Section 5.—Conceptual Understanding and Groundwater Quality of the Basin-Fill Aquifer in Spanish Springs Valley, Nevada

By Jena M. Huntington

in

Conceptual Understanding and Groundwater Quality of Selected Basin-Fill Aquifers in the Southwestern United States

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Basin Overview

Spanish Springs Valley is a relatively small basin about 5 mi northeast of Reno, Nevada within the Truckee River Basin (fig. 1) that is undergoing rapid population growth. The valley is bounded on the east by the Pah Rah Range, whose highest summit, Spanish Springs Peak, reaches an altitude of about 7,400 ft. To the west are Hungry Ridge and an unnamed extension that approaches an altitude of 6,000 ft. The northern border of the valley is a bedrock outcrop that creates a topographic divide less than 0.5 mi long between Hungry Ridge and the Pah Rah Range, while shallow bedrock marks the southern boundary (Berger and others, 1997). The drainage area for Spanish Springs Valley is about 77 mi^2, of which basin fill covers about 29 mi^2. The valley is about 11 mi long and 3 to 4 mi wide, and slopes from an altitude of about 4,600 ft in the north to about 4,400 ft in south.

Spanish Springs Valley has an arid to semiarid climate as a result of its location within the rain shadow of the Sierra Nevada Range. Summers are hot and dry, with daytime temperatures occasionally exceeding 100°F, and winters are cool, with temperatures sometimes falling below 0°F (Berger and others, 1997). Analysis of modeled precipitation data for 1971–2000 (PRISM Group, Oregon State University, 2004) resulted in an average annual precipitation value of about 9 in. over the Spanish Springs Valley floor (McKinney and Anning, 2009). The surrounding mountains receive 9 to 11 in. of precipitation in an average year, and more than 13 in. may fall at the higher altitudes of the Pah Rah Range (Berger and others, 1997). There are no naturally perennial streams in the valley.

Rangeland covers much of Spanish Springs Valley, while only a small part is agricultural land (U.S. Geological Survey, 2003). The Orr Ditch, a diversion from the Truckee River used for irrigation, flows into the valley from the south and terminates near its center. Water from the diversion, combined with minor amounts of water from springs and wells, irrigated about 550 acres of agricultural land in 2001, primarily alfalfa and pasture. Irrigation return flow and some groundwater discharge is collected in the North Truckee Drain and returned to the Truckee River in the Truckee Meadows basin to the south.

In 2008, the population of Spanish Springs Valley was calculated as about 47,000 within the alluvial basin, of which about 18.5 mi^2, or about 23 percent, was residential land (Christian Kropf, Washoe County Department of Water Resources, written commun., 2009). Groundwater pumped from the basin-fill aquifer is an important source of drinking water in the valley, although plans are for future population growth to be supported by imported water from the Truckee River (Truckee Meadows Water Authority, 2004).

Infiltration from septic-tank systems has become a source of groundwater recharge in some residential areas in the valley as more than 2,000 systems were installed from the early 1970s to 1995 (Rosen and others, 2006a); in 2009, more than 2,300 such systems were in use (Christian Kropf, written commun., 2009). The Nevada Division of Environmental Protection has issued directives to ensure that existing homes currently on septic systems and new homes in the valley be connected to centralized sewage disposal systems because of increasing nitrate concentrations in groundwater (Rosen and others, 2006a). Elevated concentrations of nitrate in groundwater are an important water-quality concern for the valley.

Water Development History

Spanish Springs Valley was named after several springs on the south central part of the valley floor (fig. 1). A land survey in 1872 noted that the main spring area was about 66 ft long by 33 ft wide and was surrounded by smaller springs (Berger and others, 1997). Early agricultural activity in the valley used the water from these springs and from shallow flowing wells for irrigation. The amount of irrigated land increased in the southern part of the valley after construction of the Orr Ditch in 1878. Agricultural land use within the area serviced by the Orr Ditch has remained relatively unchanged based on comparisons of aerial photographs taken in 1956, 1977, and 1994 and of assessor parcel maps, although since 1994, agricultural acreage has decreased as new homes have been built in the southwestern part of the valley (Berger and others, 1997).

