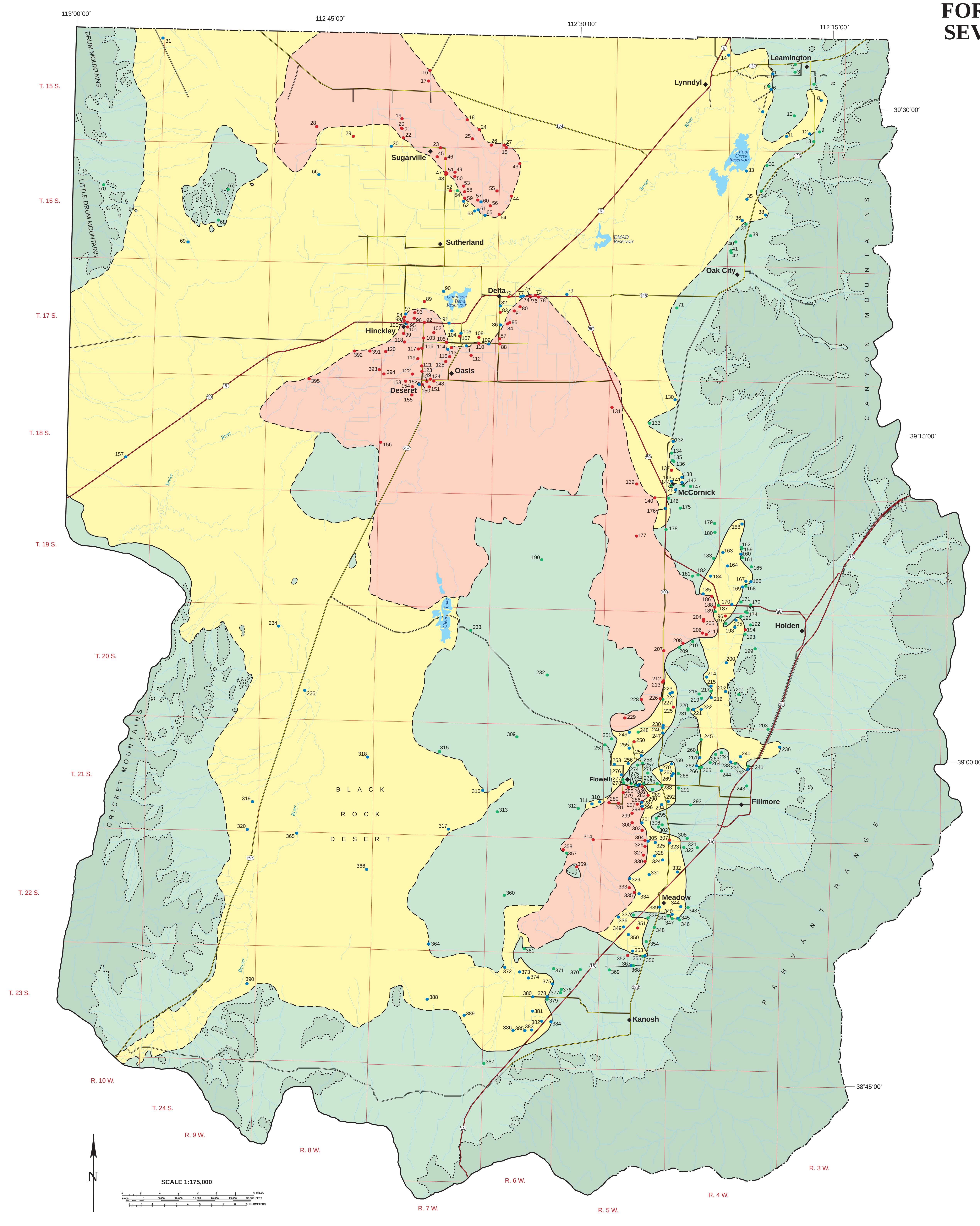
MAP OF RECHARGE AND DISCHARGE AREAS FOR THE PRINCIPAL BASIN-FILL AQUIFER, SEVIER DESERT, MILLARD COUNTY, UTAH

by Noah P. Snyder

Digital compilation by Janine L. Jarva



EXPLANATION

🟩 PRIMARY RECHARGE AREA
Consolidated rock, usually uplands

🟩 PRIMARY RECHARGE AREA
Unconsolidated basin fill

🟨 SECONDARY RECHARGE AREA

🟥 DISCHARGE AREA

——— – – – – Boundary between recharge areas and discharge areas, dashed where approximate

········ Boundary of valley fill

——— Boundary of study area

—·—·— Boundary of county (serving as boundary of study area)

WELLS Number refers to site number in appendix A

● PRIMARY RECHARGE WELL
Confining layers not present; wells completed in principal aquifer; hydraulic gradient is downward.

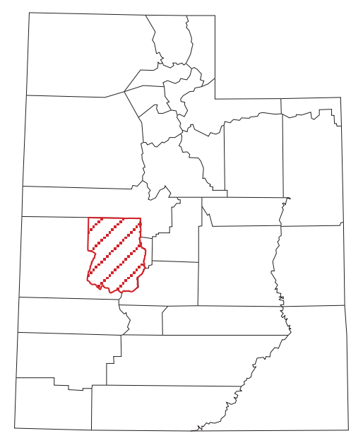
● SECONDARY RECHARGE WELL
Confining layers present; wells completed in principal aquifer; hydraulic gradient is downward.

● DISCHARGE WELL
Confining layers present; wells completed in principal aquifer; hydraulic gradient is upward from principal aquifer to shallow unconfined aquifer.

——— US Highways

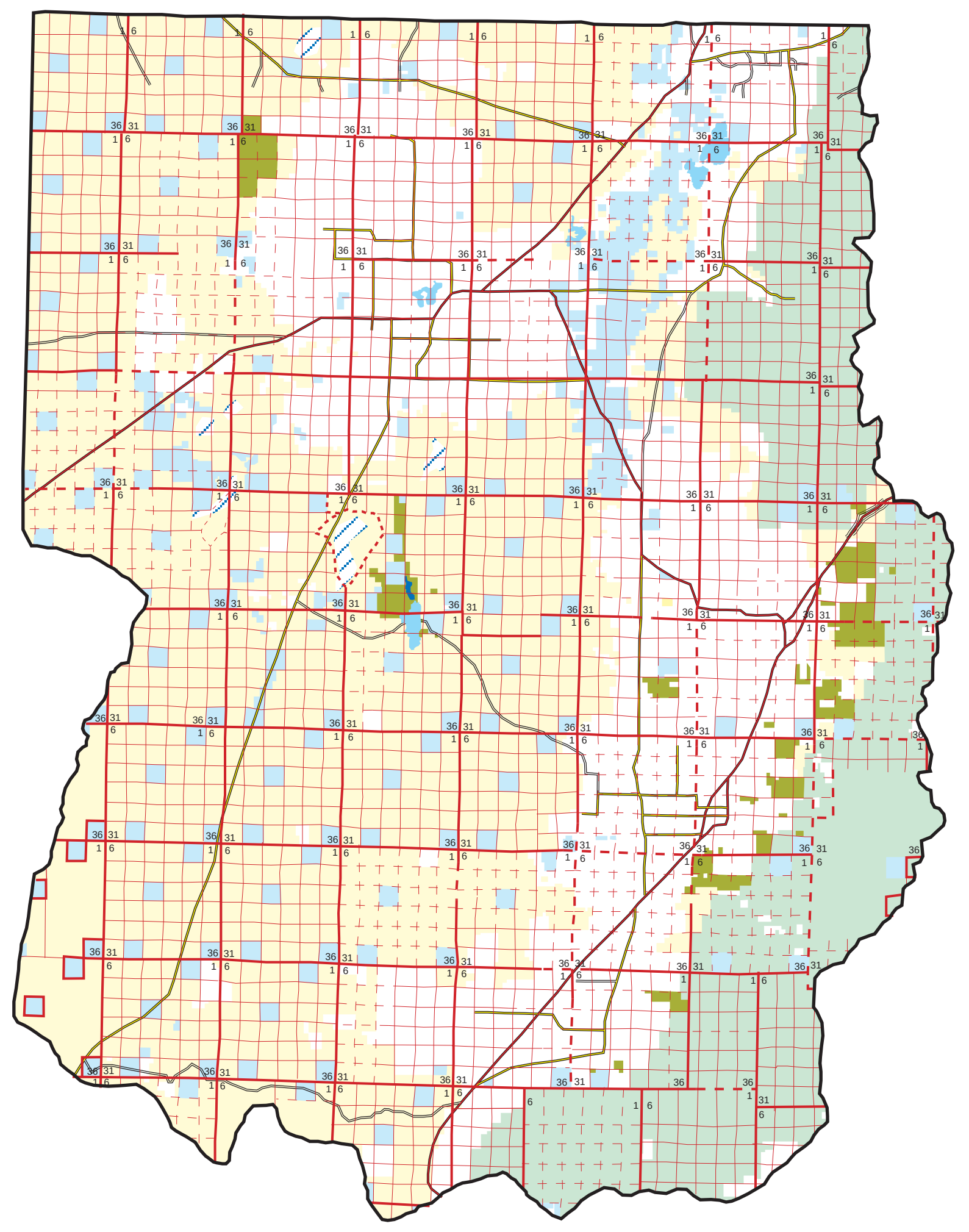
——— State Highways

——— County & City Roads



LOCATION MAP

This map was partially funded by the U.S. Environmental Protection Agency under the Clean Water Act, Section 319, nonpoint source program, and by the Utah Department of Environmental Quality, Division of Water Quality.



Ownership

🟩 Forest Service
🟨 Bureau of Land Management
🟦 State of Utah
🟧 Native American Reservations
⬜ Private Land
⬜ Military Reservations
🟪 National Parks
🟪 State Parks
🟩 State Wildlife Reserve
🟥 National Recreation Area
🟫 National Wildlife Refuge
🟨 Forest Service and BLM Wilderness
🟪 Public Water Reserve
🟪 Bureau of Reclamation

ADMINISTRATIVE OWNERSHIP INSET MAP

Digital data from the State Geographic Information Database (SGID)

Snyder

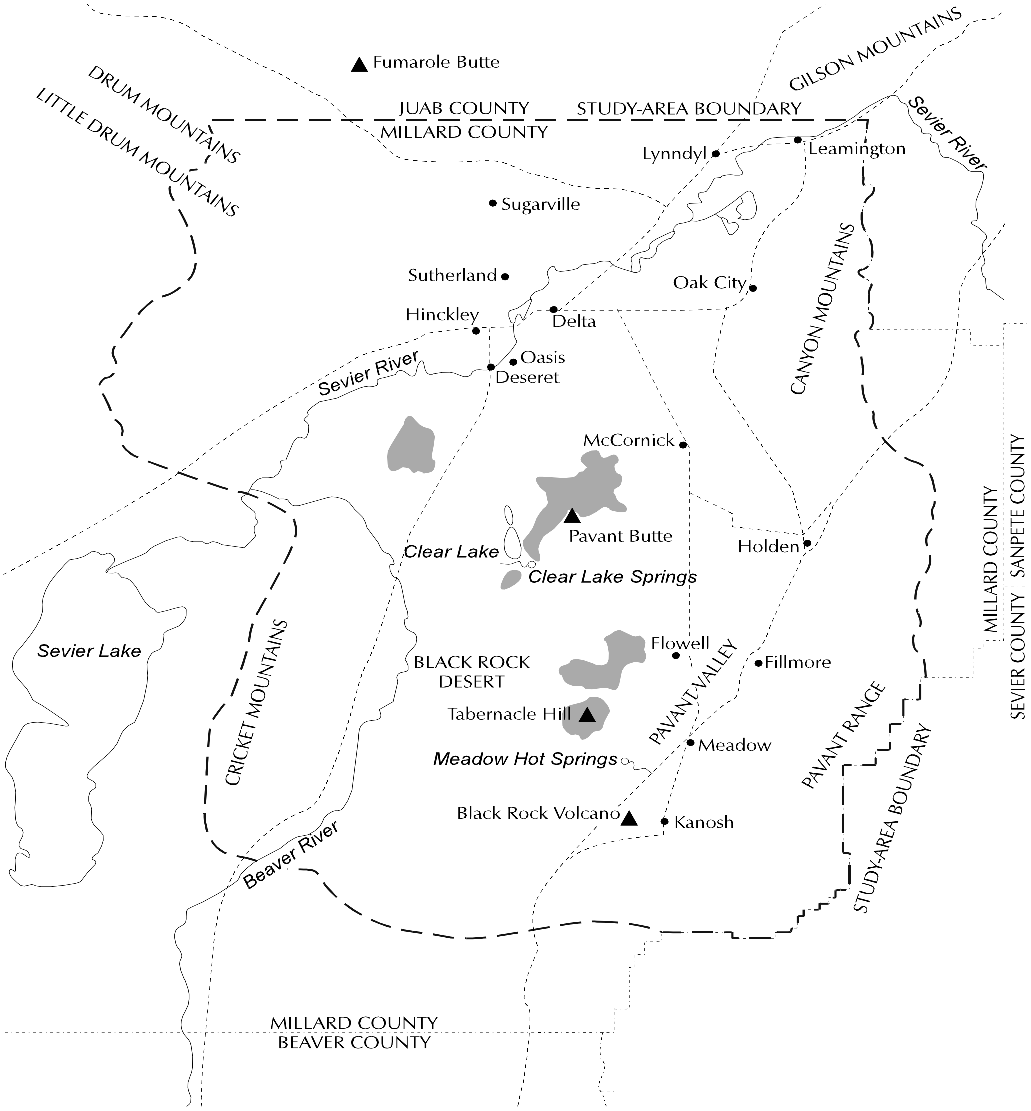
Recharge and discharge areas, Sevier Desert, Millard County, Utah

UGS Map 175

MAP OF RECHARGE AND DISCHARGE AREAS FOR THE PRINCIPAL BASIN-FILL AQUIFER SYSTEM SEVIER DESERT, MILLARD COUNTY, UTAH

by

Noah P. Snyder



MAP 175 **1998**

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MAP OF RECHARGE AND DISCHARGE AREAS FOR THE PRINCIPAL BASIN-FILL AQUIFER SYSTEM, SEVIER DESERT, MILLARD COUNTY, UTAH

by Noah P. Snyder

ABSTRACT

Ground water from the principal unconsolidated basin-fill aquifer system is the most important source of agricultural and culinary water in the Sevier Desert. Recharge and discharge areas for the principal aquifer system were mapped to aid in management of potential contaminant sources to help protect ground-water quality.

