INFILTRATION AND QUALITY OF WATER FOR TWO ARROYO CHANNELS, ALBUQUERQUE, NEW MEXICO, 1988-92

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 95-4070

Prepared in cooperation with the
CITY OF ALBUQUERQUE PUBLIC WORKS DEPARTMENT

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1995

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CONVERSION FACTORS AND VERTICAL DATUM

In this report, most measurements are given in inch-pound units. If the data were collected as a metric unit, however, the metric unit is given first followed by the inch-pound unit.

Multiply	By	To obtain
inch	25.40	millimeter
inch per day	25.40	millimeter per day
inch per year	25.40	millimeter per year
foot	0.3048	meter
mile	1.609	kilometer
square mile	2.590	square kilometer
square foot	0.09290	square meter
pound per square inch	0.06897	bar
cubic foot	0.02832	cubic meter
cubic foot per second	0.02832	cubic meter per second

Temperatures in degrees Celsius (°C) and degrees Fahrenheit (°F) can be converted by the equations:

$$°F = 9/5\ (°C) + 32$$

$$°C = (°F-32)/1.8$$

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

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ABSTRACT

Selected reaches of Grant Line Arroyo and Tijeras Arroyo in Albuquerque, New Mexico, were studied to collect information about the amount and quality of infiltration through arroyo channels. Infiltration rate was calculated for selected reaches of Grant Line Arroyo and Tijeras Arroyo based on instantaneous streamflow-loss volumes, wetted channel area, and instantaneous evaporation rates measured during 1988-92. Infiltration rates at Grant Line Arroyo ranged from 0.0 to 0.6 foot per day, and at Tijeras Arroyo from 2.28 to 30 feet per day. The evaporation rate ranged from one-tenth of 1 percent to 2 percent of the infiltration rate.

Infiltration rates differed with the location of the reach isolated for measurement and with the time of day of the infiltration-rate measurement. Differences in intrinsic permeability of the sediments may be the most important factor affecting spatial variations in infiltration. The most important factor affecting temporal variations in infiltration may be the temperature of the water and sediment where infiltration occurs.

Annual evaporation rates were greatest over saturated stream sediments and ranged from 802 to 1,025 millimeters per year or from 31.57 to 40.35 inches per year. Annual evaporation rates were least over unsaturated, unvegetated soil and ranged from 174 to 291 millimeters per year or from 6.85 to 11.46 inches per year. Annual evapotranspiration rates over grasses or shrubs or both were about one-half the rates over saturated stream sediments. Rates were similar for Grant Line and Tijeras Arroyos. The land-surface vegetation, availability of water at the land surface, availability of energy to enable a change of state from water to vapor, existence of a vapor concentration gradient, and a turbulent atmosphere to carry the vapor away may be the factors that determine the amount of evaporation and evapotranspiration.

Water in Grant Line Arroyo and Tijeras Arroyo met U. S. Environmental Protection Agency drinking-water regulations for nitrate, volatile organic compounds, dissolved lead, and dissolved and total arsenic, barium, cadmium, chromium, copper, iron, silver, zinc, selenium, chloride, and sulfate concentrations. Total lead concentration in one sample from Tramway Floodway Channel, a tributary to Tijeras Arroyo, was 55 micrograms per liter, exceeding the Environmental Protection Agency drinking-water regulation of 50 micrograms per liter. Dissolved-solids concentrations calculated from the sum of cations and anions usually exceeded the Environmental Protection Agency drinking-water dissolved-solids regulation of 500 milligrams per liter at Tijeras Arroyo above Four Hills Bridge.

INTRODUCTION

The city of Albuquerque is the largest single user of ground water from the Albuquerque-Belen Basin in central New Mexico (fig. 1). Because the City of Albuquerque Public Works Department is responsible for providing an adequate future water supply to residents, they need information on how the water resource is replenished within the Albuquerque-Belen Basin. Infiltration and recharge are critical components in the replenishment of ground-water resources within the basin and can also influence the chemical quality of ground water.

A significant amount of the replenishment of the water resource may come from infiltration through arroyo channels. Understanding the amount, location, and quality of water that infiltrates the arroyo channels will aid city officials in managing projects that affect arroyo channels, such as lining of the channels, artificial recharge, and impoundments. To address these needs, the U. S. Geological Survey, in cooperation with the City of Albuquerque Public Works Department, conducted a study to investigate the quantity and quality of water infiltrating through selected reaches of two arroyos in the Albuquerque metropolitan area.

Purpose and Scope

The purpose of this report is to: (1) estimate infiltration for selected reaches of Grant Line and Tijeras Arroyos in Albuquerque, New Mexico, and (2) describe the quality of the water that flows in the arroyos. Basic data were collected at 3 sites in the Grant Line Arroyo and at 29 sites in the Tijeras Arroyo drainage basin. Data collection included measurements of evaporation, evapotranspiration, streamflow, soil-matric potential, soil temperature, and water quality. Water-quality samples were collected for laboratory analysis. Measurements of evaporation and evapotranspiration allowed more accurate infiltration estimates. Soil-matric-potential and soil-temperature sensors installed at two study sites allowed observation of infiltrating water to about 10 feet below the arroyo bed. Small-diameter, shallow wells installed along selected transects for one study location allowed observation of the water table and collection of ground-water samples. Ground-water samples were analyzed for concentrations of major ions, nutrients, selected trace elements, and selected organic compounds. Data were collected from October 1988 to August 1992.

