level		2-13-1944	425	DI	92	Analysis.
(S-22-61) 10dab1	257		R. E. Whitney		1924	12						Cannot measure water level		4- 8-1946	15	DI	82	12-in. casing to unknown depth; 8-inch casing to unknown depth.
(S-22-61) 10dad1	258		R. E. Whitney		1924	8										DI	81	
(S-22-61) 10dad2	259		R. E. Whitney		1924	8										DI	82	
(S-22-61) 11aab1						60	18				+2.0	Top of 2-in. by 6-in. timber across well	—14.83	3-27-1946		N,O		
(S-22-61) 11aad1				John Frewalt	1945	8	98				+1.0	Top of casing	—16.82	4- 9-1946		N		
(S-22-61) 11bac1	55		F. W. Leadbetter		1909	8	208					Cannot measure water level or flow				N		
(S-22-61) 11bac2	352		F. W. Leadbetter		1940	8	175				+0.5	Top of casing	+7.12	3-27-1946		DI		Analysis.
(S-22-61) 11bac3	261		F. W. Leadbetter		1912													Analysis; well destroyed.
(S-22-61) 11bdb1	262		F. W. Leadbetter		1912	8										DI	80	
(S-22-61) 11bdb2	263		F. W. Leadbetter			10										DI	83	
(S-22-61) 11bdc1	264		F. W. Leadbetter		1912	8					+0.5	Top of collar on casing	+7.0	6-22-1944		DI	83	
(S-22-61) 12bbb1	266		T. Sakai			6					+2.0	Top of ell	+38.8	3-28-1945	15	N,O	82	Analysis; 6-inch casing to unknown depth; 8-inch casing to unknown depth.
(S-22-61) 15abc1				Horace Taylor	1926	8	33						Dry	4- 8-1946				Dry in 1946.
(S-22-61) 16ccc1	365	10705	Buck Dalton			10					+0.65	Bottom of lowest bullet hole in casing	—84.55	3-26-1945		N,O		
(S-22-62) 1bcc1	492		T. A. Wells	Joe Evans		6	800					Cannot measure water level			10	DI		Log.
(S-22-62) 1bdc1	432	10825	M. E. Ward and Johnson			60					+1.5	Top of tin well cover at southwest corner of manhole	—6.28	3-15-1945		N		
(S-22-62) 1cab1	493		T. A. Wells			6										N		

TABLE 2—*Continued.*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Altitude	Measuring Point: Above (+) or Below (—) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (—) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-22-62) 1cba1	350	*10602	Carl A. Foster	......	......	48	......	......	......	......	0.0	Top of 2-in. plank cover	—13.87	3-17-1946	......	N,O	75	Analysis.
(S-22-62) 1cbc1	494	......	T. A. Wells	Joe Evans	1942	8	1135	......	......	......	+1.3	Top of 8-in. plug	+30.2	3-27-1946	......	DI,O	91	Analysis; log.
(S-22-62) 1cbc2	......	......	White Courts	......	......	60	......	......	......	......	0.0	Top of 1-in. by 6-in. board well cover	—5.95	3-15-1945	......	DI	....	Analysis.
(S-22-62) 1cbd1	495	......	T. A. Wells	Joe Evans	1942	8	910	......	......	......	......	......	......	......	......	DI	....	Log; well filled to 850 feet in 1942.
(S-22-62) 1cbd2	......	......	Pittman Recreation Center	......	......	4	......	......	......	......	+1.8	Top of 4-in. to 2-in. bushing	+35.8	11-30-1944	......	DI,P		
(S-22-62) 1ccc1	431	10826	M. E. Ward and Johnson	Joe Evans	1941	....	300	......	......	......	......	......	......	......	......	P	....	Analysis; drilled to 815 feet in 1941; filled to 300 feet in 1946.
(S-22-62) 6bac1	137	......	C. A. Heaton	......	1912	8	790	......	......	......	......	......	......	......	......	....	....	Well destroyed in 1945.
(S-22-62) 6bbc1	136	......	C. A. Heaton	......	......	8	......	......	......	......	......	Cannot measure water level	......	4- 9-1946	2	S	73	
(S-22-62) 9cdb1	424	10961	A. G. Klinger	Bert Hairgrove	1943	8	125	......	......	......	+2.5	Top of 5-in. to 2½-in. welded reducer	+2.45	8-30-1944	27	DI	75	Log.
(S-22-62) 9cdb2	423	10961	A. G. Klinger	Bert Hairgrove	1943	12	125	......	......	......	+1.6	Top of casing	+12.1	8-30-1944	22	DI	74	Log.
(S-22-62) 9dcc1	382	10785	Roy Cram	Joe Evans	1942	10	180	......	......	......	+0.8	Top of casing	—17.61	3-17-1946	......	N,O	....	Analysis; log.
(S-22-62) 12abc1	496	......	T. A. Wells	Bert Hairgrove	1944	6	440	......	......	......	+5.8	Top of casing	—15.80	3-21-1945	......	N,O	....	Well cleaned out and deepened to 810 ft. by O. G. Hairgrove, 1946; well flowing in 1946.
(S-22-62) 12abd1	......	......	Fred Clemore	......	......	6	250+	......	......	......	......	Cannot measure water level......				DI	....	5 G. M. pumped during 1945.
(S-22-62) 12aac1	......	......	James Brown	......	......	6	200+	......	......	......	......	Cannot measure water level......				DI	....	5 G. M. pumped during 1945.
(S-22-62) 12aac2	......	......	Pittman Court	......	......	6	......	......	......	......	......	Cannot measure water level......				DI	....	5 G. M. pumped during 1945.
(S-22-62) 12aad1	......	......	Silver Slipper	......	......	6	......	......	......	......	......	Cannot measure water level......				DI	....	5 G. M. pumped during 1945.
(S-22-62) 12aad2	......	......	Swanky Club	......	......	8	......	......	......	......	......	Cannot measure water level......				DI	....	5 G. M. pumped during 1945.

*Canceled.

TABLE 3

Logs and Casing Records of Wells in Las Vegas and Indian Spring Valleys, Nevada

INDIAN SPRING VALLEY

(S–16–56)8ab. Las Vegas Army Airfield—Indian Springs, sub-base. Land surface altitude 3,132 feet; diameter 6 inches; 6-inch casing to 322 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	1	1
Cemented gravel	19	20
"Loose" gravel	4	24
Cemented gravel	16	40
Broken rock and gravel	20	60
Cemented rock and sand	24	84
Cemented gravel	18	102
Cemented rock and gravel	42	144
Cemented gravel	8	152
Cemented rock and gravel	20	172
Cemented rock	22	194
Cemented gravel	50	244
Clay and gravel	4	248
Cemented gravel	22	270
Sand and gravel	34	304
Clay	2	306
Cemented gravel	4	310
"Limerock and shale"	266	576
Total depth	....	576

LAS VEGAS VALLEY

(S–19–60) 4dab1. P. J. Goumond. Diameter 18 inches, 18-inch casing to 200 feet, 16-inch casing from 143 to 780 feet, perforated 311 to 606 feet with 4 slots every 18 inches.

Material	Thickness (feet)	Depth (feet)
Light tan clay	10	10
Dark and medium tan clay	70	80
Light greenish tan clay	10	90
Dark and medium tan clay, water level 210 feet below surface	210	300
Pebble and granule-gravel, water level 13 feet below surface	10	310
Granules and coarse sand (Underlain by thin layer greenish clay)	10	320
Light tan clay with few pebbles, water flowing at surface	32	352
Light green clay with few small pebbles	8	360
Light tan clay some caliche pebbles or nodules	40	400
Light green clay with some light tan clay layers	30	430
Light and medium tan clay	30	460
Very light tan clay, nodular with some caliche	6	466
White marly clay nodules with little light tan clay	4	470
Medium tan clay	40	510
Medium tan clay with some medium sand and pebbles	5	515
Light tan clay, few pebbles	45	560
Pebble gravel, little sand, few clay balls	6	566
Fine sand, few pebbles and granules, water	4	570
Clay with few granules and little fine sand	22	592
Fine and medium grained sand, water	8	600
Coarse sand and granules with some medium and fine sand, little clay, water	10	610
Light to medium tan clay	170	780
Total depth	....	780

TABLE 3—*Continued*

(S–19–60) 9aba1. P. J. Goumond. Diameter 14 inches, 14-inch casing to 12 feet, 8-inch casing to 700 feet perforated with ¼-by-4-inch slots from 231 to 257 feet, 309 to 335 feet, 534 to 631 feet, and 656 to 681 feet.

Material	Thickness (feet)	Depth (feet)
Gravel	7	7
Greenish tan clay	33	40
Pink silty clay	30	70
Caliche	2	72
Granule gravel, some pink silty clay	10	82
Tan silty clay	18	100
Cemented gravel	15	115
Tan silty clay	5	120
Cemented gravel	16	136
Tan silty clay, some granular gravel	36	172
Tan silty clay	44	216
Coarse - grained sand, much silt, little clay	4	220
Cemented gravel	5	225
Tan silty clay	15	240
Tan fine-grained sand, little pink silt	3	243
Granule gravel and coarse-grained sand, silty with some clay	15	258
Tan silty fine-grained sand	8	266
Pink silty sandy clay	34	300
Granule gravel, few pebbles, some tan silty clay	10	310
Medium - to - coarse-grained gray sand, little silt, flow of water	7	317
Caliche	4	321
Medium - grained gray sand, little silt, flow of water	2	323
Tan silty clay, few pebbles and granules	4	327
Fine-grained gray sand, flow of water	2	329
Tan silty clay, few pebbles and granules	3	332
Fine to medium-grained silty sand	3	335
Tan silty clay, few pebbles and granules	5	340
Fine to coarse-grained gray sand, flow of water	6	346
Tan silty clay	14	360
Tan silty clay, few pebbles and granules	8	368
Tan clay, little silt, few granules	35	403
Caliche	2	405
Granule gravel, fine-to medium - grained sand, few pebbles, little clay and silt	7	412
Tan silty clay, few granules	82	494
Granule gravel, little sand, some silt and clay	4	498
Granule gravel, fine-to medium - grained sand, flow of water	10	508
Granule gravel, some sand and silt	4	512
Tan silty clay, some gravel and sand	23	535
Fine-grained pink silty sand	4	539
Fine to medium-grained gray sand, little silt, flow of water	7	546
Tan silty clay, much gravel	3	549
Fine to medium-grained sand, some granule and pebble gravel, flow of water	37	586
Tan silty clay few granules and pebbles	3	589
Fine - grained gray sand, flow of water	2	591
Tan silty clay, some gravel	9	607
Fine-grained sand, few granules, flow of water	3	610
Tan silty clay, some gravel	16	626
Tan silty clay, few granules	47	673
Coarse to fine-grained gray sand, flow of water	3	676
Tan silty clay, some gravel	11	687
Fine-grained silty tan sand	18	705
Plastic pink clay, little silt	11	716
Total depth	....	716

TABLE 3—*Continued*

(S-19-60) 9abb1. P. J. Goumond. Diameter 16 inches, 16-inch casing to 21 feet, 14-inch casing to 68 feet, 12-inch casing to 631 feet, perforated with ¼-by-4-inch slots from 531 to 631 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	6	6
Brown clay	9	15
"Near-surface" water level	....	15
Brown clay	55	70
Brown clay, few gravel strata	125	195
Caliche	3	198
Clay	21	219
Caliche	16	235
Gravel	63	298
Cemented gravel	12	310
Sand, flow of water	2	312
Cemented gravel	9	321
Sand, flow of water	3	324
Cemented gravel	4	328
Sand, flow of water	7	335
Cemented gravel	4	339
Sand, flow of water	7	346
Brown clay	2	348
Sand, flow of water	2	350
Brown clay, few gravel strata	51	401
Sticky clay	43	444
Clay, few gravel strata	20	464
Clay	12	476
Cemented gravel	20	496
Sand, flow of water	9	505
Cemented gravel	12	517
White clay	3	520
Sand, flow of water	3	523
Cemented gravel	35	558
Sand, flow of water	7	565
Cemented gravel	12	577
White clay	3	580
Cemented gravel	11	591
Sand, flow of water	2	593
Cemented gravel	1	594
Sand, flow of water	2	596
Cemented gravel	24	620
Sand, flow of water	5	625
Brown clay	20	645
Clay and sand	5	650
Sand, flow of water	2	652
Brown clay	26	678
Sand, flow of water	17	695
Brown clay	11	706
Total depth	....	706

(S-19-60) 9bcc1. P. J. Goumond. Diameter 10 inches, 10-inch casing to 140 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Hard cemented gravel	95	95
Brown clay, water-100	10	105
Cemented gravel	6	111
Brown clay	74	185
Hard cemented gravel	5	190
More water 80 ft. of top		
Water gravel, water, 34 ft. of top	10	200
Cemented gravel	66	266
Water gravel	9	275
Cemented gravel	180	455
Brown clay	20	475
Cemented gravel	95	570
Brown clay	14	584
Cemented gravel	6	590
Clay	25	615
Hard cemented gravel	30	645
White clay	23	668
Yellow clay	2	670
Hard white clay	21	691
Hard cemented gravel	24	715
White clay	15	730
Cemented gravel	100	830
Total depth	....	830

(S-19-60) 9bdd1. P. J. Goumond. Diameter 8 inches, 8-inch casing to 1,001 feet, perforated 110 to 1,000 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Yellow and brown clay	77	77
White clay, small streaks gravel	18	95
Brown clay, streaks of gravel. Hit first water 110. More 130	60	155
Brown clay, streaks of gravel	31	186
Brown clay and shales	29	215
Brown clay	49	264
Hard cemented gravel	6	270
Water sand. Water up 25 ft. of top	17	287
Cemented gravel	15	302
Yellow clay	8	310
Cemented gravel	23	333
Yellow clay	13	346
Cemented gravel	19	365
Sticky brown clay	60	425
Hard cemented gravel	10	435
More water 433–435.		
Cemented gravel	10	445
Lime, cemented gravel	24	469
Water sand	3	472
Lime, cemented gravel	28	500
More water.		
Cemented gravel	18	518
Water gravel	2	520
Water running over top of casing.		
Cemented gravel	13	533
Water sand	19	552
Lime, cemented gravel	13	565
Water gravel	5	570
Hard cemented gravel	23	593
More water 587–593.		
Sticky brown clay	88	681
Cemented gravel, water	6	687
Brown clay	3	690
Cemented gravel, more water	15	705
Brown and red clay	10	715
Cemented gravel, more water 745–750	35	750
Cemented gravel, more water	7	757
Cemented gravel	10	767
Lime, cemented gravel	30	797
Water sand	13	810
Cemented gravel	191	1,001
Total depth	....	1,001

TABLE 3—*Continued*

(S–19–60) 9cda1. E. A. and J. T. Gilcrease. Diameter 8 inches, 8-inch casing to unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)
Yellow clay	65	65
Brown shale	26	91
Gravel, water level raised in casing	4	95
Brown clay	20	115
"Hard shell"	4	119
Brown clay	71	190
"Hard shell"	4	194
Brown clay	7	201
"Hard shell"	3	204
Brown clay	11	215
"Hard shell"	4	219
Brown clay	26	245
Red clay	13	258
"Hard shell"	2	260
Hard cemented gravel	25	285
Gravel, water level raised in casing	2	287
Hard cement gravel	8	295
Hard sand "rock"	9	304
Hard cemented gravel	16	320
Cemented gravel	5	325
Gravel, flow of water	5	330
Hard cemented gravel	8	338
Brown shale	4	342
Brown clay	19	361
Gravel, flow of water	4	365
Brown clay	8	373
Gravel	2	375
Brown and black clay	2	377
Brown clay	34	411
Hard cemented gravel	10	421
Gravel, flow of water	7	433
Hard cemented gravel	10	443
Cemented gravel	5	426
Gravel, flow of water	4	447
White clay	1	448
Cemented gravel	17	465
Sand, flow of water	10	475
Gravel, increased flow of water	15	490
Shale	2	492
Clay	13	505
Cemented gravel	7	512
Sand, flow of water (732 G. M.)	18	530
Brown clay	3	533
Cemented gravel	7	540
Brown clay	60	600
Blue and brown clay	12	612
Total depth	....	612

(S–19–60) 23bbc1. E. A. and J. T. Gilcrease. Diameter 12 inches, 12-inch casing to unknown depth.

Material	Thickness (feet)	Depth (feet)
No record	280	280
Light tan clay	5	285
Light tan clay, nodular	55	340
Light tan clay	140	480
Light tan clay, nodular	20	500
Light tan clay	50	550
Light tan clay with numerous granules and few caliche pebbles, water	20	570
White clay	30	600
Light gray clay	12	612
Dark gray clay	8	620
Gray clay, few granules	7	627
Gray silt and clay, with carbonaceous material	13	640
White clay	10	650
Light pink clay	5	655
Bluish gray clay and silt with carbonaceous material	35	690
Light tan clay	20	710
Light tan clay with caliche	10	720
White silty clay	10	730
Gray clay, sticky and plastic	10	740
Light gray marly clay	7	747
Gray clay with carbonaceous material	43	790
Gray clay	10	800
White marly clay	7	807
Brown, gypsiferous silty clay	12	819
Light pink clay	38	857
Light green gray and pink mottled clay	23	880
Tan clay with granules	20	900
Tan and light green mottled clay	10	910
Total depth	....	910

(S–20–60) 36dbb1. M. D. Kidder. Land surface altitude 2,228 feet; diameter 8 inches, 8-inch casing to 262 feet, 6-inch casing to 345 feet, 4-inch casing to 381 feet. Driller's log, also reported in U. S. Geological Survey Water Supply Paper 849-D, 1941.

Material	Thickness (feet)	Depth (feet)
Clay and lime conglomerate	2	2
White clay	13	15
Caliche	4	19
Clay with caliche fragments and nodules	5	24
Yellow sandy clay	86	110
Red sand	8	118
Sandy clay	30	148
Cemented gravel, water-bearing	72	220
Uncemented gravel, water-bearing	2	222
Cemented gravel, water-bearing	54	276
Uncemented gravel, water-bearing	4	280
Cemented gravel, water-bearing	27	307
Loosely cemented gravel, water-bearing	63	370
"Limerock, bad to wash into well," water-bearing	1	371
Uncemented gravel, water-bearing	14	385
Cemented gravel, water-bearing	....	385
Total depth	....	385

TABLE 3—*Continued*

(S–20–61) 3adc3. Las Vegas Army Air Field. Diameter 12 inches, 12-inch casing to 425 feet, perforated from 203 to 239 feet.

Material	Thickness (feet)	Depth (feet)
Top soil	5	5
"Hard pan"	5	10
Sandy clay	27	37
Clay and caliche, first water surface at 40 feet	156	193
Red clay and caliche	20	213
Sand, gravel, and caliche, first flow 23 G. M.	16	229
Clay and caliche	12	241
Clay	52	293
Clay and caliche	53	346
Hard brown shale	44	390
Clay and caliche	24	414
Sand and clay	2	416
Clay and caliche	54	470
Blue clay	31	501
Total depth	....	501

(S–20–61) 13adc1. L. and M. Van Der Meer. Diameter 8 inches, 8-inch casing to 375 feet, perforated with $\frac{3}{16}$ by 2½-inch slots from 315 to 375 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	17	17
Caliche	8	25
Caliche "boulders"	2	27
White clay	20	47
Red clay	29	76
White clay, little gravel	2	78
Gravel	3	81
White clay and caliche, little gravel	58	139
Red and white clay	23	162
Red clay	18	180
Red clay, "hard streaks"	40	220
Caliche	4	224
White clay, "hard lime streaks"	46	270
"Boulders"	19	289
Red clay, little gravel	124	413
Red clay, "gritty"	23	436
Red clay, "hard streaks"	48	484
Brown and white clay, sand	21	505
Red clay "streaks of white lime"	98	603
Blue clay	16	619
"Gritty" blue clay	33	652
Black sandy clay, gravel "streaks"	30	682
Caliche	5	687
Blue clay, sand	23	710
Black clay, "white lime"	30	740
Blue clay, little white clay	46	786
Red sandy clay	9	795
Blue clay	2	797
Red clay, "hard streaks"	33	830
White clay, sandy, "hard streaks of lime"	56	886
Red clay, "hard streaks of lime"	44	930
Total depth	....	930

(S–20–61) 15dcb1. Taylor Estate. Diameter 6 inches. Driller's log.

Material	Thickness (feet)	Depth (feet)
Clay and "marl"	34	34
Caliche	2	36
Clay	4	40
Caliche and "marl"	40	80
Gravel	3	83
Soft "marl"	4	87
Caliche	6	93
Clay	5	98
Caliche	2	100
Clay	22	122
Caliche	2	124
Clay	6	130
Caliche	2	132
Clay	14	146
Caliche	4	150
Clay	3	153
Caliche	8	161
Clay	44	205
Blue "shale"	22	227
Gray and white (clay), water	11	238
Red sandy clay, water every few feet in sand lenses	212	450
Red sandy clay	35	485
White clay	20	505
Red clay, sandy	35	540
Sandy red clay, water	10	550
Red clay, sandy	75	625
Conglomerate	13	638
Sand and gravel	4	642
Silt and fine sand	163	805
Total depth	....	805

TABLE 3—*Continued*

(S–20–61) 15dcb2. Taylor Estate. Diameter 6 inches. Driller's log.

Material	Thickness (feet)	Depth (feet)
Clay and caliche	32	32
Caliche	2	*34
Clay and caliche	16	50
Caliche, water	2	52
Clay and caliche	8	60
Caliche	10	70
Clay and caliche	6	76
Caliche "conglomerate"	20	96
Red clay	5	101
Caliche "conglomerate"	2	103
Clay	2	105
Gravel and boulders	3	108
Caliche "conglomerate"	12	120
Clay	5	125
"Conglomerate"	5	130
Clay	66	196
Caliche	3	199
Clay	34	233
Caliche	1	234
Sandy clay	4	238
Red sand	5	243
"Conglomerate"	7	250
Red clay	8	258
Brown "shale"	4	262
Gray "shale"	11	273
Blue "shale"	37	310
Gray "shale"	15	325
Sandy clay	5	330
Red clay with sand and gravel lenses, water	110	440
Red clay	85	525
Sandy clay with sand and gravel lenses, water	15	540
Red clay	65	605
Gray "talc" and sand	11	616
Caliche, water	2	618
Clay with lenses of "talc" and sandy clay	47	665
Cemented sand, water	3	668
Red clay with lenses of "talc" and brown clay	92	760
Caliche "conglomerate"	15	775
Clay	60	835
Cemented sand, water	7	842
Clay, lenses of cemented sand, water	18	860
Clay	75	935
Total depth	----	935

*Water level at 22 feet.

(S–20–61) 15dcc1. Taylor Estate. Diameter 8 inches, 8-inch casing to 298 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	45	45
Caliche	5	50
Clay	5	55
Caliche	12	67
Clay	6	73
Caliche	18	92
Clay	12	104
"Conglomerate"	19	123
Clay	60	183
Caliche	2	185
Clay	45	230
Caliche	3	233
Clay	3	236
Caliche	2	238
Sandy clay	22	260
"Shale"	30	290
Sandy clay	90	380
Sticky clay	100	480
Sandy clay	8	488
Sticky clay	12	500
Total depth	----	500

(S–20–61) 19bcb1. Splane Estate. Land surface altitude 2,199 feet; diameter 9 inches, 9-inch casing to 162 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Caliche	20	20
White clay	12	32
Yellow clay	4	36
Caliche	9	45
"Rock"	3	48
Clay	4	52
"Rock"	5	57
Clay	8	65
"Rock"	2	67
Clay	15	82
"Rock"	3	85
Clay	80	165
"Cement" gravel	135	300
Total depth	----	300

(S–20–61) 19cdc1. B. V. Provenzano. Land surface altitude 2,192 feet; diameter 8 inches, 8-inch casing to 151 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soft clay and caliche	40	40
Clay	30	70
Clay and caliche	81	151
Flowing water	----	151
Clay and caliche	41	192
"Conglomerate"	48	240
Flowing water	25	265
"Conglomerate"	10	275
Total depth	----	275

(S–20–61) 19cdd1. J. F. and F. Haake. Land surface altitude 2,179 feet; diameter 8 inches, 8-inch casing to 227 feet, 6-inch casing to 262 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	10	10
Clay and caliche	15	25
Clay and caliche	45	70
Yellow clay	35	105
Clay and caliche	35	140
"Rock"	10	150
Sand and clay	50	200
Sand, water	5	205
Sand and gravel, water	57	262
Total depth	----	262

TABLE 3—*Continued*

(S–20–61) 19cdd2. J. F. and F. Haake. Land surface altitude 2,181 feet; diameter 8 inches, 8-inch casing to unknown depth.

Material	Thickness (feet)	Depth (feet)
No record	35	35
Light tan sandy silt, little clay	10	45
White sandy, calcareous silt	10	55
Tan and pink sandy silt, little clay	30	85
No record	105	190
Pink sandy silt	30	220
Granule gravel, much silt, little fine-grained sand, flow of water	10	230
Pink silty clay, little gravel	40	270
No record	20	290
Pink silty clay, few granules	10	300
Granule gravel, few pebbles, little sand and silt, flow of water	20	320
Pink silty clay	5	325
Total depth	....	325

(S–20–61) 19dab1. Southern Nevada Industries, Ltd. Land surface altitude 2,153 feet; diameter 8 inches, 8-inch casing to 286 feet, perforated 230 to 286 feet, slots ⅜-inch wide and 6 inches long. Driller's log.

Material	Thickness (feet)	Depth (feet)
Sandy loam	3	3
Caliche	4	7
White clay	15	22
Caliche	35	57
White clay	17	74
Caliche	5	79
White clay	51	130
Caliche	6	136
White clay	38	174
"Broken lime rock"	26	200
Red clay	9	209
Caliche, "broken"	21	230
Blue gravel, water	56	286
Total depth	....	286

(S–20–61) 19ddc1. E. B. Coram. Land surface altitude 2,160 feet; diameter 8 inches, 8-inch casing to 280 feet, perforated 255 to 280 feet with slots 3/16-inch wide and 3 inches long. Driller's log.

Material	Thickness (feet)	Depth (feet)
Surface soil	10	10
Caliche	10	20
"Quicksand"	24	44
Red clay	106	150
Caliche	10	160
Red clay	80	240
Caliche	15	255
Gravel, water	25	280
Total depth	....	280

(S–20–61) 20bcc1. R. J. Kaltenborn. Land surface altitude 2,128 feet; diameter 8 inches, 10-inch casing to 68 feet, 8-inch casing to 279 feet, perforated 110 to 239 feet with slots ¼-inch wide and 4 inches long.

Material	Thickness (feet)	Depth (feet)
Soil	3	3
Caliche	8	11
Clay	11	22
Gravel, "near-surface water"	2	24
Pink silty sand	16	40
Pink silty sand, many granules	10	50
Pink silty sand, red clay lenses	10	60
Very light tan nodular clay, some silt	20	80
Very light tan silty clay	30	110
Small flow of water	....	110
Very light tan silty clay, some granules and caliche nodules	20	130
Very light tan silty clay, few granules	40	170
Very light tan silty clay, dark tan clay nodules	30	200
Very light tan silty clay, many caliche nodules	10	210
Pink silty clay, few granules and caliche nodules	47	257
Pink sandy silt, many granules, flow of water	3	260
Clean, fine pink sand, water	1	261
Granule gravel, some fine pink sand, water	22	283
Total depth	....	283

TABLE 3—*Continued*

(S–20–61) 20bdb1. J. A. Griffin and M. C. Oglesby. Land surface altitude 2,115 feet; diameter 8 inches, 8-inch casing to 281 feet, 82 feet of 6-inch casing to 360 feet, 120 feet of 4-inch casing to 450 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Surface soil	2	2
Caliche	6	8
Clay, "near - surface" water at 27 feet	19	27
White clay	106	133
White clay with caliche layers	87	220
Red clay with few boulders	40	260
Red clay, layers of caliche, small flow of water cased off	105	365
Cemented gravel, flow of water	12	377
Red clay with gravel lenses	39	416
"Quicksand"	1	417
Gravel, flow of water	3	420
"Sand rock"	8	428
"Broken sand rock"	7	435
Fine sand with clay layers	15	450
Total depth	....	450

(S–20–61) 20bdd1. J. A. Griffin. Diameter 10 inches, 10-inch casing to 41 feet, 8-inch casing to 152, 197 feet of 6-inch casing from 128 to 325 feet perforated with ¼ by 2-inch slots from 270 to 317 feet.

Material	Thickness (feet)	Depth (feet)
Soil	5	5
Pink clay and caliche	13	18
"Near-surface" water level	....	18
Pink silty clay	24	42
Sand and gravel, much pink silty clay	6	48
Light pink silty clay	72	120
Sand and gravel, much pink silty clay	6	126
Light pink silty clay	24	150
Sand and gravel, some pink silty clay, water level rose in casing	8	158
Pink plastic clay, little silt	47	205
Sand and gravel, much pink silty clay	10	215
Pink silty clay	25	240
Pink clay, caliche nodules	16	265
Pink silty clay	10	275
Granule gravel and sand, some pink silty clay, flow of water	8	283
Caliche	9	292
Small pebble and granule gravel, little pink silt, flow of water	11	303
Coarse-to fine-grained pink sand, few granules	16	319
Fine-grained silty pink sand	6	325
Total depth	....	325

(S–20–61) 20cbb2. J. W. and Mae Cook. Land surface altitude 2,125 feet; diameter 6 inches, 6-inch casing to 122 feet.

Material	Thickness (feet)	Depth (feet)
Surface soil	4	4
Caliche	18	22
Gravel, "near-surface" water	1	23
Granules with much pinkish white clay	72	95
Light tan silty clay	40	135
Very light tan pink silt, numerous pebbles and little clay	10	145
Light tan silty clay	30	175
Light pink caliche, flow of water	5	180
Light pink silty clay	15	195
Light tan pink silt, few granules, some clay, increase in flow of water	50	245
Medium tan pink silty fine sand with few granules	10	255
Total depth	....	255

(S–20–61) 20cca1. T. W. Allen and D. Campbell. Land surface altitude 2,118 feet; diameter 9 inches, 9-inch casing to 80 feet, 5-inch casing to 351 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	4	4
Caliche	6	10
Clay with caliche layers, "near - surface" water	6	16
Clay with caliche layers	269	285
"Quicksand," small flow of water	15	300
Gravel with "lime shells," flow of water	58	358
Total depth	....	358

TABLE 3—*Continued*

(S–20–61) 20ccb2. W. R. Smith. Land surface altitude 2,127 feet; diameter 9 inches, 130 feet of 9-inch casing to 130 feet, 190 feet of 7-inch casing to 300 feet, perforated between 260 and 295 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	5	5
"Rock"	5	10
Sand	110	120
"Rock and clay"	140	260
Sand and gravel, flow of water	40	300
Total depth	....	300

(S–20–61) 20ccc1. S. P. James. Land surface altitude 2,115 feet; diameter 8 inches, 8-inch casing to 86 feet, 6-inch casing to 315 feet.

