

# NEVADA

## Ground-Water Quality

In Nevada (fig. 1), about 50 percent of the population, 30 percent of light industry including thermoelectric power, and 17 percent of irrigated agriculture are supplied by ground water. Of the total ground-water withdrawals, irrigation accounts for about 74 percent; public and rural supplies, about 15 percent; and industrial use, about 10 percent (U.S. Geological Survey, 1985, p. 297).

The quality of water from most aquifers in Nevada is suitable, or marginally suitable, for most uses. Most aquifers contain water with constituent concentrations (fig. 2) that do not exceed State and national drinking-water standards. However, parts of some aquifers contain water having constituent concentrations that exceed these standards. Excessive concentrations in ground water result from both natural processes and human activities (fig. 3). Natural impairment occurs in: (1) areas of shallow ground water with large evapotranspiration rates, (2) geothermal areas, and (3) aquifers containing sufficient amounts of soluble material. Human-induced contamination occurs in areas of downward percolating wastes from: (1) disposal ponds and pits associated with industrial, mining, milling, explosives-handling, and oil-production activities; (2) coal-slurry storage-ponds and process-water evaporation ponds at electric-generating stations; (3) gasoline, aviation-fuel, and diesel-fuel spills or storage-tank leaks; and (4) septic tanks. In addition, areas of potential contamination are associated with irrigation, feedlots, dairy farms, and nuclear-bomb testing sites.

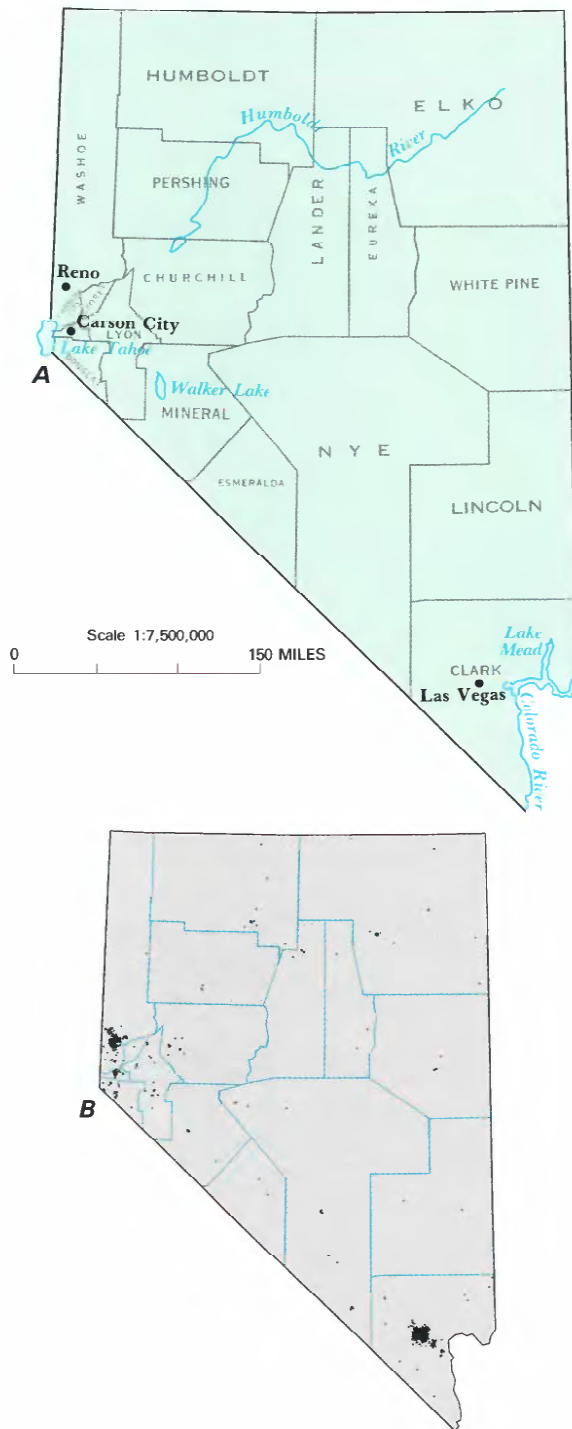
The most populated areas of Nevada (fig. 1B), which have the greatest potential for industrial development, urbanization, and waste-disposal problems, are Las Vegas Valley in the south and the Reno-Carson City area in the west. Human-induced contamination has been documented in parts of the shallow basin-fill aquifers in Truckee Meadows and the Las Vegas, Mason, Antelope, Washoe, Carson, Colorado River, and Eagle Valleys; the Whiskey Flat-Hawthorne subarea adjacent to Walker Lake; the Incline Village area in the Lake Tahoe basin; and the Marys Creek area and Winnemucca segment of the Humboldt River basin (fig. 3B).