Acknowledgment

Land owners along the Grant Line and Tijeras Arroyos have allowed access through their property to the arroyo channels. Streamflow-measurement and evapotranspiration-measurement equipment were used on the property of some land owners. Their cooperation is greatly appreciated and acknowledged.

DESCRIPTION OF THE STUDY AREA

City of Albuquerque and U.S. Geological Survey personnel chose two arroyos with channel reaches suitable for the study of infiltration in the Albuquerque metropolitan area. The two arroyos were selected in diverse drainage basin environments. The Grant Line Arroyo is in a suburban environment and the Tijeras Arroyo is in a mountain-front recharge environment. The two arroyos, Grant Line Arroyo and Tijeras Arroyo, and the studied channel reaches are shown in figure 1.

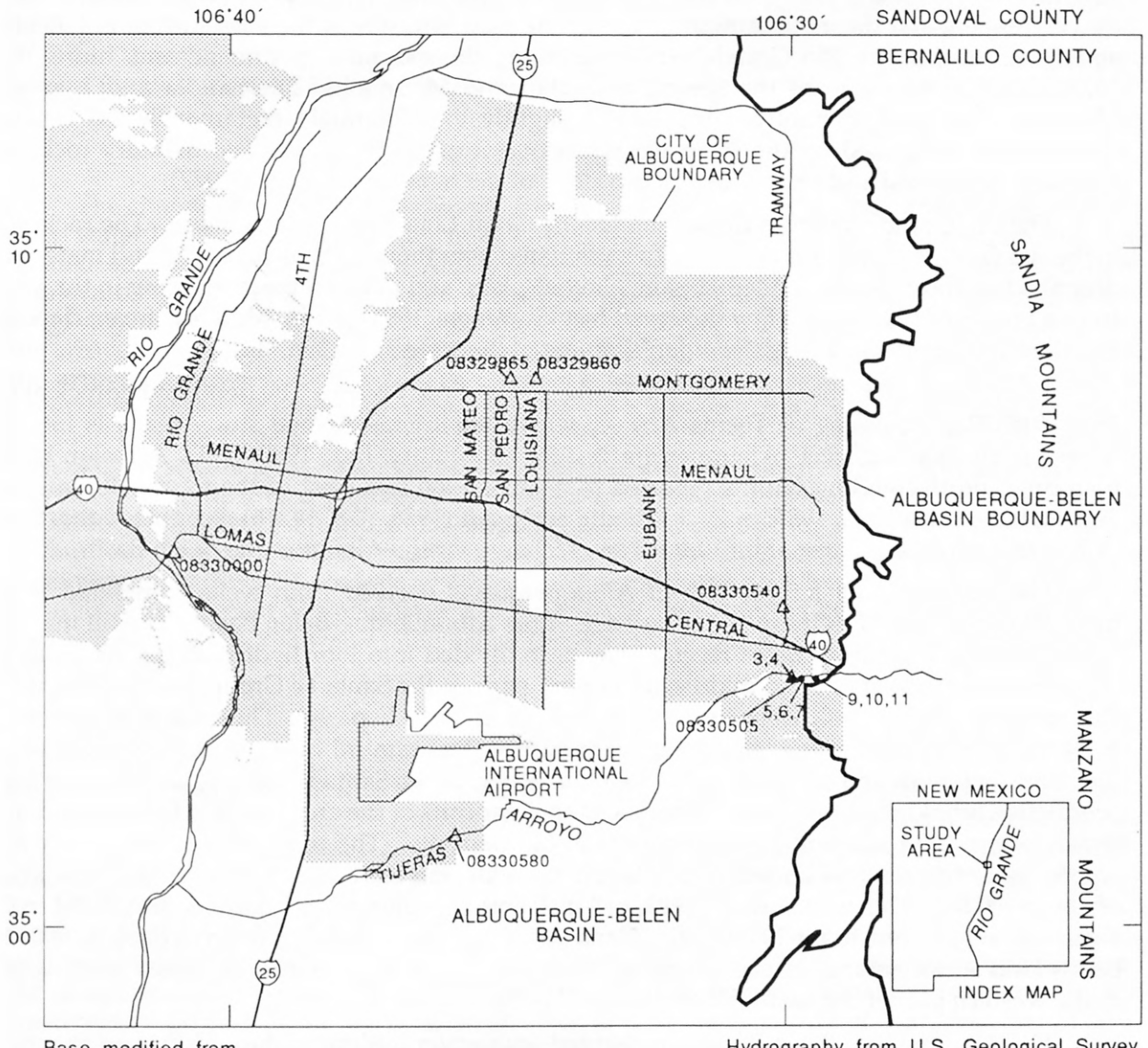


Figure 1.--Location of the study area and study sites.