The Sevier Desert is on the eastern edge of the Great Basin in east-central Utah. The basin fill consists of lacustrine, deltaic, and alluvial deposits that form aquifers and confining layers. Fractured volcanic rocks are important aquifers in the southern part of the study area. The mountains that surround the Sevier Desert and coarse-grained alluvial fans along the basin's eastern edge make up the primary recharge area. Secondary recharge and discharge areas are on the basin floor, where the principal aquifer system is under generally artesian conditions. Water levels in the principal aquifer system declined from the 1940s to the 1960s when discharge, principally for irrigation, exceeded recharge from precipitation. Water levels rose during wet years in the early to mid-1980s. A long-term decline in water quality is due to concentration of dissolved solids by evaporation, recycling of irrigation water, and recharge by lower quality water.

INTRODUCTION

Background

Ground water from wells is vital to the economy of the Sevier Desert. Springs and streams do not provide sufficient water to meet the agricultural and culinary needs of the area. The principal unconsolidated basin-fill aquifer system, hereafter referred to as the principal aquifer system, is the most important source of ground water. Recharge to the principal aquifer system is from infiltration of surface water, precipitation, and irrigation water near mountain fronts. Recharge areas are typically underlain by fractured rock and/or coarse-grained sediment having relatively little ability to inhibit infiltration or renovate contaminated water. Ground-water flow in recharge areas has a downward component and relatively fast rate of movement. Because contaminants can readily enter an aquifer system in recharge areas, management of potential contaminant sources in these areas deserves special attention to protect ground-water quality. Ground-water recharge-area mapping defines these vulnerable areas.

Ground-water recharge-area maps typically show: (1) primary recharge areas, (2) secondary recharge areas, and (3) discharge areas (Anderson and others, 1994). Primary recharge areas, commonly the uplands and coarse-grained unconsolidated deposits along basin margins, do not contain thick, continuous, fine-grained layers and have a downward ground-water gradient. Secondary recharge areas, commonly mountain front benches, have fine-grained layers thicker than 20 feet (6 m) and downward ground-water gradients. Ground-water discharge areas are generally in basin lowlands. Discharge areas for unconfined aquifers are where the water table intersects the ground surface, forming springs or seeps. Discharge areas for confined aquifers are where the ground-water gradient is upward and water is discharging to a shallow unconfined aquifer above the upper confining bed, or to a spring. Water from wells which penetrate confined aquifers may flow to the surface naturally. The extent of both recharge and discharge areas may vary seasonally and from dry years to wet years.

Purpose and Scope

The purpose of this study is to help state and local government officials and local residents protect ground-water quality in the Sevier Desert by defining recharge areas where ground-water aquifers are vulnerable to contamination. The study is a cooperative effort among the Utah Geological Survey (UGS), the Utah Division of Water Quality (DWQ), and the U.S. Environmental Protection Agency (EPA).

The scope of work included a search for well-log data, a literature review, and field reconnaissance to define general geologic and hydrologic conditions in the Sevier Desert. We collected logs for water wells drilled in the basin prior to August 1995 from the State Engineer's office. We entered well-log information into a database and plotted well locations on 1:24,000-scale base maps. Generalized recharge- and discharge-area boundaries were then drawn and digitized, along with well locations, into the State Geographic Information Database.

Setting

The study area is the southern part of the Sevier Desert in eastern Millard County, including Pahvant Valley and the northern Black Rock Desert (figure 1). The study area includes about 2,700 square miles (7,000 km^2) of the Sevier River drainage basin.

Physiography and Drainage

The Sevier Desert is in the eastern part of the Great Basin section of the Basin and Range physiographic province. The Pahvant and Canyon Ranges make up the eastern border. To the southwest and northwest are the Cricket and Little Drum Mountains, respectively. Hills and volcanic rocks between the Pahvant Range and the Cricket Mountains form the southern divide. The study area ends at the Juab County line to the north. The main source of surface water is the Sevier River which flows from the high plateaus to the east into the northeast corner of the study area through Leamington Canyon. The Beaver River enters the study area from the south, flows through the Black Rock Desert and, during high precipitation years, joins the Sevier River in the western part of the Sevier Desert. The Sevier River in the western part of the study area is usually dry due to irrigation withdrawals and evaporation, but in wet years it flows to Sevier Lake, a playa west of the study area. Many small ephemeral streams flow from the mountains into the Sevier Desert during spring.

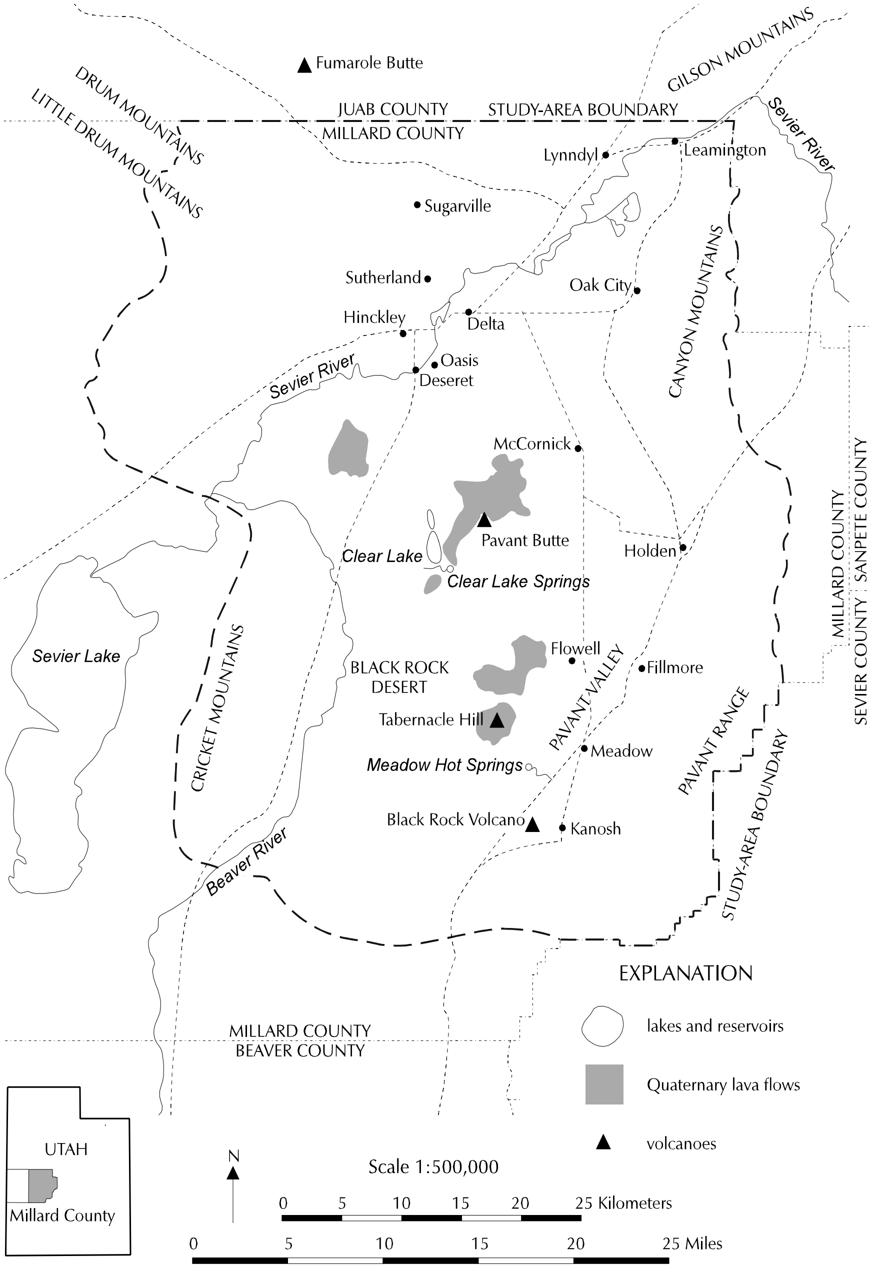

Figure 1. Map of the southern Sevier Desert study area.

Climate

Annual precipitation on the semiarid basin floor is 8.11 inches (20.6 cm) in Delta, and 8.91 inches (22.6 cm) at Clear Lake. Located at the base of the relatively humid eastern mountains, Fillmore and Oak City receive an average 16.00 and 11.59 inches (40.6 cm and 29.4 cm) of annual precipitation, respectively (Ashcroft and others, 1992). The Canyon Mountains and Pahvant Range, on the eastern side of the study area, receive over 30 inches (75 cm) of precipitation annually at the highest elevations (Ashcroft and others, 1992). Temperatures in the Sevier Desert are generally mild, rarely above 100°F (38°C) or dropping below 0°F (-18°C), and averaging around 50°F (10°C) over the year (Ashcroft and others, 1992).

Land Use

Approximately 11,000 people live in the study area. Delta and Fillmore are the largest cities, having 2,998 and 1,956 people in 1990, respectively (Utah League of Cities and Towns, 1993). Few people live in the Black Rock Desert area. Agriculture is the main land use and source of income. The Intermountain Power Project began operating in 1986. This coal-burning electric plant, northeast of Delta, employs 600 people. Economic deposits of sand and gravel, gold, lime, and salt are mined in the Sevier Desert.

Previous Studies

The ground-water hydrology of the northern part of the study area has been studied by Mower and Feltis (1968) and Holmes (1984). Mower (1965) and Holmes and Thiros (1990) examined the ground-water hydrology of Pahvant Valley. Other hydrologic studies that involve parts of the Sevier Desert include: Meinzer (1911), Nelson (1952), Handy and others (1969), Bedinger and others (1984a,b), Thompson and Nuter (1984), and Gates (1987).

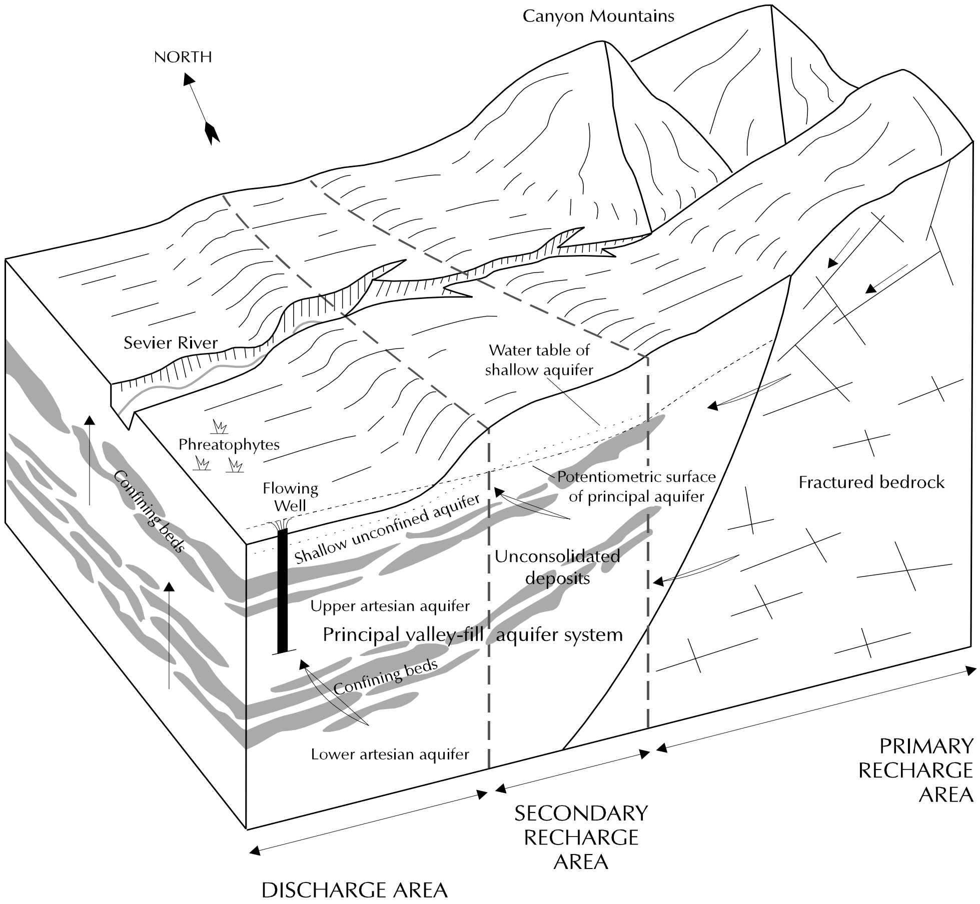

Figure 2. Schematic block diagram showing direction of ground-water flow in the Sevier Desert.