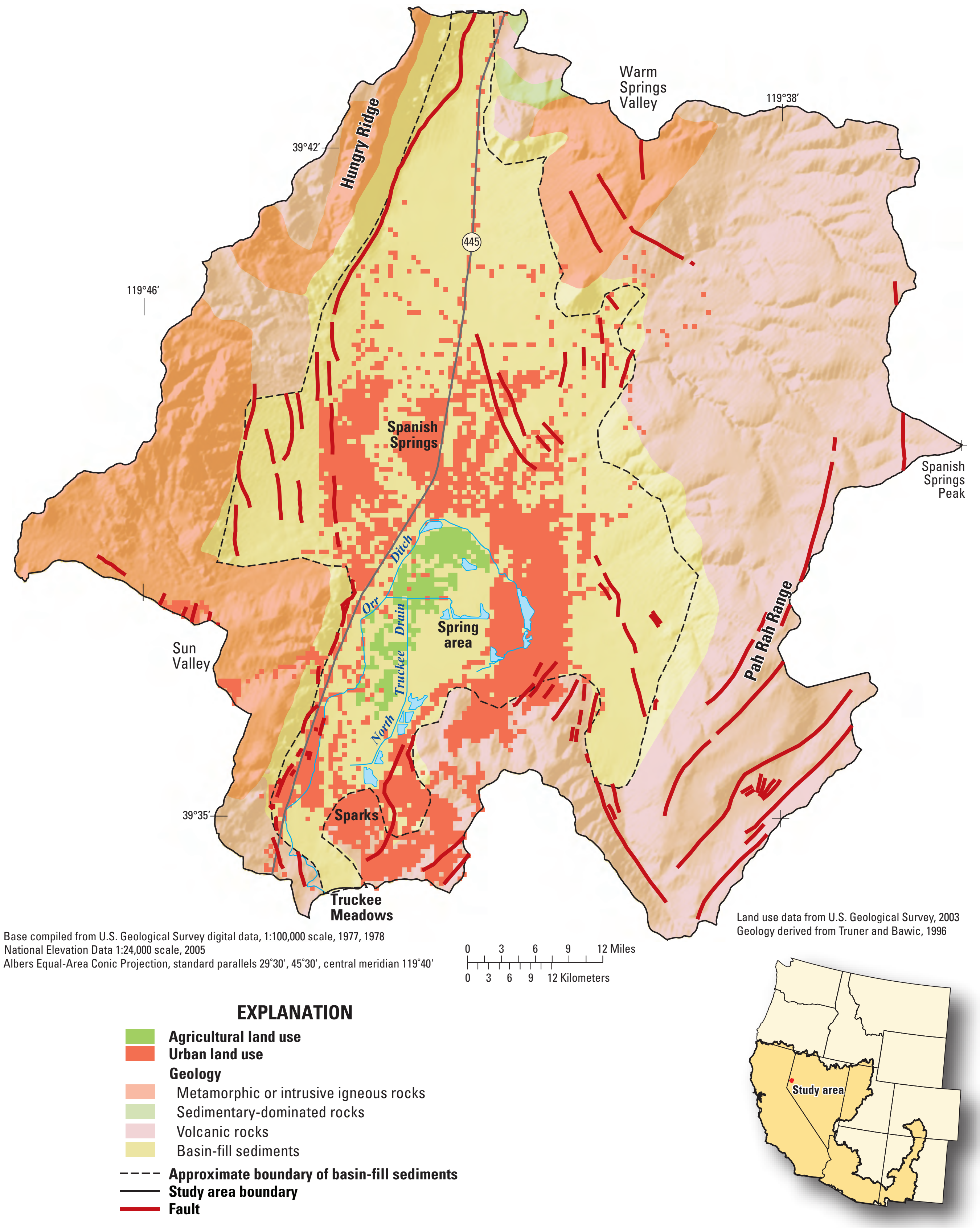

Figure 1. Physiography, land use, and generalized geology of Spanish Springs Valley, Nevada.

Groundwater was used primarily for agriculture until 1983, when it accounted for about half of the total amount pumped (Berger and others, 1997, table 10). Urban development has increased significantly since the late 1970s due to the proximity of Spanish Springs Valley to the expanding Reno-Sparks metropolitan area to the south. The addition of residential subdivisions and mobile home parks sharply increased the valley population of 790 in 1979 to 9,320 in 1994 (Berger and others, 1997, table 10), mostly in the central and southeastern parts of the valley. Homes also are now scattered to the north and near the mountain fronts with population estimates nearing 50,000. Because groundwater is the primary source for public and domestic supply in the valley, its use has increased with population growth. Depths of supply wells range from 200 ft to more than 800 ft, and depths to water range from 20 ft to nearly 200 ft below land surface (Christian Kropf, written commun., 2009).

Hydrogeology

Present-day topographic features, including the structural depressions that underlie Spanish Springs Valley, were formed by extensional faulting that began in the middle to late Tertiary period. The mountains surrounding the valley are composed of Mesozoic-age granitic and metamorphic rocks overlain by Tertiary-age volcanic rocks than contain lenses of sedimentary rocks (fig. 1). These consolidated rocks commonly have low porosity and permeability except were fractured and faulted. Although the volcanic rocks are mainly tuffs and volcanic flows and have little to no interstitial porosity, the interbedded sedimentary rocks are mostly fine-grained, partly consolidated lacustrine deposits with low permeability that may store moderate amounts of water. Connection between the basin-fill deposits and underlying consolidated rocks is suggested by an upward hydraulic gradient in the southeastern part of the valley (Berger and others, 1997).

Erosion from the surrounding mountains during Quaternary time was accompanied by the filling of the valley with interbedded, unconsolidated deposits of sand, gravel, clay and silt. The basin-fill deposits are thickest, at least 1,000 ft thick, on the western side of Spanish Springs Valley along a northeast trending trough-like feature, and become thinner to the east, based on geophysical data and drillers' logs (Berger and others, 1997; Makowski, 2006). The deposits are less than 50 ft thick along the topographic divide that forms the northern boundary of the valley. The basin-fill deposits in the southern part of Spanish Springs Valley are less than 100 ft thick and become less than 20 ft thick along the southern boundary with Truckee Meadows (Berger and others, 1997).

Conceptual Understanding of the Groundwater System

The basin-fill aquifer in Spanish Springs Valley is under mostly unconfined or water-table conditions. Although the basin is topographically closed and has a playa in the central part, the groundwater system is considered to be open, with subsurface outflow at both the northern and sourthern ends (fig. 2). The aquifer is recharged naturally by the infiltration of precipitation falling on the basin margins and on the surrounding mountains, and from human-related sources in the valley such as imported surface water, excess irrigation water, and effluent from septic-tank systems (fig. 2).