Material	Thickness (feet)	Depth (feet)
Soil	5	5
"Gravel" and "near-surface" water	17	22
White calcareous clay	23	45
Pink silty limey clay	10	55
White calcareous clay, and caliche nodules	60	115
Buff silty calcareous clay	90	205
Tan silty calcareous clay, little very fine sand	60	265
Pink silty fine sand, few granules	20	285
Pink, very fine sand, few granules, flow of water	5	290
Pink silty fine sand, few granules	25	315
Silty granular gravel and medium-grained orange sand, flow of water	10	325
Pink silty fine sand and granular gravel grading into pink silty clay and fine sand, some granules	25	350
Total depth	....	350

(S–20–61) 20cdb1. M. D. and F. Butler. Land surface altitude 2,109 feet; diameter 8 inches, 8-inch casing to 320 feet, perforated from 300 to 320 feet with slots ⅛-inch wide and 6 inches long. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	10	10
Caliche	10	20
Gravel and "near-surface" water	5	25
Clay with caliche layers	55	80
Brown clay	220	300
Cemented gravel, flow of water	40	340
Total depth	....	340

(S–20–61) 20cdc1. M. D. Butler. Land surface altitude 2,108 feet; diameter 8 inches, 8-inch casing to 310 feet, perforated from 260 to 310 with slots ⅛-inch wide and 6 inches long. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	10	10
Caliche	10	20
Gravel and "near-surface" water	5	25
Clay with caliche layers	55	80
Brown clay	220	300
Cemented gravel, flow of water	25	325
Total depth	....	325

(S–20–61) 21aba1. L. W. Noblett. Diameter 8 inches, 8-inch casing to 80 feet.

Material	Thickness (feet)	Depth (feet)
Soil	4	4
Caliche	3	7
White clay, caliche granules, "near-surface" water	8	15
Tan clay, caliche granules	10	25
Tan clay	50	75
Tan clay, caliche nodules	20	95
Tan clay	100	195
Dark tan clay	10	205
Tan clay	20	225
Dark tan clay, few granules	55	280
Fine gravel and sand, flow of water	20	300
Reddish tan clay	46	346
Total depth	....	346

TABLE 3—*Continued*

(S–20–61) 21abb1. C. Gratz. Diameter 12 inches, 12-inch casing to 194 feet, 6-inch casing to 200 feet. Well reconditioned by John Frewalt in 1946, drilled to 316 feet in April 1946. Driller's log published in U. S. Geological Survey Water-Supply Paper 365, p. 34, 1915, and erroneously reported as log of well 4 (S–20–61—19bcc1) in U. S. Geological Survey Water-Supply Paper 849-D, p. 149, 1941.

Material	Thickness (feet)	Depth (feet)
Lime	28	28
"Near-surface" water	....	28
Lime and clay	12	40
Hard cemented lime	10	50
Lime and clay mixed	20	70
Hard cemented lime	15	85
Clay mixed with lime	20	105
Very hard material	5	110
Clay and lime mixed	20	130
Lime rock	15	145
Clay and soft lime, (flowing water at 174 feet)	34	179
Hard streak	6	185
Lime and clay	4	189
Hard rock	10	199
Clay and limerock	4	203
Hard limerock, porous	8	211
Clay with rock	2	213
Hard streak	12	225
Rock	5	230
Sand and pebbles	6	236
Total depth	....	236

(S–20–61) 21dbc1. Las Vegas Building and Loan Company. Diameter 10 inches, 10-inch casing to 27 feet. Driller's log reported in U. S. Geological Survey Water-Supply Paper 365, p. 34, 1915.

Material	Thickness (feet)	Depth (feet)
Soil	12	12
White clay	10	22
Limerock	6	28
"Near-surface" water	....	28
White clay ("talc")	52	80
Sand and clay	5	85
White clay	15	100
Yellow sand and clay	5	105
White clay	3	108
Red clay and sand	7	115
White clay	5	120
Yellow clay	10	130
White clay	5	135
Yellow clay and sand	50	185
Limerock	5	190
Yellow to red clay	40	230
Sandrock	5	235
Red clay	33	268
Total depth	....	268

(S–20–61) 22aaa1. Taylor Estate. Diameter 8 inches, 8-inch casing to 99 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	180	180
"Rock"	3	183
Clay	13	196
Caliche	12	208
Clay	20	228
Cemented sand and gravel	17	245
Red clay	35	280
Caliche, flow of water	6	286
Red clay	11	297
Caliche	2	299
Red clay	6	305
Gravel, flow of water	1	306
Sand and clay	99	405
Sand and gravel	13	418
Total depth	....	418

(S–20–61) 22acd1. City of North Las Vegas. Land surface altitude 1,937 feet; diameter 8 inches, 8-inch casing to 160 feet, 548 feet of 6-inch casing, 207 feet of 4-inch casing, perforated with slots ¼-inch wide and 4 inches long from 628 to 712 feet.

Material	Thickness (feet)	Depth (feet)
No record	245	245
Gravel, flow of water	7	252
Clay and gravel	18	270
Pink, silty, coarse and medium-grained sand	40	310
Pink silt with little fine-grained sand, some clay and granules	40	350
Pink sandy silt	10	360
Pink silty clay with granules and caliche nodules	20	380
Pink sandy silt	14	394
Granular gravel, water	2	396
Plastic blue clay	34	430
Red fine-grained sand with few granules	15	445
Granular gravel and red fine-grained sand, water	3	448
Red sand, little clay, some granular gravel	42	490
Fine-grained red sand, some silt	10	500
Light gray clay	10	510
Red clay	30	540
Fine-grained red sand, some silt	30	570
Red clay, little sand and silt	20	590
Red silty clay	50	640
White sand, water	4	644
White clay	5	649
Red clay, few sand lenses	101	750
Red sand, water	2	752
Total depth	....	752

TABLE 3—*Continued*

(S-20-61) 22acd2. City of North Las Vegas. Land surface altitude 1,938 feet; diameter 10 inches, 10-inch casing.

Material	Thickness (feet)	Depth (feet)
Soil, no record	23	23
Red silty clay, few thin caliche layers	67	90
No record	24	114
Caliche, little clay	23	137
Red clay	23	160
No record	23	183
Caliche	13	196
White clay, thin caliche layers	10	206
Caliche	14	220
Pink silty clay, caliche layers	56	276
Pink silty clay, much granule gravel	39	315
Red silty clay, little gravel	30	345
Red silty clay, much gravel	24	369
Red silty clay, little gravel	21	390
Plastic blue clay	47	437
Plastic blue clay, much caliche	34	471
Red sandy and silty clay	149	620
Sandy red clay, few granules	92	712
Red silty fine-grained sand, some clay	46	758
Silty red clay, little sand and gravel	48	806
Sandy silty red clay, much fine gravel	22	828
Total depth	....	828

(S-20-61) 22cbc1. Jack Moore and C. E. Bell. Diameter 8 inches, 8-inch casing to 75 feet.

Material	Thickness (feet)	Depth (feet)
Buff silty clay with few granules	15	15
Very light pink clay	60	75
Light buff silty clay with granules	30	105
Very light pink clay	40	145
Dark brown clay with few granules of caliche	10	155
Tan clay and silt	20	175
Very light pink silty clay	30	215
Light pink clay	10	225
Black sand, water level raised to within five feet of surface	30	255
Very light pink clay	40	295
Light pink clay, few caliche granules	20	315
Light pink clay	70	385
Total depth	....	385

(S-20-61) 22dda1. Arthur Arnold. Diameter 8 inches, 8-inch casing to 240 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Light pink sandy clay, few granules	15	15
"Near-surface" water	....	15
Light pink sandy clay	40	55
Light pink and tan mottled sandy clay	5	60
Light pink sandy clay	60	120
Dark tan clay	10	130
Light pink clay	20	150
Light pink and tan mottled clay	10	160
Light pink clay	40	200
Light tan clay	10	210
Light pink clay	20	230
Light tan clay	10	240
Light pink clay	5	245
Slightly sandy granules and pebble gravel, little clay	10	255
Red clay, plastic	35	280
Cement gravel, water	10	290
Yellow and light pink clay	10	300
Total depth	....	300

TABLE 3—*Continued*

(S-20-61) 22ddd3. Harry Miller. Diameter 6 inches. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	9	9
"Near-surface" water	....	9
Soil	1	10
Caliche and white clay	5	15
Red clay	39	54
"Hard lime"	86	140
Caliche	7	147
"Hard lime"	11	158
Clay with "lime"	3	161
Red clay and 'talc"	5	166
Caliche	3	169
Clay	6	175
Caliche	8	183
"Lime and gyp"	7	190
"Lime"	18	208
Sand, water	2	210
Cemented gravel, flow of water	5	215
Clay	3	218
Cemented gravel	4	222
Clay	5	227
Cemented gravel	3	230
Sandy clay	15	245
Cemented gravel, water	3	248
Sandy clay	5	253
Cemented gravel	4	257
Red clay	5	262
Cemented gravel	5	267
Red sandy clay	19	286
Red clay	24	310
Cemented gravel, water	3	313
Red clay	19	332
"Mucky" sand	2	334
Sandy clay	66	400
White sand	3	403
Red, sandy clay	26	429
Cemented gravel	4	433
"Shale" and sand	2	435
Gray clay	12	447
Blue clay	33	480
Gray clay	7	487
Red clay	38	525
Total depth	....	525

(S-20-61) 23cbd1. R. F. Watson. Diameter 5⅝ inches, 108 feet of 5⅝-inch casing. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	10	10
Caliche and clay	48	58
Red clay, "rock," caliche	72	130
Clay, caliche	70	200
Gravel, water	10	210
Total depth	....	210

(S-20-61) 23ddb1. Mary Gaddis. Diameter 8 inches, 8-inch casing to 84 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	....	10
"Near-surface" water	....	20
Dry hard clay	to	318
Gravel, flow of water	6	324
No record	46	370
Gravel, water	....	370
No record	....	420
Total depth	....	420

(S-20-61) 26bbb1. City of Las Vegas. Diameter 8 inches, depth of 8-inch casing unknown, 6-inch casing from 263 to 502 feet, 5-inch casing from 332 to 570 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	258	258
"Cavey" red sand, flow of water	15	273
Red sandy clay	13	286
Gravel	2	288
Red sandy clay	41	329
"Quicksand"	10	339
White clay	24	363
Yellow clay	74	437
Sand	1	438
Sandy clay	12	450
Blue clay	2	492
Yellow clay	120	612
"Soapstone"	2	614
Yellow clay	150	764
Gray clay	26	790
Gray clay and red sand	8	798
Sand, water	4	802
Yellow clay	6	808
Sand, water	4	812
Total depth	....	812

(S-20-61) 27aaa2. R. B. Saunders. Diameter 4 inches, 4-inch casing to 90 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Sandy loam	4	4
Gravel and sand	4	8
"Limestone"	7	15
Clay and broken limestone	10	25
Gravel	2	27
"Near-surface" water level	....	27
Clay and "limestone"	23	50
Red clay	40	90
Green clay	2	92
Red clay	22	114
"Broken limestone," flow of water	4	118
Red clay	7	125
Red clay and "limestone"	25	150
"Broken limestone"	25	175
"Limerock" and red clay	10	185
Red clay	5	190
Sand and gravel, flow of water	10	200
Total depth	....	200

TABLE 3—*Continued*

(S-20-61) 27daa1. Las Vegas Land and Water Co. Diameter 8 inches, 8-inch casing to 41 feet; 6⅝-inch casing to 270 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	12	12
Caliche	3	15
"Near-surface" water	....	15
Clay, sand, and "lime"	60	75
White clay	72	147
Caliche	3	150
Clay and sand, water	5	155
Caliche	59	214
Sand, gravel, and clay	50	264
Caliche	9	273
Sand, flow of water	50	323
Total depth	....	323

(S-20-61) 28bca2. E. H. Thomas and H. W. Polk. Diameter 10 inches, 10-inch casing to 519 feet, perforated with one-eighth by 3-inch slots from 345 to 369 feet, 203 feet of 8-inch casing from 507 to 710 feet, perforated with ⅛ by 3-inch slots from 650 to 710 feet.

Material	Thickness (feet)	Depth (feet)
Tan sandy silt, some caliche nodules	7	7
Tan sandy silt cemented with caliche	8	15
Light pink silty clay, caliche nodules	10	25
Greenish white clay, much caliche	7	32
Caliche	9	41
Greenish white clay, silty, some caliche	16	57
Caliche	5	62
Silty white clay, caliche nodules	38	100
Caliche	2	102
Light pink clay, thin layers of caliche	52	154
Caliche	1	155
Light pink clay, thin layers of caliche	74	229
Pink clay, caliche nodules	29	258
Caliche	11	269
Pink silty clay, some granule gravel	87	356
Silty and sandy granular gravel, flow of water	7	363
Pink silty clay, some granule gravel	16	379
Caliche-cemented pink silt	10	389
Pink silty clay, some granule gravel, few layers well cemented with caliche	202	591
Caliche	4	595
Fine-grained pink sand, few granules, some clay	45	640
Red silty clay, flow of water	70	710
Total depth	....	710

(S-20-61) 28cad1. E. A. Honrath. Land surface altitude 2,057 feet; diameter 6 inches, 6-inch casing to 402 feet, 294 feet of 4-inch casing from 340 feet to 634 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	10	10
Caliche	20	30
White clay and caliche	120	150
Yellow clay and caliche	60	210
Yellow sandy clay	28	238
Caliche	3	241
Yellow sandy clay	11	252
"Quick" sand	5	257
Yellow clay	29	286
Gravel	12	298
Caliche	2	300
Red sandy clay	15	315
Red sandy clay and "quick" sand	5	320
Gravel, flow of water	65	385
Gravel	12	397
"Rock"	7	404
Sand, flow of water	46	450
Red sandy clay	18	468
Blue clay	9	477
Blue "quick" sand	63	540
White sand	10	550
Red sandy clay	30	580
"Quick" sand and clay	56	636
White sand and gravel, flow of water	14	650
Total depth	....	650

(S-20-61) 28cbd1. T. J. Thebo. Land surface altitude 2,066 feet; diameter 8 inches, 8-inch casing to 120 feet, 6-inch casing to 550 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	20	20
Clay	....	20
"Near-surface" water level	....	20
No record	8	28
Clay	10	38
Clay and caliche	52	90
Clay	16	106
Caliche	5	111
Clay	24	135
Caliche	50	185
Clay and sand	35	220
Clay	10	230
Clay and caliche	54	284
Caliche and gravel	16	300
Sand and gravel, flow of water	32	332
Sand	13	345
Clay	25	370
"White sand"	135	505
Red sand	40	545
Red sand and gravel	39	584
Red sand	26	610
"Shattered sandstone"	25	635
Sand and gravel, flow of water	15	650
Total depth	....	650

TABLE 3—*Continued*

(S–20–61) 28cda1. V. K., M. G., L. V. Clement and Lee Waite. Land surface altitude 2,056 feet; diameter 8 inches, 8-inch casing to 400 feet, 200 feet of 7-inch (O. D.) casing, and 533 feet of 4-inch casing, perforated with slots 1/16-inch wide and 4 inches long from 453–533 feet.

Material	Thickness (feet)	Depth (feet)
Soil	5	5
White clay and caliche layers	5	10
"Near-surface" water level	....	10
White clay and layers of caliche	35	45
Light gray clay	20	65
Very light pink clay	53	118
Caliche nodules and light pink clay	12	130
Dark tan clay, caliche nodules	10	140
Light tan clay, few nodules	10	150
Very light pink clay, silty	50	200
Light tan clay, few granules	40	240
Very light pink clay, few granules	10	250
Light pink clay, granules	30	280
Pink silty clay	10	290
Pink silty clay, many pebbles and granules	10	300
Pink silty clay	30	330
Pink silty clay, little sand, numerous granules	20	350
Pink silty clay and fine sand	5	355
Loosely cemented granular gravel, few pebbles, some silt and fine sand, flow of water	35	390
Light pink silty clay	50	440
Light pink fine-grained sand and silt, few granules	17	457
Light greenish blue clay	7	464
Very light pink clean medium-grained sand	6	470
Light tan fine-grained sand and silt	38	508
Light pink sand and gravel, flow of water	1	509
Light tan fine-grained sand and silt	26	535
Light pink silty fine-grained sand	40	575
Light tan silty fine-grained sand	5	580
Light pink silty fine-grained sand	54	634
Fine gravel and coarse-grained sand, flow of water	1	635
Light pink silty fine-grained sand	50	685
Cement gravel, flow of water	5	690
Total depth	....	690

(S–20–61) 29cbc1. T. E. Sharp. Land surface altitude 2,138 feet; diameter 7⅝ inches, 7⅝-inch casing to 149 feet, 402 feet of 5⅝-inch casing. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	160	160
Flow of water	....	160
No record	170	330
Cemented gravel	10	340
Sand and gravel	10	350
Clay and "muck"	7	357
Cemented gravel	13	370
Gravel	28	398
Clay	2	400
Gravel, flow of water	33	433
Sand, clay, and "broken lime"	57	490
Dry sand and boulders	5	495
Total depth	....	495

(S–20–61) 29dac1. Julia Russell. Land surface altitude 2,082 feet; diameter 8 inches, 8-inch casing to unknown depth, 6-inch casing to 453 feet, 4-inch casing to 780 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	125	125
First flow of water	....	125
No record	183	308
Red sand	9	317
Sand and caliche	17	334
Red sand	14	348
Gravel	22	370
Sand and gravel	15	385
Clay	13	398
Sand and gravel	12	410
Clay	10	420
Sand and gravel	13	433
Cement gravel	10	443
Sand and caliche	9	452
Clay	37	489
White sand	27	516
White clay	4	520
Red sand	10	530
Clay and sand	42	572
Sand	....	.....
No record	208	780
Total depth	....	780

TABLE 3—*Continued*

(S–20–61) 29dad1. Louis Perozzi. Land surface altitude 2,077 feet; diameter 9 inches, 9-inch casing to 61 feet, 6-inch casing to unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	6	6
Caliche	20	26
"Near-surface" water	....	26
Caliche (broken up)	4	30
Clay	10	40
Brown clay	30	70
Sand	30	100
Brown clay	6	106
Clay and sand	58	164
Caliche	36	200
Clay and sand	64	264
White sand, flow of water	6	270
Sand	30	300
Caliche	10	310
Sand, flow of water	50	360
Caliche and clay	41	401
Sand, flow of water	29	430
Total depth	....	430

(S–20–61) 29dbb1. John Papus. Land surface elevation 2,094 feet; diameter 7⅝ inches, 7⅝-inch casing to 400 feet, 80 feet of 6-inch casing from 395 to 475 feet, perforated with slots ¼-inch wide and 4 inches long from 400 feet to 475 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Caliche and clay	100	100
Red clay and "rock"	300	400
Red sand and clay	50	450
Sand and gravel	25	475
Total depth	....	475

(S–20–61) 29dca1. Julia Russell. Land surface altitude 2,083 feet; diameter 8 inches, 8-inch casing to 120 feet, 6-inch casing to 650 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	....	17
"Near-surface" water level	....	17
Clay and caliche	?	130±
Gravel, flow of water	?	130
No record	20	150
Sand and caliche	50	200
No record	50	250
Cement gravel, clay and sand	100	350
Flow of water	....	350
No record	300	650
Gravel, flow of water	14	664
Total depth	....	664

(S–20–61) 29dca2. U. S. Geological Survey. Land surface altitude 2,083 feet; diameter 2 inches, 2-inch casing to 22 feet.

Material	Thickness (feet)	Depth (feet)
White silty clay	20	20
White silty clay, few granules, little sand	5	25
Total depth	....	25

(S–20–61) 29ddb1. J. S. Ronnow. Land surface altitude 2,078 feet; diameter 6 inches, 6-inch casing to 72 feet, 4-inch casing to 401 feet.

Material	Thickness (feet)	Depth (feet)
Soil	4	4
White marly clay, caliche nodules	5	9
"Near-surface" water level	....	9
White marly clay, caliche nodules	86	95
Light pink silty clay, caliche nodules	60	155
Light tan silty clay, caliche pebbles, little fine-grained sand	65	220
Pink silty clay little sand and few granules	40	260
Tan silty very fine-grained sand with caliche nodules and granules	125	385
Pink sand, few granules, flow of water	5	390
Pink silty very fine-grained sand	31	421
Tan sand and caliche, much clay and silt, flow of water	10	431
Tan silty fine sand with granules of caliche	11	442
Total depth	....	442

TABLE 3—*Continued*

(S-20-61) 30adb1. L. H. Tritle. Diameter 10 inches, 10-inch casing to 322 feet, perforated with slots ⅛-inch wide from 282 to 322 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Very fine-grained light brown sand with some silt and caliche	10	10
Light gray clay with caliche and very fine-grained sand, some granules	10	20
Fine-grained light brown sand with little silt	20	40
Fine-grained tan sand, little clay	10	50
Medium brown very fine-grained sand, little silt and caliche	10	60
Fine-grained tan sand, some silt and little calcareous material	50	110
Fine-grained brownish white sand, some caliche, little silt	20	130
Fine-grained brown sand	20	150
Fine-grained light brown sand, some calcareous material	30	180
Fine-grained light brown sand, some silt, some caliche nodules, and little gravel, water	20	200
Fine-grained light brown sand, little silt and caliche	10	210
Blue clay	54	264
Gravel and sand, flow of water	54	318
Gray clay	4	322
Total depth	....	322

(S-20-61) 30bcc1. U. S. Geological Survey. Land surface altitude 2,210 feet; diameter 2 inches, 2-inch casing to 20 feet.

Material	Thickness (feet)	Depth (feet)
Soil	1	1
Caliche, pink silty clay	9	10
Granule gravel	5	15
Tan silty clay	5	20
Tan silty clay, granule gravel	10	30
Total depth	....	30

(S-20-61) 30dda1. Las Vegas Land and Water Co. Land surface altitude 2,121 feet; diameter 16 inches, 16-inch casing to 82 feet, 10¾-inch casing to 525 feet, 311 feet of 8⅝-inch casing from 489 to 800 feet, perforated from 541 to 800 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Sandy clay "shell"	51	51
Yellow clay, "shell," sand	46	97
Gravel	13	110
Yellow sandy clay, "shells"	76	186
Sandy clay, "limestone"	57	243
Sandy clay	47	290
Coarse gravel	70	360
Coarse gravel, little clay	23	383
Coarse gravel, much clay	60	443
"Hard shell"	2	445
Gravel, clay, few small boulders	37	482
Yellow clay, gravel	18	500
Sandy gravel and clay	34	534
Sandy clay	16	550
Sandy clay, gravel	20	570
Gravel, little clay	19	589
Sandy clay, gravel	61	650
Gravel	84	734
Gravel, some clay	36	770
Gravel	20	790
Clay and gravel	10	800
Total depth	....	800

(S-20-61) 30dda2. Las Vegas Land and Water Co. Land surface altitude 2,120 feet; diameter 10¾ inches, 13⅜-inch casing to 280 feet, 231 feet of 10¾-inch casing, perforated with ½-inch slots from 266 to 477 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Sand and clay	25	25
"Limestone" and clay	50	75
Clay and gravel	105	180
Sandy clay and gravel	120	300
Coarse gravel, flow of water	83	383
Gravel and clay	62	445
Sand and small gravel, flow of water	32	477
Total depth	....	477

TABLE 3—*Continued*

(S–20–61) 31aad2. Las Vegas Land and Water Co. Land surface altitude 2,137 feet; diameter 13⅜ inches, 13⅜-inch casing to 290 feet, 241 feet of 10¾-inch casing from 259 to 500 feet, perforated with ½-inch slots from 280 to 497.5 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
"Limestone" and clay	150	150
Sandy clay and "limestone"	100	250
Sandy red clay	30	280
Fine sand and small gravel, flow of water	50	330
Gravel, water-bearing	90	420
Sand and gravel, water bearing	70	490
Gravel and red clay	10	500
Total depth	....	500

(S–20–61) 31ada1. Las Vegas Land and Water Co. Land surface altitude 2,134 feet; diameter 16 inches, 16-inch casing to 40 feet, 10¾-inch casing to 506 feet, 315 feet of 7-inch casing from 480 to 795 feet, perforated from 495 to 795 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	4	4
"Limestone"	5	9
Gravel, clay	36	45
Clay and sand	20	65
"Lime" and sandy clay	40	105
"Lime" and limey clay	150	255
"Lime" and limey clay with thin layers of gravel	30	285
Medium to coarse gravel	190	475
Red sandy clay and gravel	10	485
Red sandy clay	30	515
"Lime," clay and thin layers of gravel	20	535
Medium to coarse gravel	266	801
Total depth	....	801

(S–20–61) 31add1. Las Vegas Land and Water Co. Land surface altitude 2,125 feet; diameter 13⅜ inches, 13⅜-inch casing to 275 feet, 255 feet of 10¾-inch casing from 297 to 462 feet, perforated with ½-inch slots from 244 to 462 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Caliche and clay	45	45
Gravel and clay	45	90
Clay	70	160
Sand, gravel and caliche	50	210
Gravel, some clay	35	245
Clay, some gravel	30	275
Gravel	45	320
Gravel and clay	30	350
Gravel	40	390
Gravel, little clay	70	460
Sand and clay	10	470
Gravel, clay, caliche	15	485
Total depth	....	485

(S–20–61) 31dab1. Las Vegas Land and Water Co. Land surface altitude 2,129 feet; diameter 13⅜ inches, 13⅜-inch casing to 510.6 feet, 283.8 feet of 10¾-inch casing from 476.7 to 760.5 feet, perforated with ½-inch slots. Driller's log.

Material	Thickness (feet)	Depth (feet)
Caliche and clay	25	25
Caliche and sand	10	35
Caliche and gravel	15	50
Gravel, caliche, and clay	20	70
Caliche and clay	20	90
Caliche and gravel	35	125
Caliche	20	145
Clay and caliche	55	200
Clay, gravel, and caliche	15	215
Clay and caliche	20	235
Clay and gravel	30	265
Clay	20	285
Sand and clay	15	300
Gravel, sand, and clay	15	315
Gravel, little sand	65	380
Gravel, little clay	20	400
Clay, little sand and gravel	15	415
Clay and gravel	75	490
Clay	15	505
Gravel, clay and little sand	45	550
Gravel	25	575
Gravel and sand	50	625
Gravel	50	675
Sand	35	710
Gravel, some clay	15	725
Sand	25	750
Gravel and clay, little sand	16	766
Total depth	....	766

TABLE 3—*Continued*

(S–20–61) 31dac1. Las Vegas Land and Water Co. Land surface altitude 2,132 feet; 10¾-inch casing to 904 feet, perforated with slots 3/16-inch wide and 2 inches long from 548 to 750 feet and 800 to 904 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Clay, caliche, and gravel	230	230
Gravel	130	360
Pink silty clay, granule gravel, few caliche nodules	70	430
Granule and small-pebble gravel, some pink silty clay	25	455
Pink silty clay, few granules	80	535
Granule and small-pebble gravel, some pink silty clay	35	570
Granule, small - pebble gravel, fine-to-coarse-grained sand, little pink silty clay	175	745
Pink silty clay, few granules	20	765
Granule and pebble gravel, some sand, much pink silty clay	20	785
Pink silty clay, few granules	20	805
Granule and pebble gravel, some sand and little silt	110	915
Coarse to medium-grained sand	7	922
Pink silty clay, little sand	18	940
Total depth	....	940

(S–20–61) 31ddb1. Las Vegas Land and Water Co. Land surface altitude 2,133 feet; diameter 13⅜ inches, 13⅜-inch casing to 280.2 feet, 216.6 feet of 10¾-inch casing from 193.4 to 410 feet, perforated with ½-inch slots from 193.4 to 410 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Caliche and clay	50	50
Caliche, little gravel	15	65
Clay	13	78
Caliche and clay	122	200
Gravel, caliche, and clay	20	220
Gravel and clay	55	275
Gravel	35	310
Gravel and sand	15	325
Gravel, little clay	10	335
Gravel	20	355
Clay and gravel	100	455
Clay	17	472
Total depth	....	472

TABLE 3—*Continued*

(S–20–61) 31ddc1. Las Vegas Land and Water Company. Land surface altitude 2,137 feet; diameter 13⅜ inches, 13⅜-inch casing to 494.3 feet, 376.8 feet of 10¾-inch casing from 443.2 to 820 feet, 358.9 feet of 7-inch casing from 798.6 to 1,157.5 feet, perforated with ½-inch slots from 798.6 to 1,019.9 feet and from 1,096 feet to 1,157.5 feet. Following completion of the well the 10¾-inch casing was shot-perforated between 500 and 800 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Caliche, small amounts of clay, sand, and gravel	80	80
Clay, little caliche	30	110
Caliche, some clay	75	185
Clay, some caliche	15	200
Caliche, little clay and sand	10	210
Clay, little sand and gravel	30	240
Caliche, some gravel	20	260
Clay, little caliche and gravel	30	290
Gravel, some sand and little clay, flow of water	100	390
Clay, some gravel and little sand	90	480
Clay	20	500
Gravel	30	530
Clay, little gravel	10	540
Gravel and sand	10	550
Clay, some sand and gravel	20	570
Sand, some gravel and little clay	40	610
Gravel, some clay	10	620
Gravel, flow of water	20	640
Gravel and sand, increased flow of water	10	650
Gravel, increased flow of water	20	670
Gravel and sand, increased flow of water	30	700
Gravel, increased flow of water	10	710
Sand and gravel, increased flow of water	60	770
Sand, increased flow of water	10	780
Gravel, increased flow of water	10	790
Sand and gravel, increased flow of water	10	800
Clay	5	805
Clay, little sand and gravel	5	810
Clay, some gravel	10	820
Gravel, little clay	10	830
Gravel, increased flow of water	10	840
Clay and sand, little gravel	10	850
Gravel, increased flow of water	70	920
Clay and gravel	20	940
Gravel, sand, some clay	10	950
Clay and gravel	20	970
Clay	40	1,010
Clay, little sand	10	1,020
Clay	10	1,030
Sand, increased flow of water	20	1,050
Clay, little sand	40	1,090
Gravel and sand	10	1,100
Gravel, increased flow of water	50	1,150
Clay, little gravel	40	1,190
Clay	60	1,250
Total depth	....	1,250

(S–20–61) 32acb2. R. B. Griffith. Diameter 8 inches, 8-inch casing to 338 feet, 200 feet of 6-inch casing from 300 to 500 feet, 220 feet of 5-inch casing from 440 to 660 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil and "gyp"	50	50
"Clay and rock"	250	300
Cement gravel	100	400
Gravel and sand, flow of water	10	410
Clay	50	460
"Rock"	20	480
Clay and sand	160	640
Coarse sand and gravel, flow of water	20	660
Total depth	....	660

TABLE 3—*Continued*

(S–20–61) 32acc1. R. B. Griffith. Land surface altitude 2,093 feet; diameter 10 inches, 10-inch casing to 446 feet, perforated with ¼-by-4-inch slots from 386 to 446 feet, 208 feet of 8-inch casing from 426 to 634 feet, perforated with $\frac{3}{16}$-by-2½-inch slots from 574 to 634 feet.

Material	Thickness (feet)	Depth (feet)
Red sandy silt	6	6
Caliche	34	40
White silty clay, few thin strata of caliche	80	120
Tan silty clay, few thin strata of caliche	144	264
Pink silty clay, many granules, little sand	22	286
Small - pebble gravel, few granules, some sand and pink silty clay	19	305
Pink silty clay	2	307
Caliche	3	310
Small - pebble gravel, few granules, some sand and pink silty clay	79	389
Red silty clay, some sandy pebble and granule gravel, flow of water	66	455
Red silty clay, caliche	26	481
Red silty clay, few granules, few thin caliche strata	129	610
Small-pebble and granule gravel, little sand and silt, flow of water	24	634
Red silty clay, much granule gravel and sand	26	660
Red silty hard clay	2	662
Red silty clay, little granule gravel and sand	33	695
Total depth	....	695

(S–20–61) 32cdc1. Kenneth Searles. Land surface altitude 2,101 feet; diameter 10 inches, 10-inch casing to 585 feet, perforated with ⅛-by-2-inch slots from 530 to 565 feet.