The bedrock and surficial geology of the Sevier Desert have been mapped at various scales. In this study I used only regional-scale geologic maps. Oviatt (1989, 1991) mapped the Quaternary geology for the area west of Delta and the Black Rock Desert. Bedrock geology was mapped by Steven and Morris (1983) and Morris (1987).

METHODS

The methods used in this study for identifying confining layers, classifying aquifers, and delineating recharge and discharge areas are modified from those of Anderson and others (1994). This study is concerned with the principal aquifer system and local overlying shallow unconfined aquifers (figure 2). The principal aquifer system is the most important source of ground water, and may be confined or unconfined. The principal aquifer system begins at the mountain fronts surrounding the basin where coarse-grained alluvial-fan sediments predominate and ground water is generally unconfined. In the center of the basin, fine-grained silt and clay strata form confining layers above and within the principal aquifer system. Water in sediments above the top confining layer is in a shallow unconfined aquifer. This is generally a less important source of drinking water.

I used drillers' logs of water wells to delineate primary or secondary recharge areas and discharge areas, based on the presence of confining layers and relative water levels in the principal and shallow unconfined aquifers. I compiled a database of well-log information (appendix). The use of drillers' logs requires interpretation because of the variable quality of the logs. Correlation of geology from well logs is difficult because lithologic descriptions are generalized and commonly inconsistent among various drillers. The use of water-level data from well logs is also problematic because levels in the shallow unconfined aquifer are often not recorded and because water levels were measured during different seasons and years.

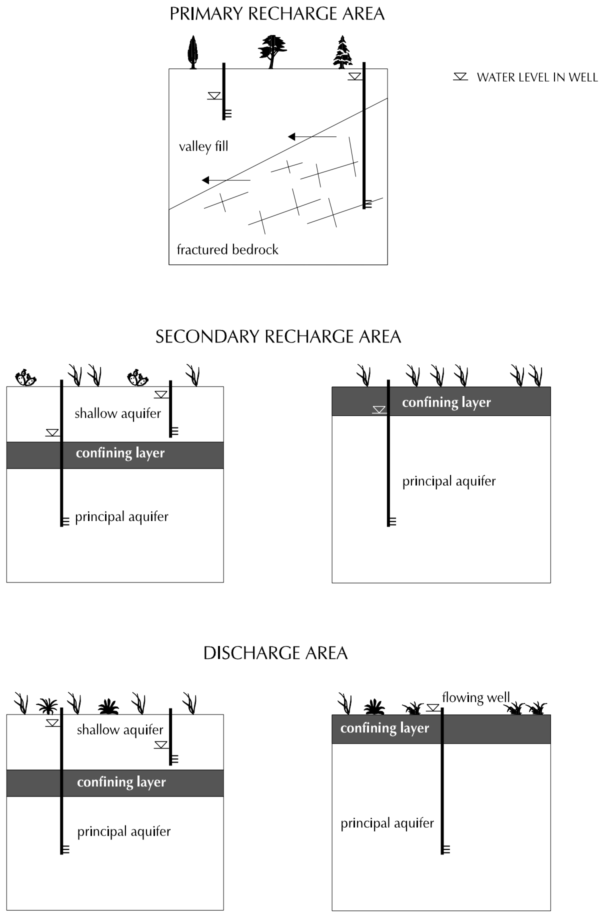

Figure 3. Relative water levels in wells in recharge and discharge areas.

Confining layers are any fine-grained (clay and/or silt) layer thicker than 20 feet (6 m) (Anderson and others, 1994). Sometimes a driller will note both clay and sand along the same interval on logs, without giving relative percentages; these are not classified as confining layers (Anderson and others, 1994). If both are checked and the word "sandy" is written in the remarks column, then the layer is assumed to be primarily a clay confining layer (Anderson and others, 1994). Sometimes a driller will mark both clay and gravel, cobbles, or boulders; these also are not classified as confining layers, although, in some areas in the Sevier Desert, layers of clay containing gravel, cobbles, or boulders behave as confining layers.

The primary recharge area for the principal aquifer system is the uplands surrounding the basin, and basin fill not containing confining layers, generally along mountain fronts (figure 3). Ground-water flow in primary recharge areas has a downward component. If present, secondary recharge areas are where there are confining layers, but ground-water flow still has a downward component. Secondary recharge areas generally extend toward the center of the basin to the point where the ground-water-flow gradient is upward (figure 3). The ground-water-flow gradient, also called the hydraulic gradient, is upward when the potentiometric surface of the principal aquifer system is higher than the water table in the shallow unconfined aquifer (Anderson and others, 1994). Water-level data for the shallow unconfined aquifer are not common but can be found on some well logs. When the confining layer extends to the ground surface, secondary recharge areas are where the potentiometric surface in the principal aquifer system is below the ground surface.

Ground-water-discharge areas, if present, are generally at lower elevations than recharge areas. In discharge areas, the water in confined aquifers discharges to the land surface or to a shallow unconfined aquifer (figure 3). For this to happen, the hydraulic head in the principal aquifer system must be higher than the water table in the shallow unconfined aquifer. Otherwise, downward pressure from the shallow aquifer will exceed the upward pressure from the confined aquifer, creating a net downward gradient indicative of secondary recharge areas. Flowing (artesian) wells, indicative of discharge areas, are marked on drillers' logs and sometimes on U.S. Geological Survey 7.5' quadrangle maps. Wells with potentiometric surfaces above the top of the confining layer can be identified from well logs. Surface water, springs, or phreatophytic plants (wetlands) can be another indicator of ground-water discharge. In some instances, however, this discharge may be from a shallow unconfined aquifer. It is necessary to understand the topography, surficial geology, and ground-water hydrology before using these wetlands to indicate discharge from the principal aquifer system.

I generally did not map small secondary recharge or discharge areas defined by local clay layers in only a few wells where surrounded completely by primary recharge areas, because contaminants entering the aquifer system above these clay layers of local extent still have a high potential to reach primary recharge areas.

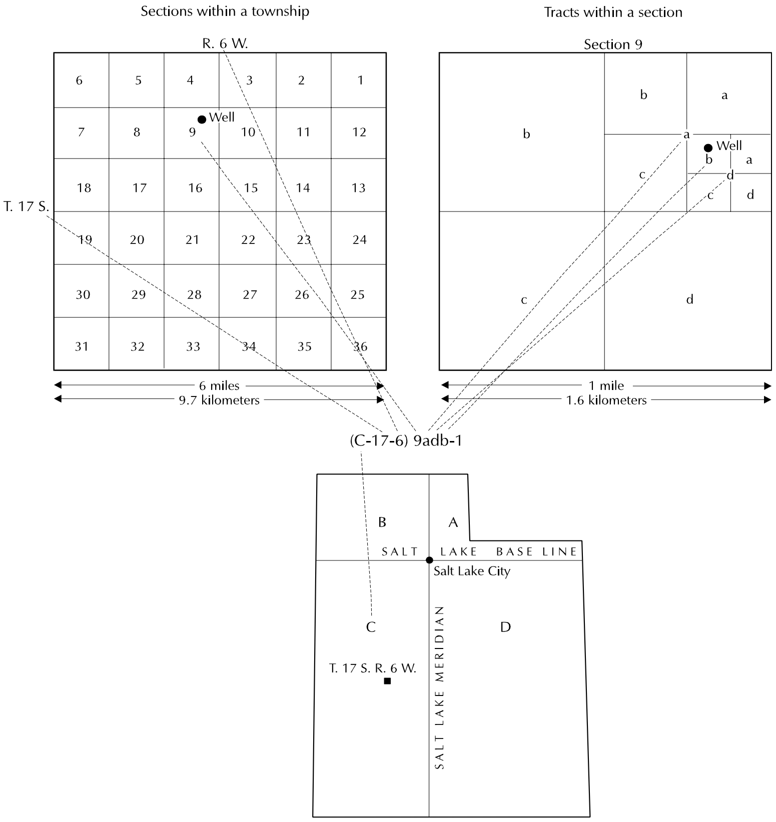

Figure 4. Numbering system for wells in Utah (see text for additional explanation).

The numbering system for wells in this study is based on the Federal Government cadastral land-survey system that divides Utah into four quadrants (A-D) separated by the Salt Lake Base Line and Meridian (figure 4). The study area is entirely within the southwestern quadrant (C). The wells are numbered with this quadrant letter C, followed by township and range enclosed in parentheses. The next set of characters indicates the section, quarter section, quarter-quarter section, and quarter-quarter-quarter section designated by a through d, indicating the northeastern, northwestern, southwestern, and southeastern quadrants, respectively. A number after the hyphen corresponds to an individual well within a quarter-quarter-quarter section. For example, the well (C-17-6) 9adb-1 would be the first well in the northwestern quarter of the southeastern quarter of the northeastern quarter of section 9, Township 17 South, Range 6 West (NW¼SE¼NE¼ section 9, T. 17 S, R. 6. W).

GEOLOGY

Bedrock

The Sevier Desert is a complexly faulted structural basin typical of the Basin and Range province of Utah and Nevada. It is surrounded by mountain ranges and contains thick unconsolidated and volcanic basin-fill deposits. Active faulting and volcanism have occurred during the Quaternary Period.

Bedrock of the mountains surrounding the Sevier Desert ranges in age from Precambrian to Tertiary. The Cricket Mountains consist primarily of Cambrian limestone and quartzite (Steven and Morris, 1983). The Pahvant Range includes this Cambrian limestone and quartzite, some Devonian dolomite and quartzite, and Cretaceous and Tertiary sedimentary rocks of the Price River, North Horn, Flagstaff, and Green River Formations (Steven and Morris, 1983). The Canyon Mountains are the type locality for the Canyon Range Formation, a Cretaceous to Tertiary conglomerate that crops out extensively in the northern part of the range. Precambrian and Cambrian quartzite and limestone, and Devonian dolomite, are also found in the Canyon Range (Morris, 1987). The Little Drum Mountains generally consist of Tertiary ash-flow tuff, but contain some Precambrian to Cambrian quartzite, limestone, and shale (Morris, 1987).

Of great importance to the Sevier Desert ground-water system are recent Tertiary- and Quaternary-age volcanic rocks in the south and northwest (figure 1). Pahvant Valley is bordered to the west by several large basalt flows and tuff cones. A local landmark, Pahvant Butte, formed as lava and tuff erupted into Lake Bonneville approximately 15,500 yr B.P. (Oviatt, 1989). The associated ash and basalt flows cover much of the surface of the Sevier Desert. Tabernacle Hill, 5 miles (8 km) west of Meadow, erupted basalt into Lake Bonneville at the Provo level in late Pleistocene time (14,500 to 14,000 yr B.P.) (Oviatt, 1991). Eruption of the Ice Springs basalt flow west of Flowell is the most recent volcanic event in the area, occurring about 660 yr B.P. (Valastro and others, 1972). This basalt covers more than 20 square miles (50 km^2) and consists of angular (aa) and ropy (pahoehoe) flows. Beaver Ridge and the Coyote Hills in the far southern part of the Black Rock Desert consist of Pleistocene and Pliocene andesite, rhyolite, and basalt (Oviatt, 1991). Other Pliocene and Pleistocene volcanics are in the Smelter Knolls and Little Drum Mountains in the northwestern corner of the study area (Oviatt 1989, 1991).