Basin-fill deposits originating from volcanic rocks are generally fine grained, and thus have lower hydraulic conductivity than coarser grained deposits derived from granitic rocks. In a groundwater flow model of the basin-fill aquifer, the top layer of the model, representing the upper 330 ft of saturated deposits, was assigned values of hydraulic conductivity ranging from less than 0.03 to 30 ft/d (Schaefer and others, 2007). In most of the central part of the valley, however, the top layer of the model was assigned a hydraulic conductivity of less than 3 ft/d.

Water Budget

Prior to any groundwater development in Spanish Springs Valley, the basin-fill aquifer was recharged by precipitation falling on the surrounding mountains that moved into the basin fill through subsurface fractures or by the infiltration of runoff at the mountain front (fig. 3*A*). Berger and others (1997) estimated this mountain-front recharge at about 830 acre-ft/yr using the Maxey-Eakin method (Maxey and Eakin, 1949 and Eakin and others, 1951), which applies a percentage of average annual precipitation within specified altitude zones to estimate recharge.

Rush and Glancy (1967, table 20) estimated that recharge to the valley under natural (predevelopment) conditions was about 1,000 acre-ft/yr, based on the assumption that the groundwater system was in equilibrium. They estimated groundwater discharge by evapotranspiration prior to construction of the Orr Ditch to be about 900 acre-ft/yr (table 1) (Rush and Glancy, 1967, table 14). Groundwater from Spanish Springs Valley may flow south to Truckee Meadows through a thin layer of basin-fill deposits or through the underlying fractured bedrock (Berger and others, 1997).

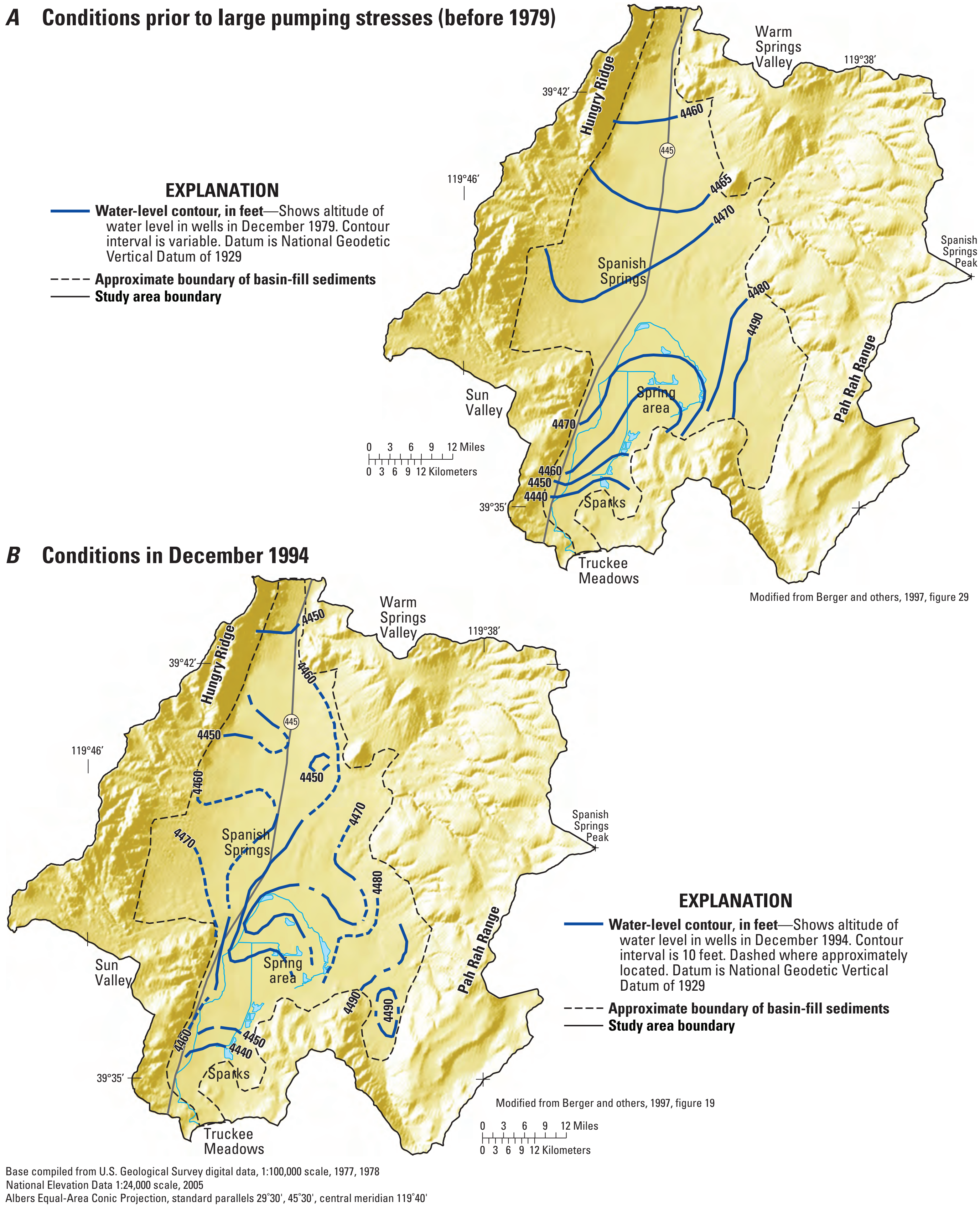

Figure 2. Groundwater levels assumed to represent conditions in Spanish Springs Valley, Nevada (*A*) prior to large pumping stresses (before 1979) and (*B*) in December 1994.