Hydrogeologic Setting

The study area is part of a structural depression and adjacent uplift or mountains. The structural depression is known as the Albuquerque-Belen Basin. The city of Albuquerque lies in the depression, and the mountainous area is to the east. Altitude of the land surface is 4,900 feet above sea level at the Rio Grande, 6,500 feet along the mountain pediment, and more than 10,000 feet at the crests of the Sandia and Manzano Mountains. The Sandia and Manzano Mountains are predominantly composed of slightly to moderately metamorphosed igneous rock, which is exposed on the steep western slope (Kues, 1990, p. 7). Sedimentary rocks are exposed on the crest and on the eastern dip slope of the mountains (Kelley, 1977).

The Rio Grande Valley is the setting for the Grant Line Arroyo study reach. The rock type in the Rio Grande Valley is erosional fill accumulated over thousands of years. The fill material is described as alluvial-fan, braided-stream, alluvial-plain, and playa deposits ranging in thickness from a few hundred feet to a few thousand feet (Summers, 1991, p. 44). Modern stream deposits less than 100 feet thick overlie the older fill material (Summers, 1991, p. 44).

Tijeras Canyon is the setting for the Tijeras Arroyo study reach. The depth to bedrock at the Four Hills Road crossing of Tijeras Arroyo, where the Tijeras Arroyo study reach is located, ranges from 35 to 120 feet (Albuquerque Testing Laboratory, Inc., 1985, p. 1). A major, basin-bounding, north-trending fault is reported to lie about 300 feet west of the road (Albuquerque Testing Laboratory, Inc., 1985, p. 1). Kernodle and Scott (1986, p. 8, 14, 16) recognized this reach of Tijeras Arroyo as an area of infiltration and recharge for the Albuquerque-Belen Basin.

The water supply for the city of Albuquerque is derived from wells completed in fill material of the Santa Fe Group of Tertiary age of the Albuquerque-Belen Basin. The fill material in the Albuquerque-Belen Basin recently has been divided into four hydrostatigraphic units by other investigators: the lower, middle, and upper parts of the Santa Fe Group, and post-Santa Fe Group valley and basin-fill deposits (Thorn and others, 1993, p. 94). Thorn and others (1993, p. 94) further stated that the most productive part of the basin-fill material is the upper part of the Santa Fe Group and to some extent the middle part of the Santa Fe Group, and that the most productive lithologies are the fluvial axial-channel deposits of the ancestral Rio Grande and, to a lesser extent, the piedmont-slope and alluvial-fan deposits. The most productive part of this aquifer system is recently known to be 2 to 6 miles wide and has a remaining saturated thickness of about 600 feet (Thorn and others, 1993, p. 94). Depth to water in supply wells completed in the basin fill ranges from about 20 feet below land surface near the Rio Grande to as deep as 600 feet below land surface along the eastern part of the basin and as deep as 900 feet below land surface in the western part of the basin (Kues, 1987, p. 14-35).

The Albuquerque-Belen Basin is recharged with water infiltrated through stream channels, with precipitation infiltrated through the land surface, and with ground water flowing across the basin boundaries. In the Rio Grande flood plain, water infiltrates from the Rio Grande and associated stream channels. In the uplifted areas, water infiltrates through arroyo channels that carry runoff to the Rio Grande. Throughout the basin, water infiltrates through the land surface. Estimates of basin boundary, tributary, and mountain-front recharge have been made by Kernodle and Scott (1986). They estimated a recharge of 14.68 cubic feet per second for Tijeras Arroyo (Kernodle and Scott, 1986, p. 13, 16).

The Rio Grande is the only perennial stream in the Albuquerque-Belen Basin. It flows generally south-southwest through the Albuquerque-Belen Basin. At the streamflow-gaging

station Rio Grande at Albuquerque (08330000; fig. 1), the average streamflow for water years 1974-91 is 1,408 cubic feet per second. The drainage area for the station is 17,440 square miles. The surface-water system also consists of arroyos, irrigation canals, and drainage ditches.

The climate at Albuquerque is temperate and semiarid. The average annual temperature at the Albuquerque International Airport for 1960-90 was 56.2 °F (U.S. Department of Commerce, 1990, p. 11). Temperature extremes at the airport during 1990 were 104 °F on June 29 and minus 7 °F on December 23 (U.S. Department of Commerce, 1990, p. 15). Average precipitation at the airport for 1960-90 was 8.12 inches per year (U.S. Department of Commerce, 1990, p. 7).

Grant Line Arroyo

The channel reach studied at Grant Line Arroyo is a small residential drainage area with a deep water table. This reach is dry most of the time and flows only when rainfall occurs. It is located about 0.25 mile north of Montgomery Boulevard between San Pedro and Louisiana Boulevards (fig. 1). This reach of Grant Line Arroyo is an unlined sand channel about 2,510 feet long, varying in width from about 4 to 8 feet. Broken concrete blocks and concrete sills stabilize the arroyo to prevent erosion in small areas along the length of the channel. A typical portion of the arroyo is shown in figure 2. The channel is bounded by residential back yards. Typical vegetation consists of grasses and shrubs along the banks and small, young poplars growing in the sand channel. The reach studied has no tributary inflows or diversions and has a drainage area of 0.052 square mile. Two gages about 2,510 feet apart measure streamflow at each end of the reach. The upstream gaging station, Grant Line Arroyo at Villa del Oso at Albuquerque (08329860), consists of an arced sill, which provides a control for accurate measurement of streamflow. The downstream gaging station, Grant Line Arroyo above San Pedro Boulevard at Albuquerque (08329865), consists of a 24-inch Parshall flume, which also provides a control for accurate measurement of streamflow. On the basis of data reported by Kues (1987, p. 4, 32, and 46) for nearby wells, the water table below the arroyo channel is estimated to be about 600 feet below land surface.