Material	Thickness (feet)	Depth (feet)
Soil	10	10
White silty clay, few granules and little sand, few thin caliche layers	30	40
Granule and small-pebble-gravel, many caliche nodules, little white silty clay	10	50
Pink silt, few granules, some clay	10	60
Tan silty clay	30	90
Tan silty clay, few granules, caliche nodules	30	120
Tan silty clay	110	230
Dark tan silty clay, few caliche nodules	20	250
Dark tan silt, few small pebbles and granules, some clay	30	280
Tan silty clay, some granules	50	330
Small pebble and granule gravel, much tan silty clay	10	340
Tan silty clay, some granules	10	350
Pebble and granule gravel, some tan silty clay	10	360
Tan silty clay	60	420
Blue clay	15	435
Tan silt, little clay and very fine - grained sand	5	440
Light tan silt, few granules	50	488
Light tan silt and greenish blue clay, much caliche and few large pebbles	2	490
Red clay, caliche nodules	10	500
Dark tan silt, few granules, little fine sand	20	520
Tan silt	10	530
Red silt	10	540
Red silty clay	10	550
Fine to medium-grained pink sand, flow of water	15	565
Small pebble and granule gravel, little pink silty sand, increased flow of water	20	585
Total depth	....	585

TABLE 3—*Continued*

(S–20–61) 32cdd1. E. W. and L. Cragin. Land surface altitude 2,093 feet; diameter 10 inches, 10-inch casing to 100 feet; 8-inch casing to 440 feet, perforated with ¼-by-4-inch slots from 360 to 420 feet, 154 feet of 6-inch casing from 390 to 544 feet, perforated with ¼-by-4-inch slots from 445 to 485 feet, 40 feet of 5-inch casing from 535 to 575 feet, perforated with ¼-by-4-inch slots from 555 to 575 feet.

Material	Thickness (feet)	Depth (feet)
Soil	3	3
Caliche	2	5
Red silty clay	11	16
"Near-surface" water level	....	16
Red silty clay	11	27
Light pink silty clay	18	45
Tan clay	7	52
Brown silty clay	23	75
Caliche	2	77
Brown silty clay	15	92
Caliche	1	93
Brown silty clay	5	98
Caliche	1	99
Cemented pebble gravel	3	102
Pink silty clay	7	109
Light greenish blue clay	1	110
Pink silty clay	15	125
Pink silty clay, much gravel	11	136
Brown silty clay	20	156
Pink silty clay, thin layers of caliche	14	170
Pink silty clay	60	230
Pink silty clay, little gravel	20	250
Caliche	5	255
Pink silty clay	10	265
Caliche, little gravel	14	279
Caliche	9	288
Light pink clay, many granules, some sand	82	370
Red sandy silt, layers of pebble gravel, flow of water	30	400
Red silty clay	15	415
Red fine-grained sand	10	425
Red silty clay	70	495
Gravel, some silt and sand, flow of water	5	500
Red fine-grained sand	35	535
Pink silty clay	10	545
Red fine-grained sand	10	555
Gray, medium-grained sand	15	570
Caliche	2	572
Sandy silty gravel, flow of water	3	575
Total depth	....	575

(S–20–61) 32dda1. Adrian Kuffer. Land surface altitude 2,069 feet; diameter 5⅝ inches, 5⅝-inch casing to 380 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Sandy loam	8	8
"Broken lime rock"	15	23
White clay	14	37
"Rock"	3	40
White clay	13	53
"Broken lime rock"	2	55
White clay	14	69
"Broken lime rock"	4	73
Clay	62	135
"Broken lime rock"	3	138
Clay and "broken lime rock"	121	259
"Broken lime rock" and sand	21	280
Red clay	52	332
Gravel and clay	3	335
Clay	15	350
Clay and gravel	20	370
Gravel, flow of water	38	408
Sand and clay	10	418
Total depth	....	418

(S–20–61) 32ddb2. M. R. Russell. Land surface altitude 2,075 feet; diameter 10 inches, 10-inch casing to 181 feet, 8-inch casing to 215 feet, 200 feet of 7-inch casing, perforated and set at unknown depth, 108 feet of 5-inch casing, perforated and set at unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	7	7
Hard lime with streaks of gypsum	16	23
Near-surface water level	....	23
Hard lime with streaks of gypsum	177	200
Hard gravel with thin layers of clay	100	300
"Cement gravel"	61	361
Loose gravel	4	365
Cement gravel, small flow of water at 400 feet	45	410
Clay	5	415
"Cement gravel"	40	455
Red clay	5	460
Blue clay	8	468
"Quicksand"	12	480
"Cement gravel," flow of water at 496 ft.	20	500
Yellow clay and quicksand with thin layers of gravel, flow of water	144	644
Total depth	....	644

TABLE 3—*Continued*

(S–20–61) 32ddd1. H. D. Gerken. Diameter 5⅝ inches, 5⅝-inch casing to 342 feet, 85 feet of 4-inch casing from 322 to 407 feet, perforated from 322 to 392 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Sandy loam	7	7	Gravel and clay	13	279
"Lime rock"	8	15	Red clay	48	327
White clay	3	18	Gravel, flow of water	5	332
"Broken limerock"	7	25	Clay and gravel, increased flow of water	3	335
Gravel and clay	2	27	Gravel	7	342
Red clay	1	28	Red clay	3	345
"Broken limerock"	45	73	Gravel, flow of water	10	355
White clay	5	78	Cement gravel, increased flow of water	55	410
"Limerock"	1	79			
White clay	34	113			
"Broken limerock" and clay	153	266	Total depth	....	410

(S–20–61) 33bcc1. H. A. Studwell. Land surface altitude 2,067 feet; diameter 6 inches, 6-inch casing to 375 feet, perforated from 330 feet to 375 feet with slots ¼-inch wide and 2 inches long. Driller's log.

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Soil	12	12	Clay	20	355
"Limestone"	2	14	Clay and gravel	20	375
Near-surface water level	....	14	Gravel and sand, flow of water	25	400
"Limestone"	2	16	Clay	100	500
Layers of clay and "limestone"	284	300	Clay and "caving sand"	20	520
Clay	30	330			
Sand, flow of water	5	335	Total depth	....	520

(S–20–61) 33cbc1. J. L. Filby. Land surface altitude 2,068 feet; diameter 8 inches, 8-inch casing to 133 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Soil	12	12	"Rock"	5	244
White clay	7	19	Clay	17	261
"Limerock"	2	21	"Rock"	6	267
White clay	19	40	Clay	6	273
"Rock"	2	42	"Cement gravel"	57	330
White clay	7	49	Red sand and clay	8	338
"Limerock"	2	51	"Cement" and loose gravel, flow of water	52	390
Clay	26	77			
"Limerock"	3	80			
Clay	159	239	Total depth	....	390

(S–20–61) 33cca1. E. H. Allen. Land surface altitude 2,059 feet; diameter 3 inches, 3-inch casing to 312 feet, 1½-inch casing (inside of 3-inch casing) to 400 feet. A 1-inch pipe (outside of 3-inch casing) to 200 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
"Limestone" and clay	15	15	Sand and "limestone," small flow of water	10	330
Near-surface water level	....	15	Clay and "limestone"	60	390
"Limestone"	55	70	Gravel, flow of water	10	400
Sand and clay	130	200			
Sand, flow of water	10	210			
"Limestone" and clay	110	320	Total depth	....	400

(S–20–61) 33cca3. Margaret Folsom. Land surface altitude 2,054 feet; diameter 5⅝ inches, 5⅝-inch casing to 400 feet, perforated from 360 to 400 feet with slots ⅜-by-6-inches. Driller's log.

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Sandy loam	7	7	Red clay	15	280
Broken "lime rock"	4	11	"Blue" gravel, flow of water	10	290
White clay	8	19	Red clay	10	300
"Lime rock" and clay	12	31	Broken "limestone"	10	310
White clay	12	43	Red clay	30	340
Broken "lime rock"	7	50	Clay and gravel	20	360
White clay	20	70	Red clay	30	390
Broken "lime rock"	5	75	"Blue" gravel, flow of water	10	400
White clay	35	110			
Broken "lime rock"	10	120			
White clay	24	144			
Broken "limerock"	6	150	Total depth	....	400
Broken "lime in layers'	115	265			

TABLE 3—*Continued*

(S–20–61) 33cdc1. G. C. Blaine and Clifford A. Jones. Diameter 5⅝ inches, 5⅝-inch casing to 432 feet unperforated. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil and clay	12	12
White clay	38	50
Red sandy clay	50	100
Red clay with streaks of red sand	182	282
White sand	18	300
Red clay	50	350
Gravel	10	360
Red clay	40	400
Red sand	32	432
White sand, flow of water	18	450
Red clay	42	492
Blue clay	....	492
Total depth	....	492

(S–20–61) 33dad1. Mrs. Frank Beam. Diameter 8 inches, 8-inch casing to 90 feet, 6-inch casing to 595 feet. Driller's log reported in U. S. Geological Survey Water-Supply Paper, 849-D, 1941.

Material	Thickness (feet)	Depth (feet)
Sandy loam	6	6
"Lime rock"	22	28
Blue clay	17	45
"Lime rock"	7	52
Blue clay	28	80
White clay	35	115
Red clay	12	127
Pink clay	32	159
Clay	61	220
"Lime rock"	1	221
Clay, small flow of water	32	253
"Lime rock"	4	257
Red clay	30	287
"Lime rock"	5	292
Red clay	43	335
"Lime rock"	7	342
Clay	28	370
"Sandstone"	10	380
Clay	31	411
"Sandstone," flow of water	9	420
Red clay	5	425
Sandstone	12	437
Red clay	51	488
Sand and clay	14	502
Sand	48	550
Sand and gravel, flow of water	50	600
Total depth	....	600

(S–20–61) 34adc1. S. W. Craner. Diameter 8 inches, 8-inch casing to 178 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	6	6
Rock	2	8
Clay	11	19
Rock	6	25
Clay	162	187
"Lime rock," flow of water	2	189
Clay	12	201
"Lime rock," flow of water	2	203
Red clay	42	245
Sand, flow of water	2	247
Clay	3	250
"Cement" gravel	18	268
Clay	86	354
"Cement" gravel	....	354
Total depth	....	354

(S–20–61) 34dbb1. P. J. Goumond. Diameter 5⅝ inches, 5⅝-inch casing to 475 feet, 163 feet of 4-inch perforated casing from 450 feet to 613 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil, clay, and caliche	30	30
Yellow clay	130	160
Sand, flow of water	10	170
Clay	100	270
Clay and gravel	20	290
Clay and rock	150	440
Blue clay	25	465
Red clay	85	550
Sand	10	560
Red clay	40	600
Sand, flow of water	10	610
Red clay	28	638
Total depth	....	638

TABLE 3—*Continued*

(S–20–61) 35cac1. E. A. Clark. Diameter 8 inches, 8-inch casing to 370 feet, perforated with ⅜-by-6-inch slots from 146 to 150 feet and 255 to 263 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Soil	8	8	Red clay	6	177
Caliche	10	18	"Gravelly clay"	18	195
White clay	30	48	Sand and gravel	45	240
Caliche	2	50	Red clay	15	255
Red clay	7	57	Gravel, flow of water	3	258
Caliche conglomerate	7	64	Red sand, gravel	5	263
White clay	41	105	Red sand	61	324
Red clay	5	110	Blue mud	58	382
Red sand	1	111	Red clay	10	392
Red clay	19	130	Red sandy clay	15	407
Red sand	2	132	White sand, flow		
Red clay	14	146	of water	31	438
Caliche, flow of water	4	150	Sandy red clay	32	470
White sand	10	160	Sand	....	470
Caliche	4	164			
Red clay	3	167			
Caliche	4	171	Total depth	....	470

(S–20–61) 35cbb1. J. H. Ladd Estate. Diameter 6 inches, 6-inch casing to 410 feet, 4-inch casing to 710 feet, perforated between 410 and 420 feet and 600 and 650 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Soil	20	20	Clay	180	600
White clay and caliche	30	50	"Quick" sand, flow of		
Clay	100	150	water	50	650
Gravel	10	160	Clay with some sand		
Clay	230	390	layers	145	795
Blue clay	20	410			
Gravel, flow of water	10	420	Total depth	....	795

(S–20–61) 35ddc2. Estella C. Beam. Diameter 8 inches, 8-inch casing to 81 feet, 6-inch casing to 310 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Soil	7	7	Clay and sand	35	135
Caliche	3	10	Sand and gravel,		
"Near-surface" water			flow of water	65	200
level	....	10	Brown clay	20	220
Clay	10	20	Clay	30	250
Sand	10	30	Sand, flow of water	50	300
Clay	51	81	Clay	118	418
Brown clay	9	90			
Caliche, artesian water	10	100	Total depth	....	418

(S–20–61) 36bbb1. A. C. Delkin. Diameter 7⅞ inches, 7⅞-inch casing to 300 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Soil	10	10	Sandy clay	50	300
"Near-surface" water			"Quick" sand, flow of		
level	....	10	water	25	325
Gravel	5	15			
Yellow clay	235	250	Total depth	....	325

TABLE 3—*Continued*

(S–20–61) 36bbc1. W. M. Metzer. Diameter 6 inches, 6-inch casing to 130 feet.

Material	Thickness (feet)	Depth (feet)
Soil	2	2
White clay	3	5
Light tan clay	17	22
"Near-surface" water level	....	22
Light tan clay	63	85
White marly clay	5	90
Very sandy pink silt, little clay	25	115
White silty clay, little sand	10	125
Light pink silty clay, few granules, little sand	46	171
Brown sand, flow of water	4	175
Light pink silty clay	70	245
Silt and fine sand, many granules, flow of water	10	255
Sandy granule and pebble subangular gravel, little clay, flow of water	16	271
Sandy silt, little pink clay	4	275
Pink silty clay, few granules	30	305
Pink sandy silt	35	340
Sand, flow of water	4	344
Pink silt and clay	6	350
Fine - and medium-grained sand, numerous granules, some clay, flow of water	15	365
Total depth	....	365

(S–20–61) 36bcb1. K. G. Speirs. Diameter 7 inches, 7-inch casing to 130 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	10	10
"Near-surface" water level	....	10
Caliche	10	20
"Hard" clay	160	180
Sand and gravel, flow of water	10	190
Caliche	10	200
"Hard" clay	130	330
Gravel, flow of water	10	340
Total depth	....	340

(S–20–61) 36cbc1. U. S. Geological Survey. Diameter 1 inch, 1-inch casing to 22 feet.

Material	Thickness (feet)	Depth (feet)
Pink silty clay	25	25
Total depth	....	25

(S–20–61) 36cca1. E. A. Clark Estate. Diameter 5⅝ inches, 5⅝-inch casing to 437 feet, perforated with ½-by-2-inch slots from 220 to 225 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Clay and caliche	25	25
Clay	55	80
Gravel	5	85
"Rock"	5	90
Clay	6	96
"Rock"	5	101
"Rock" and clay	19	120
"Rock"	6	126
Clay	4	130
"Rock"	10	140
Clay	10	150
"Rock"	5	155
Red sandy clay	65	220
"Quick" sand, flow of water	5	225
Red sandy clay	170	395
Sand	5	400
Yellow clay	3	403
Blue clay	17	420
Red sandy sticky clay, small flows of water at various levels	217	637
Total depth	....	637

TABLE 3—*Continued*

(S–20–61) 36cca2. Sunrise Acres Water Association. Diameter 8 inches, 8-inch casing to 467 feet, perforated from 223 to 231 feet with 16 evenly spaced slots, from 273 to 277 feet with 12 evenly spaced slots, from 353 to 358 feet, with 12 evenly spaced slots, from 372 to 376 feet with 12 evenly spaced slots, at 400 feet with 4 evenly spaced slots, and from 417 to 419 feet with 8 evenly spaced slots; all slots ⅜-inch wide and 4 inches long.

Material	Thickness (feet)	Depth (feet)
Tan silt and sand, little clay	15	15
"Near-surface" water level	....	15
Tan silty clay, little sand	35	50
Tan silty clay, little sand, few granules	20	70
Light green silty clay	3	73
Pink silty clay, little fine-grained sand	27	100
Gray silty fine-grained sand	10	110
Pink silty clay, few granules	25	135
Tan clay, caliche nodules	5	140
Tan silty fine-grained sand, little pebble gravel	12	152
Pink silty clay, caliche nodules	3	155
Fine-grained pink silty sand, flow (1 G.M.) of water	7	162
Fine-grained pink sand and clay, few granules	3	165
Fine-grained pink silty sand	1	166
Pink silty clay, few granules and pebbles	14	180
Pink silty clay	7	187
Pink silty clay, few granules	3	190
Pink silty clay, large nodules of caliche and white clay	9	199
Pink silty fine-grained sand, granule gravel, flow (4 G.M.)* of water	11	217
Pink plastic silty clay, some sand	20	237
Pink silty sand, few granules	3	240
Pink silty clay	15	255
Pink sandy clay	10	265
Pink silty clay	11	276
Pink silty sand, flow (7 G.M.)* of water	1	277
Pink plastic clay	13	290
Pink fine-grained sand, some clay, flow (12 G.M.)* of water	10	300
Pink silty clay, sandy	60	360
Pink silty sand, little clay, flow (20 G.M.)* of water	10	370
Pink sandy clay, much silt	20	390
Pink silty clay, caliche nodules	5	395
Pink sandy, silty clay	35	430
Pink, fine-grained sand, little clay (26 G.M.)* of water	15	445
Greenish blue clay	15	460
Pink silty clay	40	500
Total depth	....	500

*Total flow of water from well—includes flow from upper aquifers.

TABLE 3—*Continued*

(S–20–61) 36ccb1. L. G. and M. C. Biel. Diameter 10 inches, 10-inch casing to 42 feet, 8-inch casing to 290 feet, perforated between 266 and 290 feet with slots $\frac{3}{8}$-inch wide and 2 feet long.

Material	Thickness (feet)	Depth (feet)
Soil	1	1
White clay	9	10
Caliche	1	11
"Near-surface" water level	....	11
Caliche	1	12
Gray clay	3	15
Gravel, some coarse-to medium-grained sand	3	18
Gray clay, pink silt and little sand	22	40
Sand	2	42
Pinkish buff clay	8	50
Pinkish brown silty clay, some gravel, little sand	9	59
Pinkish buff silty clay, little sand	11	70
Caliche	13	83
Light pink clay, little silt, few pebbles	6	89
Brownish gray silt, little clay and sand	16	105
Light buff clay, caliche	2	107
Buff clay, some silt and pebbles	16	123
Pinkish brown silt and clay	12	135
Caliche, flow of water	10	145
Pink calcareous clay	13	158
Light pink nodular silty clay	2	160
Caliche, some brownish silt, flow of water	7	167
Reddish silt, some clay	8	175
Fine-grained pink sand, some silt	5	180
Red clay, some fine-grained sand and silt	30	210
Pink silt, little fine-grained sand	20	230
Fine-grained red sand, little gravel	5	235
Red clay, little fine-grained sand; silt, some gravel	10	245
Red fine-grained sand, few granules	7	252
Red silty clay	6	258
Red fine-grained sand, silty	9	267
Light pink very fine-grained sand	5	272
Red fine-grained sand, some silt and clay, flow of water	20	292
Light pink silty very fine-grained sand	23	315
Light greenish white silt	6	321
Red silty, fine-grained sand, some clay	19	340
Red silty, fine-grained sand, flow of water	6	346
Total depth	....	346

(S–20–61) 36ccd1. William Clark. Diameter 10 inches, 10-inch casing to 40 feet, 8-inch casing to 103 feet.

Material	Thickness (feet)	Depth (feet)
No record	50	50
Pink silty clay, few granules and caliche nodules	125	175
Pink silty clay	20	195
No record, flow of water	5	200
Total depth	....	200

(S–20–62) 3bbd1. Las Vegas Army Air Field. Diameter 8 inches, 8-inch casing to 200 feet, perforated with $\frac{1}{4}$-by-4-inch slots between 120 and 200 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Clay and gravel	120	120
"Lime rock," clay and some red clay	130	250
Sand, silt, little gravel	10	260
Total depth	....	*260

*Measured depth of well in 1946 was 242 feet.

(S–20–62) 4add1. Las Vegas Army Air Field. Diameter 16 inches, 16-inch casing to 800 feet, perforated from 90 to 784 feet with eight $\frac{5}{8}$-by-$3\frac{1}{2}$-inch slots every 10 inches. Driller's log.

Material	Thickness (feet)	Depth (feet)
Yellow clay and caliche	90	90
First aquifer; water level rose to 73 ft.	....	90
Yellow clay and caliche	182	272
Second aquifer; water level rose to 20 ft.	....	272
Yellow clay and caliche	428	700
Sandy gray clay	100	800
Total depth	....	800

TABLE 3—*Continued*

(S–20–62) 4dca1. Las Vegas Army Air Field. Land surface altitude 1,866 feet; diameter 16 inches, 16-inch casing to 786 feet, perforated from 150 to 740 feet with four ¾-by-3½-inch slots every 18 inches. Driller's log.

Material	Thickness (feet)	Depth (feet)
Caliche	102	102
Gravel, sand, and broken caliche, water	8	110
Caliche, clay, and sand	74	184
Caliche and clay	188	372
Sand and fine gravel, water	44	416
Caliche and clay	184	600
Blue clay	55	655
Caliche	53	708
"Strange formation"	2	710
"Soapstone"	2	712
Fine - grained sand, water level at 51 feet	26	738
Caliche	2	740
"Quick" sand	12	752
Clay and caliche	26	778
"Quick" sand, "small pieces of wood turning to coal"	17	795
Total depth	....	795

(S–20–62) 18bbc2. G. W. and Inez Rittenhouse. Diameter 8 inches, 8-inch casing to 63 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	20	20
Brown clay	22	42
"Near-surface" water level	....	42
White clay and gravel	5	47
Brown clay, thin gravel layers	103	150
Gravel, water level rose in casing	10	160
Brown clay	20	180
Gravel, caliche, water level rose in casing	23	203
Total depth	....	203

(S–20–62) 19bab1. Joe Hannig. Diameter 8 inches, 8-inch casing to unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)
Silt	29	29
White clay	2	31
Sand, water	4	35
Sand, hard	9	44
Pebbles	1	45
Clay	50	95
Silt	12	107
Hard sand	1	108
Clay	32	140
Total depth	....	140

(S–20–62) 19bcc1. Byron Thornton. Diameter 8 inches, 8-inch casing to unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)
Sand	1	1
Silt	22	23
Gravel	1	24
Caliche	6	30
"Near-surface" water level	....	30
Caliche	2	32
Gravel	3	35
Hard sand	4	39
Clay	46	85
Caliche	10	95
Clay	5	100
Caliche	2	102
Clay	3	105
Caliche	2	107
Clay	13	120
Caliche	5	125
Clay	25	150
White clay	1	151
Total depth	....	151

(S–20–62) 19bdd1. J. E. Hardin. Diameter and casing record unknown. Driller's log.

Material	Thickness (feet)	Depth (feet)
Silt	29	29
White clay	6	35
Caliche	5	40
Clay	40	80
Caliche	5	85
Hard sand	10	95
Red clay	19	114
Hard sand, water	6	120
Red clay	....	120
Total depth	....	120

TABLE 3—*Continued*

(S–20–62) 19cab1. W. E. Sayler. Diameter 6 inches, 6-inch casing to unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)
White clay	27	27
Gravel	1	28
"Near-surface" water level	....	28
White clay	6	34
"Rock"	7	41
Red clay	1	42
Hard sand	35	77
Red clay	41	118
Gravel	3	121
Caliche	1	122
Red clay	3	125
Sand	1	126
Gravel	4	130
"Red rock"	2	132
Red clay	1	133
Sand	28	161
Red clay	1	162
Sand	2	164
Gravel	1	165
"Rock"	1	166
Hard sand	9	175
Blue clay	1	176
Hard sand	9	185
Red clay	11	196
Total depth	....	196

(S–20–62) 19dba1. I. H. Ault. Diameter 9 inches, 9-inch casing to 55 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Silt	....	3
Gravel	5	8
Silt	22	30
Hard sand	1	31
"Near-surface" water; water level rose to 27 feet	....	31
Hard sand	4	35
"Rock"	8	43
"Rock" and clay	11	54
"Rock"	14	68
Clay	12	80
Caliche	2	82
Clay	16	98
Blue clay	7	105
Clay	5	110
Caliche	1	111
Blue clay	2	113
"Rock"	2	115
Blue clay	2	117
"Rock"	5	122
Sand	6	128
Hard sand	7	135
Total depth	....	135

(S–20–62) 32bbb1. E. B. and Margie Grubb. Diameter 8 inches, 8-inch casing to 200 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
"Top soil"	15	15
"Near-surface" water level	....	15
"Top soil"	3	18
Clay	50	68
Sandy gravel, water	6	74
Clay	26	100
White "talc"	5	105
Sandy gravel, water	13	118
Clay	12	130
White "talc"	20	150
Clay	150	300
"Gyp"	5	305
Sandy clay	20	325
Red clay	37	362
Red, green, light tan, blue, and black clay	138	500
Total depth	....	500

(S–20–62) 33ccc1. U. S. Geological Survey. Diameter 1 inch, 1-inch casing to 42 feet.

Material	Thickness (feet)	Depth (feet)
Tan silty clay	15	15
Tan silty clay, caliche nodules	10	25
Tan silty clay	17	42
Total depth	....	42

(S–21–61) 1aba1. R. J. Kaltenborn. Diameter 10 inches, 10-inch casing to 60 feet, 8-inch casing to 482 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	20	20
"Near-surface" water level	....	20
Clay	140	160
Caliche	10	170
Clay	50	220
Caliche	10	230
Red clay	50	280
Caliche	10	290
Red clay	40	330
Caliche	20	350
Red clay and "shale"	90	440
Blue clay	30	470
Red clay and gravel	30	500
Gravel, flow of water	18	518
Red clay and sand	132	650
Gravel and clay flow of water	50	700
Clay and sand	30	730
Gravel and "quick" sand	80	810
Total depth	....	810

TABLE 3—*Continued*

(S-21-61) 1bba1. Colony Club. Diameter 6 inches, 6-inch casing to 345 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Soil	10	10	Sandy clay	140	250
"Near-surface" water	....	10	Yellow clay	80	330
Gravel	10	20	"Quick" sand, flow of water	15	345
Yellow clay	30	50			
Gravel	10	60			
Yellow clay	50	110	Total depth	....	345

(S-21-61) 1bda1. R. J. Kaltenborn. Diameter 8 inches, 8-inch casing to 140 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Clay with "rock ledges"	100	100	Clay with "boulders"	500	750
Red clay	145	245	Gravel, flow of water	10	760
Small gravel, flow of water	5	250	Total depth	....	760

(S-21-61) 2cbb1. Henry Hunt. Land surface elevation 1,996 feet; diameter 6 inches, 6-inch casing to 410 feet, 774 feet of 4-inch casing from 226 to 1,000 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Soil	12	12	Clay	17	275
Sandy clay	28	40	Sand and clay	105	380
Silty sand and gravel	5	45	"Gray shale"	25	405
Clay	20	65	Sandy clay	40	445
Sandy clay	5	70	Red sand	10	455
Clay and gravel	9	79	Sandy clay	5	460
Caliche	5	84	Sand	15	475
Sandy clay	35	119	Clay	15	490
Caliche	2	121	Alternating clay and sand stratas	483	973
Clay	24	145	Broken caliche, sand layers, flow of water	52	1,025
Caliche	4	149	Red sandy clay, few fine-grained sand layers every few feet, flow of water	95	1,120
Clay	65	214			
Caliche	7	221			
Clay	24	245			
Caliche	6	251			
Clay	4	255			
Caliche	3	258	Total depth	....	1,120

(S-21-61) 2cbb2. U. S. Geological Survey. Land surface altitude 1,996 feet; diameter 1½ inches, 1½-inch casing to 20 feet.

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Brown silt, little clay	15	15	Light tan sandy silt	5	20
			Total depth	....	20

(S-21-61) 2dcc1. R. J. Kaltenborn. Diameter 8 inches, 8-inch casing to unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Soil	2	2	Cemented gravel	68	186
Caliche	54	56	"Loose boulders"	14	200
Clay	12	68	Cemented gravel	198	398
Clay and caliche	5	73			
Clay	45	118	Total depth	....	398

(S-21-61) 2ddc1. B. Dennison. Diameter 8 inches, 8-inch casing to 50 feet.

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Clay and caliche	230	230			
Sand and gravel	10	240	Total depth	....	240

TABLI 3—*Continued*

(S–21–61) 3baa1. S. J. Lawson. Diameter 4 inches, 4-inch casing to 370 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	7	7
"Gypsum"	11	18
"Gyp" and gravel	2	20
"Gyp" and caliche	160	180
Clay	60	240
Caliche, flow of water	5	245
"Gyp"	4	249
Caliche, flow of water	7	256
Red clay	14	270
Cemented gravel, flow of water	20	290
Red sandy clay	60	350
Fine gravel and sand, flow of water	5	355
Red sand and clay	10	365
Cemented gravel, some loose gravel, flow of water	33	398
Red sand, flow of water	4	402
Clay	1	403
Total depth	....	403

(S–21–61) 3cbb1. Otto and Loriene Underhill. Diameter 4 inches, 9-inch casing to 80 feet, 4-inch casing to 434 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil and gravel	15	15
White clay	85	100
Tan clay	200	300
Coarse sand, flow of water	10	310
Light brown clay	160	470
Blue clay	15	485
Red gravel, flow of water	10	495
Red clay	17	512
Total depth	....	512

(S–21–61) 3cbb2. Wilson-Mikkelsen. Diameter $5\frac{5}{8}$ inches, $5\frac{5}{8}$-inch casing to 395 feet, 200 feet of 4-inch casing from 370 to 570 feet, perforated from 550 to 570 feet with $\frac{1}{4}$-by-4-inch slots. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	6	6
"Gyp rock"	20	26
White clay	158	184
Caliche	2	186
White clay	114	300
Red sand	88	388
Red "shale"	2	390
Red sand, flow of water	8	398
Brown "shale"	5	403
Brown sand	7	410
White sand	20	430
Gravel, flow of water	2	432
White sand	6	438
Blue clay	44	482
White sand	5	487
Red sand	75	562
Gravel, flow of water	20	582
Red sand	84	666
Total depth	....	666

(S–21–61) 4aad1. Opaco Lumber Co. Diameter 10 inches, 5-foot length of 10-inch casing welded to top of 30-foot length of 18-inch casing which extends to 32 feet, 458 feet of 13-inch casing from 2 to 460 feet, perforated from 338 to 438 feet with slots, 408 feet of 10-inch casing from 362 to 770 feet, perforated from 642 to 770 feet with slots. All perforations made with welding torch. Driller's log.

Material	Thickness (feet)	Depth (feet)
Top soil	7	7
Sand, water-bearing	3	10
Yellow clay	30	40
Caliche	30	70
Cemented gravel	5	75
Caliche	15	90
Yellow silt	60	150
Caliche	40	190
Cemented gravel	5	195
Caliche	20	215
Red clay	35	250
"Brown hardpan"	5	255
Red clay	45	300
Red sand, flow of water	10	310
Red clay	50	360
"Red hardpan"	20	380
Red silty clay	50	430
"Red hardpan"	10	440
Red sand	5	445
"Red hardpan"	15	460
Blue clay	50	510
Caliche	10	520
Red silty clay	30	550
Red sand, flow of water	10	560
Red silty clay	10	570
Red sand and gravel, flow of water	30	600
Red sand, flow of water	70	670
Sand and clay strata, flow of water	40	710
Sticky red clay	10	720
Red sand, flow of water	10	730
Sticky red clay	20	750
Red sand, flow of water	10	760
Sticky red clay	20	780
Red sand, flow of water	5	785
1-foot-thick layers of "red water sand" and sticky red clay	8	793
Total depth	....	793

TABLE 3—*Continued*

(S-21-61) 4aca1. E. F. and M. Nelson. Diameter 10 inches, 10-inch casing to 470 feet, 450 feet of 8-inch casing from 450 to 900 feet, perforated with ¼-by-2-inch slots from 550 to 560 feet and 595 to 615 feet.