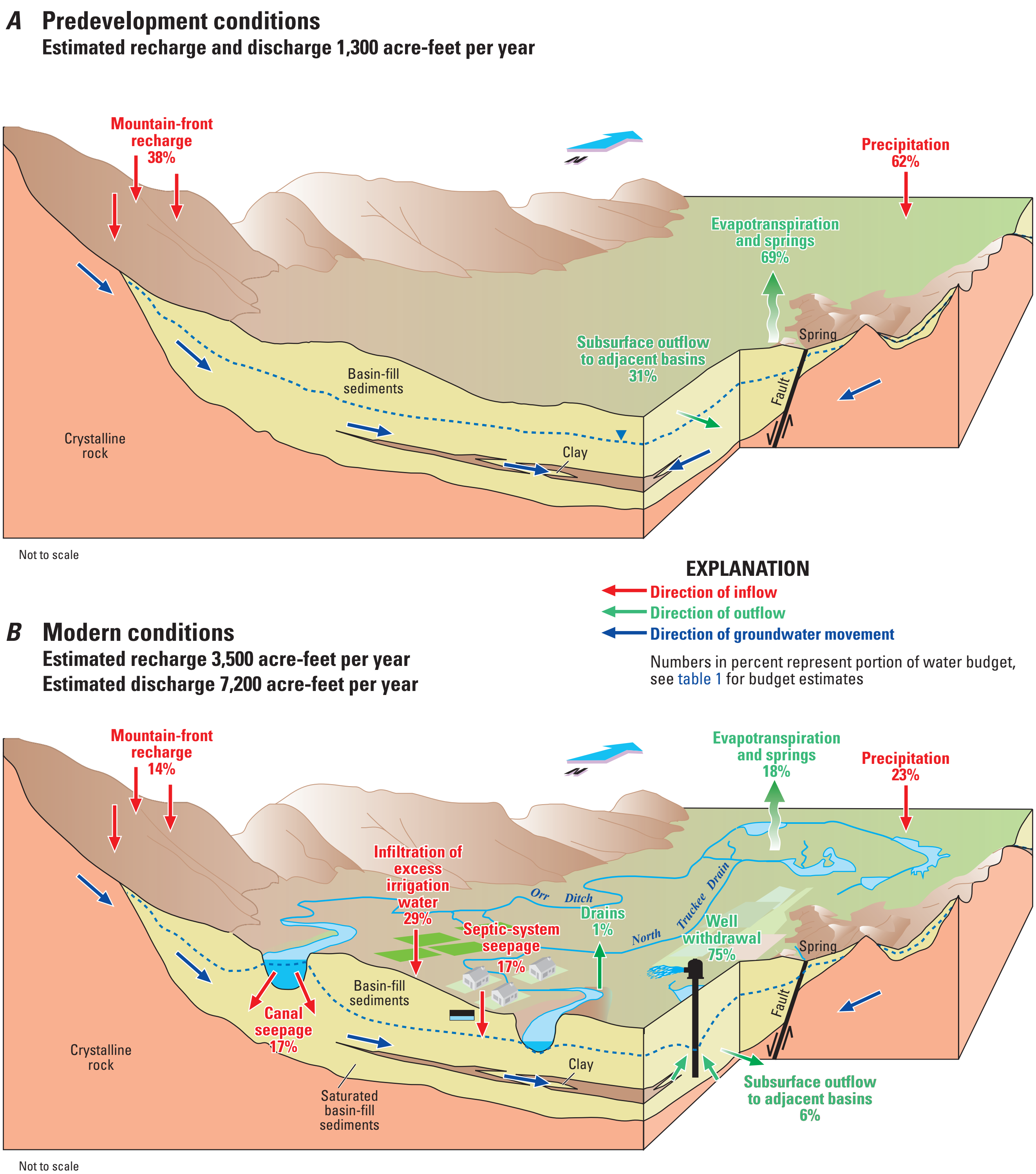

Figure 3. Generalized diagrams for Spanish Springs Valley, Nevada, showing the basin-fill deposits and components of the groundwater system under (*A*) predevelopment and (*B*) modern conditions.

Table 1. Estimated groundwater budget for the basin-fill aquifer in Spanish Springs Valley, Nevada, under predevelopment and modern conditions.

[All values are in acre-feet per year and are rounded to the nearest hundred. Estimates of groundwater recharge and discharge under predevelopment and modern conditions were derived from the footnoted sources. The budgets are intended only to provide a basis for comparison of the overall magnitudes of recharge and discharge between predevelopment and modern conditions, and do not represent a rigorous analysis of individual recharge and discharge components. Percentages for each water budget component are shown in figure 3]

	Predevelopment conditions	Modern conditions	Change from predevelopment to modern conditions
Budget component		**Estimated recharge**	
Mountain-front recharge	[1]500	[1]500	0
Infiltration of precipitation on alluvial basin	[2]800	[2]800	0
Canal seepage	0	[2]600	600
Infiltration of excess irrigation water	0	[2]1,000	1,000
Septic-system seepage	0	[6]600	600
Total recharge	**1,300**	**3,500**	**2,200**
Budget component		**Estimated discharge**	
Evapotranspiration and springs	[3] 900	[2]1,300	400
Well withdrawals	0	[5]5,400	5,400
Drains	0	[2]100	100
Subsurface outflow to south	[3]100	[3]100	0
Subsurface outflow to north	[4]300	[4]300	0
Total discharge	**1,300**	**7,200**	**5,900**
Change in storage (total recharge minus total discharge)	0	-3,700	-3,700

[1] Assumed to equal estimated residual between predevelopment recharge and discharge.