### WATER QUALITY IN PRINCIPAL AQUIFERS

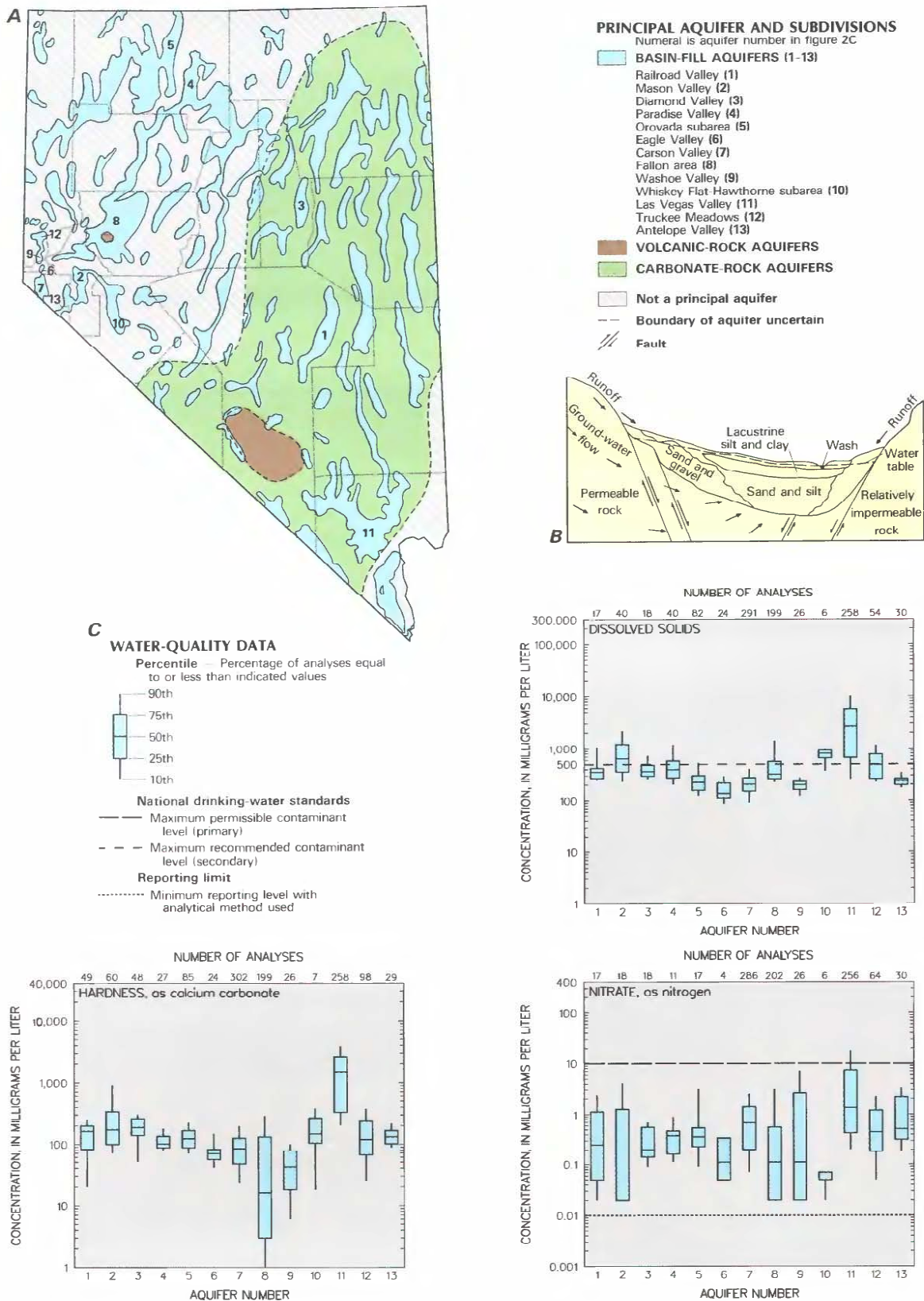
Principal aquifers in Nevada are basin-fill deposits, carbonate rocks, and to a lesser extent, volcanic rocks (fig. 2A). Virtually all ground-water withdrawals have been from the upper 500 feet of the basin-fill aquifers. Carbonate-rock aquifers in eastern Nevada have not been significantly developed as a water supply, but are an important source of water. About 50 springs, discharging a combined total of about 90 Mgal/d (million gallons per day) from the carbonate-rock aquifers, are used for irrigation and drinking-water supplies. Volcanic-rock aquifers extend over hundreds of square miles, but only one volcanic-rock aquifer, in the Carson Desert (Churchill County) of west-central Nevada, has been developed. The quality of most water from the volcanic-rock aquifers is suitable or marginally suitable for most uses.

### BACKGROUND WATER QUALITY

A graphic summary of selected water-quality variables compiled from the U.S. Geological Survey's National Water Data Storage and Retrieval System (WATSTORE) and files of the Nevada Division of Environmental Protection (NDEP) is presented in figure 2C. The summary is based on dissolved-solids, hardness (as calcium carbonate), nitrate (as nitrogen), fluoride, and arsenic analyses of



**Figure 1.** Selected geographic features and 1985 population distribution in Nevada. *A*, Counties, selected cities, and major drainages. *B*, Population distribution, 1985; each dot on the map represents 1,000 people. (Source: *B*, Data from U.S. Bureau of the Census 1980 decennial census files, adjusted to the 1985 U.S. Bureau of the Census data for county populations.)



**Figure 2.** Principal aquifers and related water-quality data in Nevada. *A*, Principal aquifers. *B*, Generalized hydrogeologic section showing typical distribution of unconsolidated deposits in a basin-fill aquifer. *C*, Selected water-quality constituents and properties, 1950-86. (Sources: *A*, *B*, U.S. Geological Survey, 1965. *C*, Cohen and Loeltz, 1964; Huxel and others, 1966; Worts and Malmberg, 1966; Everett and Rush, 1967; Harrill and Lamke, 1968; Huxel and Harris, 1969; Van Denburgh and Rush, 1974; Kaufmann, 1976; Patt and Hess, 1976; Armstrong and Fordham, 1977; Nowlin, 1982; Seitz and others, 1982; Van Denburgh and Schaefer, 1986; U.S. Geological Survey, U.S. Bureau of Reclamation, and Nevada Division of Environmental Protection files; national drinking-water standards from U.S. Environmental Protection Agency, 1986a,b.)