Material	Thickness (feet)	Depth (feet)
Buff silty clay	50	50
Tan silty clay	30	80
Pink silty clay, few caliche nodules	35	115
Pebble gravel, much pink clay	2	117
Pink silty clay, little sand and few granules	183	300
Pink silty sandy clay, many granules	30	330
Pink clay, little silt	20	350
Pink silt, many granules	10	360
Pink sandy silt	15	375
Granule gravel, many pebbles, little sand and silt	20	395
Pink silty clay, little sand	45	440
Pink sandy silt, few pebbles and granules, little clay	10	450
Pink silty sand, few pebbles and granules, little clay	20	470
Light greenish blue plastic clay, few caliche nodules	30	500
Light tan silt, little clay	10	510
Pink silt	10	520
Pebble gravel, few granules, some pink silt, little clay, flow of water	1	521
Pink silty fine-grained sand, flow of water	19	540
Pink plastic clay	10	550
Pink sandy silty clay, many granules and pebbles, flow of water	30	580
Pink silty clay	15	595
Pink silty sand, few granules, flow of water	25	620
Pink sandy silt and clay	125	745
Pink silty sand, little clay, few granules, flow of water	25	770
Pink sandy silt, few granules, much clay	20	790
Fine-grained pink sand, little silt, flow of water	10	800
Plastic red clay	10	810
Pink silty clay, few granules	35	845
Plastic red clay	5	850
Pink silty sand, many granules, flow of water	20	870
Pink silty clay	10	880
Pink sandy silt, some gravel, flow of water	10	890
Pink plastic silty clay	10	900
Total depth	....	900

(S-21-61) 4bbb3. E. A. Honrath. Land surface altitude 2,069 feet; diameter 8 inches, 8-inch casing to 300 feet, 341 feet of 6-inch casing from 80 to 421 feet, perforated with ¼-by-1-inch slots from 221 to 241 feet, 281 to 301 feet, and 341 to 421 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	7	7
Pink silty clay, few caliche strata	5	12
"Near-surface" water level	....	12
Pink silty clay, few caliche strata	20	32
Pink silty clay, few caliche strata and few gravelly strata	228	260
Red plastic silty clay	20	280
Red plastic silty clay, some granules and sand	15	295
Gray granule gravel and some sand, flow of water	2	297
Red silty clay some sand and fine gravel	43	340
"Cemented gravel"	40	380
Gray granule and small pebble gravel, some sand, flow of water	5	385
"Cemented gravel"	67	452
Greenish blue plastic clay	4	456
Light red silty clay, little gravel	36	492
Total depth	....	492

(S-21-61) 4bcb1. L. G. McNeil. Diameter 7 inches, 7-inch casing to 238 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Surface formation	260	260
"Rock," flow of water	60	320
Cemented gravel, flow of water	7	327
No record	21	348
Flow of water	....	348
"Caving material"	6	354
Total depth	....	354

TABLE 3—*Continued*

(S–21–61) 4dac1. Theodore Michelas. Diameter 7⅝ inches, 7⅝-inch casing to 548 feet, 300 feet of 7-inch casing from 500 to 800 feet, perforated from 500 to 800 feet with ¼-by-4-inch slots. Driller's log.

Material	Thickness (feet)	Depth (feet)
White clay	22	22
"Rock" and clay	436	458
Blue clay	32	490
Red clay, sand	320	810
Total depth	....	810

(S–21–61) 4dac2. Theodore Michelas. Diameter 7 inches, 7-inch casing to 527 feet, perforated with ½-by-2-inch slots from 374 to 386 feet, 175 feet of 6-inch casing from 475 to 650 feet, perforated with 1/16-by-6-inch slots from 620 to 650 feet.

Material	Thickness (feet)	Depth (feet)
Soil	3	3
Light pink clay	4	7
Sand and gravel	5	12
"Near-surface" water level	....	12
Light tan clay	3	15
Caliche	6	21
Light tan clay	9	30
Light pink clay	15	45
White clay	6	51
Sandy clay	9	60
White clay	5	65
Light pink silty clay	20	85
Sand	5	90
Caliche	6	96
Light pink silty clay	69	165
Tan clay, caliche	15	180
Light pink silty clay	105	285
Medium tan silty clay	2	287
Light pink silty clay	13	300
Caliche	14	314
Medium tan silty clay	56	370
Pebble-gravel, granules, some medium-grained and fine-grained sand, little clay, flow of water	21	391
Caliche	6	397
Pink fine-grained sand and silt	28	425
Light pink silty clay	5	430
Sand and sandy clay	60	490
Light greenish blue clay	29	519
Red sand and silt	31	550
"Quick" sand	20	570
Pink fine-grained sand and silt, little clay	73	643
Gravel and sand, flow of water	4	647
Pink silt and clay	3	650
Total depth	....	650

(S–21–61) 5caa1. Splane Estate. Diameter 8 inches, 8-inch casing to 136 feet, 341 feet of 6-inch casing from 61 to 402 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Surface "rock," clay and "talc"	130	130
"Rock"	5	135
Sandy clay and "talc"	52	187
"Lime rock"	3	190
Clay and "lime rock"	10	200
"Lime rock"	3	203
Sandy clay and "talc"	65	268
"Conglomerate"	59	327
Red sand	8	335
Sand and gravel	61	396
"Sand rock"	2	398
Sandy clay	16	414
Sand	6	420
Clay	4	424
"Cemented sand"	2	426
Clay	4	430
"Cemented sand"	2	432
Sand, flow of water	17	449
"Cemented sand"	3	452
Clay	28	480
Sand, "sand rock," and clay, flow of water	66	546
"Cemented sand"	39	585
Total depth	....	585

(S–21–61) 6aca1. J. and A. Edmonds. Land surface altitude 2,169 feet; diameter 8 inches, 8-inch casing to 30 feet, 6-inch casing to 287 feet, perforated with 3/16-by-3-inch slots from 255 to 287 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Caliche	30	30
White clay	20	50
Caliche	10	60
Red clay	40	100
Caliche	5	105
Red clay	40	145
Caliche	15	160
Red sandy clay	90	250
Hard sand	5	255
Sand and gravel, flow of water	33	288
Total depth	....	288

TABLE 3—*Continued*

(S–21–61) 6aca2. Sebastian Mikulich. Land surface altitude 2,174 feet; diameter 9 inches, 9-inch casing to 40 feet, 7-inch casing to unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	2	2
Caliche	10	12
"Near-surface" water level	....	12
Caliche	17	29
Clay	10	39
Caliche	5	44
Clay	104	148
Caliche	6	154
Caliche and gravel	4	158
"Sandstone" gravel	5	163
Caliche and gravel, flow of water	77	240
Caliche and gravel, flow of water	89	329
Total depth	....	329

(S–21–61) 6adc2. Leo Pahor. Land surface altitude 2,164 feet; diameter 6 inches, 41 feet of 8-inch casing from 1 to 42 feet, 6-inch casing to 288 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	3	3
"Loose" gravel	13	16
"Near-surface" water level	....	16
"Loose" gravel	24	40
Brown clay	98	138
"Conglomerate" gravel	10	148
Brown clay	139	287
Caliche	5	292
"Lime conglomerate," flow of water	26	318
Total depth	....	318

(S–21–61) 6adc3. E. M. and A. M. Ladd. Land surface altitude 2,165 feet; diameter 8 inches, 8-inch casing to 80 feet, 334 feet of 6-inch casing from 26 to 360 feet, perforated with ¼-by-8-inch slots from 315 to 360 feet.

Material	Thickness (feet)	Depth (feet)
Soil	2	2
Gravel	4	6
Clay	6	12
Gravel	2	14
"Near-surface" water level	....	14
Tan silty clay, some granules and pebbles	27	41
Caliche	9	50
Tan silty clay, few thin layers of caliche	220	270
Caliche	10	280
Granule gravel, some sand, much pink silt and clay	10	290
Granule gravel, much sand, little pink silt and clay	10	300
Sandy and silty pink clay	10	310
Silty pink clay	8	318
Sandy pink silt, much sand, many granules	12	330
Gray coarse-to medium-grained sand, little silt and few granules	18	348
Fine-to medium-grained gray sand, some granular gravel, flow of water	12	360
Total depth	....	360

(S–21–61) 7ddb1. F. T. Roberts. Diameter 8 inches. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	50	50
Light pink silty clay, few granules	120	170
Pink silty clay	215	385
Red silty sand, flow of water	15	400
Total depth	....	400

(S–21–61) 9acd1. Vegas Valley Development Co., Ltd. Diameter 7⅝ inches, 7⅝-inch casing to 500 feet, 60 feet of perforated 6-inch casing from 490 to 550 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Clay and "rock"	300	300
Yellow clay, some "rock"	150	450
Blue clay	20	470
Red clay	60	530
Sand, flow of water	20	550
Total depth	....	550

TABLE 3—*Continued*

(S–21–61) 9cdc1. Hotel El Rancho, Inc. Diameter 10 inches, 10-inch casing to 200 feet, 389 feet of 6-inch perforated casing from 196 to 585 feet.

Material	Thickness (feet)	Depth (feet)
Soil	2	2
Light pink silt, some clay and few granules	18	20
Caliche	5	25
Light pink silt, some clay	27	52
"Near-surface" water	....	52
Small pebble gravel, little sand and clay	4	56
Pink sandy silt, little clay	14	70
Pink silty clay, few granules	30	100
Cemented small gravel and caliche	5	105
Pink silty clay	20	125
Pink silt, little clay and granules	5	130
Pink silty clay	50	180
Red clay	10	190
Pink silty clay	15	205
Granular gravel, few pebbles, some fine-to-coarse-grained sand	15	220
Pink sandy silt, little clay, few granules and pebbles	115	335
Granular gravel, coarse sand, silty clay, some pebbles	15	350
Pink silty clay, few granules, little sand	110	460
Pink silty clay, pebbles and granules	10	470
Pink silty clay	16	486
Plastic bluish green clay	9	495
Pink silty clay, few sandy layers	55	550
Pink sandy silt, many granules, flow of water	10	560
Pink sandy silt and fine-grained sand, increased flow of water	10	570
Fine-grained sand, few granules, little silt, increased flow of water	15	585
Total depth	....	585

(S–21–61) 9dcc1. Pacific States Theatres. Diameter 10 inches, 10-inch casing to 92 feet, 8-inch casing to 505 feet, perforated with ¼-by-4-inch slots from 470 to 505 feet, 92 feet of 6-inch casing from unknown depth to approximately 585 feet, perforated with ¼-by-4-inch slots from 545 to 585 feet.

Material	Thickness (feet)	Depth (feet)
Soil	2	2
White clay and caliche	16	18
Clay	4	22
"Near-surface" water level	....	22
Light pink clay, thin layers of caliche	158	180
Pink silty clay, few granules, some sand	20	200
Sandy gravel, some silt and clay, flow of water	10	210
Pink clay	10	220
Red clay, few granules and pebbles	10	230
Pink silty clay, few granules and pebbles, little sand	80	310
Caliche and gravel, flow of water	5	315
Pink silty clay, few granules and little sand	90	405
Granular gravel and sand, flow of water	5	410
Pink silty clay, little sand and few granules	15	425
White clay	5	430
Pink silt and sandy clay	7	437
Bluish green plastic clay, few thin red clay layers	48	485
Pink silty and sandy clay, thin layers of red clay	55	540
Granular and pebble gravel, some fine-grained sand; flow of water	5	545
Red sandy silt, increased flow of water	35	580
Pink silty and sandy clay	20	600
Total depth	....	600

(S–21–61) 11bbb1. Nevada Hotel Co. Diameter 8 inches, 8-inch casing to 532 feet, perforated with slots from 480 to 532 feet, 130 feet of 6-inch casing from 520 to 650 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
"Chalky lime"	40	40
"Hard lime"	10	50
"Broken lime"	200	250
"Lime," flow of water	10	260
No record	130	390
"Gray shale"	20	410
No record	70	480
"Conglomerate," sandy, flow of water	52	532
"Lime"	68	600
"Sandy"	50	650
Total depth	....	650

TABLE 3—*Continued*

(S-21-61) 14cdd1. U. S. Geological Survey. Diameter 1½ inches, 1½-inch casing to 30 feet.

Material	Thickness (feet)	Depth (feet)
Pink silty clay, gypsum crystals	5	5
Pink silty clay, caliche, many granules	5	10
Pink sandy silt, little clay	10	20
Pink sandy silt, few granules, some clay	15	35
Total depth	....	35

(S-21-61) 15bcc1. T. A. Wells. Diameter 10 inches, 10-inch casing to 64 feet, 8-inch casing to 395 feet, perforated with ¼-by-4-inch slots from 255 to 275 feet, from 295 to 315 feet, and from 335 to 395 feet, 182 feet of 6-inch casing from 358 to 540 feet, perforated with ¼-by-4-inch slots from 483 to 540 feet.

Material	Thickness (feet)	Depth (feet)
Soil	3	3
Light pink sandy silt, little clay	15	18
"Near-surface" water level	....	18
Silty gravel	2	20
Light pink silt, few granules	7	27
Medium-grained silty sand	3	30
White silty clay	28	58
Pink silty clay	80	138
Pink silty clay, many granules	2	140
Dark pink silty clay	25	165
Pink silty clay, sandy, many granules	5	170
Pink silty clay	6	176
Pink silty clay, sandy, many pebbles	3	179
Pink silty clay	36	215
Granule gravel, much pink silt and sand	12	227
Pink silt, some fine sand, little clay	10	237
Pink silty clay	36	273
Granule gravel, much pink silt, few pebbles	7	280
Pink silty clay	30	310
Granules, gravel, much silty sand, little clay, flow of water	23	333
Pink silty clay, much gravel	29	362
Coarse- to fine-grained sand, little silt, flow of water	8	370
Red silt and clay, much sand	20	390
Sandy granule gravel, flow of water	10	400
Pink silt, little clay	10	410
Pink silty clay, little fine-grained gravel	15	425
Plastic red clay	6	431
Greenish blue plastic clay	18	449
Plastic red clay	32	481
Red medium - grained sand, few granules, flow of water	14	495
Red sandy silt, few granules	35	529
Plastic red clay	11	540
Red sandy silt	10	550
Sand and fine gravel, flow of water	5	555
Red silt, little sand and clay	111	666
Fine-to medium-grained red silty sand, flow of water	19	685
Red sandy silt, little clay	76	761
Fine-to medium-grained pink sand, some silt	64	825
White fine-grained sand, little silt	35	860
Red and pink sand, much silt, little clay	22	882
Pink silty medium-grained sand, flow of water	8	890
Red silty sand, some clay	2	892
Total depth	....	892

(S-21-61) 16bcc1. State of Nevada, Department of Highways. Diameter 10 inches, 10-inch casing to 151 feet, 201 feet of 8-inch casing from 151 to 352 feet, 200 feet of 6-inch casing from 352 to 552 feet. Casing perforation record unknown. Driller's log.

Material	Thickness (feet)	Depth (feet)
Gravel	6	6
Caliche	2	8
"Layers of rock and clay"	416	424
Blue clay	36	460
"Quick" sand, flow of water	10	470
Sandy red clay	74	544
Gravel, flow of water	3	547
Sandy red clay	217	764
Cemented gravel, flow of water	106	870
Red clay	30	900
Total depth	....	900

TABLE 3—*Continued*

(S–21–61) 16bdb1. John Stafford. Diameter 5⅝ inches, 5⅝-inch casing to 497 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Equal amounts of caliche and white clay	150	150
Caliche and clay	265	415
"Squeezing clay"	15	430
Red clay	28	458
"Quick" sand, flow of water	10	468
Red clay	57	525
"River" gravel, flow of water	2	527
No record	32	559
Total depth	....	559

(S–21–61) 17aca1. U. S. Geological Survey. Diameter 2 inches, 2-inch pipe to 30 feet.

Material	Thickness (feet)	Depth (feet)
Tan sandy silt	5	5
Granule gravel, much tan silty clay	10	15
Tan silt, little sand	5	20
Pink silty clay	20	40
Total depth	....	40

(S–21–61) 20aaa1. Murray and Agnes Wollman. Diameter 10 inches, 10-inch casing to 98 feet, 8-inch casing to 412 feet, 205 feet of 6-inch casing from 400 to 605 feet, perforated with ¼-by-4-inch slots from 545 to 605 feet.

Material	Thickness (feet)	Depth (feet)
Light pink silty clay, many granules	20	20
White, calcareous, silty clay, some sand	6	26
"Near-surface" water level	....	26
White, calcareous, silty clay, some sand	24	50
Pink clay, few granules	20	70
Pink sandy silt, few granules	10	80
Red silty clay	40	120
Pink silt, little clay	60	180
Light pink silty clay, little caliche	10	190
Pink silt, some clay and granules, little sand	30	220
Pink silty clay	10	230
Pink silt, little sand and clay and few granules	180	410
Blue clay	10	420
Red clay	10	430
Red sandy silt	17	447
Red silty medium-grained sand, flow of water	5	452
Red sandy silt	28	480
Light greenish blue clay	10	490
Red sandy silt	70	560
Red silty medium-grained sand, flow of water	10	570
Red sandy silt	135	705
Pink silty sand, few granules, flow of water	5	710
Total depth	....	710

TABLE 3—*Continued*

(S–21–61) 26bbb2. A. J. and L. C. Wood. Diameter 10 inches, 10-inch casing to 101 feet, 8-inch casing to 397 feet, perforated with ⅜-by-7-inch slots 2 feet apart from 250 to 290 feet, 198 feet of 6-inch casing from 397 to 595 feet perforated with ⅜-by-7-inch slots 2 feet apart from 555 to 595 feet.

Material	Thickness (feet)	Depth (feet)
Soil	3	3
White calcareous silty clay	7	10
Pink silty clay	10	20
"Near-surface" water level	....	20
Pink silty clay, few granules	10	30
Granule gravel, and fine to medium-grained sand, some silt	1	31
Pink silty clay	9	40
Pink silty clay. caliche nodules	45	85
Caliche, pink silty clay	10	95
Pink silty clay, few granules	34	129
Granule gravel, silty and sandy, water level rose in casing	1	130
Pink silty clay, many granules, few pebbles	45	175
Granule and pebble gravel, much pink silt and clay, water level rose in casing	15	190
Pink silty clay, few caliche nodules	7	197
Granule gravel, little sand, much pink silt, flow of water	18	215
Pink silty clay	9	224
Pink silty clay, many granules, and few pebbles, and little sand	21	245
Pink silty clay, caliche	10	255
Pink silty clay	4	259
Granular gravel and sand, much pink silty clay	18	277
Granular gravel and sand, little pink silt, flow of water	3	280
Pink silty clay, many granules, some sand	20	300
Pink, fine-grained silty sand	9	309
Pink, fine-to-medium-grained sand, flow of water	1	310
Pink, fine-to-medium-grained silty sand	10	320
Granule gravel, little sand, much pink silty clay	21	341
Red plastic clay	19	360
Pink clay, some silt	205	565
Fine-to-medium-grained sand, few granules flow of water	30	595
Total depth	....	595

(S–21–61) 27baa2. Lawrence Henz. Diameter 8 inches, 8-inch casing to 41 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	4	4
"Gyp"	14	18
Clay	122	140
Gravel, flow of water	5	145
Clay with "gravel streaks"	193	338
Total depth	....	338

(S–21–61) 27baa3. Bell Telephone Co. Diameter 10 inches, 10-inch casing to 100 feet, 8-inch casing to 603 feet, perforated with ⅜-by-8-inch slots every 2 feet from 512 to 603 feet.

Material	Thickness (feet)	Depth (feet)
Soil	3	3
Caliche	16	19
Red silty clay, some small gravel and caliche nodules	81	100
White clay, caliche nodules	10	110
Red silty clay, few pebbles, granules, and caliche nodules	100	210
Red silty clay, few granules and caliche nodules	40	250
Red silt and fine-grained sand, few granules, some clay	50	300
Granule gravel, some sand, much pink silt, flow of water	30	330
Pink silty clay, much granular gravel, little sand	40	370
Red clay	10	380
Red silty clay, little gravel	80	460
Red clay	20	480
Pink silty clay, little fine-grained sand	10	490
Pink silty clay, little gravel	110	600
Silty medium - and coarse-grained sand, flow of water	5	605
Total depth	....	605

TABLE 3—*Continued*

(S–21–61) 35dcc1. Vail Pittman. Diameter 6 inches, 6-inch casing to 150 feet, 4-inch (inside diameter) casing to 398 feet, 31 feet of 4-inch (standard) casing from 398 to 429 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
"Gyp blow sand"	3	3
"Conglomerate"	4	7
"Gyp"	2	9
"Conglomerate"	4	13
"Gyp"	9	22
"Lime rock"	2	24
"Near-surface" water level	....	24
"Gyp" and clay	51	75
"Lime rock"	1	76
Red clay	24	100
"Lime rock"	1	101
Red clay	55	156
"Conglomerate," flow of water	4	160
Red clay	2	162
"Conglomerate"	6	168
Red clay	21	189
"Conglomerate"	1	190
Red clay	22	212
"Conglomerate"	88	300
"Gray shale"	15	315
Red clay	107	422
"Lime reefs" and clay	6	428
"Conglomerate"	1	429
Red clay	2	431
"Conglomerate"	31	462
Red clay	3	465
Total depth	....	465

(S–21–61) 36adc2. U. S. Geological Survey. Diameter 1½ inches, 1½-inch casing to 20 feet.

Material	Thickness (feet)	Depth (feet)
Tan silty clay	15	15
Tan silty clay	5	20
Total depth	....	20

(S–21–62) 3ccc1. U. S. Geological Survey. Diameter 1 inch, 1-inch casing to 25 feet.

Material	Thickness (feet)	Depth (feet)
Tan silt, some clay	30	30
Total depth	....	30

(S–21–62) 8cca1. Gladys L. Splane. Diameter 8 inches, 8-inch casing to unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)
Caliche	10	10
Silt	2	12
Gravel	3	15
Sand and gravel	15	30
"Near-surface" water level	....	30
Sand and gravel	5	35
Sand and clay	15	50
"Rock"	2	52
Clay	11	63
"Near-surface" water level rose noticeably	....	63
"Rock"	3	66
Sandy clay, some gravel and boulders	39	105
"Rock"	4	109
"Rock," clay, and sand	17	126
"Rock"	3	129
"Rock," sandy clay, and "talc"	25	154
"Limestone"	2	156
Clay and "talc"	4	160
"Limestone"	10	170
Clay and "talc"	20	190
Sandy clay	10	200
"Limestone"	15	215
Clay	10	225
"Limestone"	5	230
Sandy clay	22	252
"Limestone"	13	265
Sandy clay	15	280
Gravel	10	290
Red sand, flow of water	8	298
"Clean" sand, increased flow of water	30	328
"Hard" sand, increased flow of water	2	330
Gravel, increased flow of water	20	350
Sandy clay	30	380
Red clay	5	385
"Gypsite"	10	395
Sand	30	425
"Limestone"	1	426
Clay	2	428
Sand	7	435
"Limestone"	3	438
Clay and sand	7	445
"Limestone"	5	450
Clay	5	455
"Limestone"	4	459
Clay, some fine-grained sand and silt	91	550
Sand and gravel, flow of water	15	565
Total depth	....	565

(S–21–62) 15bca1. U. S. Geological Survey. Diameter 1 inch, 1-inch casing to 22 feet.

Material	Thickness (feet)	Depth (feet)
Tan silty clay	5	5
Pink silty clay	10	15
Tan silty clay	10	25
Total depth	....	25

TABLE 3—*Continued*

(S–21–62) 17ddc1. Whitney Taxpayer's Association. Diameter 8 inches, 8-inch casing to 60 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	5	5
Red sandy clay	15	20
"Near-surface" water level	....	20
Red sandy clay	155	175
Brown sandy clay	90	265
"Sandstone"	4	269
Brown clay	81	350
Red clay and small gravel	10	360
Red clay	90	450
Sand	25	475
"Sandstone" and gravel, flow of water	8	483
Sand	22	505
Hard "sandstone"	2	507
Sandy clay	8	515
Sand	24	539
Brown sandy clay	1	540
Total depth	....	540

(S–21–62) 20ddd1. J. Bunch, L. Netherton, and L. Thurman. Diameter 6 inches, 6-inch casing to 230 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	5	5
Cemented gravel and rock	10	15
Red clay	77	92
Yellow clay and gravel	6	98
Red clay	42	140
Brown sandy clay	30	170
Brown and red clay	15	185
Brown and gray clay	19	204
"Limestone"	1	205
Brown clay	195	400
Hard "sandstone"	12	412
Sand, flow of water	3	415
Hard "sandstone"	15	430
"Cemented sand," increased flow of water	28	458
Total depth	....	458

(S–21–62) 20ddd2. J. Bunch, L. Netherton, L. Thurman. Diameter 6 inches, 6-inch casing to 212 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	10	10
"Limestone rock"	20	30
Yellow clay	20	50
"Near-surface" water level	....	50
Yellow clay	150	200
Gravel	10	210
Sticky yellow clay	210	420
Gravel	5	425
"Sandstone," flow of water	75	500
Total depth	....	500

(S–21–62) 21cbc1. L. E. Billman. Diameter 8 inches, 8-inch casing to 370 feet, 230 feet of 6-inch casing to 600 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	5	5
Red clay, "streaks of lime"	1	6
Red clay	214	220
Sand, flow of water	2	222
Red clay	136	358
Sand, flow of water	9	367
"Limestone"	2	369
Sand and gravel, flow of water	12	381
Cemented gravel, flow of water	65	446
Red sandy clay	19	465
"Bentonite" (blue clay)	13	478
Red clay	12	490
Sand, flow of water	8	498
Red clay, "streaks of bentonite"	20	518
"Bentonite," "streaks" of red clay	38	556
Brown sandy clay	7	563
Hard brown "sandstone"	15	578
Sand, flow of water	52	630
Red clay	10	640
Brown clay	5	645
Hard "sandstone"	5	650
Total denth	....	650

(S–21–62) 21cbc2. L. E. Billman. Diameter 8 inches, 8-inch casing to 440 feet, unknown length of 6-inch casing to 500 feet, perforated with slots ¼-inch wide from 440 to 500 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Surface clay	40	40
"Near-surface" water, water level rose to 12 feet	....	40
Sticky yellow clay	390	430
Quicksilver and gravel, flow of water	12	442
Yellow clay	58	500
Total depth	....	500

TABLE 3—*Continued*

(S–21–62) 27bcd1. R. R. Stadelman. 7⅝-inch casing to 58 feet, 5⅝-inch casing to 332 feet, perforated with ⅛-by-2-inch slots from 323 to 332 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	25	25
"Gypsum"	5	30
"Near-surface" water level	....	30
White clay	20	50
Gravel	8	58
Sandy clay	42	100
Red clay with "crystals"	98	198
Brown "shale"	52	250
Gray "slate"	10	260
Yellow clay	125	385
Sand, flow of water	3	388
Yellow clay	9	397
Sand	2	399
Yellow clay	18	417
Sand	3	420
Yellow clay	30	450
Total depth	....	450

(S–21–62) 29ccb1. J. R. Bond. Diameter 2 inches, 2-inch casing to unknown depth, 6-inch casing from end of 2-inch casing to unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	387	387
"Conglomerate"	13	400
Clay with "sand seams"	430	830
"Hard lime"	5	835
Clay with "sand pockets"	310	1,145
"Hard lava rock or basalt"	20	1,165
Total depth	....	1,165

(S–21–62) 30bd. L. H. Hamp. Diameter 8 inches, 8-inch casing to 235 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	40	40
Pink silty clay	18	58
Pink silty clay, caliche nodules	49	107
Pink silty clay	94	201
Pink silty clay, few granules and little sand	25	226
Tan silty clay	114	340
Pink silty clay	45	385
Silty fine-to-medium-grained sand, few granules, flow of water	15	400
Pink silty clay	25	425
Total depth	....	425

(S–21–62) 30dcb1. C. A. and Una Stewart. Diameter 8 inches, 8-inch casing to 100 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Tan clay, caliche nodules	15	15
Pink silty clay, few thin layers of caliche	180	195
No record	163	358
Medium-grained silty sand, flow of water	42	400
Total depth	....	400

(S–22–61) 1bcb2. J. K. Houssels. Diameter 6 inches, 6-inch casing to 124 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
"Soil"	90	90
Gravel	20	110
Clay	70	180
"Conglomerate," flow of water	118	298
Clay	82	380
"Conglomerate," flow of water	70	450
Clay	5	455
Total depth	....	455

(S–22–61) 1cbb1. J. K. Houssels. Diameter 8 inches, 8-inch casing to unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	220	220
Cemented gravel	18	238
Gravel, flow of water	1	239
White clay	57	296
"Mixed" clay	59	355
Red sandy clay, flow of water	25	380
"Hard lime," flow of water	60	448
Red clay	602	1,050
Red clay, flow of water	1	1,051
Red clay	65	1,116
Total depth	....	1,116

TABLE 3—*Continued*

(S–22–61) 1cbb2. J. K. Houssels. Diameter 6 inches, 6-inch casing to unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	110	110
Cemented gravel	4	114
Clay	65	179
Gravel, flow of water	2	181
Clay	5	186
Cemented gravel	109	295
Clay	45	340
Total depth	....	340

(S–22–61) 1dac1. Y. Tomiyasu. Diameter 8 inches, 8-inch casing to 103 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
"Conglomerate"	40	40
Clay	94	134
Gravel and sand, flow of water	14	148
Gravel and clay	15	163
"Cemented rock"	No record	
Gravel and sand, flow of water	....	203
Total depth	....	203

(S–22–61) 2aba1. L. H. Irvin. Diameter 4 inches, 4-inch casing to 337 feet, 153 feet of 6-inch casing from 2 to 155 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	140	140
"Conglomerate," flow of water	50	190
"Conglomerate"	100	290
"Shale"	47	337
"Soft conglomerate"	51	388
"Hard conglomerate," flow of water	....	388
Total depth	....	388

(S–22–61) 2ccc1. Henry Wick. Land surface altitude 2,073 feet; diameter 10 inches, 10-inch casing to unknown depth, 8-inch casing to 200 feet, 235 feet of 7-inch casing from 190 to 425 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	4	4
"Gravel and clay"	19	23
"Near-surface" water level	....	23
"Gravel and clay"	177	200
Cemented gravel with thin layers of clay	40	240
Sand and gravel, flow of water	5	245
Cemented gravel with thin layers of clay	235	480
Sand and gravel, flow of water	5	485
Cemented gravel with thin layers of clay	115	600
Total depth	....	600

(S–22–61) 3bda1. H. H. Hair. Land surface altitude 2,116 feet; diameter 8 inches, 8-inch casing to 366 feet, 4-inch casing to unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)
Sandy soil	8	8
Caliche	1	9
"Gyp" and clay, "lime reefs"	14	23
Caliche	5	28
White "marl," "gyp," and "lime"	20	48
Red clay	53	101
Caliche	4	105
Clay and "gyp"	9	114
Caliche	1	115
Clay	63	178
Caliche	2	180
Clay	10	190
Caliche	5	195
Clay	5	200
"Conglomerate"	20	220
Clay and "gyp"	30	250
"Conglomerate"	77	327
Gray "shale"	13	340
Red "shale"	12	352
Red clay	18	370
Flow of water	4	374
Total depth	....	374

(S–22–61) 3caa1. H. Nickerson. Land surface altitude 2,102 feet; diameter 6 inches, 6-inch casing to unknown depth, 4¼-inch casing to 353 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	190	190
"Conglomerate"	130	320
Sandy "shale"	30	350
Red clay	23	373
"Conglomerate," flow of water	22	395
Total depth	....	395

TABLE 3—*Continued*

(S–22–61) 3cab2. N. L. and M. S. White. Diameter 8 inches, 8-inch casing to 84 feet, 6-inch casing to 395 feet, perforated with ¼-by-6-inch slots from 333 to 395 feet.