[2] Estimated for 1994 conditions by Berger and others (1997).

[3] Rush and Glancy (1967, table 14).

[4] Hadiaris (1988).

[5] Lopes and Evetts (2004, table 1).

[6] Rosen and others (2006a, p. 10)

Rush and Glancy (1967) used Darcy's Law to estimate about 100 acre-ft/yr of subsurface outflow to the south. A hydraulic gradient between Spanish Springs Valley and Warm Springs Valley may allow subsurface outflow to the north (Berger and others, 1997). About 280 acre-ft/yr was simulated in a steady-state flow model as subsurface outflow through the northern boundary (Hadiaris, 1988), and about 170 acre-ft was simulated under 1994 conditions (Berger and others, 1997, table 11). For this report, total recharge to the basin-fill aquifer in Spanish Springs Valley under predevelopment conditions is assumed to have been in equilibrium with natural discharge through evapotranspiration and estimated subsurface outflow to adjacent basins, and is estimated to have been about 1,300 acre-ft/yr (table 1).

The groundwater budget for Spanish Springs Valley changed with construction of the Orr Ditch in 1878 and the expansion of residential development since about 1979. Many of the estimates of recharge and discharge for the valley presented in this report are for conditions studied in 1994 by Berger and others (1997). In that year transmission losses from the 7-mile long, unlined Orr Ditch locally recharged an estimated 590 acre-ft of Truckee River water to shallow parts of the basin-fill aquifer. In basins similar to Spanish Springs Valley, about 40 percent of applied irrigation is assumed to infiltrate far enough to reach the groundwater system. Therefore, assuming that 40 percent of the water applied for irrigation infiltrates to the water table, about 860 acre-ft of water applied for irrigation from the Orr Ditch recharged shallow parts of the aquifer in 1994 (Berger and others, 1997, p. 47). Recharge from excess (unconsumed) groundwater applied for irrigation outside the area encompassed by the Orr Ditch was estimated to be about 170 acre-ft (Berger and others, 1997, p. 50). Precipitation in 1994 was below normal, resulting in less than the usual amount of water being diverted to the Orr Ditch. More recharge (than in 1994) to the shallow groundwater system from canal seepage and from excess irrigation water likely occurs during average and above average precipitation conditions.

Rapid population growth in Spanish Springs Valley resulted in a large increase in the use of individual septic-tank systems. Seepage from septic system leach fields was estimated to be 75 percent of the total amount of water delivered to homes during the winter months (Berger and others, 1997, p. 50). This equated to about 450 acre-ft of seepage in 1994. Rosen and others (2006a, p. 10) used an estimate of 227 gallons per day for septic tank discharge per household. With continued residential development in the valley, more than 2,300 homes now use septic systems (Rosen and others, 2006a, p. 3), and an estimated 585 acre-ft of seepage from septic-tank systems enters the basin-fill aquifer each year. Residential developments built since 2006 are connected to centralized sewage disposal systems (Joseph Stowell, Washoe County Department of Water Resources, written commun., 2009).

Water pumped from wells increased from about 500 acre-ft in 1979 to 2,600 acre-ft in 1994 (Berger and others, 1997, table 10). About 5,400 acre-ft was pumped in 2000; 56 percent from domestic wells, 43 percent from public-supply wells, and only one percent from irrigation wells (Lopes and Evetts, 2004, table 1). The 6 public-supply wells completed in basin-fill deposits and pumped in 2007 (Washoe County Department of Water Resources, 2008), are located within or near residential areas to the west and north of the Orr Ditch. Prior to residential development, these areas were rangeland, in which the only source of groundwater recharge was from the surrounding mountains. When wells are pumped, the natural directions of groundwater flow near these wells are likely affected, and some water recharged by losses from the Orr Ditch or from excess irrigation water may be intercepted by the wells nearest to the ditch.

Recharge to the shallow part of the basin-fill aquifer from canal seepage and infiltration of excess irrigation water has been accompanied by discharge to the North Truckee Drain and an increase in discharge through evapotranspiration compared to predevelopment conditions (table 1). The difference between estimated recharge and discharge under conditions in 1994, or the amount removed from aquifer storage, is about 3,700 acre-ft/yr. Most of the discharge from the basin-fill aquifer under modern conditions is from wells at least 200 ft deep, whereas most of the recharge is now to shallower parts of the aquifer system. The vertical connection between shallow and deep parts of the aquifer is dependent on the confining layers separating them and the hydraulic gradient between them, although there is little evidence to support laterally extensive confining layers in Spanish Springs Valley.

Groundwater Movement

Under predevelopment conditions, groundwater flowed predominantly from the west and east toward the center of the valley where it is was discharged by evapotranspiration and to springs (fig. 2*A*). North of the Orr Ditch, water also flowed north where it discharged from the valley into an adjacent basin. Following basin development, groundwater flows predominantly to the North Truckee Drain and municipal wells, although some water continues to flow north away from the influence of the Orr Ditch and pumping centers (fig. 2*B*).