water samples collected from 1950 to 1986 from the basin-fill aquifers in Nevada. Percentiles of these variables are compared to national standards that specify the maximum concentration or level of a contaminant allowed in a drinking-water supply as established by the U.S. Environmental Protection Agency (1986a,b). The primary maximum contaminant level standards are health related and are legally enforceable. The secondary maximum contaminant level standards apply to esthetic qualities and are recommended guidelines. The primary drinking-water standards include maximum concentrations of 10 mg/L (milligrams per liter) nitrate (as nitrogen), 4.0 mg/L fluoride, and 50  $\mu\text{g/L}$  (micrograms per liter) arsenic. The secondary drinking-water standards include maximum concentrations of 500 mg/L dissolved solids and 2.0 mg/L fluoride. The State drinking-water standards include maximum concentrations of 1,000 mg/L dissolved solids, 10 mg/L nitrate (as nitrogen), 1.4 to 2.4 mg/L fluoride (depending on air temperature), and 50  $\mu\text{g/L}$  arsenic, and a recommended maximum concentration for dissolved solids of 500 mg/L (Nevada Division of Health, 1977).

The summary (fig. 2C) contains water-quality data for 13 of the basin-fill aquifers. The data are limited to the basin-fill aquifers because virtually all withdrawals of ground water and water-quality analyses have been from these aquifers. Limited data preclude the interpretation of lateral or vertical chemical changes within the basin-fill aquifers. If more than one analysis for a well was available, the mean values of constituents were used in plotting the data.

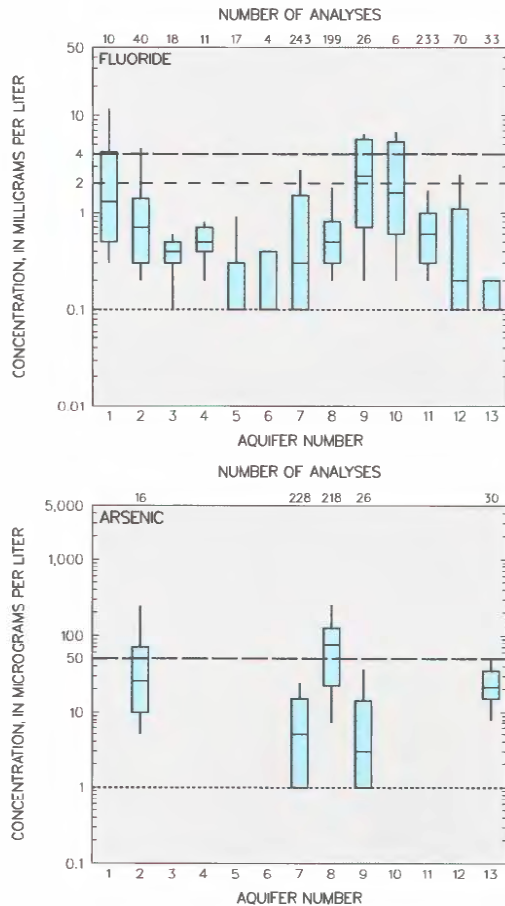


Figure 2. Principal aquifers and related water-quality data in Nevada—Continued

## Basin-Fill Aquifers

Median dissolved-solids concentrations for the basin-fill aquifers generally do not exceed the national or State drinking-water standards. However, in local areas the water commonly contains more than 1,000 mg/L dissolved solids and constituent concentrations exceed the standards (figs. 2C, 3B). Generally, this exceedance occurs where deposits naturally contain significant amounts of soluble minerals, where ground water is discharged by evapotranspiration, or where ground water is affected by geothermal activity.

In the southeast part of the Las Vegas Valley basin-fill aquifer, naturally occurring dissolved-solids concentrations are large, generally greater than 2,000 mg/L, resulting principally from the dissolution of gypsum and evaporite salts. Large concentrations of naturally occurring arsenic, sulfate, nitrate, and fluoride are prevalent in many of the basin-fill aquifers. The large concentrations are derived from dissolution of (1) arsenic-containing volcanic rocks, mineral coating on the grains of detrital rocks, or sedimentary organic matter, (2) gypsum, (3) nitrogen-bearing sediments or spring deposits, and (4) fluoride minerals.

Areas of ground-water evapotranspiration, which can encompass hundreds of square miles, generally contain water that is slightly saline (1,000–3,000 mg/L dissolved solids) to brine (more than 35,000 mg/L dissolved solids). Water with a dissolved-solids concentration smaller than 500 mg/L typically recharges basin-fill aquifers on alluvial fans around the margins of the aquifers. The water then becomes more mineralized by dissolving minerals as it flows through the basin-fill deposits (fig. 2B). In areas of shallow ground water, evapotranspiration can further concentrate constituents in the water, resulting in areas with naturally occurring large dissolved-solids concentrations.

Ground water in areas of geothermal activity commonly contained more than 1,000 mg/L dissolved solids. This water also can contain fluoride concentrations that exceed national drinking-water standards, and excessive concentrations of arsenic and boron.

Hardness of water in the basin-fill aquifers ranged from soft (less than 60 mg/L) to very hard (more than 180 mg/L; fig. 2C). Water hardness, a function of calcium and magnesium concentrations, is derived primarily from natural processes, such as dissolution of limestone, dolomite, or calcium-rich volcanic rocks.