Material	Thickness (feet)	Depth (feet)
Soil	4	4
Light tan silty clay	16	20
"Near-surface" water level	....	20
Light tan silty sand	10	30
Pink silty sand, little gravel and clay, water level rose in casing	10	40
Pink silty clay	28	68
Small-pebble-and-granule - gravel, some sand, much pink silty clay	12	80
Pink plastic silty clay	5	85
Granule gravel, coarse-to-medium - grained sand, some silt	10	95
Pink silty clay	65	160
Coarse - grained sand, much pink silty clay	5	165
Pink silty clay	40	205
Granule-gravel and sand, pink silty clay	20	225
Pink silty clay	80	305
Coarse-to-fine-grained sand, much silt	5	310
Pink silty clay	30	340
Pink silty coarse-to-fine - grained sand, little clay	5	345
Pink silt, little clay and caliche nodules	25	370
Light greenish blue clay	5	375
Pink silty clay	5	380
Granule gravel and sand, some pink silt, water level rose in casing	2	382
Light tan silt, caliche	3	385
Pink silty clay, few sand and caliche strata	15	400
Granule gravel, coarse-grained sand and pink silty clay, few pebbles	15	415
Tan silt	5	420
Pink silty clay, much sand, many granules	10	430
Very fine-grained, uniform tan sand, flow of water	5	435
Total depth	....	435

(S–22–61) 3ccb1. Dewey Williams. Land surface altitude 2,153 feet; diameter 10 inches, 10-inch casing to 246 feet, 164 feet of 5⅝-inch casing from 246 to 410 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Layers of "rock" and clay	14	14
"Near-surface" water level	....	14
Layers of "rock" and clay	201	215
Cemented gravel	101	316
"Caving" red clay	56	372
Cemented gravel	56	428
Layers of cemented gravel and clay	97	525
"Limestone"	50	575
Total depth	....	575

(S–21–61) 3dda1. Henry Wick. Land surface altitude 2,077 feet; diameter 10 inches, 10-inch casing to 220 feet, 8-inch casing to 335 feet.

Material	Thickness (feet)	Depth (feet)
Dark gray clay	15	15
Pink silty clay, few granules	1	16
Granules, some gray clay	2	18
Pink silty clay, few granules	25	43
Granule and pebble-gravel, much pink silty clay	2	45
Pink silty clay, few granules	123	168
Caliche, much pink clay	19	187
Sand and gravel, flow of water	13	200
Pink silty clay	5	205
Light pink, silty, fine-grained sand, little medium-grained sand	20	225
Light pink, silty, fine-grained sand, some clay	5	230
Fine and medium-grained light pink sand, little clay	30	260
Light pink fine-grained silty sand	15	275
Sandy pink silt and clay	5	280
Medium - grained sand, few granules, much silt and some clay	5	285
Tan clay and silt, some medium-grained sand	5	290
Light tan clay	30	320
Fine-grained sand, few granules, little silt	10	330
Tan medium-grained sand, little silt	2	332
Tan fine - to - coarse-grained sand, few granules, little gray plastic clay	3	335
Pebble - gravel, few granules, much sand, little tan clay	....	335
Total depth	....	335

TABLE 3—*Continued*

(S-22-61) 10accl. Gladstone Corporation. Diameter 12 inches, 12-inch casing to unknown depth, 130 feet of 6-inch casing to unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	27	27
Gravel	5	32
Clay	8	40
"Conglomerate"	20	60
Clay	7	67
"Conglomerate"	5	72
Clay	8	80
"Conglomerate"	4	84
Clay	6	90
"Conglomerate"	6	96
Clay	9	105
"Conglomerate"	5	110
Clay	15	125
"Conglomerate (basalt)"	215	340
Hard red clay, gravel	11	351
Boulders, clay, "conglomerate"	232	583
"Conglomerate," water level rose to 18 ft.	....	583
No record	102	685
Gray "lime"	30	715
Total depth	....	715

(S-22-62) 1bccl. T. A. Wells. Diameter 6 inches, 6-inch casing to 451 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	435	435
Blue clay	16	451
Gray and white "lime"	49	500
Clay with "lime shells"	100	600
Brown clay	100	700
Brown and red clay	105	805
Gray and black sand, flow of water	55	860
Total depth	....	860

(S-22-62) 1cbcl. T. A. Wells. Diameter 8 inches, 8-inch casing to 400 feet. 200 feet of 5⅝-inch casing from 400 to 600 feet, perforated with ¼-by-4-inch slots from 550 to 600 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Gravel	35	35
"Near-surface" water level	....	35
Gravel	45	80
Clay	305	385
Sand, flow of water	15	400
"Bentonite" (blue clay)	20	420
Clay	130	550
Sand, flow of water	10	560
"Hard sand," flow of water	110	670
"Shale"	465	1,135
Total depth	....	1,135

(S-22-62) 1cbdl. T. A. Wells. Diameter 8 inches, 8-inch casing to 500 feet. 300 feet of 6-inch casing to unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)
Gravel	32	32
"Near-surface" water level	....	32
Gravel	8	40
Yellow and red clay with loose boulders	735	775
Gray and black sand, flow of water	75	850
Gray and black sand, flow of water	....	910
Total depth	....	910

(S-22-62) 9cdb2. A. G. Klinger. Diameter 12 inches, 12-inch casing to 55 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Gravel, sand, clay	75	75
Gravel, flow of water	35	110
Gravel, sand, clay	15	125
Total depth	....	125

(S-22-62) 9dccl. Roy Cram. Diameter 10 inches, 10-inch casing to 100 feet, perforated with ¼-by-1-inch slots from 20 to 80 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Gravel and some large boulders	180	180
Total depth	....	180

TABLE 4

Analyses of Water from Wells and Springs in Las Vegas and Indian Spring Valleys, Nevada

(Analyses by M. R. Miller, University of Nevada, Agricultural Experiment Station, or W. B. Adams, Public Service Division, University of Nevada, Department of Food and Drugs, except as noted. See tables 2 and 3 for descriptive data for wells.)

						Parts Per Million										
Well No. and location	State Engineer's local field No.	Depth (feet)	Temperature (°F.)	Date of collection	Specific electrical conductance (Kx10⁵ at 25°C)	Dissolved solids	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na and K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulphate (SO_4)	Chloride (Cl)	Alkalinity (as $CaCO_3$)	Hardness (as $CaCO_3$)
INDIAN SPRING VALLEY																
(S-16-56) 5dd	....	600	....	6-20-42	......	340	25	87	23	6	0	239	98	20	196	312
(S-16-56) 9bb2	....	50	....	3-18-42	......	415	22	86	20	42	tr	329	95	14	270	297
LAS VEGAS VALLEY																
(S-19-60) 9abb1	428	631	....	9-13-45	40.7	338	....	38	28	5	0	240	22	3.9	......	211
(S-19-60) 9cda1	429	612	70	10-23-44	......	350	....	46	26	4	....	250	19	5	......	221
(S-19-60) 21ccc1	....	8	....	9-13-45	46.7	394	....	55	29	3	0	274	31	2.8	......	256
(S-19-60) 23bbc1	449	560	70	10-25-44	44.2	350	....	46	26	4	....	250	19	5	......	222
(S-19-60) 27aab1	384	605	70	10-23-44	42	358	....	44	27	8.9	0	247	23	8.8	......	219
(S-20-60) 24adb1 [1,2]	2	385	....	9-14-12	35	251	7	52	3	43	0	235	34	4	......	141
(S-20-61) 3dab1 [3]	314	242	71	5- 1-41	......	245	13	54	15	24	tr	237	45	7	194	196
(S-20-61) 4add1 [1]	318	850	71	10-12-31	73	200	17	12	19	71	0	220	72	7.1	......	108
(S-20-61) 18bcc1	505	412	....	2-16-45	43.4	352	....	46	26	12	21	212	30	5.3	......	222
(S-20-61) 19abd1	5	260	70	10-23-44	42.8	357	....	49	26	4.8	0	238	32	7.1	......	228
(S-20-61) 19ddc1	354	280	70	....	43.2	364	....	48	26	8.7	0	242	34	6	......	224
(S-20-61) 20cac1	166	347	70	9-15-34	......	240	9	44	14	33	0	237	30	10	194	167
(S-20-61) 20cbc1	7	278	71	10-18-44	42.7	361	....	49	26	5.9	0	242	33	6.2	......	227
(S-20-61) 20cdc1	360	325	71	10-18-44	42.8	359	....	49	26	4.6	0	238	36	5.3	......	230
(S-20-61) 27adb1	213	......	....	....	......	323	18	78	21	9	0	249	61	22	204	281
(S-20-61) 27cdd1	276	357	....	6-14-35	......	335	37	57	9	33	0	232	22	28	190	179
(S-20-61) 28cbd1	12	660	74	1-19-45	40.2	334	....	43	23	10	0	221	31	6	......	200
(S-20-61) 28cda1	403	440*	76	10-25-44	37.5	312	....	38	22	10	0	210	27	5	......	185
(S-20-61) 28cda1	403	690†	76	10-25-44	38.4	310	....	38	24	11	6	192	33	6	......	193
(S-20-61) 28dac1	199	640*	....	1-19-45	33.5	280	....	46	22	6.7	0	171	24	11	......	203
(S-20-61) 28dac1	199	805†	....	1-19-45	40.8	317	....	40	22	9.2	0	210	30	5.3	......	192
(S-20-61) 29cbc2[1]	83	600	75	2- 5-32	298	235	17	64	20	7.9	0	233	58	5.5	......	242
(S-20-61) 29ccc1	77	......	....	10- 2-42	......	265	10	60	19	11	0	220	45	13	180	228
(S-20-61) 29dbb1	380	475	72	10-18-44	42.9	354	....	48	25	5.7	0	236	33	5.3	......	224
(S-20-61) 29dca1	52	664	74	10-24-44	42.3	343	....	46	25	6.2	0	227	32	7.1	......	216

TABLE 4—*Continued*

Well No. and location	State Engineer's local field No.	Depth (feet)	Temperature (°F.)	Date of collection	Specific electrical conductance (Kx10⁶ at 25°C)	Parts Per Million: Dissolved solids	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na and K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulphate (SO_4)	Chloride (Cl)	Alkalinity (as $CaCO_3$)	Hardness (as $CaCO_3$)
(S-20-61) 30bbb1[1]	109	350	72	3-27-31	870	246	18	51	24	7.6	0	249	38	tr	......	227
(S-20-61) 32acb2	390	660	77	2-16-45	44.1	365	....	46	25	11	0	235	40	7.1	......	220
(S-20-61) 33cca1	205	200*	71	....	44.7	369	....	46	28	9.2	0	233	44	8.8	......	229
(S-20-61) 33cca1	205	400†	72	....	44.6	373	....	47	26	12	0	233	46	8.8	......	225
(S-20-61) 33cca2	206	226	....	2-21-38	......	280	22	84	tr	32	0	270	47	7	221	210
(S-20-61) 33ccb2	15	425	....	....	42.3	357	....	49	13	26	3.6	231	25	7.8	......	177
(S-20-61) 34adc1	47	354	69	1-19-45	32.6	255	....	28	19	11	0	162	26	8.8	......	148
(S-20-61) 34bcb1	159	......	....	6-14-41	......	460	25	84	25	50	0	305	144	16	250	312
(S-20-61) 35cbb2	363	460	....	9-14-45	33.9	256	....	31	22	4	tr	162	32	6	......	166
(S-20-61) 35ddc2	368	418	....	9-14-45	37.7	319	....	39	26	5	tr	206	40	3.2	......	205
(S-20-61) 36bbb1	393	325	69	1-19-45	42.4	356	....	44	26	10	0	233	36	7.1	......	216
(S-20-62) 4add1	416	800	71	5- 5-41	......	255	15	60	17	15	0	244	34	12	200	220
(S-20-62) 19bbb1	444	......	....	12-17-45	......	294	51	25	10	56	0	204	35	15	28	102
(S-20-62) 19cab1	442	......	....	12-17-45	......	408	30	39	15	84	0	221	110	32	181	159
(S-21-61) 2cbb1	51	1120	83	1-19-45	50.8	382	....	32	18	50	0	152	124	6.2	......	154
(S-21-61) 3abb2	238	(*)	70	9-14-45	42.3	337	....	45	26	4.1	tr	218	41	2.8	......	219
(S-21-61) 3abb2[3,4]	238	807†	....	9-14-45	39.8	310	....	40	23	5.5	0	199	39	3.2	......	196
(S-21-61) 3bcc2	172	800	72	10-10-35	......	225	22	51	13	26	0	210	50	10	172	181
(S-21-61) 4aad1	386	793	74	1-19-45	41.8	351	....	41	23	17	0	223	37	9.6	......	197
(S-21-61) 4baa1	48	381	72	1-19-45	44.8	376	....	31	27	29	0	236	46	7.1	......	188
(S-21-61) 4dac2	420	650	70	10-25-44	40.4	309	....	36	26	10	16	174	42	5	......	197
(S-21-61) 4ddb1	88	400	....	10- 9-45	......	265	20	60	17	2	0	195	44	10	160	220
(S-21-61) 7acc1	155	(*)	72	3-15-45	45.8	372	....	49	28	7.1	0	232	51	5.3	......	236
(S-21-61) 7acc1	155	355†	72	3-15-45	45.8	376	....	48	27	10	0	232	52	7.1	......	232
(S-21-61) 9acd1	377	550	72	10-17-44	42.4	350	....	45	24	11	0	223	39	8.8	......	212
(S-21-61) 18dbd1[1]	30	300	....	9-10-30	65	329	16	68	32	12	0	243	109	10	......	301
(S-21-61) 21bbb1	123	325	70	10-17-44	39.9	322	....	40	24	9.2	0	204	40	5.3	......	197
(S-21-61) 27cbb1[1,2]	35	400	....	9-18-12	184	430	21	85	31	10	0	210	165	10	......	340
(S-21-61) 27ccc1[3,4]	38	263	75	10-17-44	54.4	478	....	61	31	20	0	253	101	11	......	282

20 62
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TABLE 4—*Continued*

Well No. and location	State Engineer's local field No.	Depth (feet)	Temperature (°F.)	Date of collection	Specific electrical conductance (Kx10⁶ at 25°C)	Dissolved solids	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na and K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulphate (SO_4)	Chloride (Cl)	Alkalinity (as $CaCO_3$)	Hardness (as $CaCO_3$)
						Parts Per Million										
(S-21-61) 29ddal	93	260	70	10-17-44	57.4	462	....	67	34	7.3	0	227	118	8.8	......	306
(S-21-61) 33bacl	39	224	78.5	10-27-30	105	410	19	81	25	31	0	245	148	12	......	304
(S-21-61) 35dccl	125	300*	....	8- 5-27	49	912	....	151	52	35	0	219	418	38	......	590
(S-21-61) 35dccl	125	485†	....	8- 5-27	66	745	....	116	39	42	0	168	358	22	......	451
(S-21-62) 3bacl [1,2]	339	546	....	12-24-12	2.1	7355	15	500	150	1509	tr	51	4008	658	......	1865
(S-21-62) 4aaa2 [1]	337	180	....	4-19-29	......	1306	....	142	94	120	0	254	681	60	......	741
(S-21-62) 17ddcl	374	540	....	3-18-42	......	3113	74	228	68	678	0	154	1599	378	126	849
(S-21-62) 20dddl	407	458	76	12-21-42	118	371	46	66	20	25	0	144	134	15	118	247
(S-21-62) 21dddl	295	......	....	7-13-42	......	3705	48	246	98	765	0	78	2252	192	64	1017
(S-21-62) 27bcbl	342	525	....	7-13-42	......	2360	37	148	46	511	0	81	1356	136	66	559
(S-21-62) 27bcdl	355	450	....	7-13-42	......	3050	48	240	119	544	0	107	1678	308	88	1088
(S-21-62) 27cbal	296	420	....	7-13-42	......	2388	37	158	45	504	0	81	1372	128	66	580
(S-21-62) 27cccl [1]	....	375	....	9-27-26	1.75	6378	82	610	358	805	0	204	2855	1140	......	2993
(S-21-62) 28aadl	293	420	....	7-13-42	......	2820	35	162	63	573	0	81	1600	161	66	663
(S-21-62) 28acdl [3]	297	18	....	9-20-12	......	2827	71	295	164	297	12	197	1233	417	......	1410
(S-21-62) 28adal	294	570	....	7-13-42	......	3250	70	282	188	474	0	181	1641	460	148	1476
(S-21-62) 29bccl	301	......	....	8- 4-42	......	420	22	64	34	11	tr	181	147	16	148	299
(S-21-62) 29ccbl	133	700	....	7-13-42	......	580	36	79	39	33	tr	195	232	20	160	357
(S-21-62) 29cccl	134	404	....	7-13-42	......	715	25	110	50	29	tr	215	327	20	176	480
(S-21-62) 30dbbl	128	390	77	8- 4-42	......	602	12	110	42	18	0	160	315	20	131	447
(S-21-62) 31bdc2	132	600	74	7-13-42	......	805	21	147	50	8	0	158	392	37	130	572
(S-22-61) 1bcb4 [1,2]	272	......	....	9-17-12	15	1380	36	193	73	104	0	191	587	168	......	782
(S-22-61) 1bdbl [1]	62	......	....	9-25-30	......	1546	34	229	94	128	0	182	901	107	......	959
(S-22-61) 1dacl [3,4]	57	209	....	7-13-42	......	1018	25	177	56	44	0	207	448	94	170	672
(S-22-61) 2abal	226	200	76	10-17-44	109	775	....	134	57	2.3	0	198	353	30	......	568
(S-22-61) 3accl	122	......	....	7- 3-41	......	882	....	148	40	55	0	207	452	10	170	534
(S-22-61) 3caal	121	395	84	7- 3-41	......	863	21	150	44	40	0	171	453	22	140	555
(S-22-61) 3ddal	434	335	84	6-15-45	113.8	838	....	158	53	.7	9.0	176	441	.5	......	613
(S-22-61) 10bdal [1,2]	69	305	90	9-18-12	60	857	30	155	50	15	0	205	405	35	......	592
(S-22-61) 11bac2	352	175	....	3-28-45	106.9	848	....	140	52	25	tr	202	404	24	......	566
(S-22-61) 11bac3 [1,2]	261	......	....	9-17-12	30	1044	35	177	56	47	0	215	483	67	......	672
(S-22-61) 12bbbl	266	......	82	10-17-44	100.1	851	....	120	51	58	0	157	414	52	......	508

TABLE 4—*Continued*

Well No. and location	State Engineer's local field No.	Depth (feet)	Temperature (°F.)	Date of collection	Specific electrical conductance (Kx10[5] at 25°C)	Parts Per Million: Dissolved solids	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na and K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulphate (SO_4)	Chloride (Cl)	Alkalinity (as $CaCO_3$)	Hardness (as $CaCO_3$)
(S–22–62) 1cba1	350	465	75	7–13–42	......	1800	62	210	50	253	0	117	753	284	96	730
(S–22–62) 1cbc1	494	1135	....	3–15–45	248	1785	....	106	20	436	0	84	1027	112	......	347
(S–22–62) 1cbc2	....	......	....	3–15–45	277	2196	....	120	31	536	0	323	932	254	......	427
(S–22–62) 1cbd2	....	850	....	7–13–42	......	2555	63	76	9	743	0	160	1296	256	131	227
(S–22–62) 1ccc1	431	300	....	9–24–45	316	1953	....	174	85	378	tr	102	513	700	......	782
(S–22–62) 9dcc1	382	180	....	11– 9–42	......	943	35	98	56	124	tr	176	279	218	144	475
(S–20–61) Composite sample of wells and springs used for Las Vegas City Water Supply. 10–2–42					......	265	10	60	19	11	....	220	45	13	......	228
Composite sample of Las Vegas Springs and Well. (S–20–61) 29ccc1, Las Vegas City Water Supply. 1927						291	12	58	25	17	0	259	48	18	......	248

[1]Taken from Hardman, George and Miller, M. R., Quality of the Waters of Southeastern Nevada, Drainage Basins and Water Resources, pp. 24–29; University of Nevada Agricultural Experiment Station, Bulletin No. 136, July 1934.

[2]Taken from Carpenter, Everett, Ground Water in Southeastern Nevada, table facing p. 30, U. S. Geological Water-Supply Paper 365, 1915.

[3]Earlier analysis available from Hardman, George and Miller, M. R., Quality of the Waters of Southeastern Nevada, Drainage Basins and Water Resources, pp. 24–29; University of Nevada Agricultural Experiment Station, Bulletin No. 136, July, 1934.

[4]Earlier Analysis available from Carpenter, Everett, Ground Water in Southeastern Nevada, table facing p. 30, U. S. Geological Survey Water-Supply Paper 365, 1915.

*Shallow flow.

†Deep flow.

APPENDIX II

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TABLE 1

Index for State Engineer's Local Field Numbers, Permit Numbers, and U. S. Geological Survey Numbers of Wells in Las Vegas and Pahrump Valleys, Nevada.

(State Engineer's local field numbers are arranged in consecutive order)

LAS VEGAS VALLEY

State Engineer's local field No.	Well No.	Permit No.	State Engineer's local field No.	Well No.	Permit No.
515	(S-21-61) 4acd1	....	537	(S-21-61) 21abb1	11559
516	(S-21-61) 16bac2	11197	538	(S-21-61) 16ccd1	11579
517	(S-21-61) 20daa1	11253	539	(S-19-60) 16dd	11196
518	(S-20-61) 28cbc1	11409	540	(S-19-60) 9abc1	11342
519	(S-21-61) 16bcd2	11414			
520	(S-20-61) 28bdc1	11422	542	(S-20-61) 19dcd1	11210
521	(S-20-61) 28bac1	11423	543	(S-22-61) 5a	11320
522	(S-21-61) 4bba1	11431	544	(S-20-61) 13dbb1	11357
523	(S-20-61) 36ccc2	11472			
524	(S-21-61) 2bdc1	11480	546	(S-20-61) 25ccd1	11500
525	(S-22-61) 12bbb2	11494	547	(S-21-61) 26bbd1	11512
526	(S-21-62) 30bcd1	11495	548	(S-20-61) 17cdb2	11549
527	(S-21-61) 16bcd3	11497	549	(S-20-61) 20dab1	11584
528	(S-21-61) 1aab3	11503	550	(S-22-61) 9bba1	11591
529	(S-21-61) 16ccc2	11520	551	(S-21-61) 15bac1	11658
530	(S-20-61) 12aca1	11550	552	(S-22-61) 2bba1	11722
531	....	11487	553	(S-20-60) 2ddd1	10977
532	(S-22-61) 2ddc2	11554	554	(S-19-60) 27bdc1	
533	(S-21-61) 15cbb1	11556	555	(S-19-60) 33baa1	
534	(S-21-61) 29aaa1	11560	556	(S-20-61) 23bdc2	11596
535	(S-20-61) 29cbb2	11567			
536	(S-21-61) 6abc1	10794			

PAHRUMP VALLEY

State Engineer's local field No.	Well No.	Permit No.	State Engineer's local field No.	Well No.	Permit No.
1	(S-20-53) 14dcc1	6100	24	(S-21-54) 3acc1	10599
2	(S-20-53) 14dcd1	6100	25	(S-21-54) 3dcb1	10600
3	(S-20-53) 23aba1	6101	26	(S-20-53) 24cdd2	
4	(S-20-53) 23bc	10492	27	(N-24-8)* 26b	

*San Bernardino Base and Meridian.

PAHRUMP VALLEY—*Continued*

State Engineer's local field No.	Well No.	Permit No.
5	(S-20-53) 24cbb1	10491
6	(S-20-53) 14dcc2	10489
7	(S-20-53) 24cdd1	10998
8	(S-20-53) 22bcd1	
9	(S-20-53) 15da1	
10	(S-20-53) 15da2	
11	(S-20-53) 15da3	
12	(S-20-53) 14cbc1	
13	(S-20-53) 15add1	
14	(S-20-53) 15adc2	
15	(S-20-53) 15adc1	
16	(S-20-53) 15bdd1	11001
17	(S-20-53) 15bdc1	11092
18	(S-21-54) 3bda2	10571
19	(S-21-54) 3cad1	10572
20	(S-20-53) 10cdd1	11038
21	(S-21-54) 3dc	10472
22	(S-21-54) 10aac1	
23	(S-21-54) 15aca1	
28	(S-19-53) 10cb1	11185
29	(S-19-53) 15bd1	11184
30	(S-19-53) 16da1	11181
31	(S-19-53) 22ab1	11183
32	(S-19-53) 22da1	
33	(S-19-53) 27ac1	11180
34	(S-20-53) 6ad1	
35	(S-20-53) 14dcc3	
36	(S-20-53) 14dcc4	
37	(S-20-53) 15acd1	
38	(S-20-53) 15acd2	
39	(S-20-53) 15bdd2	
40	(S-20-53) 24caa1	
41	(S-21-53) 1add1	
42	(S-21-53) 24aa1	
43	(S-21-53) 24aa2	
44	(S-21-54) 3bda1	
45	(S-21-54) 19dd1	
46	(S-21-54) 19dd2	
47	(S-21-54) 19dd3	
48	(S-21-54) 19dd4	
49	(S-21-54) 21cd1	
50	(S-21-54) 28bd1	
51	(S-21-54) 28ca1	
52	(S-21-54) 31dd1	
53	(S-21-54) 31dd2	
54	(S-22-54) 25a1	
55	(S-22-54) 25b1	
56	(S-22-54) 25c1	

TABLE 2

Record of wells in Las Vegas, Pahrump, and Indian Spring Valleys, Nevada. (Use of Water—DI, Domestic and irrigation; Ind., Industrial; N, Unused; O, Observation; P, Public supply; S, Stock.)

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Altitude	Measuring Point: Above (+) or Below (—) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (—) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute) Flow	Use	Temperature (°F)	Remarks
INDIAN SPRING VALLEY																		
(S-16-56) 8aa1	—	—	Tim Harnedy	Rodgers & Smith	1946	10	165	—	—	—	+0.7	Top of 8-in. casing	—27.25	11- 1-46	—	DI	—	Log.
(S-16-56) 9ca1	—	—	Tim Harnedy	Rodgers & Smith	1946	12	200	—	—	—	+1.3	Top of 8-in. casing	—19.26	11- 1-46	—	DI	—	Log.
LAS VEGAS VALLEY																		
(S-19-60) 9ab	540	11342	P. J. Goumand	Thomas C. Miller	1946	14	826	—	—	2479	—	—	—	—	340	DI	—	Log.
(S-19-60) 16dda1	539	11196	E. A., J. T., and W. O. Gilcrease	Las Vegas Drilling Co.	1946	10	709	—	—	—	—	—	—	—	—	—	68	Log.
(S-19-60) 27bdc1	554	—	Geological Survey (Test Well)	Geological Survey	1946	5	905	—	—	2361.3	+0.5	Top of 5-in. collar	+36.1	12-18-46	40	—	70	Log.
(S-19-60) 33baa1	555	—	Geological Survey (Test Well)	Geological Survey	1946	8	1008	—	—	2407.60	+0.4	Top of collar of 8-in. casing	+22.0	12-18-46	70	—	70	Log.
(S-20-60) 1ccc1	—	—	F. E. Gowen	Las Vegas Drilling Co.	1946	8	156	—	—	2268.29	+1.1	Top of 8-in. casing	—44.02	12-24-46	—	N	—	Log.
(S-20-60) 2ddd1	553	10977	Arthur E. Gray	Canemona Drilling Co.	1946	10	707											
(S-20-60) 12aca1	530	11550	Frank E. and Olga Gowen	Las Vegas Drilling Co.	1946	8	665	—	—	2245.88	+1.0	Top of 8-in. casing	—31.24	12-24-46	—	N	—	Log.
(S-20-61) 13dbb1	544	11357	Joe Cardinal	John Frewalt	1946	8	293	—	—	1851.81	+2.2	Top of casing	—41.18	12-28-46	—	DI	—	Log.
(S-20-61) 19dcd1	542	11210 11711	V. O. Eastland and E. B. Coram	Rogers & Smith	1946	10	480	250–280	462–48	—	+1.0	Top of 10-in. casing	+17.1	10-31-46	264	DI	70	Log.
(S-20-61) 20dab1	549	11584	Emil M. Pahor	Leveritt Drilling Co.	1946	8	306	220–240	285–29	—	+1.0	Top of casing	+25.1	11-27-46	70	DI	70	Log.
(S-20-61) 23bdc2	556	11596	R. J. Kaltenborn	Bert Hairgrove	1946	8	200	—	—	1888.92	+0.8	Top of 8-in. casing	+8.4	1- 9-47	10	DI	—	Log.
(S-20-61) 25ccd1	546	11500	Ebbie H. Davis	John Frewalt	1946	8	348	—	—	1830.73	+0.5	Top of 8-in. casing	+10.4	12-16-46	3	DI	—	Log.
(S-20-61) 28bac1	521	11423	Waale, Camplan, and Thomas, Inc.	Las Vegas Drilling Co.	1946	10	711	—	—	—	+0.3	Top of 10-inch welded cap	+22.8	7-16-46	30	P	—	Log.
(S-20-61) 28bdc1	520	11422	Waale, Camplan, and Thomas, Inc.	Las Vegas Drilling Co.	1946	10	700	—	—	—	0.0	Top of 10-in. casing	+50.0	11-21-46	20	P	—	Log.
(S-20-61) 28cbc1	518	11409	Theodore Werner and Kenneth Searles	Las Vegas Drilling Co.	1946	8	845	—	—	—	+2.0	Top of 8-in. tee	+45.3	7-24-46	53	DI	—	Log.
(S-20-61) 29cbb2	535	11567	Thomas E. Sharp	Las Vegas Drilling Co.	1946	10	967	—	—	2143.11	+2.3	Top of lower flange of 10-in. gate valve	+39.7	10-19-46	1200	DI	76	Log.