Unconsolidated Sediments

The basin fill of the Sevier Desert consists of lacustrine and deltaic sediments deposited during several Pleistocene lake cycles, and interlacustrine fluvial and alluvial-fan deposits. Volcanic ash layers within lake deposits are continuous marker beds found in much of the basin. The area stratigraphy provides an excellent record of the Quaternary history of lakes in the area. Eolian sand, mostly reworked deltaic deposits, is found in the northwestern part of the study area (Oviatt, 1989).

Fine-grained lacustrine deposits of Pliocene to Pleistocene age are widespread in the Sevier Desert (Oviatt, 1989). Deposits of the most recent lake, Lake Bonneville, can be differentiated from those of pre-Bonneville lakes. The older lacustrine sediments are calcareous clay, silt, and sand, and indurated nearshore limestone deposited in a pre-Bonneville lake or lakes (Oviatt, 1989). Fine- to coarse-grained deposits associated with Lake Bonneville overlie these older sediments. Bonneville deposits include deep-water white marl, nearshore sand and gravel, and lagoonal silt, sand, and clay (Oviatt, 1989).

Deltaic sediments were deposited where the Sevier and Beaver Rivers flowed into Lake Bonneville. A large silt and fine sand regressive underflow fan-delta stretches from Leamington Canyon to Delta (Oviatt, 1989). Coarse-grained fan-delta sand and gravel were deposited by the Beaver and Sevier Rivers during the Bonneville regression (Oviatt, 1989, 1991).

Alluvial-fan and fluvial sediments were deposited in the Sevier Desert during interlacustrine periods, and overlie and interbed with lacustrine deposits. Most of the surface sediments in the study area are post-Bonneville sand, silt, and clay floodplain, channel, or overbank deposits of the Sevier and Beaver Rivers (Oviatt, 1989, 1991). These deposits are largely reworked lacustrine deposits, so their hydrologic characteristics and appearance are similar.

GROUND WATER

The majority of the wells in the Sevier Desert tap unconsolidated basin-fill aquifers. These aquifers can be divided into two types: the shallow unconfined aquifer, and the principal aquifer system. The latter can be further divided into the upper and lower artesian aquifers in the northeastern part of the study area (figure 2). Some wells in Pahvant Valley tap a fractured-volcanic-rock aquifer. Water enters the aquifers from the Sevier River east of Leamington, seepage from ephemeral mountain streams and irrigation, and infiltration of precipitation.

Ground-water quality in the Sevier Desert varies considerably due to concentration of salts by evaporation near the surface and arsenic contamination from volcanic rocks (Holmes, 1984). Drinking-water and ground-water protection regulations in Utah classify ground water, based largely on total-dissolved-solids concentrations, as follows: class IA (pristine), less than 500 mg/L; class II (drinking water quality), 500 to 3,000 mg/L; class III (limited use), 3,000 to 10,000 mg/L; and class IV (saline), more than 10,000 mg/L. Class IA and II waters are considered suitable for drinking, provided concentrations of individual contaminants do not exceed state and federal ground-water-quality standards. Water having total-dissolved-solids concentrations in the higher part of the class II range is generally suitable for drinking water only if treated, but it can be used for some agricultural or industrial purposes without treatment. Most ground water in the Sevier Desert is class IA and II.

Fractured-Rock Aquifers

Fractured-rock aquifers in the Sevier Desert include sedimentary and metasedimentary rocks in surrounding mountains and underlying the basin fill, and Cenozoic volcanic rocks overlying and interbedded with the basin fill. Few wells are drilled into fractured-rock aquifers in the Sevier Desert, due to the thickness and productivity of basin-fill aquifers. Several springs and wells in Pahvant Valley receive water from fractured basalt, which is an important aquifer that both recharges and receives water from the principal aquifer system. Springs discharge from bedrock in the mountains surrounding the Sevier Desert. Little is known about the quantity of water within or the characteristics of fractured-rock aquifers in the mountains.

Aquifer Characteristics

Wells and springs in volcanic rocks can yield large amounts of water. Clear Lake Springs discharges about 9,900 gallons per minute (625 L/s) from the Pahvant Butte basalt (Holmes, 1984). Many other productive springs are associated with volcanic rocks in the Sevier Desert. Pumped wells in fractured basalt near Flowell in Pahvant Valley yield over 3,000 gallons per minute (200 L/s), and have transmissivities of 3,000,000 square feet per day (280,000 m^2/day) (Mower, 1965). These large values are likely from wells tapping highly fractured volcanic rock. Hydraulic characteristics are unavailable for aquifers in the sedimentary and metamorphic rocks in the surrounding mountains.

Recharge and Discharge

The volcanic-rock aquifers have a direct hydraulic connection to the basin-fill aquifers in many parts of the Sevier Desert. Clear Lake Springs discharges water that flows west from the Pahvant Valley unconsolidated basin-fill aquifer through the Pahvant Butte basalt aquifer (Mower and Feltis, 1968). Some recharge also comes from direct precipitation on volcanic rock. Discharge from fractured bedrock aquifers in the mountains surrounding the Sevier Desert is probably an important source of recharge to the basin-fill aquifer, but its relative contribution is unknown (Mower and Feltis, 1968).

Water Quality

Clear Lake Springs and well (C-18-8) 24ada-1 both discharge from volcanic rock in the northern Black Rock Desert. Enright and Holmes (1982) report total dissolved solids of 1,970 and 2,030 mg/L, respectively. In Pahvant Valley, wells drawing water from basalt range from 528 to 4,490 mg/L total dissolved solids (Mower, 1965). These values are higher than two springs with total dissolved solids of 523 and 331 mg/L that discharge from sedimentary rocks in the Canyon Mountains (Enright and Holmes, 1982). In general, volcanic-rock aquifers have more total dissolved solids than unconsolidated basin-fill or other fractured-rock aquifers (Holmes, 1984). Arsenic in water in some wells in or near volcanic rocks is believed to have been leached from the rocks (Holmes, 1984).

Unconsolidated Basin-Fill Aquifers

The unconsolidated basin-fill aquifers are the most important sources of water in the Sevier Desert.

Aquifer Characteristics

The basin fill consists predominantly of lacustrine, deltaic, and alluvial deposits. In general, the coarser material is in alluvial fans along the mountain fronts, and the finer material is in lacustrine deposits in the central portions of the basin. Thick, fine-grained confining layers are present throughout much of the Sevier Desert, and artesian conditions are widespread.

The northeastern part of the study area has two aquifers that make up the principal unconsolidated basin-fill aquifer system, overlain locally by shallow unconfined aquifers (figure 2). The principal aquifers are predominantly sand and gravel, and the intervening and overlying confining layers are mostly silt and clay, although the boundaries between aquifers and confining layers are commonly indistinct. The confining layer that separates the upper artesian aquifer from the lower artesian aquifer near Lynndyl is 400 to 500 feet (120-150 m) thick (Mower and Feltis, 1968). The water table in the shallow unconfined aquifer is about 50 feet (15 m) below the land surface (Holmes, 1984). The basin fill fines toward the center and western part of the study area where the aquifers contain more silt and clay. The confining layer between the aquifers thins to 100 to 175 feet (30 to 55 m) at Sugarville, and may not be present in the northwestern part of the study area where the upper and lower artesian aquifers are hydraulically connected (Mower and Feltis, 1968).

Transmissivity of the upper artesian aquifer ranges from 47,000 square feet per day (4,400 m^2/day) near Lynndyl to 3,600 square feet per day (340 m^2/day) west of Sugarville (Holmes, 1984). Transmissivities for the lower artesian aquifer range from 27,000 square feet per day (2,500 m^2/day) near Lynndyl to 2,000 square feet per day (190 m^2/day) south of Delta (Holmes, 1984). These values are consistent with the observation that the aquifers fine toward the center of the basin.

In Pahvant Valley, there is one principal aquifer, composed primarily of alluvial-fan sand and gravel. Lake Bonneville did not reach the base of the Pahvant Range, and the basin fill above the Provo shoreline (4,830 feet [1,470 m]) is coarse and the principal basin-fill aquifer is unconfined. In the confined system, near Flowell, the principal basin-fill aquifer is 140 to 200 feet (40-60 m) deep, with 15 to 75 feet (5-23 m) of clay overlying it (Holmes and Thiros, 1990). West of Flowell and Kanosh, coarse deposits thin and lacustrine clays restrict vertical ground-water flow, causing the potentiometric surface of the confined principal aquifer system to be greater than 50 feet (15 m) above the land surface (Mower, 1965; Holmes and Thiros, 1990). Pump tests on wells in the basin-fill aquifer in Pahvant Valley yielded a range of transmissivities from 2,000 to 40,000 square feet per day (200-4,000 m^2/day) (Mower, 1965). The low values in this range indicate sand and gravel aquifers having a high percentage of fines.

Recharge and Discharge

Ground water in the Sevier Desert generally moves with the Sevier and Beaver Rivers to the west toward Sevier Lake. Water enters the system as ephemeral stream runoff from the mountains (including those north of the study area), infiltration from rivers and irrigation, direct precipitation on the valley floor, and subsurface inflow from bedrock. Water leaves through evapotranspiration, discharge to rivers, and subsurface outflow to Sevier Lake (Holmes, 1984; Holmes and Thiros, 1990).

The main source of recharge to the principal aquifer system is seepage from intermittent streams from the surrounding mountains during spring snowmelt (Mower, 1965; Holmes, 1984). Most of the small mountain streams lose their surface flow when they cross onto coarse-grained alluvial-fan deposits at the basin margins. Ephemeral streams also flow from mountains north of the study area and recharge the basin-fill aquifers. The Sevier River does not provide much recharge to the basin-fill aquifers directly. Some water enters the aquifers at the mouth of Leamington Canyon, but generally the Sevier River gains water from subsurface inflow and loses water to irrigation (Holmes, 1984).

Infiltration of water from reservoirs, unconsumed irrigation, and canal leakage provides recharge to the shallow unconfined aquifer in the center of the basin, where thick confining layers and upward ground-water gradients impede recharge to the principal aquifer system. These sources, including the Central Utah Canal, provide significant local recharge to the principal aquifer system along its eastern margin from Leamington to Kanosh (Mower, 1965; Holmes, 1984). This is a wide primary recharge area, created by coarse proximal delta sediments and alluvial fans (plate 1). Some of this area, especially east of Fillmore, is above the Lake Bonneville highstand, so fine-grained lacustrine deposits are not present.

Direct precipitation on the basin floor is an insignificant source of recharge in most of the basin (Mower, 1965; Holmes, 1984). Approximately 5 percent of the precipitation that falls on the coarse-grained alluvial fans above 4,800 feet (1,440 m) in Pahvant Valley recharges the principal aquifer (Holmes and Thiros, 1990). Subsurface inflow from the volcanic rocks within the basin and sedimentary rocks in the surrounding mountain ranges is a source of recharge, but its relative contribution is unknown.

Ground water discharges through evapotranspiration, springs and seepage to rivers, subsurface outflow, and wells. Evapotranspiration by phreatophytes varies with depth to ground water, salinity, and vegetation, but is a large part of the annual discharge. Seepage to the Sevier River is also a source of discharge. Water re-enters the river as subsurface inflow near Leamington and in the central part of the basin where the water table is shallow (Holmes, 1984). Water exits the study area along the western edge through subsurface outflow. Discharge to wells varies greatly, depending on the amount of available surface water in a given year, which causes great fluctuations in water levels as discussed below.

The low-elevation parts of the Sevier Desert around Delta and Pahvant Valley are discharge areas or secondary recharge areas (plate 1). The generally fine-grained sediments confine the aquifers, and many wells in the area flow or have historically flowed to the surface.

Water-Level Changes

The Sevier Desert has had some declines in water levels since pumping for irrigation began in the 1940s. A long period of below-average precipitation from about 1948 to 1966 caused many wells to stop flowing and reduced water levels in wells as much as 50 feet (15 m) (Batty and others, 1993). Heavy pumping for irrigation during dry years has also caused some changes in ground-water flow direction in Pahvant Valley near Kanosh and Flowell (Holmes and Thiros, 1990). Studies done by the U.S. Geological Survey in the 1960s for the Sevier Desert near Delta (Mower and Feltis, 1968) and Pahvant Valley (Mower, 1965) documented areas where wells had ceased to flow. I classified these areas as secondary recharge areas for this study because of the current downward hydraulic gradient (plate 1). Gates (1987) reports speculation in the 1960s that mining of ground water in the Sevier Desert had begun, and these observed declines would be permanent. However, several years of above-average and record precipitation in the early to mid-1980s raised water levels in most aquifers to their 1940s and 1950s levels (Batty and others, 1993). Two interrelated factors are responsible for this recovery (Gates, 1987). First, increased precipitation provided more water to recharge the principal aquifer system. Second, increased surface-water flow reduced the need to pump ground-water reservoirs for irrigation, allowing water levels to stabilize and rise. Average annual ground-water withdrawals in the study area from 1980 to 1986 were one-third to two-thirds of average withdrawals from 1973 to 1979 (Gates, 1987). From 1988 to 1993 precipitation in the area was below average, and in many areas water levels have begun to decline again, and these fluctuations will likely continue (Holmes and Thiros, 1990; Batty and others, 1993).