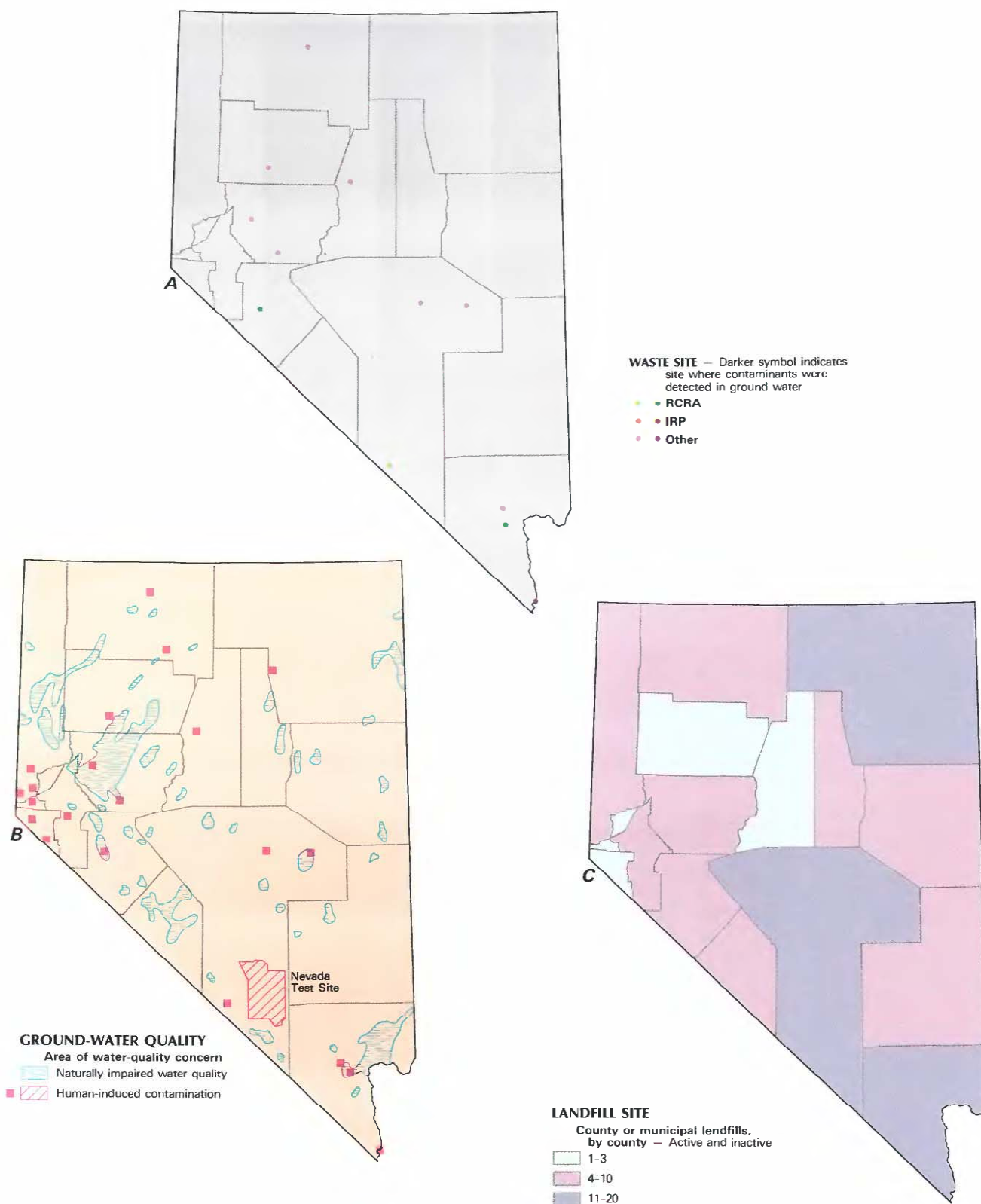
No median concentrations of nitrate exceeded the national drinking-water standard. However, nitrate concentrations in ground water have been increased locally by natural sources, such as solution of minerals that contain nitrogen, or percolation of water through organic material (Patt and Hess, 1976). The Las Vegas Valley basin-fill aquifer contains water suitable for most uses. However, in the southeastern part and in a small area (7 square miles) in the north-central part of the aquifer (fig. 3B), naturally occurring nitrate concentrations exceed 300 mg/L (Patt and Hess, 1976).

Median fluoride concentrations, which range from 0.1 to 2.4 mg/L in the basin-fill aquifers, do not exceed the national drinking-water standard (4.0 mg/L). However, maximum concentrations did exceed the drinking-water standard in some water from 8 of the 13 basin-fill aquifers. Most of the fluoride is probably from dissolution of fluoride-bearing rocks.

Arsenic concentrations exceeded the drinking-water standard (50  $\mu\text{g/L}$ ) in parts of all the basin-fill aquifers sampled (fig. 2C). Naturally occurring arsenic concentrations exceeding 50  $\mu\text{g/L}$  commonly are associated with geothermal waters and alluvial-lacustrine and volcanic deposits.

## Carbonate-Rock Aquifers

Water quality in the carbonate-rock aquifers is suitable for most uses. Water from the springs in eastern Nevada generally is hard (121–180 mg/L as calcium carbonate) to very hard (more than



**Figure 3. Selected waste sites and ground-water-quality information in Nevada.** *A*, Resource Conservation and Recovery Act (RCRA) sites; Department of Defense Installation Restoration Program (IRP) sites; and other selected waste sites, as of 1986. *B*, Areas of naturally impaired water quality, and areas of human-induced contamination, as of 1986. *C*, County and municipal landfills, as of 1986. (Sources: *A*, Van Denburgh and Rush, 1974; Nevada Division of Environmental Protection, 1979; Geraghty and Miller, Inc., 1980; Seitz and others, 1982; Nowlin, 1986; U.S. Department of Defense, 1986; Van Denburgh and Schaefer, 1986; James Thompson, U.S. Environmental Protection Agency, written commun., 1986. *B*, Van Denburgh and Rush, 1974; Patt and Hess, 1976; Garside and Schilling, 1979; Geraghty and Miller, Inc., 1980; Nowlin, 1982; Seitz and others, 1982; Nowlin, 1986; Van Denburgh and Schaefer, 1986; and Nevada Division of Environmental Protection files. *C*, Dan Gross, Nevada Division of Environmental Protection, written commun., 1986.)