Stable-isotope data indicate that Truckee River water moving into the aquifer by infiltration from the Orr Ditch is more enriched in the heavier isotopes of oxygen and hydrogen than is groundwater recharged near the mountain fronts (Berger and others, 1997, fig. 16). Water sampled from a 193-ft deep well about 2,000 ft north of the Orr Ditch had a tritium activity of 10 pCi/L, implying that a component of the water was recharged since about 1958 (Welch, 1994, p. 16; Berger and others, 1997, p. 41). Stable isotope analysis indicates that this water consists of about 35 percent natural recharge and 65 percent Truckee River water from the Orr Ditch (Berger and others, 1997, p. 41), which supports the assumption that some imported Truckee River water flows northward from the Orr Ditch.

Concentrations of stable isotopes in water collected from a well just south of the Spanish Springs Valley border, near the North Truckee Drain, indicate a mixture of natural recharge and Truckee River water (Berger and others, 1997, p. 41). Tritium activities measured in water sampled from wells deeper than 150 ft throughout the valley were less than 1 pCi/L, with the exception of the 2 wells mentioned previously that contain a component of Truckee River water and 3 other wells near the Orr Ditch. These data indicate that precipitation recharged after 1952 (the beginning of above-ground nuclear testing) has not yet reached deeper groundwater in the vicinity of these wells (Welch, 1994, p. 16). Water samples collected from shallow observation wells in the area irrigated with water from Orr Ditch had tritium activites greater than 20 pCi/L, indicative of modern water, or water recharged after 1952. Chloroflourocarbons (CFCs) were analyzed in samples collected in 1993–94 from 19 wells throughout Spanish Springs Valley (Berger and others, 1997). All 19 wells contained concentrations of CFCs such that each has a fraction of modern water.

Effects of Natural and Human Factors on Groundwater Quality

The general water-quality characteristics as well as the occurrence and concentrations of individual chemical constituents and organic compounds of groundwater in Spanish Springs Valley varies areally across the basin. Additional recharge to the basin-fill aquifer system has affected groundwater quality in parts of the basin. Surface water diverted from the Truckee River for irrigation and groundwater pumped for domestic and public supply are now sources of recharge in parts of the valley through water transported in the Orr Ditch, infiltration of excess irrigation water, and septic-tank effluent. Although the shallow part of the groundwater system has received most of this additional recharge water, with a consequent increase in concentrations of dissolved solids and nitrate, the concern is for the deeper aquifer that is the source of drinking-water supply in this growing residential area.

The chemical characteristics of groundwater in the valley were evaluated on the basis of data collected from 22 wells sampled as part of a study on the groundwater flow system in 1993–94 (Berger and others, 1997; data in Emett and others, 1994, p. 557 and Clary and others, 1995, p. 732) and data from 8 water-supply wells sampled as part of the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program in 2002–03 (data in Stockton and others, 2003) (fig. 4). Results of analyses of water from five of the NAWQA sampled wells were used to characterize the occurrence and concentrations of anthropogenic organic compounds in water used for public supply in the valley (Rosen and others, 2006b). Additional groundwater sampling was completed as part of studies to 1) identify sources of nitrate to the groundwater system (Seiler, 2005) and 2) determine the amount of nitrogen entering groundwater from septic-tank systems in the valley (Rosen and others, 2006a; data in Bonner and others, 2004).

General Water-Quality Characteristics and Natural Factors

Water in the basin-fill aquifer system in Spanish Springs Valley is primarily a sodium-bicarbonate/calcium-bicarbonate type. Waters sampled from 2 wells completed in fractured bedrock in the southern part of the valley, however, are a sodium-sulfate type, which likely reflects the mineral composition of the volcanic rocks in the area. Analyses of samples of groundwater collected during several studies in the valley indicate the following general properties and chemical characteristics:

- The pH of the water in 22 wells sampled by Berger and others (1997) ranged from 7.0 to 9.0 with a median value of 7.8; dissolved-oxygen concentrations of these samples ranged from 0.1 to 8.6 mg/L with a median value 2.8 mg/L.
- Dissolved-solids concentrations in the 22 wells sampled by Berger and others (1997) ranged from 155 to 2,680 mg/L with a median value of 237 mg/L. Dissolved-solids concentrations were generally less than 200 mg/L in water from wells in the spring area and the area to the east, less than 260 mg/L in water from wells in the northern and western part of the valley, and greater than 350 mg/L in water from wells near the Orr Ditch.
- Oxidation-reduction (redox) conditions in the aquifer are primarily oxygen reducing (Schaefer and others, 2007, fig. 3.4*B*).
- Arsenic concentrations in water from the eight supply wells sampled in the NAWQA study ranged from 1.5 to 18.8 µg/L (Stockton and others, 2003). In samples from 3 of these wells, the maximum contaminant level (MCL) for arsenic in drinking water of 10 µg/L was exceeded (U.S. Environmental Protection Agency, 2008; each time "MCL" is mentioned in this section, it denotes this citation).

Potential Effects of Human Factors

Recharge associated with human activities accounts for more than half of Spanish Springs Valley's groundwater budget, while pumping from wells is now the primary path of discharge from the basin-fill aquifer (table 1). Pumping and the resulting changes in hydraulic gradients can cause changes in groundwater quality by enhancing the downward movement of shallow groundwater and the vertical or lateral movement of water from adjacent consolidated rock to parts of the basin-fill aquifer used for water supply.