TABLE 2—*Continued*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Measuring Point: *Altitude*	Measuring Point: Above (+) or Below (—) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (—) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-20-61) 36ccc2	523	11472	M. E. Ward	Bert Hairgrove	1946	8	429	—	—	1852.65	+0.7	Top of 8-in. casing	+13.9	7-31-46	22	P	—	Log.
(S-21-61) 1aabc	528	11503	Nate Mack	O. G. Hairgrove	1946	8	490	—	—	1824.88	—	Cannot measure water level	—	—	5	DI	—	Log. Pumped 25 G. M. in 1946.
(S-21-61) 2bdc1	524	11480	H. J., G. M., and M. V. Stocker	Rodgers & Smith	1946	10	490	—	—	1989.39	+1.0	Top of 8-in. casing	—	5-31-46	—	DI	74	Log.
(S-21-61) 4acd1	515	—	C. L. Ronnow and C. W. Wengert	—	—	8	—	—	—	—	+0.5	Top of casing	+22.9	2-17-47	—	DI		
(S-21-61) 4bba1	522	11431	Nick Pahor	Rodgers & Smith	1946	8	450	—	—	—	+1.2	Top of 6-in. casing	—	6-21-46	—	DI	—	Log.
(S-21-61) 6abc1	536	10794	William Hinson	Bert Hairgrove	1946	10	272	—	—	—	+0.3	Top of 8-in. casing	+2.5	6- 3-46	2	DI	72	Log. Pumped 100 G. M. in December 1946.
(S-21-61) 7ddb2	—	—	J. V. Karns	J. V. Karns	—	60	25	—	—	—	+1.0	Top of board well-cover	—22.95	9- 4-46	2	DI		
(S-21-61) 15bac1	551	11658	John N. and Helen Beville	D. G. Arnall	1946	12	379	—	—	—	+1.0	Top of 12-in. casing	+9.5	11-22-46	125	DI	—	Log.
(S-21-61) 15cbb1	533	11556	T. A. Wells	Joe Metz	1946	10	925	483–492	340–390 755–760 912–923	2050.53	+1.0	Top of 8-in. casing	+6.85	10-29-46	70	DI	75	Log.
(S-21-61) 16bac2	516	11197	John P. Hughes	Las Vegas Drilling Co.	1946	6	456	—	—	—	+0.7	Top of 6-in. casing	—15.38	8- 3-46	—	DI	—	Log.
(S-21-61) 16bcd2	519	11414	James S. Fulcher	North Las Vegas Drilling Co.	1946	10	540	—	—	—	—	Not possible to measure water level	—	7- -46	5	—	—	Log. Pumped 20 G. M. in 1946.
(S-21-61) 16bcd3	527	11497	Otilla Techow	Las Vegas Drilling Co.	1946	6¼	312	—	—	—	+1.3	Top of 6-in. casing	—15.07	8-20-46	—	DI	—	Log.
(S-21-61) 16cbd4	—	—	Frank E. Gowen	Las Vegas Drilling Co.	1946	8	85	—	—	—	+1.4	Top of 8-in. casing	—20.74	8- 8-46	—	DI	—	Log.
(S-21-61) 16ccc1	440	11519	Nevada Projects Corporation	Canemona Drilling Co.	1946	10	605	—	—	—	+2.4	Top of 10-in. welded cap	+31.8	5-14-46	38	DI	77	Log.
(S-21-61) 16ccc2	529	11520	Nevada Projects Corporation	Canemona Drilling Co.	1946	10	977	—	—	—	+0.95	Top of 10-in. welded cap	+40.6	10-24-46	57	DI	78	Log.
(S-21-61) 16ccd1	538	11579	Nevada Projects Corporation	Canemona Drilling Co.	1946	10	1255	—	—	—	+1.5	Top of 10-in. casing	+34.5	12-18-46	46	DI	—	Log.
(S-21-61) 20daa1	517	11253	A. F. Winter	Canemona Drilling Co.	1946	8	920	—	—	—	+3.1	Top of 8-in. welded cap	+25.0	7-18-46	40	DI	80	Log.
(S-21-61) 21abb1	537	11559	Murray Woolman	North Las Vegas Drilling Co.	1946	8	737	—	—	—	+1.1	Top of 8-in. casing	+24.3	10-29-46	31	DI	76	Log.
(S-21-61) 26bbd1	547	11512	Evelyn S. Potter	North Las Vegas Drilling Co.	1946	8	325	—	—	—	+0.8	Top of 8-in. casing	+24.9	1- 6-47	45	DI	74	Log.
(S-21-61) 28ccb1	—	—	Roland Wiley	Bert Hairgrove	—	6	185	—	—	—	+0.7	Top of casing	—21.30	12-12-46	—	DI		

TABLE 2—*Continued*

											Measuring Point		Pressure Head or Water Level					
Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Altitude	Above (+) or Below (—) Land Surface (feet)	Description	Above (+) or Below (—) Measuring Point (feet)	Date of Measurement	Yield (gallons a minute) Flow	Use	Temperature (°F)	Remarks
(S-21-61) 29aaa1	534	11560	Murray Woolman	Bert Hairgrove	1946	8	540	330–345	500–510	—	+3.0	Top of 6-in. tee	+14.4	9– 6–46	60	DI	72	Log.
(S-21-62) 30bcd1	526	11495	Chris Wilson	Canemona Drilling Co.	1946	8	455	—	—	—	+1.4	Top of 8-in. casing	+80.2	6–26–46	150	DI	78	Log.
(S-22-61) 5a	543	11320	G. Giesler	Canemona Drilling Co.	1946	10	905	900–905	145–155 600–650 800–850	—	0.0	Land surface	—78.23	10–21–46	—	P	—	Log. Well unfinished in 1946.
(S-22-61) 9bba2	550	11591	Opaco Lumber Co.	Canemona Drilling Co.	1946	8	603	480–603	195–240 125–140	—	+1.0	Top of 8-in. casing	—86.03	2– 3–47	—	DI	—	Log.
(S-22-61) 12bbb2	525	11494	Nat Wolff	Rodgers & Smith	1946	8	460	—	—	—	+1.0	Top of 6-in. casing	+39.9	11–19–46	27	DI	—	Log.
PAHRUMP VALLEY																		
(N-24-8) 26b*	27	—	Bureau of Land Management	W. P. A.	—	72	22	—	—	—	+0.2	Top of plank well-cover	—17.82	3–19–46	—	S,O	64	Pumped 10 G.M. in 1946.
(S-19-53) 10cb1	28	11185	Elmer Bowman	Elmer Bowman	1946	18	250	—	—	—	+0.5	Top of tie	—90.42	9– 9–46	—	N	—	Well casing pulled, 1946.
(S-19-53) 15bd1	29	11184	Ray Van Horn	Elmer Bowman	1945	16	64	—	—	—	+0.3	Top of board well-cover	—58.03	3–23–46	—	DI	—	Pumped 5 G. M. in 1946; no casing in well.
(S-19-53) 16da1	30	11181	Ray Van Horn	Frank Buol	1913	8	700 ±	—	—	—	0.0	Top of casing	—38.93	3–17–45	—	DI	—	Pumped 300 G. M. on March 17, 1945.
(S-19-53) 22ab1	31	11183	Ray Van Horn	Art and Harry House	1946	16	540	—	—	—	0.0	Top of pump base	—41.34	2– 7–47	—	DI	72	Log; pumped 700 G. M. on Feb. 7, 1947.
(S-19-53) 22da1	32	—	Norman and Lester Shurtliff	Pounder Bros.	—	20	—	—	—	—	0.0	Land surface	—47.0	2– 7–47	—	—	—	Log; well not completed Feb. 7, 1947.
(S-19-53) 27ac1	33	11179	J. P. Cayton	Murphy	1946	16	480	—	—	—	—	Cannot measure water level	—	9– 9–46	85	N	76	Log; well not completed Feb. 7, 1947.
(S-20-53) 6ad1	34	—	—	—	—	6	471	—	—	—	+0.5	Top of Casing	—5.42	9– 9–46	—	N,O		
(S-20-53) 10cdd1	20	11038	George A. Fink	H. D. Martin	1944	12	715 ±	—	—	—	—	Cannot measure water level	—	9– 9–46	50	N	77	Log.
(S-20-53) 14cbc1	12	—	Raycraft	—	1915	10	360	—	—	—	—	Cannot measure water level	—	9– 9–46	56	DI	80	Log; 10-in. casing to unknown depth; 8-in. casing to unknown depth.
(S-20-53) 14dcc1	1	6100	Ray Thomas	—	1915	8	254	—	—	—	+2.0	Top of casing	+3.2	3– 6–45	20	DI	78	Log; well cleaned out by Thomas C. Miller in 1944.
(S-20-53) 14dcc2	6	10489	Ray Thomas	Joe Evans	1937	10	302	—	—	—	—	Cannot measure water level	—	9– 9–46	Tr	N	78	Log.
(S-20-53) 14dcc3	35	—	Ray Thomas	Barber & Bridge	1944	16	460	—	—	—	0.0	Top of 16-in. cap on casing	+4.05	3– 6–45	745	DI	—	Log.
(S-20-53) 14dcc4	36	—	Ray Thomas	Barber & Bridge	1946	16	495	—	—	—	—11.8	¾-in. outlet on casing	+14.0	9–10–46	—	DI	78	Log.

*San Bernardino Base and Meridian.

TABLE 2—*Continued*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	*Altitude*	Measuring Point: Above (+) or Below (—) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (—) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-20-53) 14dcd1	2	6100	Ray Thomas	—	1915	—	322	—	—	—	—	—	—	—	—	—	—	Log; well near small spring.
(S-20-53) 15acd1	37	—	Frank Buol	—	—	8	—	—	—	—	+0.4	Top of casing	—12.47	9–10–46	1	DI		
(S-20-53) 15acd2	38	—	Frank Buol	—	—	10	—	—	—	—	+0.3	Top of casing	.00	9–10–46	—	N	78	
(S-20-53) 15adc1	15	—	Frank Buol	Frank Buol	1915	8	520	—	—	—	+2.2	Top of 8-in. welded cap	+33.0	4– 4–44	25	DI	—	Main supply well for Buol ranch.
(S-20-53) 15adc2	14	—	Frank Buol	Frank Buol	1913	8	316	—	—	—	0.0	Top of 8-in. casing	—1.44	9–10–46	—	DI	—	Pumped 2 G. M. through 1946.
(S-20-53) 15add1	13	—	George P. Brooks	Frank Buol	1913	4	301	—	—	—	—	—	—	9–10–46	2	—	82	
(S-20-53) 15bdc1	17	11092	A. F. Cayton	H. D. Martin	1943	10	212	—	—	—	—	—	—	9–10–46	25	—	74	Log.
(S-20-53) 15bdd1	16	11001	J. P. Cayton	H. D. Martin	1943	8	400	—	—	—	+1.1	Top of collar on 8-in. casing	+30.9	9–10–46	27	—	78	Log.
(S-20-53) 15bdd2	39	—	A. F. Cayton	Frank Buol	1913	4	—	—	—	—	+0.8	Top of 2-in. tee	+8.0	9– 9–46	9	DI	77	Well on west side of reservoir.
(S-20-53) 15da1	9	—	Raycraft	—	1915	8	354	—	—	—	—	—	—	9– 9–46	10	DI	80	
(S-20-53) 15da2	10	—	Raycraft	—	1915	10	176	—	—	—	—	—	—	9– 9–46	150	DI	80	
(S-20-53) 15da3	11	—	Raycraft	—	1915	10	350	—	—	—	—	—	—	9– 9–46	10	DI	80	
(S-20-53) 22bcd1	8	—	Ray Thomas	—	1910													
(S-20-53) 23aba1	3	6101	Ray Thomas	—	1915	14	516	—	—	—	—	—	—	9– 9–46	270	DI	78	Log.
(S-20-53) 23bc1	4	10492	Ray Thomas	Joe Evans	1937	14	400	—	—	—	—	—	—	9–10–46	400	DI	—	Log.
(S-20-53) 24caa1	40	—	Ray Thomas	—	—	10	570	—	—	—	—	Top of 10-in. casing	—25.10	3–17–45	—	N,O		
(S-20-53) 24cbb1	5	10491	Ray Thomas	—	—	10	—	—	—	—	—	—	—	9–10–46	10	N	76	Bridged at 21 feet.
(S-20-53) 24cdd1	7	10998	Ray Thomas	Barber & Bridge	1944	16	897	—	—	—	—	—	—	9–10–46	122	S	74	Log; 1000 G. M. pumped July 1944.
(S-20-53) 24cdd2	26	—	Ray Thomas	—	—	12	—	—	—	—	+0.5	Top of welded plate on casing	+2.17	4– 4–44	5	N	74	Bridged at 84 feet.
(S-21-53) 1add1	41	—	—	F.E.R.A.	—	10	—	—	—	—	—1.5	Top of casing	—25.50	9–12–45	—	N		
(S-21-53) 24aa1	42	—	Townsend	—	—	10	120	—	—	—	+1.3	Top of casing	—23.44	3–19–46	—	N		
(S-21-53) 24aa1	43	—	Townsend	—	—	72	73	—	—	—	0.0	Top of 6-in. by 6-in. cribbings, east side	—22.54	9–11–46	—	N	—	Well in pit about 100 feet N.E. of (S-20-53) 24aa1.

TABLE 2—*Continued*

Well No. and Location	State Engineer's Local Field No.	State Permit No.	Owner	Driller	Year Completed	Diameter (inches at land surface)	Depth (feet)	Principal Aquifer (depth, feet)	Other Aquifers (depth, feet)	Altitude	Measuring Point: Above (+) or Below (—) Land Surface (feet)	Measuring Point: Description	Pressure Head or Water Level: Above (+) or Below (—) Measuring Point (feet)	Pressure Head or Water Level: Date of Measurement	Yield (gallons a minute): Flow	Use	Temperature (°F)	Remarks
(S-21-54) 3acc1	24	10599	H. D. Cornell	Roscoe Moss Co.	1941	18	737	—	—	—	—	—	—	9-11-46	900	DI	—	Log.
(S-21-54) 3bda1	44	—	H. D. Cornell	Joe Evans	1937	8	—	—	—	—	—3.5	Top of clamp on 8-in. casing	+16.9	10-13-44	—	N,O		
(S-21-54) 3bda2	18	10571	H. D. Cornell	Roscoe Moss Co.	1940	16	720	—	—	—	—4.0	Top of 16-in. casing	+15.5	9-11-46	907	DI	—	Log.
(S-21-54) 3cad1	19	10572	H. D. Cornell	Roscoe Moss Co.	1941	16	730	—	—	—	0.0	Top of 20-in. casing	+17.0	4- 4-44	2025	DI	75	Log.
(S-21-54) 3dc1	21	10472	H. D. Cornell	Roscoe Moss Co.	1941	14	720	—	—	—	—18.0	Top of 12-in. valve wheel	+12.5	9-11-46	900	DI	75	Log.
(S-21-54) 3deb1	25	10600	H. D. Cornell	Roscoe Moss Co.	1939	16	970	—	—	—	+1.8	Top of 18-in. casing	+10.5	9-11-46	900	DI	75	Log.
(S-21-54) 10aac1	22	—	H. D. Cornell	Roscoe Moss Co.	1940	14	800	—	—	—	+0.3	Top of 14-in. casing	—28.34	10-13-44	—	N,O	—	Log.
(S-21-54) 15aca1	23	—	Rooker	Roscoe Moss Co.	1940	20	506	—	—	—	0.0	Top of casing	—31.00	9-11-46	—	N	—	Log.
(S-21-54) 19dd1	45	—	Churchill	Churchill	1944	10.5	72	—	—	—	+1.0	Top of can casing	—35.30	3-19-46	—	N		
(S-21-54) 19dd2	46	—	Churchill	Churchill	1944	10.5	76	—	—	—	+1.0	Top of 4-in. wooden clamp	—34.71	9-11-46	—	N		
(S-21-54) 19dd3	47	—	Churchill	Churchill	1944	10.5	—	—	—	—	—	—	—	—	—	N		
(S-21-54) 19dd4	48	—	Churchill	Churchill	1944	10.5	80	—	—	—	—	—	—	—	—	N		
(S-21-54) 21cd1	49	—	Louis Sharp	—	—	9	164	—	—	—	+2.8	Top of casing	—20.00	3-19-46	—	N		
(S-21-54) 28bd1	50	—	Kellogg Estate	—	—	10	140	—	—	—	+1.0	Top of casing	—19.74	3-19-46	—	N		
(S-21-54) 28ca1	51	—	Kellogg Estate	—	—	6	300+	—	—	—	+1.5	Top of 6-in. welded cap on casing	+20.8	9-11-46	5	S		
(S-21-54) 31dd1	52	—	Spanker (?)	—	—	10	102	—	—	—	0.0	Top of casing	—70.22	3-19-46	—	N		
(S-21-54) 31dd2	53	—	Spanker (?)	—	—	72	21	—	—	—	0.0	Top of casing of adjacent cased well	—19.85	3-19-46	—	N		
(S-22-54) 25a1	—	—	Roland Wiley	Art House	1946	24	888	—	—	—	0.0	Land surface	—17.17	9-11-46	—	N,O	—	Casing pulled.
(S-22-54) 25b1	—	—	Roland Wiley	—	—	12	26	—	—	—	0.0	Top of casing	—17.57	9-11-46	—	DI		
(S-22-54) 25C1	—	—	Roland Wiley	—	—	10	93	—	—	—	+0.4	Top of wooden platform over well	—35.78	9-11-46	—	N		

TABLE 3

Logs and Casing Records of Wells in Las Vegas, Pahrump, and Indian Spring Valleys, Nevada

INDIAN SPRING VALLEY

(S-16-56) 8aa1. Tim Harnedy. Diameter 10 inches, 10-inch casing to 50 feet, 165 feet of 8-inch casing from surface.

Material	Thickness (feet)	Depth (feet)
Light tan silty clay, a few granules and pebbles	35	35
First water encountered	----	35
Gravel and sand, much light tan silty clay	5	40
Light tan silty clay with a few thin interbedded lenses of water-bearing gravel and sand	70	110
Tan silty clay, a few lenses of water-bearing sand and gravel	55	165
Total depth	----	165

(S-16-56) 9ca1. Tim Harnedy. Diameter 12 inches, 12-inch casing to 10 feet, 133 feet of 8-inch casing from surface to 133 feet.

Material	Thickness (feet)	Depth (feet)
Tan silty clay, a few pebbles and some sand	22	22
Pebble and granule gravel, a little sand, water at 22 feet	2	24
Tan silty clay, a few pebbles and granules	6	30
Tan silty clay	10	40
Light greenish - blue plastic clay	5	45
Gravel, sand and clay, water	1	46
Light greenish - blue plastic clay, a few pebbles and granules	14	60
Tan silty clay, a few pebbles and some sand	85	145
Granule gravel and some sand, a few pebbles, some tan silty clay, water	5	150
Light tan silty clay, few granules, a little sand	35	185
Gravel and sand, some tan silty clay, water	2	187
Tan silty clay, a few pebbles, a little sand	13	200
Total depth	----	200

TABLE 3—*Continued*

(S-19-60) 9ab. P. J. Goumand. Land surface altitude 2,479 feet; diameter 14 inches. 14-inch casing to 142 feet, 8-inch casing to 546 feet.

Material	Thickness (feet)	Depth (feet)
Gravel	6	6
Tan clay	24	30
Tan clay, some gravel	12	42
Tan clay	8	50
Reddish-brown, silty clay	40	90
"Near-surface" water level	—	90
Reddish-brown silty clay	6	96
Tan clay	24	120
Pebble and granule gravel, a little tan silty clay, water	7	127
Tan silty clay	56	183
Tan silty clay, some gravel	17	200
Tan silty clay	30	230
Tan silty clay, some gravel	10	240
Tan silty clay, a few granules	40	280
Fine- to medium-grained sand, some gravel cemented with caliche	6	286
Granule and pebble gravel, much fine- to coarse-grained sand, flow of water	24	310
Gravel and sand cemented with caliche, some silt and clay	15	325
Granule to pebble gravel, some sand, flow of water	20	345
Gravel and sand cemented with caliche, a little clay and silt	6	351
Tan plastic clay, some gravel	44	395
Tan silty clay, some gravel	41	436
Tan plastic clay	4	440
Gravel and sand cemented with caliche	2	442
Plastic tan clay	11	453
Tan silty clay	5	458
Gravel and sand cemented with caliche, much silt and clay	22	480
Gravel and sand cemented with caliche	13	493
Granule gravel and sand, flow of water	7	500
Gravel and sand cemented with caliche	9	509
Granule gravel and sand, flow of water	3	512
Coarse- to fine-grained sand a few granules, cemented with caliche	4	516
Sand, some pebbles and granules, flow of water	4	520
Sand and granules cemented with caliche	6	526
Sand, flow of water	33	559
Sand and gravel cemented with caliche	10	569
Sand and gravel, flow of water	26	595
Sand and gravel cemented with caliche	10	605
Sand, flow of water	9	614
Sand and gravel cemented with caliche	7	621
Coarse pebble gravel	10	631
Sand, flow of water	3	634
Coarse pebble gravel, flow of water	1	635
Tan silty clay	65	700
Cemented gravel	2	702
Tan silty clay, a few pebbles and boulders	108	810
Sand, many granules	8	818
Tan silty clay	8	826
Total depth	—	826

TABLE 3—*Continued*

(S–19–60) 16dda1. E. A., J. T., and W. O. Gilcrease. Diameter 10 inches, 10-inch casing to 210 feet, perforated with ¼ by 8-inch slots from 190 to 210 feet.

Material	Thickness (feet)	Depth (feet)
Pebble gravel, some fine- to coarse-grained sand, a little silt	11	11
White silty clay	15	26
Caliche, a little clay and gravel	6	32
Tan silty clay	9	41
Caliche, a little clay and gravel	5	46
Tan silty clay, a few caliche layers	108	154
Tan silty clay, a few caliche layers, a few pebbles	64	218
Pebble and granule gravel, much tan silty clay, some caliche	4	222
Pebble gravel, a few granules, some sand, some tan silty clay and caliche	29	251
Caliche, a little tan clay	2	253
Tan silty clay, many caliche layers	127	380
Pebble gravel, some sand, a little silt	16	396
Tan silty clay	6	402
Pebble gravel, a little sand, much tan silty clay, cemented with caliche	37	439
White clay layers interbedded with thin gravel strata	34	473
Granule and pebble gravel, caliche, some sand	25	498
White silty clay	18	516
Pink silty clay, a little gravel and caliche	99	615
Pebble gravel, some sand, a little tan silty clay	22	637
Red clay, caliche nodules	14	651
Granule gravel, some sand, a little silt and clay	22	673
Tan silty clay, some cemented gravel strata	36	709
Total depth	—	709

TABLE 3—*Continued*

(S-19-60) 27bdc1. U. S. Geological Survey. Land surface altitude 2,361 feet; diameter 5 inches, 5-inch casing to 83.5 feet.

Material	Thickness (feet)	Depth (feet)
Light tan silty clay and pebble gravel, some caliche	10	10
Light tan silty clay, a little caliche, some snail shells	20	30
Light tan coarse-grained sand, a little silty clay	10	40
Light pink silty clay, a few pebbles, a little caliche	5	45
Light pink silty clay, much caliche, a little coarse sand	10	55
Pink clay, a little caliche	20	75
Thin caliche layers interbedded with pebble gravel and sand	15	90
Light pink silty clay, some caliche, a few pebbles	45	135
Brown clay, a little silt, some caliche	15	150
Light pink silty clay, some caliche nodules	10	160
Light brown silty clay and caliche, some pebble gravel	10	170
Light brown silty clay and caliche	10	180
Light brown clay	17	197
Light brown silty clay, some caliche	13	210
Light brown silty clay, a little caliche, a few pebbles	5	215
Silty light brown clay, a little fine sand, a few caliche layers	15	230
Light brown silty clay, a few caliche layers	60	290
Light brown silty clay, a few thin hard brown caliche layers	10	300
Light brown silty clay, a few caliche layers and a few pebbles	8	308
Hard brown caliche	1	309
Light brown silty clay, a few nodules and layers of caliche	103	412
Caliche and coarse-grained sand, flow of water	8	420
Black fine-grained sand, flow of water	5	425
Light brown silty clay, hard caliche layers	5	430
Light brown silty clay, a little fine-grained sand, and a few pebbles	10	440
Light brown silty clay and some caliche, a few pebble and a little sand	45	485
Light brown silty clay, a few caliche nodules	5	490
Hard brown caliche layers, a little clay	5	495
Light brown silty clay, much caliche	65	560
Light brown silty clay, some caliche, a little fine-grained sand	30	590
Light brown silty clay, a few layers of caliche, a few small granules and pebbles	20	610
Light brown silty clay, a little caliche	40	650
Fine- to coarse-grained sand, many granules, much light brown silty clay, flow of water	20	670
Brown silty clay, a few caliche nodules, a few pebbles and granules	15	685
Light green plastic clay layers interbedded with a few thin layers of white plastic clay and brown clay, a few caliche nodules, a little coarse- to fine-grained sand, a few pebbles	25	710
Slate-gray plastic clay	5	715
Brown and green clay layers, some coarse- to fine-grained sand	20	735
Some thin brown clay layers, interbedded with thin coarse-grained sand and pebble-gravel lenses, water-bearing(?)	30	765
Light brown silty clay, few caliche nodules, some medium- to fine-grained sand	30	795
Coarse-grained sand and granules, some light brown silty clay	5	800
Light brown silty clay, some medium- to fine-grained sand, a little light green clay	20	820
Medium- to coarse-grained gray sand, a few granules, some light brown silty clay, water-bearing(?)	30	850
Medium- to coarse-grained gray sand, few granules much light brown silty clay	5	855
Light brown silty clay, much medium- to coarse-grained gray sand, some caliche layers	10	865
Light brown silty clay, some fine- to coarse-grained sand, some pebbles	40	905
Total depth	----	905

TABLE 3—*Continued*

(S-19-60) 33baa1. U. S. Geological Survey. Land surface altitude 2,407 feet; diameter 8 inches, 8-inch casing from surface to 92.5 feet.

Material	Thickness (feet)	Depth (feet)
Granule to pebble gravel, some light brown silty clay	6	6
Boulders, some sand and light brown silty clay	6	12
Brown silty clay, a few caliche nodules	10	22
Boulders, a little tan silty clay	13	35
Brown caliche	5	40
Caliche, a few pebbles, some tan silty clay	5	45
Brown caliche, a few pebbles and a few light tan silty clay layers	45	90
Fine- to coarse-grained gray sand and light tan silty clay, some caliche	7	97
Coarse - grained sand, a little light tan silty clay	2	99
Brown caliche, hard gray sand, and a little light tan silt	4	103
Cobble pebble and granule gravel, some tan silty clay	2	105
Light tan silty clay, some white caliche, a little sand	5	110
Cobble and granule gravel, a few small boulders, some tan silty clay	5	115
Tan silty "mealy" clay, a little coarse-grained sand, much caliche	8	123
Gray silty clay, a little sand	5	128
Green and brown clay, some caliche, a few rocks, a little sand	5	133
Light tan silty clay, caliche nodules, a little sand	17	150
Tan silty clay, some coarse-grained sand, a few pebbles, a little caliche	10	160
Fine- to coarse-grained sand, much caliche, some tan silty clay	20	180
Tan silty clay, a little sand, some hard brown caliche layers and some caliche nodules	215	395
Tan silty clay, a few pebbles and boulders, some coarse-grained sand	10	405
Coarse - grained sand and pebble gravel, a few cobbles, a little silt and clay	8	413
Coarse- to fine-grained sand and granules, some tan silty clay	2	415
Medium- to fine-grained sand (grain size grades downward in section) cemented with some caliche, a little tan silty clay	70	485
Fine- to coarse-grained sand, pebble to granule gravel, a little silt and one thin layer of tan clay	5	490
Coarse - grained sand, granules, and small pebbles	10	500
Tan medium- to fine-grained silty sand, some caliche cement	17	517
Tan silty clay, a little fine - grained sand, some caliche	23	540
Tan fine-grained silty sand, a little medium sand	5	545
Tan silty clay, a few caliche layers	15	560
Tan silty clay, some caliche and a little sand, a few granules	40	600
Granular gravel, much tan silty clay and some sand	5	605
Light tan clay, a little caliche, much medium- to fine-grained sand	10	615
Tan clay, a little sand and caliche	10	625
Tan clay, a few caliche layers	20	645
Granule and pebble gravel, coarse- to medium - grained sand, a few clay layers and caliche cement	10	655
Coarse- to medium-grained gray sand, a few pebbles and and boulders, a few thin clay layers cemented with caliche	175	830
Medium-grained sand, much silt, some coarse-grained sand, a little caliche cement and a little clay	45	875
Light tan silty clay and some fine- to medium - grained sand, cemented caliche layers	15	890
Light tan silty clay, a little sand and caliche	25	915
Medium- and fine-grained gray sand, much tan silty clay	35	950
Medium- and fine-grained gray sand, a little tan silty clay	10	960
Light tan clay, a little sand	10	970
Medium- and fine-grained sand, some tan silty clay, a few pebbles	38	1,008
Total depth	—	1,008

TABLE 3—*Continued*

(S–20–60) 1ccc1. Frank E. Gowen. Land surface altitude 2,267 feet; diameter 8 inches, 8-inch casing to 84 feet.

Material	Thickness (feet)	Depth (feet)
Surface sand	0	2
Lime, hardpan	31	33
White clay and lime	5	38
Gravel	2	40
White clay and gravel streaks	21	61
Caliche	1	62
Red clay and gravel streaks	16	78
Caliche	8	86
White clay	32	118
Caliche	1	119
Red clay and hard streaks	37	156
Total depth	—	156

(S–20–60) 2ddd1. Arthur E. Gray. Diameter 10 inches, 10-inch casing to 92 feet, 700 feet of 8-inch casing to 700 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	3	3
Caliche and clay	37	40
"Near-surface" water level	—	40
Caliche and clay	5	45
Yellow clay	175	220
Clay and gravel	23	243
Gravel, water-bearing	17	260
Gravel and clay	25	285
Cemented gravel	127	412
Gravel and clay	56	468
Cemented gravel	58	526
Clay	2	528
Cemented gravel	4	532
Sand	3	535
Gravel	4	539
Clay	42	581
Cemented gravel	9	590
"Loose" gravel, water	3	593
Cemented gravel	2	595
"Loose" gravel, water	2	597
Cemented gravel	17	614
Clay	5	619
Blue clay	26	645
Clay	19	664
Cemented gravel	24	688
Fine-grained, cemented gray sand	19	707
Total depth	—	707

(S–20–60) 12aca1. Frank E. and Olga Gowen. Land surface altitude 2,245 feet; diameter 8 inches, 654 feet of 8-inch casing, perforated from 482 feet to 611 feet, 325 feet to 360 feet, and 631 feet to 654 feet with ¼- by 6-inch slots.

Material	Thickness (feet)	Depth (feet)
Tan silty fine-grained sand	6	6
Tan silty clay, many hard caliche layers	17	23
Tan silty clay, a little caliche	23	46
Tan silty clay, some gravel lenses, and layers of caliche	44	90
Tan silty clay, caliche nodules, a few caliche layers	161	251
Red silty medium-grained sand	5	256
Tan silty clay, caliche layers	10	266
Tan silty clay, a few thin lenses of granule gravel	9	275
Pebble to granule gravel, much coarse- to fine-grained gray sand, a little silt and clay	68	343
Tan silty clay, a few pebbles and caliche nodules	47	390
Tan silty clay, much hard caliche and a little gravel	148	438
Tan silty clay, some caliche	39	477
Granule gravel, much sand and a little tan silty clay	48	525
Red silty clay, a few pebbles	24	549
Granule and pebble gravel, a little sand and silt	11	560
Granule and pebble gravel, much tan silty clay and fine sand	37	597
Granule gravel, much fine- to medium-grained tan sand	13	610
Red silty clay, some granule gravel and sand	38	648
Granule gravel and sand, some silty clay	6	654
Greenish-blue and red plastic clay	11	665
Total depth	—	665

TABLE 3—*Continued*

(S–20–61) 4addl. George Craig. Land surface altitude 2,058 feet; diameter 10 inches, 10-inch casing to unknown depth.