180 mg/L), owing to the dissolution of carbonate minerals. Dissolved-solids concentrations in carbonate-rock aquifers do not exceed the State drinking-water standard of 1,000 mg/L.

### Volcanic-Rock Aquifers

Water in the volcanic-rock aquifer in the Carson Desert of west-central Nevada is suitable for most uses. However, arsenic concentrations are large, ranging from 73 to 140  $\mu\text{g/L}$ . These concentrations exceed the national primary drinking-water standard of 50  $\mu\text{g/L}$ .

### EFFECTS OF LAND USE ON WATER QUALITY

Water in some of the basin-fill aquifers has been contaminated by downward percolation of industrial wastes, milling-waste fluids, explosives wastes, possibly oil-well brines from disposal ponds or pits, coal-slurry storage ponds, and process-water evaporation ponds at electric-generating stations. Excessive leakage or spills of gasoline, diesel fuel, and aviation fuel from storage tanks and contamination by effluents from septic-tank systems have contributed to the contamination of water in some of the basin-fill aquifers.

#### Waste Disposal

Nevada has one operating low-level waste-disposal site near Beatty (Nye County), three commercial facilities at an industrial complex near Henderson (Clark County) that are either closed or in the process of being closed, and an Army ammunition plant at Hawthorne (Mineral County) that require monitoring of ground-water quality under the Federal Resource Conservation and Recovery Act (RCRA) of 1976 (James Thompson, U.S. Environmental Protection Agency, written commun., 1986). In addition, the State has: a military hazardous-waste area at Nellis Air Force Base in Las Vegas Valley (U.S. Department of Defense, 1986), the Nevada Test Site for nuclear-bomb testing in southern Nevada (fig. 3B), two sites in central Nevada where underground nuclear tests were conducted, four pesticide-disposal sites, industrial waste-disposal sites in the Las Vegas and Carson Valleys, previously used settling ponds for oil-well brine in Railroad Valley, an electric-generating station with process-water evaporation ponds and coal-slurry storage ponds in the Colorado River valley, and 107 landfills (figs. 3A, 3C). For these areas, minimal information is available on the quality of ground water, mainly because of a lack of wells. As a result, only the industrial sites in southeastern Las Vegas Valley and Carson Valley; the fluid-disposal pits for explosives wastes associated with shell- and bomb-casing cleaning in the Whiskey Flat-Hawthorne subarea near Walker Lake; and the process-water evaporation ponds and coal-slurry storage ponds in the Colorado River valley have documented ground-water contamination (Geraghty and Miller, Inc., 1980; Harding-Lawson Associates, 1986; Dan Gross and Doug Zimmerman, Nevada Division of Environmental Protection, written commun., 1986; and U.S. Bureau of Reclamation, unpublished data on file in the U.S. Geological Survey office, Carson City, Nevada).

As of September 1985, 16 hazardous-waste sites at 2 facilities in Nevada, including the site at Nellis Air Force Base, had been identified by the U.S. Department of Defense (DOD) as part of their Installation Restoration Program (IRP) as having potential for contamination (U.S. Department of Defense, 1986). The IRP, established in 1976, parallels the U.S. Environmental Protection Agency (EPA) Superfund program under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. The EPA presently ranks these sites under the hazard ranking system and may include them in the National Priorities List (NPL). Of the 16 sites in the program, 5 sites contained contaminants but did not present a hazard to the environment. One IRP site at one facility (fig. 3A) was considered to present a hazard significant enough to warrant response action in accordance with CERCLA. The remaining sites were scheduled for confirmation studies to determine if remedial action is required.

Contamination from an industrial site at Henderson near Las Vegas has increased the dissolved-solids concentrations in the Las Vegas Valley basin-fill aquifer to about 10,000 mg/L near the site (Dave Hemphill, U.S. Bureau of Reclamation, written commun., 1986). The increase is due mainly to leakage of industrial organic compounds—primarily benzene, chlorinated benzene compounds, trichloromethane (chloroform), and organophosphates—from the industrial site into the aquifer. Dithioic acids and hexachlorocyclohexane (BHC) also have been detected in the ground water at the site (Geraghty and Miller, Inc., 1980). In addition, organic compounds, primarily benzene with dissolved organophosphates, are present—both floating at the top of the water table and at the bottom of wells because of the differences in densities of the associated fluids. The layer of organic compounds is about 2 to 5 feet thick in three wells near the organophosphate waste ponds and contains as much as 530,000 mg/L benzene and 54,000 mg/L carbophenothion (Geraghty and Miller, Inc., 1980). The compounds are principally from a 30,000-gallon leak of benzene from an underground storage tank that occurred in 1976. The benzene subsequently migrated downgradient beneath the organophosphate waste ponds, dissolving the downward-percolating organophosphate compounds. By 1980, the benzene had migrated between 3,000 and 5,000 feet downgradient from the tank (Geraghty and Miller, Inc., 1980). Chromium concentrations as large as 90,000  $\mu\text{g/L}$  also are present at the site from leakage of processing fluids (Dan Gross, Nevada Division of Environmental Protection, written commun., 1986).