Tijeras Arroyo

The channel reach studied at Tijeras Arroyo is a large, sparsely populated drainage area with a shallow water table. The reach is located at the eastern boundary of the Albuquerque city limits where Four Hills Road crosses Tijeras Arroyo and extends eastward beyond the city limits (fig. 1). This reach of Tijeras Arroyo is an unlined sand and gravel channel about 1 mile long, and lies within a flood-plain area varying in width from about 20 to 400 feet and bounded by cliffs to the north and south (fig. 3). The arroyo channel itself varies from about 2 to 10 feet wide and is part of the flood plain deposited on granitic rocks that form the Manzano Mountain pediment to the south and the Sandia Mountain pediment to the north. Vegetation is sparse in the westernmost portion of the study reach but increases to the east. About 1,000 feet east of Four Hills Bridge the channel supports the growth of salt cedars and cottonwoods as well as other small trees, shrubs, weeds, and grasses. A gage consisting of a 12-inch Parshall flume embedded in concrete provides the control for streamflow measurement at a point about 100 feet upstream from Four Hills Road Bridge. This gaging station is called Tijeras Arroyo above Four Hills Bridge at Albuquerque (08330505). The drainage area upstream from this gage is 77 square miles. Mean daily streamflow of less than 1 cubic foot per second usually passes the gage from mid-October to mid-May as a result of upstream seepage from the water table, rainfall, and snowmelt. During the summer months the gage is usually dry unless flow occurs as a result of rainfall. The response of small-diameter, shallow wells installed during this study shows that the water table is usually hydraulically connected to the stream at the gage.

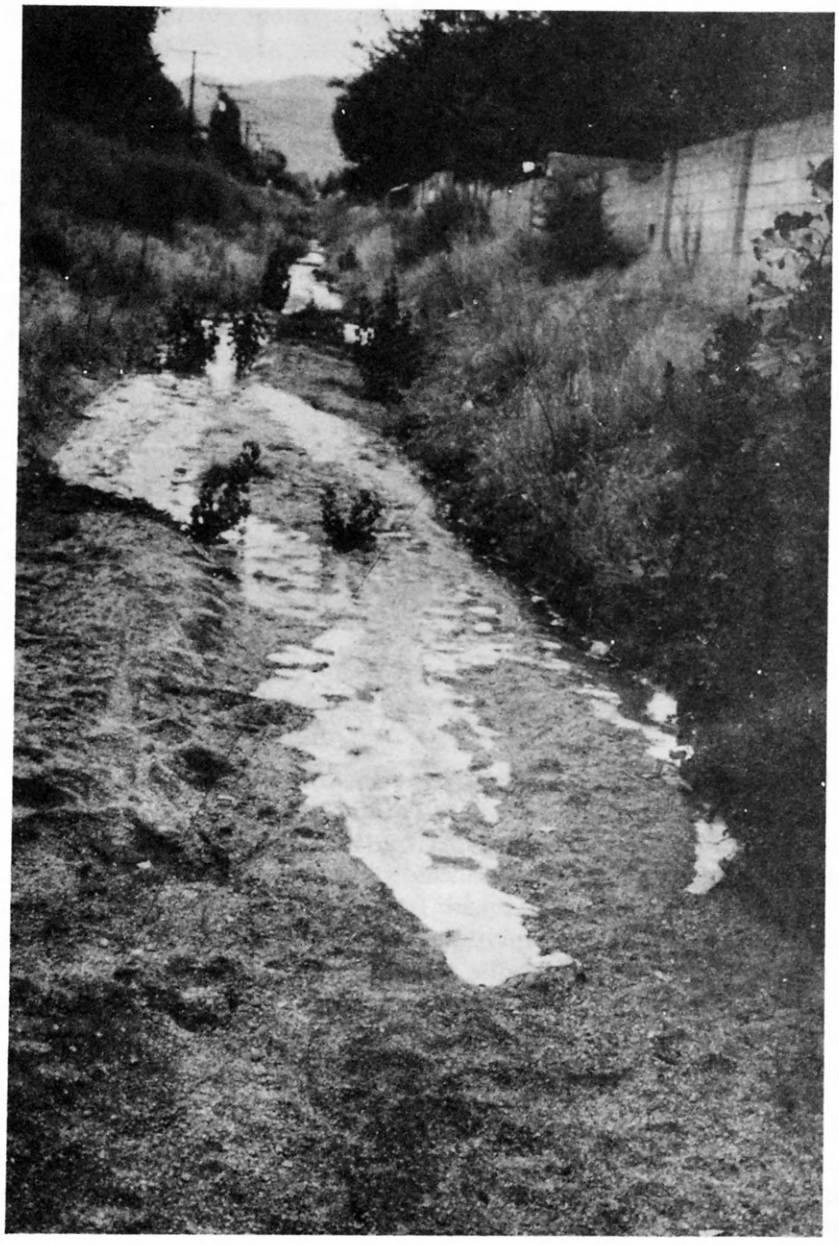
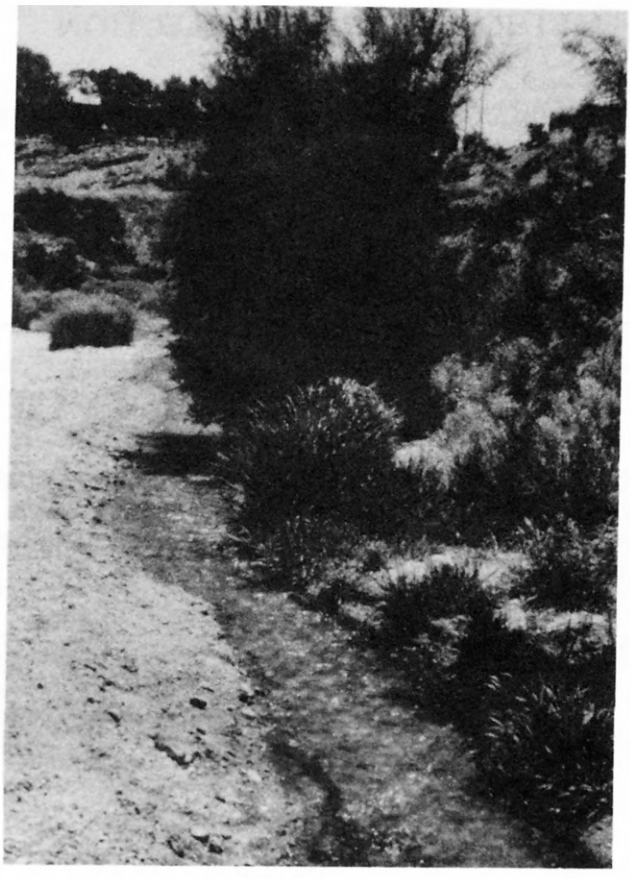