Material	Thickness (feet)	Depth (feet)
Clay, gypsum, and lime	80	80
Lime and clay	220	300
Sand, flow of water	15	315
"Sandstone"	20	335
Blue and brown clay	90	425
Small gravel, increased flow of water	20	445
Blue clay, some thin lenses of gravel and shale	55	500
Clay and shale	118	618
Sand, increased flow of water	3	621
Clay	182	803
Gravel, increased flow of water	4	807
Clay	30	837
No record	63	900
Total depth	....	900

(S–20–61) 13dbb1. Joe Cardinal. Land surface altitude 1,850 feet; diameter 8 inches, 8-inch casing to 89 feet.

Material	Thickness (feet)	Depth (feet)
Light pink silty clay, a little caliche	48	48
Near-surface water level	....	48
Pink silty clay	32	80
Brown silty clay, a few thin layers of fine-grained sand	20	100
White clay	20	120
Light tan silty clay	10	130
Tan silty clay	10	140
Fine-grained silty sand, water	10	150
Pink silty clay, caliche nodules and a few thin layers of jointed caliche	143	293
Total depth	....	293

(S–20–61) 19dcd1. Van O. Eastland and Ezra B. Coram. Diameter 10 inches, 10-inch casing to 160 feet, 80 feet of 12-inch casing from 160 feet to 240 feet, 340 feet of 8-inch casing from surface to 340 feet, 133 feet of 6-inch casing from 247 to 380 feet, perforated with slots 3/16-inch wide from 260 to 380 feet.

Material	Thickness (feet)	Depth (feet)
White silty clay, caliche, a little gravel and sand	20	20
Light tan silty clay, a little caliche	5	25
Greenish-tan silty clay, caliche nodules	5	30
Light tan silty clay, a little fine-grained sand, a few hard caliche layers, a few thin lenses of plastic brown clay	75	105
Greenish-tan silty clay, caliche nodules	5	110
Tan silty clay, caliche nodules	40	150
Cemented gravel, much tan silty clay	8	158
Tan silty clay, caliche nodules, a little fine-grained sand	57	215
Cemented gravel, much tan silty clay	15	230
Tan silty clay	20	250
Pink silty clay, a little fine-grained to coarse-grained sand, a few granules, flow of water	10	260
Fine- to coarse-grained red and gray sand, a few pebbles and granules, increased flow of water	16	276
Tan silty clay, some sand and granules	34	310
Granules and coarse- to fine-grained gray sand, much pink silty clay, increased flow of water	10	320
Tan silty clay, some sand and granules	40	360
Granules and coarse- to fine-grained gray sand, some tan silty clay, increased flow of water	20	380
Tan silty clay, much sand and some fine gravel	20	400
Tan silty clay, some fine-grained sand	60	460
Fine- to medium-grained tan and gray sand, increased flow of water	20	480
Total depth	....	480

TABLE 3—*Continued*

(S-20-61) 20dab1. Emil M. Pahor. Diameter 8 inches, 8-inch casing to 306 feet, perforated with 3/16-inch slots.

Material	Thickness (feet)	Depth (feet)
Light pink silty clay	15	15
White clay and caliche	3	18
Near-surface water level	—	18
White silty clay, caliche	12	30
Pink silty clay	125	155
Pink silty clay, caliche	65	220
White, fine-grained sand, flow of water	2	222
Caliche, a little pink silty clay	4	226
Pink silty clay	12	238
Caliche, pink silty clay	3	241
Pink silty clay	37	278
Caliche, pink silty clay	2	280
Pink silty clay, some small pebble gravel and sand	5	285
Pebble and granule gravel, much coarse to medium-grained gray sand, flow of water	20	305
Pink silty clay	1	306
Total depth	—	306

(S-20-61) 23bdc2. R. J. Kaltenborn. Land surface altitude 1,888 feet; diameter 8 inches, 8-inch casing to 200 feet.

Material	Thickness (feet)	Depth (feet)
Tan silty clay	140	140
Caliche, a few lenses of sand and gravel, many lenses of tan silty clay, flow of water	25	165
Pebble and granule gravel, some tan silty clay, some fine- to coarse-grained sand, increased flow of water	35	200
Total depth	—	200

(S-20-61) 25cca1. O. A. Effinger. Diameter 4 inches, 4-inch casing to 44 feet, 291 feet of 6-inch casing from 44 feet to 335 feet, perforated from 295 to 335 feet.

Material	Thickness (feet)	Depth (feet)
Light gray silty clay	30	30
Tan silty sand, a few granules, some caliche nodules	10	40
Light pink clay	20	60
Silty and sandy pink clay	90	150
Limy white clay	30	180
Pink silty clay, caliche nodules	80	260
Light pink silty clay, a little fine-grained sand	20	280
Pink silty clay, some sand	20	300
Pink sandy silt	18	318
Orange silty sand, flow of water	4	322
Pink sandy silt	43	365
Total depth	—	365

(S-20-61) 25ccd1. Ebbie H. Davis. Land surface altitude 1,830 feet; diameter 8 inches, 8-inch casing from surface to 82 feet, 317 feet of 4-inch casing from surface to 317 feet.

Material	Thickness (feet)	Depth (feet)
White silty clay, little sand and gravel	12	12
Near-surface water level	—	12
White silty clay	28	40
Tan silty clay	20	60
Light tan silty clay	15	75
Tan silty clay	35	110
Light tan silty clay	30	140
White silty clay, calcareous	30	170
Light tan silty clay	20	190
White calcareous clay	10	200
White calcareous clay, caliche nodules	10	210
Light tan silty clay	90	300
Light tan and tan, fine- to medium-grained sand, much silt, a few granules, flow of water	48	348
Total depth	—	348

TABLE 3—*Continued*

(S–20–61) 28bac1. Waale, Camplan, and Thomas, Inc. Diameter 10 inches, 10-inch casing to 397 feet, perforated with slots ¼-inch wide from 388 feet to 397 feet, 307 feet of 8-inch casing from 397 feet to 704 feet, upper end welded to lower end of 10-inch casing, perforated from 617 feet to 700 feet with ¼-inch slots.

Material	Thickness (feet)	Depth (feet)
Light tan silty clay	6	6
Caliche layers and tan silty clay	27	33
Light tan silty clay, some caliche	72	105
Tan silty clay, many caliche layers	81	186
Tan silty clay, a few gravel lenses	14	200
Granule and pebble gravel	14	214
Tan silty clay, a little gravel, some caliche	50	264
Granule to pebble gravel, some medium- to coarse-grained gray sand, some red silty clay	8	272
Granule and pebble gravel, a little sand and clay	3	275
Granule to pebble gravel, coarse- to medium-grained sand, much tan silty clay	19	294
Tan silty clay, some sand and gravel	54	348
Tan silty clay, some caliche	40	388
Granule to pebble gravel, some sand, much tan silty clay	12	400
Tan silty clay, a little gravel and sand	64	464
Coarse- to medium-grained sand, some granule and pebble gravel, a little tan silty clay	14	478
Silty tan clay, a little caliche, a few very thin gravel lenses	139	617
Granule gravel and fine- to medium grained sand, some tan silty clay	68	685
Tan silty clay	26	711
Total depth	....	711

(S–20–61) 28bdc1. Waale, Camplan, and Thomas, Inc. Diameter 10 inches, 10-inch casing to 397 feet, perforated with slots ¼-inch wide from 270 to 295 feet and from 350 to 395 feet, 303 feet of 6-inch casing from 388 feet to 691 feet, perforated with ¼-inch wide slots from 620 to 691 feet.

Material	Thickness (feet)	Depth (feet)
Tan silty clay, a little sand	5	5
Tan silty clay, hard caliche layers	13	18
Light tan calcareous clay, some caliche layers	58	76
Tan silty clay, caliche nodules	70	146
Tan silty clay, some caliche layers	3	149
Tan silty clay, few caliche layers	124	273
Granule gravel, medium- to coarse-grained sand, some tan silty clay	16	289
Granule gravel, much tan silty clay, little sand	6	295
Tan silty clay, little caliche	15	310
Granule to pebble gravel, coarse- to medium-grained sand, some tan silty clay	20	330
Tan silty clay, little caliche	15	345
Granule to pebble gravel, fine to coarse sand	42	387
Tan silty and sandy clay	85	472
Granule gravel, coarse- to medium-grained sand, much tan silty clay	15	487
Interbedded layers of light greenish-blue plastic clay and tan silty clay	43	530
Tan silty clay	102	632
Fine- to medium-grained sand, little gravel, much tan silty clay	68	700
Total depth	....	700

TABLE 3—*Continued*

(S-20-61) 28cbc1. Theodore Werner and Kenneth Searles. Diameter 8 inches, 684 feet of 8-inch casing from surface to 684 feet, perforated with ¼- by 6-inch slots from 570 to 684 feet, 161 feet of 6-inch casing from 684 feet to 845 feet, perforated with ¼- by 6-inch slots from 684 to 690 feet and from 695 feet to 845 feet.

Material	Thickness (feet)	Depth (feet)
Tan silty clay	7	7
Tan silty clay, layers of caliche	7	14
Caliche layers, tan silty clay, a few thin lenses of gravel	30	44
Tan silty clay, a little caliche	25	69
Tan silty clay, a few caliche layers	25	94
Light tan clay, some caliche	11	105
Tan silty clay, a little caliche	145	250
Tan silty clay, many caliche layers, a little gravel	40	290
Granule to pebble gravel, a little sand and silt	8	298
Tan silty clay, much caliche	17	315
Granule gravel, much medium- to coarse-grained sand, a few pebbles and a little tan silty clay	46	361
Red clay, a little silt	7	368
Red silty clay, a few pebble- to granule-gravel and sand lenses	61	429
Red silty clay	10	439
Light bluish - green clay, a few thin layers of red clay	15	454
Red silty clay, some sand	71	525
Red silty clay, caliche layers	41	566
Red silty clay, a few thin layers of fine gravel, little sand	48	614
Fine granule gravel, coarse- to medium-grained sand, some red silty clay	51	665
Sandy red clay and silt	7	672
Granule gravel, coarse- to medium - grained sand, a little silt	8	680
Sandy red clay, a little fine gravel	140	820
Red silty clay, a little granule gravel	25	845
Total depth	—	845

TABLE 3—*Continued*

(S-20-61) 29cbb2. Thomas E. Sharp. Land surface altitude 2,141 feet; diameter 10 inches, 10-inch casing from surface to 581 feet, perforated with 32 ⅛-inch by 2-inch slots per foot from 136 feet to 581 feet; cemented, surface to 150 feet around casing; bottom of casing open.

Material	Thickness (feet)	Depth (feet)
Soil	1	1
Caliche, a few boulders	21	22
Tan silty clay, a little sand, much caliche	27	49
Tan silty clay, a little sand	19	68
Red silty clay, a little caliche	4	72
Tan silty clay, a little caliche	14	86
Caliche and light tan silty clay	5	91
Tan silty clay, caliche, a little gravel	27	118
Tan silty clay, a little caliche	44	162
Tan silty clay, much caliche	23	185
Tan silty clay, some caliche	109	294
Pebble gravel, caliche, some light tan silty clay	6	300
Red silty clay, some caliche	23	323
Granule to pebble gravel, a little sand and tan silty clay, some caliche	125	448
Red silty clay, a little caliche and gravel lenses	8	456
Pebble and granule gravel, a little sand and silt	6	462
Tan silty clay	10	472
Gray medium- to coarse-grained sand, some granule gravel, some pink silty clay	13	485
Red plastic clay, a little silt and a few pebbles	7	492
Granule gravel, a little sand, some pink silty clay	16	508
Red silty clay, a few gravel and sand lenses	71	579
Granule gravel, a few pebbles, some sand, much red silty clay	33	612
Red silty clay	3	615
Granule to pebble gravel, some sand, and a little silt	105	720
Light tan silty clay, a little gravel and sand	8	728
Fine- to coarse- grained sand, some granule gravel, some tan silty clay	41	769
Tan silty clay	8	777
Fine- to coarse-grained gray sand, much granule gravel, a few pebbles, some tan silty clay	29	806
Tan silty clay, a little gravel	6	812
Fine- to coarse-grained gray sand, much granule gravel, some tan silty clay, a little gravel	96	908
Light tan silty clay, a little gravel	8	916
Red silty clay, a few sand and gravel lenses	51	967
Total depth	—	967

(S-20-61) 29ccc1. Las Vegas Land and Water Co. Land surface altitude 2,120 feet, diameter 16 inches, 16-inch casing to 22 feet, 12-inch casing to 572 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Caliche	23	23
Clay and caliche	7	30
Caliche	2	32
Clay	23	55
Caliche	3	58
Clay	37	95
Caliche	3	98
Clay	27	125
Caliche	5	130
Clay	18	148
Lime boulders	6	154
Clay	81	235
Caliche	3	238
Clay and "lime"	14	252
Caliche	10	262
Clay	28	290
Gravel and boulders, flow of water	128	418
Clay	21	439
Gravel, flow of water (about 460 g.p.m.)	13	452
Caliche	22	474
Clay	86	560
Cemented gravel, flow increased to 1,900 g.p.m.	75	635
Total depth	—	635

TABLE 3—*Continued*

(S-20-61) 36bac1. C. K. and A. M. Ryerse. Land surface altitude 1,822 feet, diameter 8 inches, 8-inch casing to 84 feet.

Material	Thickness (feet)	Depth (feet)
Pink silty clay	100	100
Very fine-grained silty white sand	10	110
White calcareous clay, a little silt	10	120
Pink silty clay	20	140
Red plastic clay	10	150
Light pink silty clay	20	170
White calcareous clay, a little silt	40	210
Gray plastic, and white, calcareous, silty clay	60	270
Red silty clay	10	280
Silty red sand, a little gravel, flow of water	40	320
Pink plastic clay, a little silt	5	325
Pink silty clay	35	360
Pink fine-grained silty sand, flow of water	20	380
Pink sandy silt and clay	90	470
Total depth	—	470

(S-20-61) 36ccc2. M. E. Ward. Land surface altitude 1,852 feet, diameter 8 inches, 8-inch casing to 80 feet, 351 feet of 6-inch casing from 30 feet to 381 feet, perforated with slots from 301 to 381 feet.

Material	Thickness (feet)	Depth (feet)
Tan silty clay	3	3
Granules, pebbles, and some sand and clay	7	10
Tan silty clay	5	15
Near-surface water level	—	15
Granules, pebbles, some sand and clay, near-surface water	1	16
Tan silty clay, some caliche	72	88
Granules, pebbles, some sand and a little tan silty clay, flow of water	2	90
Tan silty clay, a few granules, a little sand, some caliche nodules	60	150
Tan silty clay, a few thin lenses of gravel and sand, flow reportedly increased through this interval	210	360
Fine- to medium-grained gray sand, a few granules and pebbles, increased flow of water	4	364
Bluish-green plastic clay	6	370
Tan silty clay, a few thin gravel and sand lenses with much clay	59	429
Total depth	—	429

(S-21-61) 1aab3. Nate Mack. Land surface altitude 1,824 feet, diameter 8 inches, 8-inch casing to 124 feet.

Material	Thickness (feet)	Depth (feet)
Light tan clay	10	10
Near-surface water level	—	10
Light tan clay	4	14
First water encountered	—	14
Gravel, sand, a little clay	2	16
Tan silty clay	44	60
Tan silty clay, a few thin gravel lenses, caliche nodules	160	220
Tan silty clay, some fine-grained sand	120	340
White plastic clay	10	350
Tan silty clay	5	355
Fine- to medium-grained red sand, much tan silty clay, flow of water	5	360
Red plastic clay layers interbedded with white plastic clay	5	365
Tan silty clay	25	390
Thin granule gravel and sand lenses interbedded with tan silty clay, increased flow of water	10	400
Tan silty clay	90	490
Total depth	—	490

TABLE 3—*Continued*

(S-21-61) 2bdc1. H. J., G. M., and M. V. Stocker. Land surface altitude 1,988 feet, diameter 10 inches, 135 feet of 10-inch casing from surface to 135 feet, 455 feet of 8-inch casing from surface to 455 feet, 41 feet of 6-inch casing from 440 feet to 481 feet, perforated with ¼- by 4-inch slots.

Material	Thickness (feet)	Depth (feet)
Tan silty clay, a little sand	35	35
Tan silty clay, a few lenses of granule gravel	5	40
Light tan silty clay	20	60
Tan silty clay, a few caliche layers	50	110
Tan silty clay, much granule gravel, water	5	115
Tan silty clay	50	165
Tan silty clay	110	280
Tan silty clay, caliche layers	20	300
Tan fine- to coarse-grained sand, a few granules, flow of water	30	330
Tan silty clay, caliche	35	365
Tan silty clay	35	400
Caliche layers, a little clay	5	405
Red silty clay	40	445
Red silty clay, a little fine-grained sand	10	455
Red silty clay	7	462
Fine- to medium-grained red sand, flow of water	12	474
Red silty clay	16	490
Total depth	—	490

(S-21-61) 4bba1. Nick Pahor. Diameter 8 inches, 8-inch casing from surface to 115 feet, 6-inch casing from surface to 420 feet, perforated between 400 and 420 feet.

Material	Thickness (feet)	Depth (feet)
Tan silt, a little clay	10	10
White silty clay, some caliche	5	15
Near-surface water level	—	15
White silty clay, a little fine gravel and sand	5	20
Pink silty clay	150	170
Pink silty sand, a little gravel, flow of water	5	175
Pink silty clay	125	300
Fine-grained gravel and medium-grained sand, flow of water	10	310
Pink silty clay	55	365
Large gravel, pink silty clay	5	370
Pink silty clay	20	390
Medium- and fine-grained sand, a little gravel, flow of water	10	400
Pink silty sand, a little clay	15	415
Pink silty clay, a little fine-grained sand	35	450
Total depth	—	450

(S-21-61) 6abc1. William Hinson. Diameter 10 inches, 10-inch casing to 39 feet, 117 feet of 8-inch casing from surface to 187 feet, 192 feet of 6-inch casing from 20 to 212 feet, perforated with ⅜- by 6-inch slots from 124 to 212 feet.

Material	Thickness (feet)	Depth (feet)
Tan silty clay, a little sand and gravel	2	2
Tan silty clay, a little sand and gravel, much caliche	22	24
Near-surface water level	—	24
Granule gravel, fine- to medium-grained sand, a few pebbles, much tan silty clay	14	38
Tan silty clay, a few thin sand and gravel lenses	102	140
Tan silty clay, many layers of caliche	20	160
Tan silty clay, a little fine- to medium-grained red sand	70	230
Granule to pebble gravel, much fine- to coarse-grained sand, little tan silty clay, flow of water	20	250
Tan silty clay	22	272
Total depth	—	272

TABLE 3—*Continued*

(S-21-61) 9dcb1. Leland M. and Lillian L. Woods. Diameter 10 inches, 10-inch casing from surface to 430 feet, 388 feet of 8-inch casing from 300 feet to 688 feet, perforated with ¼-inch by 2-inch slots from 625 feet to 640 feet.

Material	Thickness (feet)	Depth (feet)
Tan silty clay, a few layers of caliche and a few lenses of sand and gravel	70	70
Tan silty clay, a little fine sand	140	210
Tan silty clay, much sand and granule gravel, a few caliche nodules	10	220
Tan silty clay	15	235
Tan silty clay, much sand and granule gravel	10	245
Tan silty clay	75	320
Red fine- to medium-grained sand, a few granules and pebbles, a little tan silty clay	10	330
Granule gravel, a little sand, a few pebbles, much tan silty clay	8	338
Tan silty clay	127	465
Tan silty clay, a few pebbles and granules	10	475
Bluish-green plastic clay	15	490
Tan silty clay	35	525
Red medium- to fine-grained sand, a few granules and pebbles, flow of water	5	530
Tan silty clay	5	535
Pebble gravel, some sand and granules, much tan silty clay	5	540
Tan silty clay	30	570
Tan silty clay, a few granules, a little sand	10	580
Tan silty clay	10	590
Tan silty clay, much gravel and sand	35	625
Granule and pebble gravel, some sand, some tan silty clay, flow of water	30	655
Tan silty clay	33	688
Total depth	—	688

(S-21-61) 15bac1. John N. and Helen Beville. Diameter 12 inches, 120 feet of 12-inch casing from surface to 120 feet, 375 feet of 8-inch casing from surface to 375 feet, 8-inch casing perforated with ¼-inch by 4-inch slots from 210 feet to 230 feet and 325 feet to 375 feet.

Material	Thickness (feet)	Depth (feet)
Surface sand and soil	5	5
Tan silty sand, a few boulders	2	7
Tan silty sand	3	10
Near-surface water level	—	10
Pebble and granule gravel, some silt and sand	11	21
Light pink silty clay	21	42
Pink silty clay	7	49
Pink silty clay and caliche	8	57
Pink silty clay, caliche nodules, a few pebbles	16	73
Red silty clay (hard)	3	76
Light pink silty clay, a few caliche nodules	10	86
Red silty clay, a few caliche layers and nodules	19	105
Caliche nodules, a few pebbles, pink silty clay	3	108
Pink silty clay, a few caliche nodules	42	150
Light red silty clay, caliche nodules	19	169
Light red silty clay	41	210
Pebble and granule gravel, coarse- to fine-grained sand, some silt, water	10	220
Light red silty clay, a few pebbles, a little caliche	25	245
Light red silty clay, a little sand, a few caliche layers	51	296
Red plastic clay, a little silt	7	303
Red silty clay, a few pebbles	23	326
Red fine- to medium grained sand, many large pebbles, flow of water	25	351
Granule and pebble gravel, flow of water	25	376
Red plastic clay, a little silt	3	379
Total depth	—	379

TABLE 3—*Continued*

(S-21-61) 15cbb1. T. A. Wells. Diameter 10 inches, 10-inch casing to 105 feet, 380 feet of 8-inch casing to 380 feet, 180 feet of 6-inch casing from 350 feet to 530 feet, perforated from 432 to 453 feet, and from 472 to 512 feet with ¼- by 4-inch slots.

Material	Thickness (feet)	Depth (feet)
Sandy and silty soil	5	5
Light pink silty clay, many granules, some sand	5	10
Caliche, small pebble- and granule-gravel, a little silty clay	5	15
Near-surface water level	—	15
Light pink silty clay, a few granules, a little sand	45	60
Tan silty clay	26	86
Pink silty clay, caliche nodules	44	130
Pink silty clay, and caliche	50	180
Pink silty clay, some fine gravel, a little caliche	65	245
Pink silty clay	8	253
Granule gravel, some sand, much pink silty clay	5	258
Pink silty clay, some caliche	32	290
Red fine-grained sand interbedded with pink and red clay, a little gravel, flow of water	30	320
Red plastic clay	20	340
Fine-grained gray sand, interbedded with thin bed of red clay, a little fine gravel, flow of water	50	390
Plastic red clay	3	393
Pink silty clay, some caliche	32	425
Light greenish-blue plastic clay	15	440
Red clay	5	445
Red, fine-grained sand interbedded with thin layers of red clay, a little fine gravel, flow of water	33	478
Red clay	5	483
Granule gravel and fine-grained sand lenses interbedded with little clay	9	492
Red clay, a little sand and silt	16	508
Red silty clay, much granule gravel, a little sand	2	510
Pink silty clay, a few thin lenses of fine-grained red sand	245	755
Tan fine-grained sand, flow of water	5	760
Pink silty clay, many granules	10	770
Red silty clay, a few thin fine-grained sand lenses	90	860
Red fine- and medium-grained sand, flow of water	52	912
Red silty clay	13	925
Total depth	—	925

(S-21-61) 16bac2. John P. Hughes. Diameter 6 inches, 446 feet of 6-inch casing from surface to 446 feet, perforated with ¼- by 6-inch slots from 224 to 266 feet and from 403 to 446 feet.

Material	Thickness (feet)	Depth (feet)
Granule and pebble gravel, some tan silty clay	18	18
Light tan silty clay, caliche layers	4	22
Granule and pebble gravel, caliche, a little clay	13	35
Light tan silty clay	6	41
Granule and pebble gravel, a little clay	8	49
Light tan clay, a little gravel	8	57
Tan silty clay, a little caliche	32	89
Tan silty clay, much caliche, a little gravel	66	155
Caliche layers, a little clay	9	164
Tan silty clay, much pebble gravel and granules	46	210
Granule and pebble gravel, a little tan clay	31	241
Tan silty clay, some gravel	46	287
Gravel, caliche, a little clay	16	303
Tan silty clay, a little gravel	107	410
Plastic red clay	22	432
Tan silty clay, many caliche layers	8	440
Plastic red clay	2	442
Caliche, a little tan silty clay	3	445
Pebble and granule gravel, a little sand and clay	11	456
Total depth	—	456

TABLE 3—*Continued*

(S-21-61) 16bbd1. Hotel El Rancho, Inc. Diameter 10 inches, 10-inch casing to 610 feet, 802 feet of 8-inch casing from 169 to 972 feet.

Material	Thickness (feet)	Depth (feet)
Pink silty clay, a few thin layers of caliche	200	200
Fine-grained pink sand, much pink silty clay	10	210
Small pebble- and granule-gravel, caliche, much pink silty clay	10	220
Pink silty clay, little sand, many caliche layers	70	290
Pebble and granule gravel, some sand, much pink silty clay, caliche	40	330
Pink silty clay, caliche, a little sand and gravel in a few thin lenses	130	460
Light greenish-blue plastic clay, a little sand and gravel in thin lenses	28	488
Light pink silty clay, a little fine-grained sand	52	540
Pebble to granule gravel, caliche, pink silty clay	10	550
Pink silty clay with thin layers of fine-grained red sand	60	610
Red silty clay	15	625
Red plastic clay	10	635
Red sandy clay	5	640
Red plastic clay	30	670
Brown fine-grained sand	3	673
Red plastic clay, a little sand	32	705
Red fine-grained sand	3	708
Red silty clay	87	795
White fine-grained sand, thin layers of caliche, flow of water	70	865
Red silty clay	95	960
Caliche	3	963
Red fine-grained sand, flow of water	3	966
Red silty clay	6	972
Total depth	—	972

(S-21-61) 16bcd2. James S. Fulcher. Diameter 10 inches, 10-inch casing to 102 feet, 8-inch casing to 540 feet, perforated from 460 to 540 feet.

Material	Thickness (feet)	Depth (feet)
White silty clay, some coarse sand, some caliche layers	17	17
Near-surface water level	—	17
Pink silty clay, some granules and coarse-grained sand	12	29
Fine- to coarse-grained sand and gravel, a little pink silty clay	3	32
Pink and tan silty clay, numerous layers of caliche	60	92
Fine- to coarse-grained sand, some pebble and granule gravel, much pink silty clay	4	96
Alternating layers of pink silty clay and hard caliche, a few caliche nodules, a few layers of white marly clay, a few pebbles, a little sand	114	210
Gravel reported by driller	5	215
Pink silty clay and a little gravel and sand	5	220
Pink silty clay, a little sand and some granules, a few caliche nodules, a few pebbles, water	40	260
Clay and gravel	20	280
Gravel	20	300
Clay	30	330
Gravel and clay	91	421
Pink silty clay, some layers of sand and gravel	7	428
Granule gravel, some medium- to coarse-grained sand	4	432
Red plastic clay	28	460
Fine-grained light pink sand, a little silt, a few granules, water	12	472
Pink silty clay, a little fine-grained red sand	48	520
Pink fine- to medium-grained sand, flow of water	13	533
Pink medium- to fine-grained sand, a few granules, flow of water	7	540
Total depth	—	540

TABLE 3—*Continued*

(S–21–61) 16bcd3. Otilla Techow. Diameter 6¼ inches, 6¼-inch casing to 302 feet, perforated with ¼- by 4-inch slots from 202 feet to 222 feet and from 282 feet to 302 feet.

Material	Thickness (feet)	Depth (feet)
Tan silty clay, much sand and gravel, a few boulders	14	14
Light tan silty clay, a little caliche	28	42
Tan silty clay, a few caliche layers, a few thin sand and gravel lenses	82	124
Light tan silty clay, caliche nodules	26	150
Tan silty clay, caliche layers	76	226
Granule and pebble gravel, a little sand, some tan silty clay	19	245
Caliche	2	247
Tan silty clay, a few thin gravel lenses	28	275
Pebble and granule gravel, a little sand, some tan silty clay	23	298
Tan silty clay, a few caliche layers	14	312
Total depth	—	312

(S–21–61) 16cbb4. Frank E. Gowen. Diameter 8 inches, 8-inch casing to 61 feet.

Material	Thickness (feet)	Depth (feet)
Gravel and rock	3	3
Boulders	9	12
Boulders	4	16
White clay and gravel	5	21
Lime, hardpan	3	24
White clay and gravel	7	31
Hard lime and gravel	19	50
White clay	9	59
Red clay	15	74
Hard brown lime	4	78
Red clay and a little gravel	1	79
Hard brown lime	1	80
Red clay	5	85
Total depth	—	85

(S–21–61) 16ccc1. Nevada Projects Corporation. Diameter 10 inches, 10-inch casing to 564 feet.

Material	Thickness (feet)	Depth (feet)
Light tan to white calcareous silty clay, a few caliche layers	65	65
Tan silty clay, a few caliche layers and thin lenses of sand gravel	323	388
Tan silty clay, much gravel	14	402
Tan silty clay	8	410
Light bluish - green plastic clay	20	430
Tan silty clay	10	440
Plastic red clay	10	450
Tan silty clay	75	525
Granule and pebble gravel, some sand, and tan silty clay, flow of water	30	555
Tan silty clay and a few layers of red plastic clay	50	605
Total depth	—	605

TABLE 3—*Continued*

(S-21-61) 16ccc2. Nevada Projects Corporation. Diameter 10 inches, 10-inch casing from surface to 490+ feet, 327 feet of 8-inch casing from 490 to 817+ feet. No record of perforations.

Material	Thickness (feet)	Depth (feet)
White silty clay, a little sand, a few granules	45	45
Pebble gravel, granules, a little sand and silty clay	5	50
Tan silty clay, a few granules and pebbles	55	105
Tan silty clay, caliche nodules, many granules and pebbles	5	110
Tan silty clay, a few granules and pebbles, a little caliche	50	160
Tan silty clay, a few granules, a little sand	131	291
Granule gravel, much tan silty clay	19	310
Tan silty clay, granules, a little sand	80	390
Plastic red clay	31	421
Light greenish - blue plastic clay	9	430
Plastic red clay	11	441
Fine- to medium-grained red sand, a few granules, flow of water	15	456
Sandy red silty clay, caliche nodules	24	480
Plastic red clay	10	490
Tan silty clay	25	515
Granule and pebble gravel, much tan silty clay	15	530
Tan silty clay	15	545
Tan silty clay, some gravel	4	549
Tan silty clay	141	690
Fine- to medium-grained red sand, a little gravel, flow of water	1	691
Tan silty clay	14	705
Granule to pebble gravel, fine- to coarse-sand, a little tan silty clay, flow of water	60	765
Tan silty clay, gravel and sand	15	780
Fine- to medium-grained sand, a few pebbles	10	790
Pink silty clay, much gravel and sand	60	850
Pink silty clay	40	890
Fine- to medium grained sand, granules, some pink silty clay	10	900
Pink silty clay	20	920
Plastic red clay, a few granules and little sand	57	977
Total depth	....	977

TABLE 3—*Continued*

(S-21-61) 16ccd1. Nevada Projects Corporation. Diameter 10 inches, 10-inch casing to 697 feet, perforated from 520 to 540 feet with ¼- by 6-inch slots, 785 feet of 8-inch casing from 350 to 1,135 feet, perforated from 740 to 765 feet with ¼- by 6-inch slots.