Traces of trichloroethylene (TCE); 1,1,1 trichloroethane (1,1,1-TCA); 1,1,2 trichloroethane and 1,2,2 trifluoroethane (Freon 113); and 1,1 dichloroethylene (1,1-DCE) have been detected in water in the Carson Valley basin-fill aquifer (Dan Gross, Nevada Division of Environmental Protection, written commun., 1986). These organic compounds apparently have percolated into the aquifer from a nearby industrial site.

Explosives—principally ammonium picrate, ammonium nitrate, and trinitrotoluene (TNT) from fluid-disposal pits associated with shell- and bomb-casing cleanout—have percolated into the basin-fill aquifer between Hawthorne and Walker Lake in Mineral County. Dissolved solids have increased from natural concentrations of 1,000–2,000 mg/L to 2,000–3,000 mg/L, and nitrate (as nitrogen) has increased from natural concentrations of less than 2 mg/L to 130 mg/L between 1952 and 1979 (Van Denburgh and Schaefer, 1986). Nitrate had migrated at least 3,200 feet from the fluid-disposal pits, whereas ammonium nitrate and TNT had moved about 1,200 feet by 1979.

Coal-slurry storage ponds and process-water evaporation ponds at the Mohave Electric-Generating Plant in the Colorado River valley have contaminated the shallow basin-fill aquifer. Natural dissolved-solids concentrations of less than 1,000 mg/L in the ground water had increased to a maximum of 3,620 mg/L by 1985 in the contaminated areas (Harding-Lawson Associates, 1986).

Percolation of oil-well brines from previously used settling ponds may have contaminated the basin-fill aquifer in Railroad Valley, according to Van Denburgh and Rush (1974, p. 31).

### Mining

Ground water in the Weed Heights area of Mason Valley has been contaminated downgradient from dumps and ponds used for disposal of brine and tailings fluid and gangue from copper ore-milling operations. Copper was mined and milled in the area from 1953 to 1978. A study by Seitz and others (1982) indicated the following maximum concentrations of constituents in two shallow wells nearest the dumps and ponds: 38,000 mg/L dissolved solids; 8,360 mg/L hardness (as calcium carbonate); 6,500  $\mu\text{g/L}$  boron; 26,000 mg/L sulfate; 340  $\mu\text{g/L}$  arsenic; 6,800  $\mu\text{g/L}$  cobalt; 24,000  $\mu\text{g/L}$  copper; 6,300,000  $\mu\text{g/L}$  iron; 88,000  $\mu\text{g/L}$  manganese; 6,200  $\mu\text{g/L}$  nickel; and 13,000  $\mu\text{g/L}$  zinc.

Copper also was mined and smelted in the Ruth and McGill areas (White Pine County) of Steptoe Valley and mined and milled in the Mountain City area (Elko County) of the Owyhee River valley. Ground-water-quality data are too sparse to determine if these areas are being affected.

### Urbanization

Water in the basin-fill aquifers along the northwest shore of Topaz Lake in Antelope Valley (Nowlin, 1982) and in Washoe Valley (Armstrong and Fordham, 1977) has been contaminated by septic-tank effluent. However, concentrations of nitrate, the principal effluent contaminant, generally do not exceed the 10-mg/L drinking-water standard (fig. 2C); water from one well in these two valleys exceeded the standard.

Contamination by petroleum products has been documented at 10 sites in the urbanized areas of Las Vegas, Reno, Carson City, Yerington (Lyon County), Winnemucca (Humboldt County), Carlin (Elko County), and Incline Village (Washoe County), as of 1985. Leakage and spillage of gasoline, aviation fuel, and diesel fuel from underground and surficial storage tanks have resulted in localized contamination of the shallow basin-fill aquifers. In places, layers of petroleum products more than 7 feet thick, but generally less than 1 foot thick, have been measured floating on top of the water table. Overall, of the 10 sites with documented petroleum-product contamination in Nevada, 3 have contaminant-recovery programs in progress, 1 has contaminant recovery planned, and 6 have contaminant recovery completed or not needed. In addition, four areas of suspected contamination currently (1986) are being evaluated to determine the effect on the subsurface environment (Dan Gross, Nevada Division of Environmental Protection, written commun., 1986).

### POTENTIAL FOR WATER-QUALITY CHANGES

Waste-disposal, industrial, urbanized, nuclear-bomb testing, mining, and irrigation areas are all possible sites for present and future contamination. However, because of the limited information available on the quality of ground water in these areas, the nature and extent of contamination may go undetected. Some areas of known contamination are no longer active disposal sites, and some facilities used for storing wastes have been upgraded. Existing contaminant plumes, however, will continue to migrate and affect larger parts of the aquifer unless the contaminants are removed or contained.

Most areas of documented human-induced contamination have active ground-water restoration programs. Others are being studied to determine the nature and extent of contamination and the methods that will be needed to mitigate the problem. Organic contamination in the basin-fill aquifer near Henderson in Las Vegas Valley probably will decrease in the future because contaminants are being removed from the affected ground water. Localized contamination of the Carson Valley basin-fill aquifer by organic solvents currently (1986) is being studied to define the extent of contamination and to determine what future actions are needed. A program to remove contamination from a copper ore-milling operation in the Weed Heights area (Lyon County) also has been implemented. Continued use of septic tanks in the Antelope and Washoe Valley areas, as well as future development, probably will result in a continued increase in the concentration of nitrate from these effluents. Oil-well brines now are disposed in injection wells in Railroad Valley, so possible future contamination of the basin-fill aquifer from downward migrating brines is not anticipated (Dan Gross and Doug Zimmerman, Nevada Division of Environmental Protection, oral commun., 1986).