Figure 2.--Grant Line Arroyo unlined sand channel and typical vegetation, 1985.



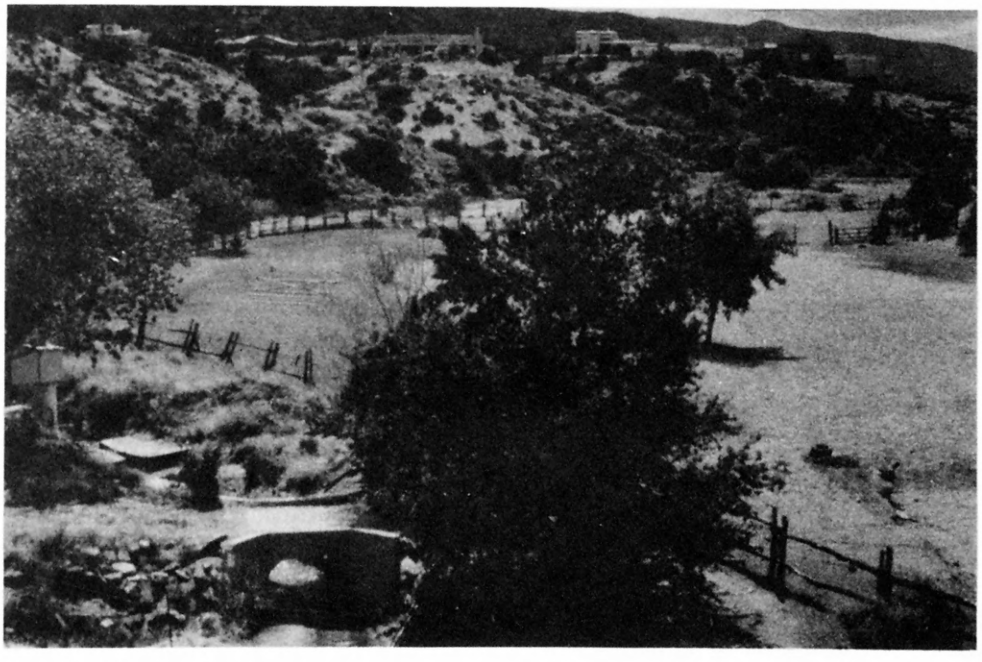


Figure 3.--Tijeras Arroyo, unlined sand and gravel channel and typical vegetation, May 1992 (photographs by J.E. Constantz, U.S. Geological Survey).

METHODS OF DATA COLLECTION

Basic data were collected at 3 sites in the Grant Line Arroyo drainage basin and at 29 sites in the Tijeras Arroyo drainage basin. The basic data collected included evaporation, evapotranspiration, streamflow, water temperature, soil temperature, soil-matric potential, water quality, and water levels. Table 1 (all tables are in the back of the report) summarizes the frequency and dates of data collection at the sites.

Instrumentation used to collect data in the field varied with the site and the purpose of the site visit. Both installed and portable instruments were used to collect data. Installed instruments included flumes, soil-matric-potential sensors, soil-temperature sensors, wells, and data loggers. Portable instruments included the evapotranspiration chamber, 3-inch and 6-inch flumes, thermometers, data loggers, and water-quality equipment.