Human activities in the rapidly expanding residential area in the valley have the potential to release chemicals that may ultimately reach supply wells (table 2). Analysis of water samples collected from five public-supply wells in the valley in 2002–03 showed the presence of anthropogenic organic compounds in three wells (Rosen and others, 2006b). The herbicide atrazine and its degradation product deethylatrazine were detected in one well at concentrations less than 0.05 µg/L, much less than the MCL of 3 µg/L for atrazine. The volatile organic compounds (VOCs) chloroform and bromoform (both disinfection byproducts of the water treatment process) were detected in water from one well each, also at very low concentrations, well below the MCL of 80 µg/L for both compounds (each detection was less than 0.05 µg/L; Rosen and others, 2006b, table 3). Although the concentrations of these compounds were not a health concern, their presence in the aquifer indicates the potential for their movement from the land surface and the possibility that higher concentrations may occur in the future.

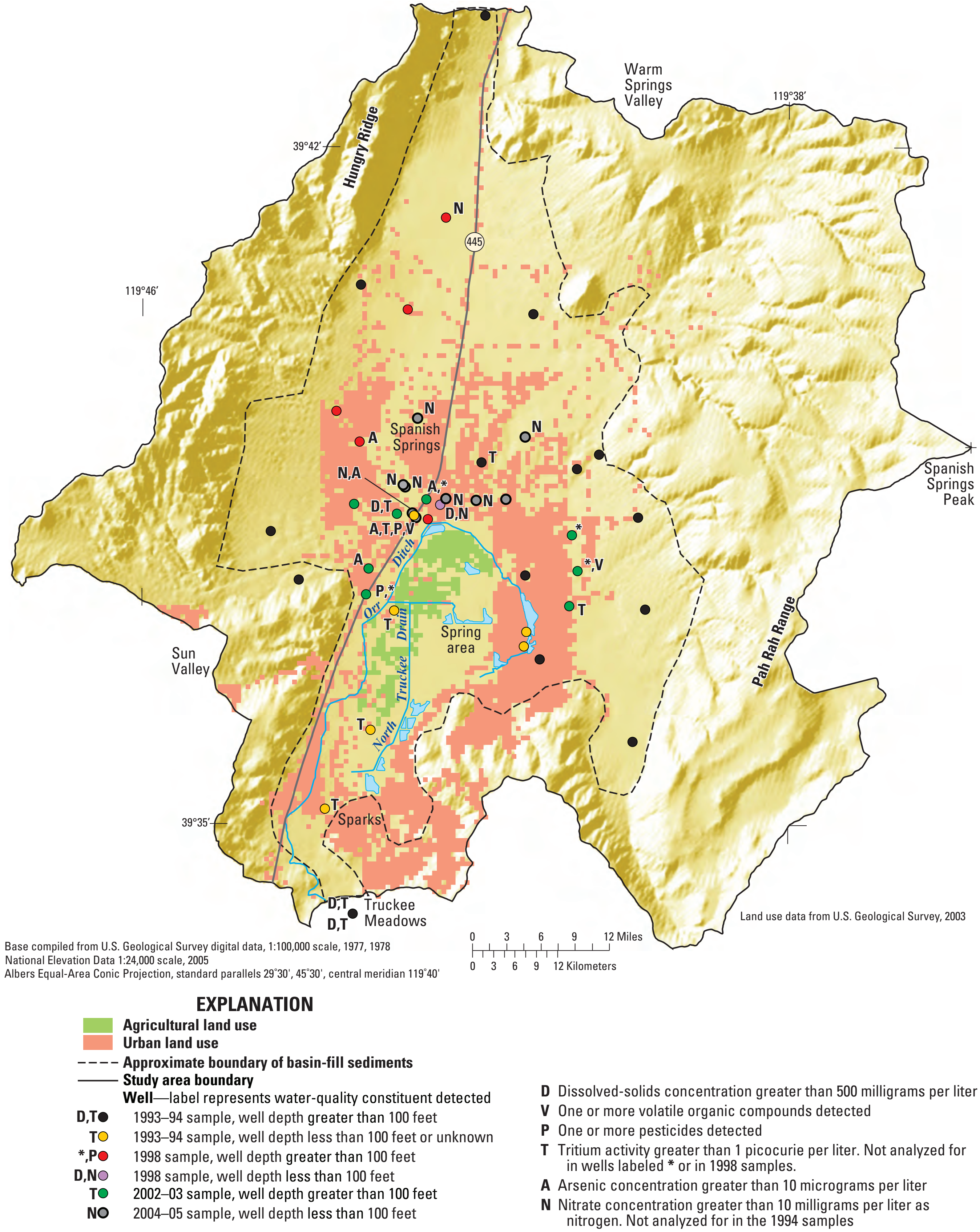

Figure 4. Location and depths of wells, and chemical characteristics of groundwater sampled in various studies from 1993 to 2005, Spanish Springs Valley, Nevada.

Table 2. Summary of selected constituents in groundwater in Spanish Springs Valley, Nevada, and sources or processes that affect their presence or concentration.