Possible sources of presently undetected or potential contamination include chemical- and petroleum-product storage tanks, mine and milling wastes, irrigation water that percolates to the water

table, feedlots, dairy farms, and radionuclides. Chemical, gasoline, diesel-fuel, and aviation-fuel contamination will continue to be a problem as old storage tanks develop leaks and because spills of chemicals and fuels are likely to occur. However, starting in February 1987, all new petroleum-product underground storage tanks will be constructed of noncorrosive material and will be monitored for releases. Hazardous-chemical storage tanks will have similar requirements starting in 1988 (U.S. Environmental Protection Agency, 1985). In addition, there is the potential for contamination from fuel spills associated with fire-fighting training at the Naval Air Station in Fallon (Dan Gross, Nevada Division of Environmental Protection, oral commun., 1986).

Mining activities have produced and will continue to produce tailings piles and milling wastes that are susceptible to leaching of contaminants. More than 300 mining districts throughout Nevada may be adversely affecting ground-water quality. Ground-water contamination in these areas depends mainly on the amount of waste materials produced, type of ores mined, method of mining, amount of precipitation, depth to ground water, and presence or absence of surface water (Resource Concepts, Inc., 1980). Furthermore, cyanide solutions and mercury used in gold-ore processing may be a problem as they are toxic, even in small concentrations.

Contamination from agricultural activities is possible from: (1) water used for irrigation that either has dissolved an undesirable constituent or has been concentrated by evaporation; (2) infiltration of contaminated water from feedlots or dairy farms; and (3) downward percolation of water containing agricultural chemicals (insecticides, herbicides, or fertilizers). For example, shallow ground-water samples from subsurface drains beneath an irrigated field at Fallon (Churchill County) contain large arsenic concentrations (maximum of 950  $\mu\text{g/L}$ ) derived from the soil as the irrigation water percolated to the shallow water table (Doug Zimmerman, Nevada Division of Environmental Protection, written commun., 1986).

Radionuclides from nuclear-weapon detonations beneath the Nevada Test Site in southern Nevada, Hot Creek valley (Nye County), and the Sand Springs Range (Churchill and Mineral Counties) in central Nevada may migrate into the basin-fill aquifers in the future. In addition, the Nevada Test Site is one of the areas that is being considered as a national repository for the underground storage of high-level radioactive wastes.

### GROUND-WATER-QUALITY MANAGEMENT

Ground-water quality is regulated by the NDEP, but is monitored by several State and Federal agencies. The Department may require ground-water monitoring for ground-water permits issued for industrial plants, land applications of sewage effluent, and geothermal injection wells. In addition, in 1987 the Department will assume responsibility for oil and gas injection wells, which currently are monitored by the EPA, and for issuing permits for zero-discharge heap-leaching operations. Ground-water monitoring also may be required in response to suspected contamination, such as mining sites or leaking fuel tanks (Dan Gross, Nevada Division of Environmental Protection, oral commun., 1986).

The State Health Division, Bureau of Consumer Health Protection Services, monitors ground-water quality for public and rural systems, and also monitors quality with regard to the approval of water supply and waste-water disposal facilities for subdivisions and developments, in all counties except Clark and Washoe. Clark and Washoe Counties have their own monitoring programs. All community water systems are required to monitor system water periodically for contaminants regulated under the Federal Safe Drinking Water Act and State law. Amendments to the Safe Drinking Water Act in 1986 will require monitoring of 83 additional constituents, including 14 volatile organic compounds, 29 synthetic organic chemicals, 13 inorganic chemicals, 4

microbiological contaminants, and 2 radiological contaminants (Thompson, 1986).

Radionuclide migration and ground-water quality are being monitored where underground nuclear device testing has been conducted in Nevada. These locations include the Nevada Test Site and surrounding areas, the Hot Creek Valley area, and the Sand Springs Range area. The monitoring program was initiated in 1972. Under a Memorandum of Understanding with the DOD, the EPA's laboratory in Las Vegas has operated the monitoring program to evaluate possible movement of radionuclides from the nuclear-test sites. The network consists of 22 monthly, 23 semi-annual, and 22 annual stations (Nowlin, 1986).

The U.S. Department of Agriculture makes random checks on pesticide disposal during use inspections, and any violations of pesticide-management laws are referred to the NDEP. The Nevada Department of Minerals regulates permitting for well construction relating to oil, gas, and geothermal wells. The Nevada Division of Water Resources regulates geothermal wells with regard to water rights and well construction (Dan Gross, Nevada Division of Environmental Protection, oral commun., 1986).