At Grant Line Arroyo above San Pedro Boulevard at Albuquerque and at Tijeras Arroyo above Four Hills Bridge at Albuquerque, flumes, soil-matric-potential and soil-temperature sensors, and data loggers were installed. One-half-inch-diameter, shallow wells were installed at Tijeras Arroyo above Four Hills Bridge at Albuquerque, and at two transects 1,202 and 3,000 feet above Four Hills Bridge in Tijeras Arroyo. The generalized instrumentation set up for Grant Line and Tijeras Arroyos is shown in figure 4.

Evaporation and Evapotranspiration

The portable field chamber (Stannard, 1988) is a device used to measure instantaneous evaporation and evapotranspiration. It is made of acrylic plastic in the shape of a hemisphere and isolates a surface area of about 9.7 square feet. Field personnel made portable-field-chamber measurements of instantaneous evaporation and evapotranspiration about once hourly, during daylight hours from near sunrise to sunset. Measurements were made during 1 to several days, about every month, for slightly more than 3 years beginning April 6, 1989, and ending May 19, 1992 (table 2).

The general procedure for making portable-field-chamber measurements of instantaneous evaporation and evapotranspiration included the selection of six stations for measurement at the Grant Line Arroyo and Tijeras Arroyo study sites. The stations represented the different types of land-surface conditions at each study site--generally, a mix of unsaturated, unvegetated soil; grasses or shrubs or both; and saturated stream sediments. Stations identified as "unsaturated, unvegetated soil" were away from the stream on soil that appeared to be dry and without vegetation. Stations identified as "grasses or shrubs or both" were (1) all grasses, including native grasses and various native vegetation of the same size as grass; (2) all shrubs, including native shrubs smaller than 2 feet tall that fit under the portable field chamber; or (3) a combination of grasses and shrubs. The density of the grasses or shrubs or both was not determined, but stations generally were chosen that had vegetation covering one-third or more of the land surface. Stations identified as "saturated stream sediments" were within stream braids or at the edge of the stream, where the water table was at land surface. When no water was flowing in the stream channel, as was often the case at Grant Line Arroyo, no stations with saturated stream sediments were measured.