Water Quality

Water quality in the Sevier Desert varies with location and depth. Total dissolved solids range from 200 to 20,000 mg/L (Mower, 1965; Holmes, 1984). The high values are from the shallow unconfined aquifer at the western edge of the study area near Sevier Lake. Salts are concentrated by evaporation near the surface. In general, the worst quality water is in the shallow unconfined aquifer, which is partially recharged by returned irrigation water (Mower, 1965; Holmes, 1984). The best ground water in the study area is in the lower artesian aquifer between Lynndyl and Delta (Holmes, 1984).

An area of lower quality ground water in Pahvant Valley was documented by Holmes and Thiros (1990). Wells in the farming area 5 miles (8 km) west of Kanosh have had increases in the concentration of sodium, chloride, and sulfate, causing an increase in total dissolved solids from 2,000 mg/L in the 1950s to over 6,000 mg/L at present. This decline in water quality has been attributed to two factors: (1) recharge by poor-quality water to the southwest and west during years of large withdrawals, and (2) concentration of solids in irrigation water through evaporation (Holmes and Thiros, 1990).

Nitrate concentrations are relatively high, ranging from 4 to 22 mg/L, in the Oak City area (Holmes, 1984). This is a primary recharge area, and it may be that septic-tank effluent and irrigation water are contributing to recharge of the principal aquifer system (Holmes, 1984).

Potential for Water-Quality Degradation

Holmes (1984) documents a long-term decline in water quality in the Sevier Desert. He attributes this to poor-quality water from the Sevier River, irrigation, canals, and reservoirs recharging the system. The nitrate contamination in Oak City may be an early warning of the problems associated with agriculture or rural waste-water disposal in primary recharge areas. The principal aquifer system in the populated and cultivated part of the Sevier Desert, particularly around Delta, is protected from downward leakage of contaminants by confining layers. However, the contaminants entering the system in the primary recharge area along the eastern margin of the basin may eventually reach the principal aquifer system beneath Delta.

Another related reason for the decline in water quality may be the very tight recharge and discharge budget. During dry years, water levels in wells drop, indicating a lack of recharge. The poor-quality water near Kanosh is the result of large withdrawals reversing ground-water flow, causing recharge from areas of lower quality water. Pumped poor-quality water is used to irrigate fields, where much of it re-enters the system, after concentration of dissolved solids by evaporation at the surface. The increased flow of the Sevier River during wet years can be used for irrigation, allowing the wells to rebound, and bringing new, higher quality water into the system. In a long-term drought, however, this cycle may be broken and water quality may decline more rapidly.

SUMMARY AND CONCLUSIONS

The principal aquifer system of the Sevier Desert is made up of unconsolidated basin-fill sediments of lacustrine, deltaic, and alluvial origin. Fine-grained layers form confining beds that separate the principal aquifer system near Delta into lower and upper artesian aquifers, and separate them from shallow unconfined aquifers. Fractured volcanic rocks are an important aquifer in the western Pahvant Valley. Little is known about fractured-bedrock aquifers in the sur-rounding mountains and underlying basin fill.

Primary recharge areas for the principal aquifer system are generally along the mountain front on the east side of the study area. Secondary recharge areas and discharge areas are on the basin floor. Water enters the system from the north, east, and south and exits toward Sevier Lake to the west. Water levels in wells decline during dry periods, but rebound in years of above-average precipitation. Water quality is best in the lower artesian aquifer, and worst in the shallow unconfined aquifer near Sevier Lake and the principal aquifer near Kanosh. Increased salinity and nitrate contamination in the Sevier Desert are probably due to concentration of salts by evaporation, recycling of irrigation water, and recharge by poor-quality water.

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APPENDIX

Records of Wells, Sevier Desert,
Millard County, Utah

Site number: See plate 1 for well location. Wells not used to define recharge and discharge areas are not plotted.
Local well number: See text for explanation of numbering system.
Elevation: In feet above sea level.
Well depth: In feet below land surface.
Recharge area: Y, primary recharge area; 1, secondary recharge area; N, discharge area; 2, well completed in shallow unconfined aquifer.
Water level: In feet below land surface, or feet above land surface for "+" values; +F, flowing well.
Top of confining layer: Depth to first confining layer, in feet below land surface.
Bottom of confining layer: Depth to bottom of first confining layer, in feet below land surface.
Depth to bedrock: In feet below land surface; N, bedrock not encountered.
Top of perforations: Depth to top of perforations, in feet below land surface.
Bottom of perforations: Depth to bottom of all perforations, in feet below land surface; MI, multiple perforated intervals, below bottom of uppermost perforated interval.

--, no data

Site Number	Local well number	Year well drilled	Elev-ation (ft)	Well depth (ft)	Re-charge area	Water level (ft)	Water-level date	Top of confining layer (ft)	Bottom of confining layer (ft)	Depth to bedrock (ft)	Top of perfor-ations (ft)	Bottom of perfor-ations (ft)	Notes
1	(C-15-4) 9ccc-1	1982	4740	160	I	--	--	51	94	N	140	160	
2	(C-15-4) 10bcd-1	--	4720	830	Y	--	--	--	--	N	785	810	
3	(C-15-4) 10cca-1	1979	4810	380	Y	--	--	--	--	N	360	380	
4	(C-15-4) 14bcd-1	--	4820	850	Y	--	--	--	--	N	--	--	
5	(C-15-4) 17dab-1	1951	4810	351	Y	123	04/07/51	--	--	N	236	--	
6	(C-15-4) 17dda-1	1962	4850	265	I	155	04/30/62	8	40	N	--	--	
7	(C-15-4) 20dcc-1	1964	4820	215	I	--	--	2	70	N	185	215	
8	(C-15-4) 23abc-1	1971	4925	269	I	220	04/00/71	120	160	N	--	--	
9	(C-15-4) 26dcc-1	1951	4970	660	Y	245	08/20/51	--	--	485	295	485 MI	
10	(C-15-4) 27bba-1	1979	4860	280	Y	180	06/20/79	--	--	N	260	280	
11	(C-15-4) 33aac-1	1945	4880	180	I	160	07/14/45	7	42	N	--	--	
12	(C-15-4) 35bbb-1	1957	4920	520	I	218	07/27/57	18	63	N	203	505	
13	(C-15-4) 35bcd-1	1978	4980	440	Y	295	04/03/78	--	--	415	375	415	
14	(C-15-5) 1dcd-1	1949	4790	227	I	96	12/15/49	58	170	N	--	--	
15	(C-15-6) 31ccc-1	1954	4620	195	N	+20	12/25/54	42	80	N	--	--	
16	(C-15-7) 8ddd-1	1952	4592	147	N	+8	06/30/52	--	--	N	--	--	
17	(C-15-7) 17add-1	1981	4587	221	N	3	09/01/81	9	33	N	175	211	
18	(C-15-7) 27daa-1	1952	4595	650	N	+F	05/30/52	5	60	N	175	634 MI	
19	(C-15-7) 30acc-1	1962	4575	290	N	+3	05/10/62	0	21	N	--	--	
20	(C-15-7) 30cdd-1	1957	4575	195	N	4	05/10/57	85	156	N	--	--	
21	(C-15-7) 31abb-1	1955	4580	380	N	+6	08/28/55	19	56	N	--	--	
22	(C-15-7) 31acc-1	1952	4575	336	N	+5	07/08/52	262	320	N	--	--	
23	(C-15-7) 33dcc-2	1953	4585	236	N	+F	06/00/53	130	160	N	--	--	
24	(C-15-7) 35abb-1	1953	4603	85	N	+F	09/00/53	30	75	N	--	--	
25	(C-15-7) 35bcd-1	1951	4597	594	N	+18	11/03/51	18	40	N	279	594	
26	(C-15-7) 36cdb-1	1940	4607	128	N	+5	06/29/40	25	78	N	--	--	
27	(C-15-7) 36dda-1	1982	4620	180	N	38	09/21/82	70	135	N	160	180	
28	(C-15-8) 33bbb-1	1955	4559	200	N	+F	05/15/55	0	30	N	--	--	
29	(C-15-8) 34add-1	1987	4572	155	N	+3	08/00/87	10	35	N	--	--	
30	(C-15-8) 36ddd-1	1974	4577	171	I	6	11/00/74	0	25	N	160	--	
31	(C-15-10) 1adc-1	1948	4680	701	I	42	08/12/50	0	145	700	585	--	basalt
32	(C-16-4) 5dac-1	1977	4900	302	Y	210	12/01/77	--	--	N	280	302	
33	(C-16-4) 7aab-1	1963	4800	190	I	80	12/16/63	3	70	N	168	172	
34	(C-16-4) 17abb-1	1982	4940	295	Y	192	05/17/82	--	--	N	240	295	
35	(C-16-4) 18adc-1	1964	4853	220	I	115	11/24/64	12	90	N	180	217	
36	(C-16-4) 19dbb-1	1947	4880	250	I	126	08/00/47	25	60	N	136	225 MI	
37	(C-16-4) 19ddb-1	1952	4910	344	Y	--	--	--	--	N	30	320 MI	
38	(C-16-4) 20acc-1	1982	5030	540	I	340	05/15/82	135	480	N	460	540	
39	(C-16-4) 29bcb-1	1978	4980	310	Y	245	09/14/78	--	--	N	280	310	
40	(C-16-4) 30cac-1	1971	4925	446	Y	183	12/07/71	--	--	N	190	415	
41	(C-16-4) 31bbc-1	1979	4950	353	Y	210	05/19/79	--	--	N	220	353	
42	(C-16-4) 31bcb-1	1947	4960	248	Y	193	06/00/47	--	--	N	206	224	

Site Number	Local well number	Year well drilled	Elevation (ft)	Well depth (ft)	Recharge area	Water level (ft)	Water-level date	Top of confining layer (ft)	Bottom of confining layer (ft)	Depth to bedrock (ft)	Top of perforations (ft)	Bottom of perforations (ft)	Notes
43	(C-16-6) 6dac-1	1968	4635	194	N	38	06/25/68	56	78	N	180	--	
44	(C-16-6) 18bad-1	1958	4617	225	N	+10	10/24/58	37	58	N	--	--	
45	(C-16-7) 4acc-1	1979	4587	214	N	5	10/00/79	26	200	N	200	212	
46	(C-16-7) 4ada-1	1983	4587	249	N	+1	12/00/83	5	26	N	234	--	
47	(C-16-7) 9aaa-1	1983	4595	200	N	17	06/07/83	2	160	N	180	200	
48	(C-16-7) 9aad-1	1944	4595	115	N	8	04/08/44	1	30	N	--	--	
49	(C-16-7) 10baa-1	1986	4595	180	N	2	02/27/86	107	140	N	160	180	
50	(C-16-7) 10bad-1	1962	4600	919	N	+F	--	35	100	N	500	915	
51	(C-16-7) 10bbb-1	1962	4595	350	N	+F	02/00/62	--	--	N	--	--	
52	(C-16-7) 10cdc-1	1949	4605	380	N	+3	12/23/49	30	64	N	--	--	
53	(C-16-7) 10dad-1	1978	4605	180	N	10	05/26/78	3	35	N	160	180	
54	(C-16-7) 10dcd-1	1976	4607	172	Y	12	10/20/76	--	--	N	140	172	
55	(C-16-7) 12dcd-1	1952	4607	462	N	+25	08/14/52	11	40	N	310	456 MI	
56	(C-16-7) 13cad-1	1947	4613	288	N	+20	03/06/47	1	30	N	--	--	
57	(C-16-7) 14acd-1	1985	4610	160	N	5	09/25/85	5	38	N	140	160	
58	(C-16-7) 14bbb-2	1968	4607	300	N	14	07/15/68	61	91	N	290	--	
59	(C-16-7) 14bcc-1	1962	4612	340	N	2	05/30/62	25	48	N	323	--	
60	(C-16-7) 14daa-1	1978	4610	201	1	18	09/23/78	6	80	N	185	201	da
61	(C-16-7) 14dcd-1	1983	4617	181	1	20	08/17/83	3	97	N	1	181	
62	(C-16-7) 15daa-1	1978	4613	200	1	20	02/11/78	91	119	N	185	200	
63	(C-16-7) 23abb-1	1967	4617	265	1	24	08/27/67	23	65	N	--	--	
64	(C-16-7) 24aac-1	1994	4622	380	N	28	07/11/94	205	258	N	362	379	
65	(C-16-7) 24bca-1	1945	4620	265	1	25	08/26/94	1	50	N	--	--	
66	(C-16-8) 9bdb-1	1980	4568	112	1	4	12/00/80	0	57	N	--	--	
67	(C-16-9) 15abc-1	1982	4898	560	Y	--	--	--	--	15	--	--	rhyolite
68	(C-16-9) 22ccb-1	1982	4650	1000	Y	--	--	--	--	330	--	--	basalt
69	(C-16-9) 29dcc-1	1948	4610	151	1	70	06/23/48	0	116	N	129	129	
70	(C-16-10) 16aaa-1	1979	5080	300	Y	130	04/09/79	--	--	220	217	300	
71	(C-17-5) 15bba-1	1963	4756	150	Y	30	02/06/63	--	--	N	123	138	
72	(C-17-6) 7caa-1	1960	4630	505	N	+9	08/01/60	35	56	N	--	--	
73	(C-17-6) 8adc-1	1965	4627	185	N	12	01/30/65	25	60	N	161	--	
74	(C-17-6) 8bcd-1	1972	4627	221	1	14	08/28/72	3	140	N	190	221	
75	(C-17-6) 8bdd-1	1950	4627	399	N	+8	10/03/50	15	50	N	--	--	
76	(C-17-6) 8caa-1	1950	4629	357	N	+5	11/25/50	15	40	N	--	--	
77	(C-17-6) 8cbb-1	1979	4629	175	1	15	08/00/79	37	137	N	--	--	
78	(C-17-6) 8daa-1	1981	4627	279	N	4	02/00/81	22	123	N	262	--	
79	(C-17-6) 10bdd-1	1984	4670	125	1	65	09/14/84	0	125	N	121	--	
80	(C-17-6) 17bbb-1	1940	4624	390	N	+6	03/20/40	42	70	N	--	--	
81	(C-17-6) 18aca-1	1986	4625	235	N	17	10/31/86	40	158	N	205	235	
82	(C-17-6) 18bbb-1	1979	4628	156	1	15	10/25/79	21	96	N	140	--	
83	(C-17-6) 18bcb-1	1962	4627	275	N	9	--	18	54	N	265	--	
84	(C-17-6) 18cdd-1	1950	4620	415	N	+3	02/23/50	18	50	N	--	--	