#### SELECTED REFERENCES

- Armstrong, A.T., and Fordham, J.W., 1977, Investigation of ground-water quality and its effect on suburban development in Washoe Valley, Nevada: University of Nevada, Desert Research Institute Project Report 48, 60 p.
- Cohen, Philip, and Loeltz, O.J., 1964, Evaluation of hydrogeology and hydrogeochemistry of Truckee Meadows area, Washoe County, Nevada: U.S. Geological Survey Water-Supply Paper 1770-S, 63 p.
- Everett, D.E., and Rush, F.E., 1967, A brief appraisal of the water resources of the Walker Lake area, Mineral, Lyon, and Churchill Counties, Nevada: Nevada Department of Conservation and Natural Resources Reconnaissance Report 40, 44 p.
- Garside, L.J., and Schilling, J.H., 1979, Thermal waters of Nevada: Nevada Bureau of Mines and Geology Bulletin 91, 13 p.
- Geraghty and Miller, Inc., 1980, Ground-water investigation, Stauffer Chemical Company, Henderson, Nevada: Syosset, New York, 42 p.
- Glancy, P.A., 1986, Geohydrology of the basalt and unconsolidated sedimentary aquifers in the Fallon area, Churchill County, Nevada: U.S. Geological Survey Water-Supply Paper 2263, 62 p.
- Harding-Lawson Associates, 1986, Hydrogeologic assessment report, Mohave Generating Station, Laughlin, Nevada: Tustin, California, v. 1, 81 p.
- Harrill, J.R., and Lamke, R.D., 1968, Hydrologic response to irrigation pumping in Diamond Valley, Eureka and Elko Counties, Nevada, 1950-65: Nevada Department of Conservation and Natural Resources Bulletin 35, 85 p.
- Huxel, C.J., Jr., and Harris, E.E., 1969, Water resources and development in Mason Valley, Lyon and Mineral Counties, Nevada, 1948-65: Nevada Division of Water Resources Bulletin 38, 77 p.
- Huxel, C.J., Jr., Parkes, J.E., and Everett, D.E., 1966, Effects of irrigation development on the water supply of Quinn River Valley area, Nevada and Oregon, 1950-64: Nevada Department of Conservation and Natural Resources Bulletin 34, 80 p.
- Kaufmann, R.F., 1976, Land and water use effects on ground-water quality in Las Vegas Valley: University of Nevada, Desert Research Institute Project Report 47A, 215 p.
- Nevada Division of Environmental Protection, 1979, Surface impoundment assessment final report: Nevada Department of Conservation and Natural Resources, 76 p.
- Nevada Division of Health, 1977, Water supply regulations, Part 1. Water quality standards—Monitoring, record keeping, and reporting: Nevada Bureau of Consumer Health Protection Services, 17 p.
- Nowlin, J.N., 1982, Ground-water levels and water quality in an area near Topaz Lake, Douglas County, Nevada: U.S. Geological Survey Open-File Report 80-2046, 76 p.
- 1986, Ground-water quality in Nevada—A proposed monitoring program: U.S. Geological Survey Open-File Report 78-768, 235 p.
- Patt, R.O., and Hess, J.W., 1976, Characterization of nitrogen sources contaminating shallow ground water in an arid basin, Las Vegas area, Nevada: University of Nevada, Desert Research Institute Technical Report H-W 26, 44 p.
- Resource Concepts, Inc., 1980, Ground-water pollution potential—An analysis of mining districts in Nevada: Carson City, Nevada, 39 p.
- Seitz, H.R., Van Denburgh, A.S., and La Camera, R.J., 1982, Ground-water quality downgradient from copper-ore milling wastes at Weed Heights, Lyon County, Nevada: U.S. Geological Survey Open-File Report 80-1217, 48 p.
- Thompson, J.C., 1986, The Safe Drinking Water Act—A summary of amendments to the Safe Drinking Water Act and revisions of the drinking water regulations: Public Works, September, p. 123-125, 184-188.
- U.S. Department of Defense, 1986, Status of the Department of Defense Installation Restoration Program—Information paper: Washington, D.C., U.S. Department of Defense, Office of the Assistant Secretary of Defense (Acquisition and Logistics), Environmental Policy Directorate, February, 35 p.
- U.S. Environmental Protection Agency, 1985, Underground storage tanks (UST)—The new federal law: Pamphlet, 4 p.
- 1986a, Maximum contaminant levels (subpart B of part 141, National interim primary drinking-water regulations): U.S. Code of Federal Regulations, Title 40, Parts 100 to 149, revised July 1, 1986, p. 524-528.
- 1986b, Secondary maximum contaminant levels (section 143.3 of part 143, national secondary drinking-water regulations): U.S. Code of Federal Regulations, Title 40, Parts 100 to 149, revised July 1, 1986, p. 587-590.
- 1986c, Amendment to National Oil and Hazardous Substances Contingency Plan; national priorities list, final rule and proposed rule: Federal Register, v. 51, no. 111, June 10, 1986, p. 21053-21112.
- U.S. Geological Survey, 1985, National water summary 1984—Hydrologic events, selected water-quality trends, and ground-water resources: U.S. Geological Survey Water-Supply Paper 2275, 467 p.
- Van Denburgh, A.S., and Rush, F.E., 1974, Water-resources appraisal of Railroad and Penoyer Valleys, east-central Nevada: Nevada Division of Water Resources Reconnaissance Report 60, 61 p.
- Van Denburgh, A.S., and Schaefer, D.H., 1986, Mobility of nitrogen-bearing explosives wastes in shallow ground water near Hawthorne, Nevada [abs.]: Philadelphia, Pa., 152nd National Meeting, American Association for the Advancement of Science, May 1986, Abstracts of Papers, p. 146.
- Worts, G.F., Jr., and Malmberg, G.T., 1966, Hydrologic appraisal of Eagle Valley, Ormsby County, Nevada: Nevada Department of Conservation and Natural Resources Reconnaissance Report 39, 55 p.



Exploratory well installation by the U.S. Geological Survey near Hawthorne, Nevada, September 1977. The study, at a military ammunition plant, indicated that liquid explosives wastes had percolated into the shallow basin-fill aquifer beneath disposal pits (Van Denburgh and Schaefer, 1986). (Photograph by A.S. Van Denburgh, U.S. Geological Survey.)

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