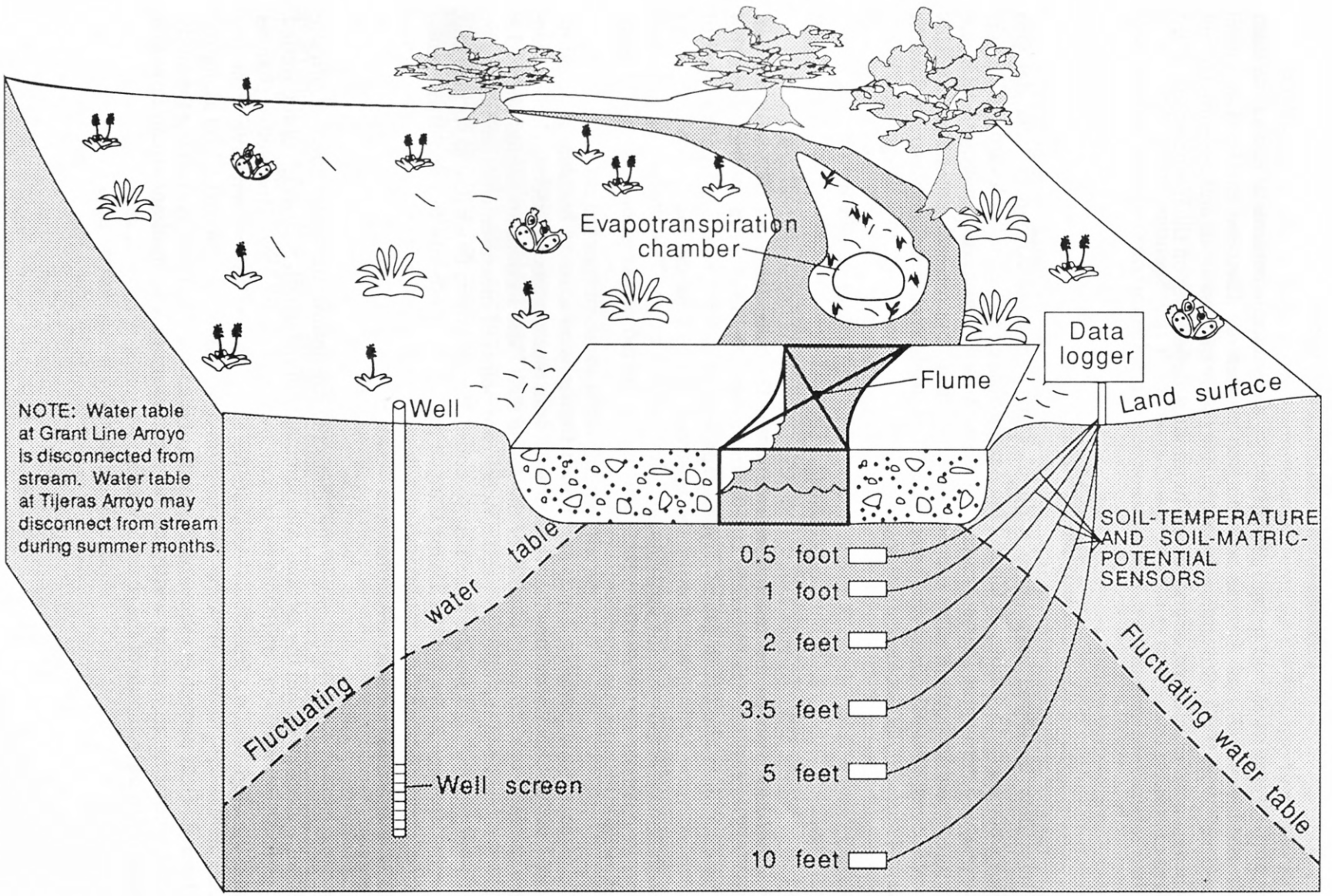


Figure 4.--Schematic of instrumentation at Grant Line Arroyo above San Pedro Boulevard at Albuquerque, New Mexico, and Tijeras Arroyo above Four Hills Bridge at Albuquerque, New Mexico.

Streamflow and Streamflow Loss

Streamflow was measured using Parshall flumes and concrete controls at several sections along Grant Line and Tijeras Arroyos according to procedures discussed in U.S. Geological Survey reports (1968, 1969). Streamflow measurements were instantaneous and measured about once an hour, every 15 minutes, or once every 10 minutes, depending on the intended use of the data.

Daily Mean Streamflow

Streamflow measured once every 5 minutes at Grant Line Arroyo at Villa del Oso (08329860), once every 15 minutes at Grant Line Arroyo above San Pedro Boulevard (08329865), and once every 15 minutes at Tijeras Arroyo above Four Hills Bridge at Albuquerque (08330505) was averaged over 24 hours to obtain a daily mean streamflow for each day of record (U.S. Geological Survey, 1990-93). Daily mean streamflow was used to compute annual streamflow for the period of record (U.S. Geological Survey, 1990-93).

Streamflow Loss

At Grant Line Arroyo the streamflow volumes at the Villa del Oso (08329860) and San Pedro (08329865) gages were used to calculate streamflow-loss volumes for rainstorm events that were large enough to affect both gages. Hydrograph flow at the downstream gage (San Pedro) was subtracted from hydrograph flow at the upstream gage (Villa del Oso). No inflows or outflows were present between the upstream and downstream gages. This site is ephemeral and flows only in response to rainstorm events. During the period of record only 11 events were suitable to make this calculation.

At Tijeras Arroyo portable 3-inch and 6-inch flumes were used to measure streamflow about once hourly at associated upstream and downstream measurement sections. Flumes were set where the flow volume was suitable for the flume size. The sections measured showed a streamflow loss between the upstream and downstream points of measurement. No inflows or outflows were present between the measured sections. Tijeras Arroyo flows due to springs and ground-water seepage in the incised Tijeras Canyon and also in response to rainstorm events. Data were not used if streamflow conditions were changing rapidly; therefore, the data represent steady-flow conditions. These measurements resulted in 160 streamflow-loss calculations during 1989-92.

The streamflow rate at the upstream site minus the streamflow rate at the downstream site is the rate of water lost within the section. Measurements of the length and width of the wetted channel section were needed to distribute the streamflow loss over the area of the wetted channel section and therefore obtain a streamflow-loss rate per unit area that was not sensitive to the size of the section. The length of the channel was measured by rolling a calibrated wheel along the stream channel. Field personnel estimated the width of the stream channel by walking the study section and estimating an average width for the entire channel. The resultant streamflow-loss rate is sensitive to the estimate of the channel width.

Daily Mean Streamflow Loss

At Tijeras Arroyo a daily mean streamflow-loss volume for May 19, 1992, was calculated from streamflow measurements taken every 10 minutes during that 24-hour period. Additional daily mean streamflow-loss calculations planned for several days following May 19 were eliminated due to a prolonged rainstorm that began about noon on May 20, 1992. During the May 19, 1992, effort the width of the wetted channel was measured about every 2 hours between 0830 and 1600, in centimeters, at 11 transects along the section to obtain a resultant streamflow-loss rate that was more accurate than the previous method of estimating the channel width.

Water Quality

Water-quality samples were collected according to procedures outlined by the U.S. Geological Survey (1982). Surface-water samples were collected from flows in arroyos and shallow, ground-water samples were collected from wells in the Tijeras Arroyo flood plain. Surface-water-quality stations included two sites located along Grant Line Arroyo (08329860 and 08329865), a third site located at Tijeras Arroyo above Four Hills Bridge (08330505), and a fourth site located at the Tramway Floodway Channel near its confluence with Tijeras Arroyo (08330540) (fig. 1). Ground-water-quality sites included three wells (wells 3, 5, and 11) within the Tijeras Arroyo flood plain upstream from Four Hills Bridge (fig. 1). The wells were constructed with one-half-inch plastic tubing and 2 feet of well screen at depth. Well 3 was 11.8 feet deep; well 5 was 11.5 feet deep; and well 11 was 7.5 feet deep.

Sample collection began October 28, 1988, and ended May 20, 1992, resulting in a total of 28 samples. Properties and constituents analyzed included specific conductance, pH, temperature, dissolved cations and anions, dissolved and total nutrients, dissolved and total trace elements, and total volatile organic compounds (U.S. Geological Survey, 1990-93).