[mg/L, milligrams per liter; n/a, not applicable]

Constituent	General location	Median value or detections	Possible sources or processes
Shallow aquifers			
Dissolved solids	Central basin near irrigated land & North Truckee Drain	362 mg/L	Excess irrigation water infiltrating through canals and (or) fields
Sulfate	Central basin near irrigated land & North Truckee Drain	24 mg/L	Associated with altered consolidated rocks
Nitrate	Near urban areas	[1]12.6 mg/L	Wastewater infiltrating from septic systems
Volatile organic compounds	Central basin	[2]5	Chlorinated municipal-supply water infiltrating through irrigated yards/turf areas
Pesticides	n/a	n/a	n/a
Principal aquifers			
Dissolved solids	Basin wide	216 mg/L	Evapotranspiration of shallow groundwater and dissolution
Sulfate	Basin wide	25 mg/L	Associated with altered consolidated rocks; excess irrigation water and canal infiltration
Nitrate	Basin wide	[3]4.1 mg/L	Wastewater infiltrating from septic systems
Volatile organic compounds	Central basin	[3]2	Chlorinated municipal-supply water infiltrating through irrigated yards/turf areas
Pesticides	Western near highway	[3]1	Excess irrigation water infiltrating through canals and (or) fields

[1] Bonner and others (2004).

[2] Michael Rosen, U.S. Geological Survey, written commun., July 22, 2009.

[3] Rosen and others (2006b).

Nitrate concentrations as nitrogen in some public-supply wells in Spanish Spring Valley are approaching the MCL of 10 mg/L. Nitrate concentrations in the five public-supply wells sampled range from 2.3 to 8.1 mg/L, although background concentrations in the aquifer are assumed to be less than about 2 mg/L (Rosen and others, 2006a, p. 8). Elevated concentrations of nitrate have been attributed to the increased use of septic-tank systems accompanying residential development in the valley rather than to the use of fertilizers (Seiler, 1999; Seiler, 2005).

Nitrate concentrations as nitrogen in water sampled from shallow wells (45 to 120 ft deep) in the Spanish Springs Valley ranged from 4.1 to 38.5 mg/L with a median value of 12.6 mg/L (data in Bonner and others, 2004). The median concentration of total dissolved nitrogen in more than 300 soil-water samples collected within the soil zone under four septic tank leach fields in residential areas north of the Orr Ditch was 44 mg/L (Rosen and others, 2006a). The concentration of total dissolved nitrogen in recharge water potentially reaching the water table ranged from 25 to 29 mg/L. Therefore, on the basis of mass-balance calculations, approximately 29 to 32 metric tons of nitrogen are contributed to the shallow groundwater from septic-tank systems and natural recharge each year; almost all of this nitrogen originates within the septic-tank systems.

Summary

The basin-fill aquifer underlying Spanish Springs Valley is a complex system that has undergone many changes during the basin's development. Generally under unconfined conditions, the aquifer is recharged naturally by the infiltration of precipitation falling on the basin margins and on the surrounding mountains. Estimated natural recharge to the aquifer (predevelopment) is assumed to equal estimated natural discharge from evapotranspiration and subsurface outflow to adjacent basins, about 1,300 acre-ft/yr.

The groundwater budget for Spanish Springs Valley changed with construction of the Orr Ditch in 1878 and the expansion of residential development since about 1979. Human-influenced sources of recharge to the groundwater system in the valley are imported surface water, excess irrigation water, and septic-tank system effluent. Continued residential development in the valley has resulted in more than 2,300 homes with septic systems with an estimated 585 acre-ft/yr of seepage from septic-tank systems to the basin-fill aquifer. New residential developments are connected to sewage systems.

Groundwater pumped from the basin-fill aquifer in Spanish Springs Valley is the primary source of drinking water, although plans are for future population growth to be supported by imported water from the Truckee River. Pumpage from wells increased from about 500 acre-ft in 1979 to 2,600 acre-ft in 1994. About 5,400 acre-ft was pumped in 2000, 56 percent from domestic wells, 43 percent from public-supply wells, and only one percent from irrigation wells. Much of the discharge from the basin-fill aquifer under modern conditions is from wells at least 200 ft deep, whereas much of the recharge is now to shallower parts of the aquifer system. The vertical connection between shallower and deeper parts of the aquifer is dependent on the potential confining layers separating them and the hydraulic gradient between them.

The additional anthropogenically derived recharge to the basin-fill aquifer system has affected groundwater quality in parts of Spanish Springs Valley. Pumping and the resulting changes in hydraulic gradients can cause changes in groundwater quality by enhancing the downward movement of shallow groundwater and the vertical or lateral movement of water from adjacent consolidated rock to parts of the basin-fill aquifer used for water supply. Concentrations of dissolved solids in the water samples ranged from 155 to 2,680 mg/L with a median value of 237 mg/L. Analysis of water samples collected from five public-supply wells in the valley in 2002–03 showed the presence of volatile organic compounds in two of the wells. Although the concentrations of these compounds were not a health concern, their presence in the aquifer indicates the potential for movement from the land surface and the possibility that higher concentrations may occur in the future.

Infiltration from septic-tank systems has become a source of groundwater recharge in some residential areas in the valley and elevated nitrate concentrations in groundwater from septic-tank effluent is an important water-quality concern. Nitrate concentrations as nitrogen in some public-supply wells are approaching the drinking-water standard of 10 mg/L. Increasing nitrate concentrations have been attributed to the increased use of septic-tank systems rather than to the use of fertilizers.

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