Material	Thickness (feet)	Depth (feet)
White silty clay and caliche	50	50
Pink silty clay, a little gravel and sand	40	90
Pink silty clay and caliche	35	125
Pink silty clay, a little caliche, a little gravel and sand	75	200
Pink silty clay	35	235
Pink silty clay, a little gravel and caliche	11	246
Sand, a little granule gravel, some silty clay	6	252
Pink silty clay, some gravel	23	275
Plastic red clay	20	295
Pink silty clay, some gravel	20	315
Granule gravel, some sand, some caliche	5	320
Gray fine- to medium grained sand	15	335
Pink silty clay	3	338
Small pebble and granule gravel, some sand	22	260
Plastic red clay	10	370
Tan fine-grained sand, a few granules	8	378
Pink silty clay	32	410
Pink silty clay, some gravel and sand	5	415
Light greenish - blue plastic clay	20	435
Red plastic clay, a few caliche nodules	15	450
Granule and small pebble gravel, much pink silty clay	2	452
Pink silty clay, a little fine-grained sand in thin lenses	68	520
Red fine-grained sand, a little granule gravel, flow of water	18	538
Pink silty clay	84	622
Red fine-grained silty sand	4	626
Pink silty clay	20	646
Granule gravel, a little sand, much clay	2	648
Pink silty clay	49	697
Granule gravel, fine- to coarse-grained sand, much pink silty clay	18	715
Granule gravel, fine- to coarse-grained sand, a little silt and clay, flow of water	50	765
Gravel and sand, much pink silty clay	10	775
Pink silty clay, some fine - grained gravel and sand	15	790
Plastic red clay	2	792
Pink silty clay, some fine-grained gravel and sand	42	834
Plastic red clay	60	894
Plastic red clay, a few thin silty sand lenses	9	903
Plastic red clay	22	925
Fine- to medium-grained sand, a few granules, some silt and clay, flow of water	15	940
Pink silty clay	50	990
Coarse- to fine-grained sand, a little silt and clay	10	1,000
Pink silty clay	30	1,030
Plastic red clay	20	1,050
Pink silty clay, a little fine-grained sand	10	1,060
Plastic red clay	10	1,070
Coarse - grained sand and granules, some silt and clay, flow of water	25	1,095
Pink silty clay	35	1,130
Coarse - grained sand, some granules, a few pebbles, and some silt and clay	40	1,170
Red silty clay	30	1,200
Granule gravel, some sand, a little silt and clay	45	1,245
Plastic red clay	6	1,251
Granule gravel, some sand, much silt and clay	4	1,255
Total depth	....	1,255

TABLE 3—*Continued*

(S-21-61) 20daa1. A. F. Winter. Diameter 8 inches, 8-inch casing to 620 feet, well filled with pea gravel from 715 to 920 feet.

Material	Thickness (feet)	Depth (feet)
Tan silty clay, a few layers of caliche, a few thin gravel and sand lenses	265	265
Tan sandy clay, a few thin gravel lenses, water	27	292
Tan silty clay, a little fine-grained sand	98	390
Light greenish - blue plastic clay	25	415
Tan silty clay, a few thin lenses of gravel and sand	110	525
Pebble gravel, much coarse- to fine-grained gray sand, a few granules	15	540
Tan silty clay	70	610
Granule gravel, some fine- to coarse-grained sand, a few pebbles, a little tan silty clay, flow of water	50	660
Fine- to coarse-grained gray sand, increased flow of water	20	680
Tan silty clay, much granule gravel, a little sand	15	695
Granule gravel, a little sand, some tan silty clay, increased flow of water	15	710
Tan silty clay, a few pebbles, a little sand	50	760
Granule gravel, some sand, some tan silty clay	20	780
Tan silty clay, some gravel and sand	10	790
Granule gravel, some sand, some tan silty clay	20	810
Tan silty clay, a few granules, a little sand	30	840
Granule gravel, a little sand, a little clay, increased flow of water	10	850
Tan silty clay, some granule gravel and sand	40	890
Granule and pebble gravel, fine- to coarse-grained sand a little tan silty clay	20	910
Tan silty clay, some gravel and sand	10	920
Total depth	—	920

(S-21-61) 21abb1. Murray Wollman. Diameter 8 inches, 8-inch casing to 417 feet, 132 feet of 6-inch casing from 408 feet to 540 feet, perforated with ¼- by 6-inch slots from 440 to 540 feet.

Material	Thickness (feet)	Depth (feet)
Light tan to white silty clay, a little sand, a few granules	2	2
Granule and pebble gravel, much light tan silty clay	3	5
Caliche	2	7
Granule and pebble gravel, much light tan silty clay	17	24
Near-surface water level	—	24
Tan silty clay, much granule and pebble gravel	11	35
Tan silty clay	165	200
Tan silty clay, a few thin sand and gravel lenses	50	250
Tan silty clay	60	310
Cemented gravel	60	370
Plastic red clay	5	375
Cemented gravel	10	385
Plastic red clay	5	390
Cemented gravel	30	420
Light greenish - blue plastic clay	14	434
Red plastic clay	6	440
Tan silty clay	35	475
Sand, flow of water	5	480
Tan silty clay	80	560
Gravel, much tan silty clay	10	570
Tan silty clay, many thin sandy lenses	65	635
Gravel and sand in thin lenses interbedded with tan silty clay	60	695
Sand, flow of water	42	737
Total depth	—	737

TABLE 3—*Continued*

(S-21-61) 26bbd1. Evelyn S. Potter. Diameter 8 inches, 8-inch casing to 143 feet.

Material	Thickness (feet)	Depth (feet)
White silty clay	20	20
Tan silty clay	190	210
Gravel, some tan silty clay and sand, some flow of water	5	215
Tan silty clay	40	255
Gravel, a little sand, some clay, increased flow of water	5	260
Tan silty clay	15	275
Gravel and sand, some clay, increased flow of water	5	280
Tan silty clay	40	320
Gravel and sand, some clay, increased flow of water	5	325
Total depth	—	325

(S-21-61) 29aaa1. Murray Woolman. Diameter 8 inches, 8-inch casing to 407 feet, perforated with ¼- by 4-inch slots from 330 to 350 feet, 132 feet of 6-inch casing from 378 feet to 510 feet, perforated from 470 feet to 510 feet.

Material	Thickness (feet)	Depth (feet)
White clay and caliche	20	20
Pink silty clay, a little sand and gravel	20	40
Pink silty clay	290	330
Sand and gravel, flow of water	15	345
Pink silty clay	45	390
Plastic red clay, few pebbles and caliche	10	400
Plastic red clay	100	500
Sand, little gravel, flow of water	10	510
Pink silty clay	30	540
Total depth	—	540

(S-21-62) 30bcd1. Chris Wilson. Diameter 8 inches, 8-inch casing to 302 feet.

Material	Thickness (feet)	Depth (feet)
Tan silty clay, a few caliche layers	35	35
Gravel, some water	5	40
Tan silty clay, white caliche nodules	20	60
Tan silty clay	50	110
Tan silty clay	10	120
Tan silty clay	20	140
Pebble and granule gravel, some sand and tan silty clay, flow of water	15	155
Tan silty clay	20	175
Gravel	5	180
Tan silty clay	45	225
Gravel	5	230
Tan silty clay	150	380
Milk-white clay	11	391
Tan silty clay	19	410
Pebble and granule gravel, much sand, and tan silty clay interbedded with gray fine- to medium-grained sand, flow of water	15	425
Gray fine- to coarse-grained sand, few granules, much red silty clay, increased flow of water	30	455
Total depth	—	455

(S-22-61) 5a. G. Giesler. Diameter 10 inches, 600 feet of 10-inch casing.

Material	Thickness (feet)	Depth (feet)
Soil and gravel	25	25
Caliche and gravel	120	145
Water struck, level rose to within 90 feet of surface	—	145
Hard red clay and caliche	205	350
Hard red clay and red sand layers	250	600
Interlayered red clay, caliche, and sand, water	250	850
Red clay	50	900
Gravel, water	5	905
Total depth	—	905

TABLE 3—*Continued*

(S–22–61) 9bba2. Opaco Lumber Co. Diameter 8 inches, 240 feet of 8-inch casing from surface, 498 feet of 6-inch casing, perforated with ⅛- by 6-inch slots from 460 to 480 feet.

Material	Thickness (feet)	Depth (feet)
Soil, sand, and gravel	5	5
Clay and gravel	115	120
Sandy clay	5	125
Gravel, water	15	140
Sand and clay	55	195
Gravel, water	45	240
Brown and white "lime"	170	410
Cemented gravel	70	480
"Lime and chert," little water	123	603
Total depth	—	603

(S–22–61) 12bbb2. Nat Wolff. Diameter 8 inches, 80 feet of 8-inch casing, 348 feet of 6-inch casing.

Material	Thickness (feet)	Depth (feet)
Pink silty clay	25	25
Near-surface water level	—	25
Pink silty clay, a few gravel lenses	5	30
Pink silty clay, some caliche	5	35
Pink silty clay	10	45
Pink silty clay, caliche layers	5	50
Pink silty clay	15	65
Sandy pink silt, a little water	7	72
Pink silty clay	83	155
Fine gravel, a little pink silty clay	15	170
Gray sandy silt and clay	15	185
Silty red clay and fine gravel	5	190
Gray sandy silt and clay	10	200
Silty sand, a little water	2	202
Pink sandy silt and clay	18	220
Pink silty clay, a little sand	75	295
Pink silty clay	35	330
Pink silty clay, some sand	10	340
Pink sandy silt	5	345
Pink fine-grained silty sand, flow of water	10	355
Pink fine-grained sand	5	360
Pink and gray medium-grained sand, a little gravel, increase in flow	50	410
Medium-grained sand, some fine gravel, increase in flow	20	430
Silty fine-grained sand	20	450
Pink silty clay	10	460
Total depth	—	460

PAHRUMP VALLEY

(S–19–53) 22ab1. Ray Van Horn. Diameter 16 inches, 16-inch casing to 280 feet, perforated from 112 feet to 124 feet, and cemented at 280 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Tan silty clay, pebbles	57	57
Near-surface water level	—	57
Tan silty clay, pebbles	63	120
Pebble gravel, coarse-grained sand, some silty clay, water level rose to 42 feet	4	124
Tan silty clay, much gravel and sand	116	240
"Loose" sand and gravel, silty clay	10	250
Tan silty clay, gravel	30	280
Cemented gravel, a few strata of "loose" sand and gravel	260	540
Total depth	—	540

(S–19–53) 22da1. Norman and Lester Shurtliff. Diameter 20 inches, 20-inch casing to unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)
Top soil	17	17
"Hardpan"	23	40
Gravel	17	57
Struck first water, level rose to within 40 feet of surface	—	57
Gravel	35	92
Clay	115	207
Cemented gravel	—	207
Total depth (2–7–47)	—	207

TABLE 3—*Continued*

(S–19–53) 27ac1. J. P. Cayton. Diameter 16 inches, 16-inch casing to unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	58	58
Struck first water, water level rose to within 40 feet of surface	—	58
No record	40	98
Water-bearing gravel	—	98
No record	67	165
Water-bearing gravel	—	165
No record	120	285
Water-bearing gravel, water level rose to within 11 feet of surface	—	285
No record	75	360
Water-bearing gravel, water level rose to within 3 feet of surface	—	360
No record	30	390
Water-bearing sand and gravel, water flowed over top of casing at surface	26	416
No record	64	480
Total depth (12–31–46)	—	480

(S–20–53) 10cdd1. George A. Fink. Diameter 12 inches, 12-inch casing to unknown depth, 8-inch casing to unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	50	50
Surface water	8	58
No record	392	450
Flow of water	50	500
No record	215	715
Total depth	—	715±

(S–20–53) 14cbc1. Raycraft. Diameter 10 inches, 10-inch casing to unknown depth. Well reconditioned in 1945 by Paul Cayton. Driller's log published in U. S. Geological Survey Water Supply Paper 450, p. 65, 1919.

Material	Thickness (feet)	Depth (feet)
No record	82	82
"Hard limestone"	3	85
Clay	5	90
Coarse cemented gravel	3	93
Clay	43	136
Cemented gravel	3	139
No record	147	286
"Hard blue limestone (bedrock)"	36	322
No record	38	360
Total depth	—	360

(S–20–53) 14dcc1. Ray Thomas. Diameter 8 inches, 8-inch casing to unknown depth. Well reconditioned by Thomas Miller in 1944. Driller's log published by U. S. Geological Survey Water Supply Paper 450, Plate XI, 1919.

Material	Thickness (feet)	Depth (feet)
Soil	2	2
Cemented gravel	24	26
Near-surface water level	—	26
Coarse cemented gravel	5	31
"Running" sand and fine gravel	11	42
"Quicksand"	7	49
Clay and fine gravel	11	60
"Stones"	11	71
"Smooth" yellow clay	3	74
Tough dry clay and coarse gravel	65	139
"Smooth" yellow clay	4	143
Cemented gravel	33	176
Clay	3	179
Cemented gravel	7	186
Clay	4	190
Coarse gravel, flow of water	14	204
Sand and fine gravel	5	209
"Stones"	4	213
Clay	1	214
"Quicksand"	3	217
Clay	4	221
Sand and fine gravel, flow of water	3	224
Coarse gravel	2	226
"Stones"	23	249
Dry clay	5	254
Total depth	—	254

(S–20–53) 14dcc2. Ray Thomas. Diameter 10 inches, 10-inch casing to unknown depth, 6-inch casing to 302 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Clay and gravel	200	200
Black sand, flow of water	102	302
Total depth	—	302

TABLE 3—*Continued*

(S-20-53) 14dcc3. Ray Thomas. Diameter 16 inches, 16-inch casing to unknown depth. Driller's log.

Material	Thickness (feet)	Depth (feet)
Tan clay with some coarse sand	50	50
Tan clay, caliche nodules	10	60
Tan silty clay	10	70
Tan silty clay, a little gravel	20	90
Tan silty clay	10	100
Tan silty clay, a little gravel	10	110
Tan silty clay	120	230
Medium-grained sand, some tan clay, a few granules	10	240
Sandy tan silty clay, a few granules	10	250
Very fine-grained gray sand	10	260
Tan silty clay	10	270
Fine- to medium-grained gray sand	10	280
Very fine-grained light gray sand, a little gravel	16	296
Pebble gravel, some sand	14	310
Small pebble gravel, some clay and sand	10	320
Pebble gravel, sand	10	330
Medium- to fine-grained sand, a few pebbles	10	340
Pebble gravel, some sand	40	380
Medium-grained sand, a little clay	23	403
Coarse- to medium-grained sand	27	430
Coarse- to medium-grained sand, some clay	30	460
Total depth	...	460

(S-20-53) 14dcc4. Ray Thomas. Diameter 16 inches, 16-inch casing to 94 feet, 13-inch casing to 422 feet, perforated from 127 to 319 feet, with three ½-inch by 3-inch slots for each foot of casing, and from 319 to 339 feet with four ½-inch by 2-inch slots for each foot of casing. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	332	332
Cemented gravel with layers of "loose" gravel, flow of water	163	495
Total depth	...	495

(S-20-53) 14dcd1. Ray Thomas. Driller's log published in U. S. Geological Survey Water Supply Paper 450, Plate XI, 1919.

Material	Thickness (feet)	Depth (feet)
Soil	5	5
Clay and gravel	26	31
Near surface water level	...	31
Clay	10	41
Fine gravel	2	43
Clay	3	46
Clay and gravel	5	51
Gravel with some clay	5	56
Gravel	11	67
Cemented gravel	1	68
Coarse cemented gravel	2	70
"Tough" clay and gravel	1	71
Clay and fine gravel	2	73
"Tough" clay and fine gravel	5	78
Hard cemented "stones"	16	94
"Smooth" clay and fine gravel	7	101
Medium gravel	39	140
Clay and gravel	3	143
Clay and fine gravel	12.5	155.5
Hard blue limestone (boulder?)	3.5	159
"Tough" clay and fine gravel	11	170
Hard rock (boulder)	2.5	172.5
Clay and fine gravel, with cemented "stones"	21	193.5
"Loose stones," flow of water	1.5	195
Sand and fine gravel	7.5	202.5
Cemented gravel	3.5	206
"Stones," flow of water	10	216
Sand and gravel	3	219
Clay	7	226
Sand and gravel, flow of water	9	235
Brown clay	14	249
Dark sand, flow of water at about 320 feet	73	322
Total depth	...	322

TABLE 3—*Continued*

(S-20-53) 15bdc1. A. F. Cayton. Diameter 10 inches, 10-inch casing to 105 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	27	27
"Surface" water	—	27
Clay	33	60
"Surface" water	—	60
Clay and grit	40	100
"Concrete clay"	85	185
"Quicksand," flow of water	15	200
Clay	12	212
Total depth	—	212

(S-20-53) 15bdd1. J. P. Cayton. Diameter 8 inches, 8-inch casing to 138 feet, 191 feet of 6-inch casing from 131 to 322 feet, perforated with 2- by 4-inch slots from 305 to 322 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
No record	27	27
Surface-water level	—	27
No record	13	40
Near-surface water struck	—	40
No record	110	150
Flow of water	5	155
No record	150	305
Flow of water	50	355
No record	45	400
Total depth	—	400

(S-20-53) 23aba1. Ray Thomas. Diameter 14 inches, cased to unknown depth. Driller's log published in U. S. Geological Survey Water Supply Paper 450, Plate XI, 1919.

Material	Thickness (feet)	Depth (feet)
Soil	3	3
Yellow clay	9	12
Blue clay, water	12	24
"Cement" with lime nodules	3	27
Clay and gravel	9	36
Cemented gravel	5	41
Coarse gravel, water rose to 10 feet	5	46
Clay and cemented gravel	4	50
Cemented gravel	8	58
Blue clay with lime streaks and cemented layers	63	121
Yellow clay with lime nodules	19	140
Cemented gravel	12	152
Yellow clay	2	154
Cemented gravel	12	166
Yellow clay with "stones"	29	195
Gravel	5	200
"Tough" yellow clay	10	210
Cemented gravel	6	216
Clay	1	217
Cemented gravel	6	223
Clay	2	225
Cemented gravel	1.5	226.5
Clay	1.5	228
Cemented gravel	10	238
"Tough" yellow clay	4	242
Cemented gravel	4.5	246.5
Clay	3	249.5
Cemented gravel	9.5	259
Clay	5	264
Cemented gravel	10	274
Yellow clay	1	275
Cemented gravel	1	276
Gray clay	3	279
Cemented gravel	8	287
Clay	2	289
Cemented gravel	1	290
Clay	1	291
Cemented gravel	2.5	293.5
Sand and fine gravel, flow of water	1	294.5
Cemented gravel	9.5	304
Yellow clay	2	306
Cemented gravel	7	313
Clay	2	315
Cemented gravel	2	317
Yellow clay	3	320
Clay and fine gravel	15	335
Cemented gravel	5	340
Clay	2	342
Cemented gravel	4	346
Clay	2	348
Cemented gravel	9	357
Gravel with clay, flow of water	3	360
Cemented gravel	5	365
Clay with cemented streaks	11	376
Cemented gravel	12	388
Clay	2	390
Very sticky clay	5.5	395.5
Cemented gravel and clay	7.5	403
Cemented gravel	1	404
Yellow clay	6	410
Cemented gravel	14	424
Clay	1	425
Sand and cemented gravel	4	429
Clay and gravel, small flow of water at 436 feet	15	444
Blue clay	4	448
Brown sandy clay	12	460
Clay and gravel	6	466
"Smooth" yellow clay	6	472
Cemented sand	3	475
"Tough" sandy clay	6	481
Clay and gravel	13	494
Sand and clay	5	499
Clay	17	516
Total depth	—	516

TABLE 3—*Continued*

(S-20-53) 23bc1. Ray Thomas. Diameter 14 inches, 14-inch casing to unknown depth, 370 feet of 7⅝-inch casing, perforated from 200 feet to 365 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Clay	200	200
Cemented gravel, flow of water	160	360
Clay	40	400
Total depth	—	400

(S-20-53) 24cdd1. Ray Thomas. Diameter 16 inches, 16-inch casing to 416 feet, perforated from 288 to 379 feet, 384 to 392 feet, and 395 to 402 feet with ½-inch by 3½-inch slots (8 slots for each foot of casing); 320 feet of 14-inch casing from 390 feet to 710 feet, perforated from 430 to 440 feet with six ½-inch by 3½-inch slots for each foot of casing, and perforated from 451 to 460 feet, 496 to 568 feet, 578 to 660 feet, and 675 to 692 feet with four ½-inch by 3½-inch slots for each foot of casing, open hole to 897 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)
Loose boulders	22	22
Cemented gravel, a few boulders	28	50
Blue clay and boulders	6	56
Soft blue clay	4	60
Hard white "rock"	5	65
Hard black "rock"	5	70
Cemented boulders	40	110
Cemented boulders and hard black streak	5	115
Small pea gravel	3	118
Brown hard "stuff"	12	130
Brown clay	6	136
White and brown hard streak	7	143
Brown clay	48	191
Brown hard streak	3	194
Soft brown clay	22	216
Brown hard streak	5	221
Brown clay	17	238
White hard streak, water level 16 feet below surface in casing	8	246
Soft white clay	10	256
White hard "stuff"	6	262
White clay	8	270
Clay, some gravel	9	279
Gray clay	9	288
Loose gravel	16	304
Cemented boulders	40	344
Coarse sand and gravel	6	350
Boulders and tight clay	18	368
Cemented gravel and boulders	11	379
"Black ledge of rock"	5	384
"⅜-inch gravel" to "8-inch rock," flow of water	8	392
Tight clay with boulders and gravel	3	395
Tight "6-inch by 8-inch boulders"	7	402
Hard cemented gravel	7	409
Tight clay and boulders	13	422
"Rocks and boulders"	8	430
"Rocks and gravel," flow of water	10	440
Yellow clay	11	451
"Rocks and gravel"	9	460
Clay and rocks	8	468
Rocky yellow clay	28	496
"Boulders and gravel"	34	530
Cemented gravel	2	532
"Rocks and boulders"	3	535
"Boulders, rock, and gravel"	12	547
Cemented "boulders and rock"	8	555
"Boulders and rock," cemented streaks	13	568
Yellow clay	5	573
Hard-packed gravel and sand	5	578
Cemented "boulders and gravel"	82	660
Cemented "boulders and gravel" with brown clay streaks	15	675
Cemented "boulders and gravel"	75	750
Gravel, brown clay streaks	13	763
Hard "boulders and gravel"	82	845
Brown clay	9	854
"Rocks and gravel"	24	878
Clay and "rock"	19	897
Total depth	—	897

(S-21-54) 3acc1. H. D. Cornell. Diameter 18 inches, 18-inch casing to 100 feet, 574 feet of 14-inch casing from 80 feet to 654 feet, perforated from 300 to 630 feet with six ½-inch by 3-inch slots in each foot of casing. Driller's log.

Material	Thickness (feet)	Depth (feet)
Clay and gravel	40	40
Near-surface water level	—	40
Clay and gravel	148	188
Gravel	10	198
Clay	18	216
Gravel	22	238
Clay	6	244
Gravel with cemented streak	166	410
Cemented gravel	190	600
Gravel with "loose streaks"	50	650
Cemented gravel	87	737
Total depth	—	737

TABLE 3—*Continued*

(S-21-54) 3bda2. H. D. Cornell. Diameter 16 inches, 16-inch casing to 80 feet, 12-inch casing to 586 feet, perforated from 520 feet to 600 feet with six ½-inch by 2½-inch slots for each foot of casing. Driller's log.

Material	Thickness (feet)	Depth (feet)
Gravel	13	13
Clay	6	19
Gravel	8	27
Clay	12	39
Gravel	30	69
Clay	6	75
Cemented gravel	4	79
Clay	43	122
Gravel	12	134
Clay	24	158
Clay and gravel	44	202
Gravel	20	222
Started flowing over casing	—	222
Gravel	128	350
Black sand, increased flow of water	18	368
Cemented gravel	32	400
"Loose" gravel, increased flow of water	40	440
Cemented gravel	246	686
Clay	1	687
Cemented gravel	29	716
White clay	4	720
Total depth	—	720

(S-21-54) 3cad1. H. D. Cornell. Diameter 16 inches, 16-inch casing to unknown depth, perforated from 500 feet to 560 feet with eight ½-inch by 3-inch slots for each foot of casing. Driller's log.

Material	Thickness (feet)	Depth (feet)
Clay and sand	100	100
Clay and sand, water-bearing	185	285
Clay and gravel, water flowed over top of casing	—	285
Clay and gravel	40	325
Cemented boulders	125	450
"Loose" boulders	35	485
Increase in flow of water	—	485
Cemented gravel	80	565
Cemented gravel with "loose" streaks, large flow of water	155	720
White clay	10	730
Total depth	—	730

(S-21-54) 3dc1. H. D. Cornell. Diameter 14 inches, 14-inch casing to 462 feet, perforated from 420 feet to 440 feet with six ½-inch by 3-inch slots in each foot of casing.

Material	Thickness (feet)	Depth (feet)
Clay and gravel	24	24
Gravel	16	40
Near-surface water level	—	40
Gravel	20	60
Clay	18	78
Clay and gravel	104	182
Cemented gravel	10	192
Clay and gravel	120	312
Cemented gravel	12	324
Clay and gravel	16	340
Cemented gravel	140	480
"Loose" gravel	22	502
Cemented gravel	218	720
Total depth	—	720

(S-21-54) 3dcb1. H. D. Cornell. Diameter 16 inches, 16-inch casing to 96 feet, 660 feet of 12-inch casing from 70 feet to 730 feet, perforated from 345 feet to 680 feet with eight ½-inch by 3½-inch slots for each foot of casing. Driller's log.

Material	Thickness (feet)	Depth (feet)
Soil	1	1
Sandy clay	7	8
Cemented gravel	4	12
Clay and gravel	68	80
Struck first water	—	80
Clay and gravel	165	245
Cemented gravel, flow of water	81	326
Cemented boulders	74	400
Cemented gravel	35	435
Cemented boulders, large flow of water	205	640
Cemented gravel	310	950
Clay and gravel	20	970
Total depth	—	970

TABLE 3—*Continued*

(S-21-54) 10aac1. H. D. Cornell. Diameter 14 inches, 18-inch casing to 80 feet, 472 feet of 14-inch casing from surface to 472 feet, perforated from 100 to 450 feet with six ½-inch by 3-inch slots for each foot of casing. Driller's log.

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Clay and gravel	20	20	Cemented gravel	121	260
Gravel and clay	60	80	"Loose" gravel	14	274
Struck first water	...	80	Cemented gravel	526	800
Gravel and clay	55	135			
Clay	4	139	Total depth	...	800

(S-21-54) 15aca1. Rooker. Diameter 20 inches, 20-inch casing to unknown depth, 14-inch casing to 130 feet. Driller's log.

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Caliche	9	9	Clay	190	300
Clay and gravel	21	30	Cemented gravel	206	506
Near-surface water level	...	30			
Clay and gravel	80	110	Total depth	...	506

TABLE 4

Analyses of Water from Wells and Springs in Las Vegas, Pahrump, and Indian Spring Valleys, Nevada

(Analyses by M. R. Miller, University of Nevada, Agricultural Experiment Station, or W. B. Adams, Public Service Division, University of Nevada, Department of Food and Drugs, except as noted. Carbonate 0.00 when determined. See tables 2 and 3 for descriptive data for wells.)

Well or spring number and location	Owner or name of well or spring	Depth (feet)	Temperature (°F)	Date of collection	Parts Per Million: Dissolved solids	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na and K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Hardness (as $CaCO_3$)
				INDIAN SPRING VALLEY											
(S-16-56) 16b1	Indian Springs	—	78	12-15-12	330	17	0.16	48	15	31	239	28	5	0.0	181
				LAS VEGAS VALLEY											
(S-17-59) 34a1[1]	Corn Creek Spring	—	—	12- 8-12	287	18	.03	54	28	17	292	26	12	4	250
(S-19-60) 9c1[2]	Tule Springs	—	69.5	4-20-29	207	—	—	52	28	1.9	255	27	8.6	—	—
(S-20-61) 15dc1[1]	Kyle Spring	—	76	9-16-12	258	8	.01	53	27	26	251	33	55	2	243
(S-20-61) 19abd1[3]	Splane Estate	260	69	1- 6-47	238	—	—	51	25	4.6	242	33	4	1.2	230
(S-20-61) 30ddc1; (S-20-61) 30ddd1[1]; (S-20-61) 31aab1	Las Vegas Springs	—	73	9-23-12	267	13	Tr.	56	23	17	239	43	2	6	234
(S-21-61) 6acc1[4]	J. D. Porter	394	72	1- 6-47	290	—	—	54	29	11	231	74	5	3.5	254
(S-21-61) 22ccc1[5]	A. P. Baker	500	72	1- 6-47	334	—	—	65	32	7.8	227	106	7	4.3	294
(S-21-61) 34abc1[6]	Tollackson	246	74	1- 6-47	332	—	—	64	30	11	223	107	6	3.9	283
(S-21-62) 29db1[1]	Grapevine Spring	—	—	12-24-12	2012	55	.3	275	130	99	239	959	172	.3	1220
(S-22-59) 7c1[1]	Cottonwood Spring	—	—	9-18-12	563	19	.4	102	43	46	290	146	11	.45	431
				PAHRUMP VALLEY											
(S-20-52) 1c1[2]	Buol Sixmile Spring	—	—	8- 5-27	538	—	—	73	18	40	365	36	6.2	—	—
(S-20-53) 14dc1[2]	Bennetts Springs	—	76.5	8- 5-27	358	—	—	50	22	8.2	244	33	.7	—	—
(S-20-53) 14dcc1[7]	Ray Thomas	254	78	8-29-16	383	8	Tr.	51	25	42	242	32	63	Tr.	230
(S-20-53) 15adc1[2]	Frank Buol	520	—	8- 5-27	391	—	—	54	17	21	268	30	.7	—	—
(S-20-56) 31d1[7]	Intermittent Spring	—	57	8-24-16	251	10	.0	59	24	4.3	273	22	5	1.5	246
(S-21-54) 3bc1[7]	Manse Spring	—	75	8-27-16	268	18	Tr.	55	29	Tr.	239	42	4.9	.0	256
(S-21-54) 3bc1[2]	Manse Spring	—	75	8- 5-27	375	—	—	52	11	30	239	42	.7	—	—
(S-22-54) 14d1[2]	Steve Brown Spring	—	—	8- 5-27	406	—	—	73	13	.0	269	51	.5	—	—
(S-22-54) 25b1[7]	Roland Wiley	26	—	8-27-16	338	13	.45	58	30	20	266	58	24	.0	—

[1]Taken from Carpenter, Everett, Ground water in southeastern Nevada: U. S. Geol. Survey Water-Supply Paper 365, table facing p. 30, 1915.

[2]Taken from Hardman, George, and Miller, M. R., Quality of the waters of southeastern Nevada, drainage basins and water resources: Univ. of Nevada Agri. Exper. Sta. Bull. No. 136, pp. 24-32, July 1934.

[3]By C. S. Howard, U. S. Geol. Survey, specific conductance 43.5, carbonate not determined, fluoride 0.2.

[4]By C. S. Howard, U. S. Geol. Survey, specific conductance 50.1, carbonate not determined, fluoride 0.2.

[5]By C. S. Howard, U. S. Geol. Survey, specific conductance 56.0, carbonate not determined, fluoride 0.1.

[6]By C. S. Howard, U. S. Geol. Survey, specific conductance 56.4, carbonate not determined, fluoride 0.3.

[7]Taken from Waring, G. A., Ground water in Pahrump, Mesquite, and Ivanpah Valleys, Nevada and California: U. S. Geol. Survey Water-Supply Paper 450C, table facing p. 80, 1921.