Site Number	Local well number	Year well drilled	Elevation (ft)	Well depth (ft)	Recharge area	Water level (ft)	Water-level date	Top of confining layer (ft)	Bottom of confining layer (ft)	Depth to bedrock (ft)	Top of perforations (ft)	Bottom of perforations (ft)	Notes
85	(C-17-6) 18dcc-1	1957	4620	820	N	+F	11/00/57	--	--	N	610	820	
86	(C-17-6) 19bbb-1	1978	4620	205	1	14	10/24/78	5	66	N	180	205	
87	(C-17-6) 19cbc-1	1957	4612	425	N	+8	09/00/57	42	200	N	--	--	
88	(C-17-6) 30bbb-2	1941	4612	532	N	+14	07/08/41	55	90	N	--	--	
89	(C-17-7) 9ccc-1	1947	4609	210	N	+2	01/30/47	1	30	N	--	--	
90	(C-17-7) 10bcb-1	1981	4619	221	1	30	07/03/81	75	125	N	161	181	
91	(C-17-7) 15cdc-1	1979	4608	220	1	20	11/25/79	6	51	N	200	220	
92	(C-17-7) 16ccc-1	1943	4602	227	N	+2	02/23/43	0	25	N	--	--	
93	(C-17-7) 17acc-1	1961	4600	520	N	4	10/16/61	30	56	N	--	--	
94	(C-17-7) 17cbb-1	1987	4596	180	1	16	10/29/87	2	26	N	160	180	
95	(C-17-7) 17ccd-1	1952	4597	321	N	+2	11/13/52	160	190	N	--	--	
96	(C-17-7) 17dcb-1	1954	4600	210	N	6	--	170	200	N	--	--	
97	(C-17-7) 18dad-1	1968	4595	133	N	+1	10/03/62	38	60	N	126	--	
98	(C-17-7) 18ddd-1	1955	4595	240	N	+F	08/00/55	30	70	N	--	--	
99	(C-17-7) 19daa-1	1946	4595	225	N	+F	04/12/46	40	80	N	--	--	
100	(C-17-7) 20bbb-1	1982	4600	155	1	41	07/18/82	8	83	N	135	155	
101	(C-17-7) 20bbd-1	1941	4600	170	N	4	12/20/41	30	90	N	--	--	
102	(C-17-7) 21acc-1	1965	4600	299	N	6	04/20/65	31	60	N	289	--	
103	(C-17-7) 21ccb-1	1953	4595	240	N	+F	10/00/53	30	70	N	--	--	
104	(C-17-7) 22bdd-1	1986	4600	229	1	10	09/00/86	0	30	N	--	--	
105	(C-17-7) 22cdc-1	1985	4600	200	N	4	06/15/85	131	173	N	180	200	
106	(C-17-7) 22daa-1	1981	4607	280	1	19	11/20/81	3	38	N	258	280	
107	(C-17-7) 22dab-1	1961	4606	450	N	3	06/19/61	39	65	N	380	--	
108	(C-17-7) 23dad-1	1941	4607	180	N	+F	05/15/41	140	170	N	--	--	
109	(C-17-7) 25baa-1	1994	4609	295	1	21	10/20/94	0	25	N	275	292	
110	(C-17-7) 26aaa-1	1954	4605	446	N	+15	11/29/54	58	92	N	--	--	
111	(C-17-7) 26bac-1	1983	4607	200	1	20	05/30/83	3	32	N	180	200	
112	(C-17-7) 26dbc-1	1960	4602	782	N	+4	01/10/61	32	60	N	752	782	
113	(C-17-7) 27bda-1	1979	4595	190	N	12	08/25/79	32	80	N	140	180	
114	(C-17-7) 27bdc-1	1980	4595	180	1	16	04/26/80	3	41	N	160	180	
115	(C-17-7) 27dbc-1	1952	4596	284	N	+4	09/27/52	28	73	N	--	--	
116	(C-17-7) 29ada-1	1944	4590	175	N	+F	05/12/44	60	140	N	--	--	
117	(C-17-7) 29adc-1	1952	4589	347	N	+F	08/00/52	20	220	N	--	--	
118	(C-17-7) 29bbb-1	1964	4593	273	N	+3	04/14/64	31	56	N	--	--	
119	(C-17-7) 29ddb-1	1976	4587	161	N	+1	09/00/76	18	140	N	--	--	
120	(C-17-7) 30cbb-1	1954	4580	220	N	+F	06/00/54	30	80	N	--	--	
121	(C-17-7) 32ada-1	1951	4587	370	N	+F	09/00/51	80	120	N	--	---	
122	(C-17-7) 32cad-1	1949	4583	200	N	+F	12/10/49	130	170	N	--	--	
123	(C-17-7) 32daa-1	1958	4589	412	N	+6	05/00/57	41	63	N	--	--	
124	(C-17-7) 33cdd-1	1979	4590	188	N	10	08/00/79	38	180	N	178	--	
125	(C-17-7) 34bba-1	1954	4593	165	N	+F	11/10/54	25	55	N	--	--	
126	(C-17-7) 25cba-1	1949	4575	245	N	+1	12/02/49	24	66	N	--	--	

Site Number	Local well number	Year well drilled	Elev- ation (ft)	Well depth (ft)	Re- charge area	Water level (ft)	Water- level date	Top of confining layer (ft)	Bottom of confining layer (ft)	Depth to bedrock (ft)	Top of perfor- ations (ft)	Bottom of perfor- ations (ft)	Notes
127	(C-17-7) 26caa-1	1950	4575	200	N	+F	05/05/50	100	140	N	--	--	
128	(C-17-7) 36dab-1	1956	5477	210	N	+F	04/00/56	30	70	N	--	--	
129	(C-17-7) 36dad-1	1946	4575	115	N	+F	01/12/46	1	50	N	--	--	
134	(C-18-5) 22cba-1	1967	4775	495	Y	--	--	--	--	N	106	480	
135	(C-18-5) 27bab-1	1951	4770	397	Y	55	01/14/51	--	--	N	90	397	
136	(C-18-5) 27bab-2	1974	4775	505	Y	95	05/24/74	--	--	N	165	500	
137	(C-18-5) 27cab-1	1957	4755	495	N	38	05/29/57	75	140	N	210	210	
138	(C-18-5) 27ddb-1	1941	4785	174	I	83	07/03/41	7	44	N	--	--	
139	(C-18-5) 32abc-1	1967	4670	166	N	11	01/04/67	30	140	N	140	164	
140	(C-18-5) 33cdd-1	1957	4700	250	N	+5	10/31/57	11	32	N	--	--	
141	(C-18-5) 34aac-1	1943	4780	225	I	50	12/15/43	4	30	N	--	--	
142	(C-18-5) 34adb-1	1970	4780	512	Y	92	09/00/69	--	--	N	105	509	
143	(C-18-5) 34bba-1	1967	4745	525	I	60	05/20/67	15	55	N	60	515	
144	(C-18-5) 34bca-2	1982	4745	523	Y	65	04/10/82	--	--	N	280	523 MI	
145	(C-18-5) 34caa-1	1950	4755	245	I	35	07/29/50	8	35	N	--	--	
146	(C-18-5) 34ccd-1	1984	4735	200	Y	35	01/25/84	--	--	N	180	200	
147	(C-18-5) 35bdb-1	1971	4810	495	Y	123	05/06/71	--	--	483	140	471	
148	(C-18-7) 4aba-1	1979	4590	213	N	10	10/00/79	36	58	N	202	--	
149	(C-18-7) 4bab-1	1952	4585	447	N	+8	12/02/52	26	65	N	--	--	
150	(C-18-7) 4bbc-2	1941	4585	165	N	+F	08/06/41	60	140	N	--	--	
151	(C-18-7) 4bdb-1	1956	4587	314	N	+F	05/00/56	30	80	N	--	--	
152	(C-18-7) 5aac-1	1976	4585	174	I	3	12/00/76	97	165	N	--	--	
153	(C-18-7) 5bba-1	1979	4580	206	N	4	08/00/79	36	87	N	197	--	
154	(C-18-7) 5bda-1	1993	4582	218	N	2	08/30/93	85	160	N	180	218	
155	(C-18-7) 5cda-1	1949	4580	330	N	+F	11/01/49	20	60	N	--	--	
156	(C-18-8) 24ada-1	1960	4567	601	N	+12	12/03/60	0	60	N	589	--	cinders
157	(C-18-10) 26bda-1	1951	4580	281	I	43	05/00/51	7	52	N	--	--	
158	(C-19-4) 7add-1	1958	4920	550	I	48	01/15/59	10	65	N	130	130	
159	(C-19-4) 17bcc-1	1970	4860	153	Y	132	04/05/70	--	--	N	138	151	
160	(C-19-4) 17ccb-1	1982	4850	357	I	153	06/01/82	0	39	344	110	350 MI	
161	(C-19-4) 17ccc-1	1970	4843	400	Y	114	08/28/70	--	--	N	120	396	
162	(C-19-4) 18add-1	1977	4860	240	Y	142	08/24/77	--	--	N	220	240	
163	(C-19-4) 18cbc-1	1971	4800	222	I	84	04/01/71	40	100	N	--	--	
164	(C-19-4) 19bcd-1	1945	4800	199	I	59	07/07/45	32	60	N	--	--	
165	(C-19-4) 20acc-1	1955	4866	170	Y	110	01/27/55	--	--	N	162	170	
166	(C-19-4) 29abc-1	1970	4850	380	I	110	04/07/70	4	90	N	135	365	
167	(C-19-4) 29bbd-1	1945	4836	172	I	72	05/30/45	0	85	N	168	172	
168	(C-19-4) 29bcd-1	1963	4830	390	Y	54	03/00/63	--	--	N	3	380 MI	
169	(C-19-4) 29cbb-1	1976	4825	180	I	84	02/02/76	120	155	N	165	180	
170	(C-19-4) 31acc-1	1946	4790	150	I	32	10/17/46	30	84	N	--	--	
171	(C-19-4) 31ada-1	1961	4815	545	Y	52	06/10/61	--	--	N	40	408	
172	(C-19-4) 32acc-1	1946	4845	210	Y	70	07/19/46	--	--	N	--	--	

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173	(C-19-4) 32cca-1	1961	4830	465	Y	67	05/05/61	--	--	N	70	433	
174	(C-19-4) 32cdc-1	1977	4830	180	Y	120	07/20/77	--	--	N	165	180	
175	(C-19-5) 3adc-1	1965	4755	530	Y	48	03/24/65	--	--	N	100	504	
176	(C-19-5) 4daa-1	1968	4725	535	1	41	10/17/68	25	65	N	70	472	
177	(C-19-5) 8dcc-1	1954	4635	270	N	+4	12/31/54	11	60	N	--	--	
178	(C-19-5) 10cbc-1	1974	4750	240	Y	75	05/20/74	--	--	N	90	220	
179	(C-19-5) 12abc-1	1967	4835	350	Y	115	02/15/67	--	--	N	115	340	
180	(C-19-5) 12dbc-1	1971	4825	374	Y	104	02/01/71	--	--	N	121	370	
181	(C-19-5) 23cdd-1	1981	4725	355	Y	40	03/20/81	--	--	N	68	355	
182	(C-19-5) 23dcd-1	1962	4740	460	Y	11	02/28/62	--	--	N	130	391 MI	
183	(C-19-5) 24abb-1	1973	4780	310	Y	63	12/00/73	--	--	N	260	310	
184	(C-19-5) 24cdd-1	1970	4770	475	1	55	03/18/70	7	55	N	75	470	
185	(C-19-5) 26ddd-1	1980	4730	165	1	13	09/30/80	2	22+	N	163	--	
186	(C-19-5) 36baa-1	1950	4760	500	N	2	05/15/50	38	90	N	425	500	
187	(C-19-5) 36dab-1	1973	4765	297	Y	54	08/22/73	--	--	N	--	--	
188	(C-19-5) 36dba-1	1949	4750	201	N	+F	05/00/49	1	196	N	--	--	
189	(C-19-5) 36dca-1	1963	4750	368	Y	25	08/02/63	--	--	N	--	--	
190	(C-19-6) 21bda-1	1982	4638	506	Y	--	--	--	--	N	--	--	basalt 270-275
191	(C-20-4) 5bbb-1	1962	4810	151	Y	75	08/03/62	--	--	N	137	149	
192	(C-20-4) 5caa-1	1970	4830	283	Y	95	09/14/70	--	--	N	125	283	
193	(C-20-4) 5cca-1	1957	4810	565	N	41	04/10/57	54	135	N	155	255	
194	(C-20-4) 5ccd-1	1959	4815	130	Y	42	07/04/59	--	--	N	--	--	
195	(C-20-4) 6aca-1	1960	4796	505	1	26	08/15/60	1	165	N	50	396	
196	(C-20-4) 6bba-1	1982	4770	375	N	50	10/30/82	98	200	N	100	375	
197	(C-20-4) 6bcd-1	1973	4770	261	Y	50	07/23/73	--	--	N	116	--	
198	(C-20-4) 6dbd-1	1962	4790	435	1	40	08/08/62	4	28	N	60	435	
199	(C-20-4) 8dac-1	1967	4890	200	Y	175	10/07/67	--	--	N	182	200	
200	(C-20-4) 18cab-1	1947	4800	100	1	47	08/00/47	20	47	N	47	88 MI	
201	(C-20-4) 30ada-1	1946	5040	144	Y	130	11/29/46	--	--	N	--	--	
202	(C-20-4) 30bba-1	1947	4860	100	1	32	08/00/47	0	25	N	42	50	
203	(C-20-4) 33cdd-1	1963	5170	220	Y	dry	06/00/63	--	--	209	--	--	
204	(C-20-5) 1bcb-1	1948	4725	430	N	+28	12/18/48	11	160	N	320	360	
205	(C-20-5) 1bcb-2	1951	4725	500	N	+20	09/02/51	10	50	N	430	450	
206	(C-20-5) 2ddd-1	1977	4725	202	N	3	11/30/77	25	70	N	190	202	
207	(C-20-5) 10ccc-1	1949	4650	243	N	+3	05/00/49	15	45	N	--	--	
208	(C-20-5) 10daa-1	1976	4685	300	N	+F	12/08/76	--	--	N	70	300	
209	(C-20-5) 10dac-1	1982	4685	220	Y	4	02/17/82	--	--	N	200	220	
210	(C-20-5) 11bdd-1	1979	4710	358	Y	50	08/01/79	--	--	N	50	358	
211	(C-20-5) 12bba-1	1950	4735	203	N	+F	04/10/50	0	67	N	--	--	
212	(C-20-5) 21daa-1	1970	4665	402	N	16	12/01/70	65	85+	N	120	360	
213	(C-20-5) 21daa-2	1961	4660	600	N	3	12/05/61	75	272	N	538	--	
214	(C-20-5) 24bbd-1	1950	4760	390	1	37	08/07/50	30	51	380	100	390	

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215	(C-20-5) 24cad-1	1950	4765	171	1	37	08/00/50	10	54	169	--	--	
216	(C-20-5) 25acb-1	1945	4775	82	1	46	05/12/45	0	42	N	75	80	
217	(C-20-5) 25baa-1	1950	4765	205	Y	35	08/00/50	--	--	196	--	--	
218	(C-20-5) 26aac-1	1948	4760	72	Y	35	04/00/48	--	--	N	--	--	
219	(C-20-5) 26add-1	1950	4761	314	Y	37	09/08/50	--	--	190	214	314	
220	(C-20-5) 26cdc-1	1963	4745	98	Y	65	07/20/63	--	--	N	--	--	
221	(C-20-5) 26dcc-1	1949	4760	107	1	87	05/09/49	35	80	N	--	--	
222	(C-20-5) 26ddd-1	1952	4787	250	1	77	06/03/52	21	80	N	80	140 MI	
223	(C-20-5) 27baa-1	1953	4685	60	1	15	11/15/53	28	50	N	--	--	
224	(C-20-5) 27bac-1	1961	4680	485	1	7	07/20/61	1	25	473	--	--	
225	(C-20-5) 27dcc-1	1976	4690	120	N	27	01/05/76	55	85	N	105	120	
226	(C-20-5) 28adc-1	1984	4665	380	N	10	06/25/84	150	235	N	360	380	
227	(C-20-5) 28add-1	1978	4670	350	Y	20	02/01/78	--	--	N	290	350	
228	(C-20-5) 29adc-1	1958	4655	500	N	+F	04/25/58	43	105	N	--	--	lava 8-43
229	(C-20-5) 32cbb-1	1953	4639	942	N	0	06/20/52	81	160	N	--	--	
230	(C-20-5) 34ccc-1	1979	4670	225	1	35	07/11/79	3	45	N	115	190	
231	(C-20-5) 35bab-1	1992	4740	165	Y	75	05/05/92	--	--	N	145	165	
232	(C-20-6) 21ada-1	1982	4880	1000	Y	--	--	--	--	540	--	--	basalt
233	(C-20-7) 11aab-1	1982	4610	1000	Y	--	--	--	--	N	--	--	basalt
234	(C-20-8) 7aba-1	1959	4580	544	1	--	--	14	101	N	--	--	
235	(C-20-8) 28bcd-1	1979	4613	651	1	40	12/00/79	0	27	N	308	--	
236	(C-21-4) 3ccd-1	1980	5270	205	1	50	06/30/80	3	34	N	50	205	
237	(C-21-4) 7bbc-1	1950	4916	93	Y	68	02/16/50	--	--	N	55	55	
238	(C-21-4) 7dbc-1	1991	4950	168	1	70	05/23/91	45	110	155	92	165	
239	(C-21-4) 7ddb-1	1973	4960	144	Y	90	04/30/73	--	--	N	90	141	
240	(C-21-4) 8bcc-1	1948	5010	114	1	66	12/22/48	0	36	N	--	--	
241	(C-21-4) 8dcc-1	1978	5050	445	Y	158	11/09/78	--	--	N	398	445 MI	
242	(C-21-4) 17baa-1	1955	5050	140	1	85	11/20/55	12	100	N	--	--	
243	(C-21-4) 17cdd-1	1955	5060	222	Y	65	05/00/55	--	--	211	67	211	
244	(C-21-4) 18bbc-1	1970	4940	140	Y	113	09/15/70	--	--	N	115	140	
245	(C-21-5) 1cbb-1	1976	4920	102	Y	46	02/07/76	--	--	N	85	100	
246	(C-21-5) 3bbb-1	1957	4680	105	1	25	10/26/57	1	40	N	78	95 MI	
247	(C-21-5) 3bcb-1	1992	4690	220	1	35	09/07/92	1	70	N	70	200 MI	
248	(C-21-5) 5abd-1	1960	4645	206	Y	44	07/10/60	--	--	N	32	78 MI	
249	(C-21-5) 5bdb-1	1974	4640	263	1	25	04/14/74	4	40	N	55	210	
250	(C-21-5) 5dcb-1	1961	4655	565	N	32	11/01/61	65	140	N	165	546	
251	(C-21-5) 6caa-1	1956	4640	90	Y	45	06/03/56	--	--	N	--	--	lava
252	(C-21-5) 6ccc-1	1981	4650	100	Y	55	05/19/81	--	--	N	68	93	lava
253	(C-21-5) 7cdd-1	1953	4650	96	1	41	03/17/53	6	27	27	--	--	lava
254	(C-21-5) 8add-1	1963	4690	270	1	59	12/28/63	50	220	N	215	242	
255	(C-21-5) 8bab-1	1966	4655	322	1	80	05/03/66	75	135	N	300	319	
256	(C-21-5) 8ccd-1	1959	4670	278	1	33	06/00/59	33	57	N	33	57	

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257	(C-21-5) 8dcd-1	1980	4690	160	Y	60	09/24/80	--	--	N	140	160	
258	(C-21-5) 8dda-1	1977	4700	180	Y	96	08/01/77	--	--	N	160	180	
259	(C-21-5) 10cda-1	1970	4830	240	I	110	01/23/70	3	48	N	116	145	
260	(C-21-5) 11aac-1	1987	4860	160	Y	32	11/11/88	--	--	N	115	160	
261	(C-21-5) 11ada-1	1972	4860	220	I	93	08/01/72	5	35	N	190	220	
262	(C-21-5) 11ddc-1	1960	4860	230	I	135	09/14/60	35	65	N	--	--	
263	(C-21-5) 12adb-1	1973	4900	185	Y	92	04/02/73	--	--	N	115	181	
264	(C-21-5) 12dcb-1	1969	4900	325	Y	97	05/18/64	--	--	265	150	265 MI	
265	(C-21-5) 13bbb-1	1978	4870	232	Y	52	04/19/78	--	--	N	167	230	
266	(C-21-5) 14aaa-1	1977	4870	240	Y	138	07/23/77	--	--	N	205	240	
267	(C-21-5) 15acc-1	1951	4790	135	I	83	06/29/51	80	125	N	--	--	
268	(C-21-5) 15adb-1	1986	4800	417	Y	31	10/07/86	--	--	305	61	206 MI	
269	(C-21-5) 15dbb-1	1963	4790	175	I	86	01/02/63	35	87	N	127	169	
270	(C-21-5) 16aad-1	1960	4760	137	I	63	10/15/59	12	44	N	134	--	
271	(C-21-5) 16bca-1	1970	4720	256	Y	36	12/26/70	--	--	N	115	252 MI	
272	(C-21-5) 16ccc-1	1982	4710	505	Y	92	--	--	--	N	90	500 MI	lava
273	(C-21-5) 16ddc-1	1979	4750	223	Y	65	03/26/79	--	--	N	--	--	
274	(C-21-5) 17cdd-1	1981	4780	198	Y	21	12/21/81	--	--	N	--	--	
275	(C-21-5) 17ddc-1	1978	4700	224	I	74	10/02/78	33	100	N	--	--	
276	(C-21-5) 18daa-1	1978	4665	90	I	70	05/23/78	5	55	N	75	--	lava
277	(C-21-5) 18dad-1	1981	4665	110	Y	65	05/13/81	--	--	N	80	--	lava
278	(C-21-5) 18ddd-1	1953	4670	135	Y	53	03/29/53	--	--	N	55	88	lava
279	(C-21-5) 19add-1	1955	4670	670	N	+F	06/01/55	20	175	N	425	650	
280	(C-21-5) 19ccd-1	1951	4655	520	N	+20	05/10/51	75	118	N	--	--	lava
281	(C-21-5) 19dcd-1	1954	4665	615	N	+F	12/12/54	180	215	N	420	607	
282	(C-21-5) 20aaa-1	1984	4700	240	N	+F	12/07/84	40	230	N	235	240	
283	(C-21-5) 20aba-1	1978	4690	252	I	50	06/12/78	45	67	N	237	252	
284	(C-21-5) 20abb-1	1978	4685	150	Y	52	06/10/78	--	--	N	133	148	
285	(C-21-5) 20bab-1	1953	4675	480	N	+40	11/28/53	185	252	N	430	480	
286	(C-21-5) 20dda-1	1961	4705	213	N	20	02/10/61	38	115	N	--	--	
287	(C-21-5) 20ddd-1	1981	4705	220	I	18	01/19/81	5	38	N	200	220	
288	(C-21-5) 21aaa-1	1973	4760	168	Y	55	11/01/73	--	--	N	138	168	
289	(C-21-5) 21abc-1	1965	4735	251	Y	40	01/21/65	--	--	N	170	251 MI	
290	(C-21-5) 21cba-1	1955	4716	630	N	+F	03/28/55	17	175	N	335	605	
291	(C-21-5) 22aaa-1	1980	4810	200	Y	140	04/18/80	--	--	N	180	200	
292	(C-21-5) 22cdb-1	1960	4780	120	I	60	05/06/60	10	55	N	--	--	
293	(C-21-5) 26abb-1	1970	4865	410	Y	185	11/16/70	--	--	N	115	402	
294	(C-21-5) 28aaa-1	1956	4750	510	I	40	--	69	130	N	300	300	
295	(C-21-5) 28dac-1	1974	4740	257	Y	45	04/02/74	65	257	N	65	257	
296	(C-21-5) 29aad-1	1961	4705	435	I	10	05/07/61	1	20+	N	330	424	
297	(C-21-5) 29aba-1	1978	4690	406	N	17	09/02/78	65	119	N	249	393	
298	(C-21-5) 29ada-1	1955	4705	598	N	+F	02/01/55	200	225	N	350	598	

Site Number	Local well number	Year well drilled	Elev- ation (ft)	Well depth (ft)	Re- charge area	Water level (ft)	Water- level date	Top of confining layer (ft)	Bottom of confining layer (ft)	Depth to bedrock (ft)	Top of perfor- ations (ft)	Bottom of perfor- ations (ft)	Notes
299	(C-21-5) 29bdd-1	1953	4690	437	N	+40	07/05/53	25	56	N	310	421	
300	(C-21-5) 29cdd-1	1953	4690	580	N	+40	09/10/53	0	100	N	360	580	
301	(C-21-5) 29ddd-1	1976	4710	504	1	28	10/14/76	0	29	N	130	468	
302	(C-21-5) 33aad-1	1961	4745	352	Y	52	10/20/61	--	--	N	190	350	
303	(C-21-5) 33bcc-1	1960	4713	350	N	+F	03/00/60	8	30	N	150	349	
304	(C-21-5) 33ccd-1	1955	4723	250	N	+F	02/00/55	--	--	N	185	250	
305	(C-21-5) 33cdd-2	1937	4730	134	1	17	05/10/37	1	22	N	60	80	
306	(C-21-5) 34bbb-1	1977	4750	200	Y	71	09/29/77	--	--	N	130	200	
307	(C-21-5) 34cdd-1	1951	4780	380	N	+F	06/25/51	18	80	N	86	380 MI	
308	(C-21-5) 35cda-1	1972	4840	168	Y	145	05/27/72	--	--	N	150	168	
309	(C-21-6) 5cad-1	1964	4642	128	Y	127	02/26/64	--	--	15	100	127	lava
310	(C-21-6) 24ddc-1	1979	4660	162	1	31	12/18/76	3	75	116	--	--	lava
311	(C-21-6) 25bab-1	1981	4660	150	1	70	05/20/81	37	138	138	130	138	lava
312	(C-21-6) 26aca-1	1953	4675	105	Y	64	05/00/53	--	--	N	--	--	lava
313	(C-21-6) 30dbb-1	1984	4660	295	1	20	09/00/84	5	98	190	--	--	lava
314	(C-21-6) 36cdd-1	1964	4670	815	N	+F	--	76	153	N	--	--	
315	(C-21-7) 10bdc-1	1976	4636	100	Y	51	12/01/76	--	--	N	75	100	
316	(C-21-7) 24acb-1	1955	4645	420	N	--	--	0	55	N	--	--	lava
317	(C-21-7) 34dab-1	1964	4700	117	1	50	02/26/64	2	90	N	90	116	
318	(C-21-8) 12dcc-1	1974	4650	150	1	40	05/31/74	30	85	N	--	--	
319	(C-21-9) 25acc-1	1935	4780	225	1	28	09/04/35	0	33	N	--	--	
320	(C-21-9) 36cdb-1	1979	4795	780	1	209	10/30/79	17	105	N	--	--	
321	(C-22-5) 2aad-1	1953	4900	335	Y	140	03/20/53	--	--	N	191	191	
322	(C-22-5) 2bac-1	1975	4840	401	Y	93	03/20/75	--	--	N	111	400 MI	
323	(C-22-5) 3abb-1	1990	4785	187	1	90	01/22/90	32	140	N	155	187	
324	(C-22-5) 3ccd-1	1956	4775	142	1	25	03/10/56	5	45	N	--	--	
325	(C-22-5) 4aab-1	1979	4745	180	1	45	10/09/79	22	120	N	160	180	
326	(C-22-5) 4bbd-1	1955	4726	250	N	+10	01/10/55	22	55	N	195	250 MI	
327	(C-22-5) 4cbd-1	1955	4721	276	N	3	06/00/55	12	62	N	62	257 MI	
328	(C-22-5) 4dca-1	1979	4750	422	1	40	06/16/79	4	38	N	95	422	
329	(C-22-5) 8cdd-1	1961	4725	470	1	20	08/27/61	75	100	N	255	456	
330	(C-22-5) 9bba-1	1955	4730	555	N	5	07/00/55	145	200	N	259	549 MI	
331	(C-22-5) 9dbc-1	1974	4752	253	1	58	01/15/74	15	105	N	210	253	
332	(C-22-5) 10dad-1	1978	4880	200	1	85	11/16/78	30	60	N	160	200	
333	(C-22-5) 17bdd-1	1977	4735	309	N	2	10/25/77	28	156	N	275	309	
334	(C-22-5) 17dad-1	1959	4755	490	1	20	06/00/59	42	64	N	60	60	
335	(C-22-5) 17dbd-1	1957	4745	560	N	+F	04/00/57	7	40	N	310	540	
336	(C-22-5) 19ddd-1	1967	4755	435	1	15	03/13/67	1	32	N	212	427	
337	(C-22-5) 20dca-1	1970	4780	348	Y	18	12/30/70	--	--	N	221	346	
338	(C-22-5) 21dcc-1	1971	4800	403	Y	51	10/25/71	--	--	N	80	401	
339	(C-22-5) 22bcc-1	1981	4840	180	1	90	05/19/81	3	37	N	162	180	
340	(C-22-5) 22dac-1	1959	4900	330	1	123	10/10/59	60	85	330	140	309	

Site Number	Local well number	Year well drilled	Elev-ation (ft)	Well depth (ft)	Re-charge area	Water level (ft)	Water-level date	Top of confining layer (ft)	Bottom of confining layer (ft)	Depth to bedrock (ft)	Top of perfor-ations (ft)	Bottom of perfor-ations (ft)	Notes
341	(C-22-5) 22dcc-1	1953	4880	340	Y	45	08/10/53	--	--	N	290	340	
342	(C-22-5) 22ddc-1	1974	4900	205	1	140	10/30/74	5	41	N	55	200	
343	(C-22-5) 23acb-1	1959	5030	260	Y	180	07/00/59	--	--	N	135	135	
344	(C-22-5) 23bca-1	1959	4970	240	1	42	09/15/59	8	32	N	80	80	
345	(C-22-5) 23ccc-2	1981	4940	160	1	120	04/24/81	32	130	N	140	160	
346	(C-22-5) 26bbb-1	1992	4960	200	Y	149	05/10/92	--	--	N	180	200	
347	(C-22-5) 27aac-1	1985	4900	140	Y	56	11/01/85	--	--	N	120	140	
348	(C-22-5) 28adc-1	1977	4815	300	Y	69	09/23/77	--	--	N	190	300	
349	(C-22-5) 29bcd-1	1971	4770	387	1	25	12/13/71	5	35	N	250	385	
350	(C-22-5) 29cdd-1	1975	4775	380	1	25	06/29/75	2	60	N	170	369	
351	(C-22-5) 29daa-1	1953	4880	265	N	+2	06/15/53	28	147	N	--	--	
352	(C-22-5) 32cdd-1	1956	4810	256	N	46	11/00/56	--	--	N	68	246	
353	(C-22-5) 32dac-1	1937	4805	182	1	36	08/08/37	3	37	N	65	178 MI	
354	(C-22-5) 33bad-1	1967	4810	415	Y	55	02/10/67	--	--	N	106	401	
355	(C-22-5) 33ccd-1	1950	4830	240	Y	51	07/17/50	--	--	N	75	174	
356	(C-22-5) 33cdd-1	1959	4830	270	1	70	08/26/59	45	87	N	127	266	
357	(C-22-6) 2cbc-1	1977	4690	380	Y	116	10/01/77	--	--	N	200	380	
358	(C-22-6) 3daa-1	1976	4687	337	N	28	04/07/76	65	115	332	133	337	lava
359	(C-22-6) 11acd-1	1965	4690	61	N	8	05/26/65	--	--	53	--	--	lava
360	(C-22-6) 20bbb-1	1958	4747	152	Y	76	06/00/58	--	--	N	22	--	lava
361	(C-22-6) 32dad-1	1953	4700	400	Y	19	01/03/53	--	--	N	26	231 MI	lava
362	(C-22-6) 32dcc-1	1953	4700	115	1	16	12/16/53	9	43	N	65	115	lava
363	(C-22-6) 35ccc-1	1991	4770	152	Y	20	07/31/91	--	--	122	140	145	lava/bedrock well
364	(C-22-7) 33daa-1	1959	4820	590	1	--	--	7	110	N	--	--	
365	(C-22-8) 5aaa-1	1949	4690	134	1	40	05/21/49	0	70	N	124	124	
366	(C-22-8) 12dca-1	1935	4750	70	1	39	11/24/35	0	50	N	50	50	
367	(C-23-5) 5acd-1	1959	4840	353	1	95	04/11/59	6	68	N	95	350	pra
368	(C-23-5) 5adc-1	1952	4850	180	Y	68	10/05/50	--	--	N	73	180 MI	
369	(C-23-5) 6dbc-1	1964	4830	197	Y	70	08/28/64	--	--	N	100	170	
370	(C-23-6) 2dad-1	1953	4800	400	Y	--	--	--	--	N	--	--	
371	(C-23-6) 3dbc-1	1950	4740	118	Y	32	10/25/50	--	--	99	--	--	lava
372	(C-23-6) 5cbc-1	1953	4710	162	1	35	04/00/53	5	41	64	--	--	lava
373	(C-23-6) 5ddc-1	1965	4705	132	1	42	01/20/65	10	52	72	95	--	lava
374	(C-23-6) 9bca-1	1957	4705	170	1	30	10/00/57	21	84	104	106	--	lava
375	(C-23-6) 10bdd-1	1982	4750	504	1	64	04/26/82	0	32	489	325	425	lava
376	(C-23-6) 10dda-1	1952	4780	200	Y	70	08/00/52	--	--	N	--	--	lava
377	(C-23-6) 10ddd-1	1979	4780	382	Y	82	05/15/79	--	--	N	222	382	lava
378	(C-23-6) 15bbd-1	1949	4745	141	1	35	--	0	32	75	--	--	basalt
379	(C-23-6) 15bca-1	1963	4750	200	Y	81	10/03/63	--	--	N	--	--	basalt
380	(C-23-6) 16bad-1	1955	4720	130	1	43	04/30/55	0	83	117	83	117	lava
381	(C-23-6) 16cdd-1	1950	4740	148	1	37	10/16/50	37	109	N	92	150	cinders
382	(C-23-6) 21add-1	1957	4800	445	1	97	03/03/57	14	28	297	100	100	lava

Site Number	Local well number	Year well drilled	Elev- ation (ft)	Well depth (ft)	Re- charge area	Water level (ft)	Water- level date	Top of confining layer (ft)	Bottom of confining layer (ft)	Depth to bedrock (ft)	Top of perfor- ations (ft)	Bottom of perfor- ations (ft)	Notes
383	(C-23-6) 21cdd-1	1961	4790	285	I	95	09/00/61	4	32	93	115	285	lava
384	(C-23-6) 22caa-1	1945	4840	150	I	122	05/21/45	25	112	N	130	145	
385	(C-23-6) 28bbb-1	1961	4770	290	I	70	04/16/61	8	70	190	70	290	lava
386	(C-23-6) 29baa-1	1959	4760	200	I	65	03/15/59	10	72	N	72	198	
387	(C-23-6) 31ccb-1	1949	4920	237	Y	215	04/28/49	--	--	N	--	--	
388	(C-23-7) 16add-1	1959	4900	390	I	225	10/09/59	5	75	N	--	--	
389	(C-23-7) 23ada-1	1972	4960	700	I	284	02/14/72	155	317	N	317	491	
390	(C-23-9) 12dcc-1	1952	4800	800	I	35	02/15/52	0	35	N	--	--	
391	(C-17-8) 25cba-1	1949	4575	245	N	+1	12/02/49	24	66	N	--	--	
392	(C-17-8) 26cca-1	1950	4575	200	N	+F	05/05/50	100	140	N	--	--	
393	(C-17-8) 36dab-1	1956	4575	210	N	+F	04/21/56	30	70	N	--	--	
394	(C-17-8) 36dad-1	1946	4575	115	N	+F	01/12/46	1	50	N	--	--	
395	(C-18-8) 4bbb-1	1949	4560	181	N	+F	09/12/49	121	161	N	--	--	