CALCULATION OF INFILTRATION

Infiltration is the movement of water through the soil surface and into pore spaces in the soil as distinguished from percolation, the movement of water through the soil (Linsley and others, 1982, p. 180). Water that has infiltrated can be intercepted or fail to percolate to the regional water table. Roots of vegetation along the streambank or within the stream's flood plain can intercept soil water, consuming it in the evapotranspirative process. In many areas infiltrated water may not reach the regional water table because subsurface soil layers having low permeability may inhibit downward percolation.

Hydrologists refer to water that percolates to the regional water table as recharge. This is often identified on the basis of a rise of water level within an observation well (Davis and DeWiest, 1966, p. 425; Freeze and Cherry, 1979, p. 215).

Water that is lost between two streamflow measurement stations in a channel reach with no intervening inflows or outflows can either be evaporated from the stream's surface or infiltrated into the soil below the stream. The infiltration rate was calculated according to equation 1:

$$\text{infiltration rate} = [(\text{streamflow at upstream gage} - \text{streamflow at downstream gage}) / \text{wetted channel area}] - \text{evaporation rate} \quad (1)$$

where infiltration rate is given in feet per day;
streamflow is given in cubic feet per day;
area is given in square feet; and
evaporation rate is given in feet per day.

Streamflow at the downstream gage is subtracted from streamflow at the upstream gage to obtain a streamflow-loss rate in cubic feet per day. The streamflow-loss rate is then divided by the wetted channel area in square feet to give a streamflow-loss rate per unit area in feet per day. The evaporation rate converted to units of feet per day is subtracted from the streamflow-loss rate per unit area to obtain the infiltration rate in feet per day. The evaporation rate from the stream was assumed to be equal to the evaporative-loss rate measured for saturated stream sediments.

The evaporation rate for the stream was small in comparison to the infiltration rate of the stream and ranged from less than one-tenth of 1 percent to 2 percent of the infiltration rate for the stream (table 3). Consideration of the evaporation rate of the stream made no difference in the calculation of infiltration because of the number of significant digits in 82 of the 171 measurements listed in table 3. The width of the wetted channel area was considered to be accurate to the nearest foot, accurate to one significant digit. The resultant infiltration rate is accurate to one significant digit. The resultant infiltration rate with only one significant digit is not sensitive to the small quantity of evaporation. However, a more accurate measurement of the wetted channel area would result in a more accurate estimate of the infiltration rate.

The 89 infiltration measurements taken during May 19, 1992, were improved by measuring the width of the stream in centimeters at 11 transects. This increased the number of significant digits from one to three. Although the evaporation from the stream was still a very small number compared to the infiltration it did make a difference in the calculation of infiltration for May 19, 1992.

Calculation of Evaporation and Evapotranspiration Rates

Evaporation is the process by which molecules of water at a water surface or other moist surface, such as soil, acquire enough energy from heated air or from the sun's radiation to escape the liquid state and pass into the gaseous state (Davis and DeWiest, 1966, p. 18; Arya, 1988, p. 183). Transpiration is the process by which plants lose water to the atmosphere by converting water molecules to the gaseous state at the leaf surface (Davis and DeWiest, 1966, p. 18; Arya, 1988, p. 185). In many instances the amount of evaporation cannot be measured separately from transpiration, hence the two processes are considered together as evapotranspiration (Davis and DeWiest, 1966, p. 18; Arya, 1988, p. 186). Evapotranspiration depends on land-surface vegetation, and its age, health, temperature, and water stress (Stull, 1988, p. 274); availability of water at the land surface; availability of energy to enable a change of state from water to vapor; existence of a vapor concentration gradient; and a turbulent atmosphere to carry the vapor away (Oke, 1987, p. 65-66).

Potential evaporation and potential evapotranspiration are the evaporation and evapotranspiration that would occur under given climatic conditions assuming that there is a free water surface or that there is never a deficiency of water available in the soil (Fetter, 1988, p. 568). Actual evaporation or evapotranspiration values generally are smaller than potential values.

A portable field chamber (Stannard, 1988) and the Penman equation (Arya, 1988, p. 192-194) were used to obtain evaporation and evapotranspiration rates. The portable field chamber measures actual evaporation and evapotranspiration, whereas the Penman equation calculates potential evaporation and evapotranspiration. The portable field chamber was used

to measure actual evaporation and evapotranspiration rates from soil or low-growing vegetation during 1989-92. The Penman equation was used to obtain an estimate of potential evapotranspiration from trees in the stream flood plain that were too large to be measured using the portable field chamber for the hydrologic budget estimate of infiltration for May 19, 1992. The potential evapotranspiration rate was then used as an estimate of the actual evapotranspiration rate for the trees. An evaporation or evapotranspiration rate, as used in this report, is expressed as a unit of length per unit time, which can be thought of as the depth of water evaporating from a surface per unit time.

Instantaneous Evaporation and Evapotranspiration Rates

To compute instantaneous evaporation or evapotranspiration by the portable field-chamber technique, vapor density was measured during a 1- to 4-minute period within the area isolated by the portable chamber. Computation of vapor density involved using the equations given in Campbell (1977, p. 22-24) and the wet-bulb and dry-bulb temperatures measured by a psychrometer mounted within the chamber. The slope of the vapor-density time series, inside the chamber before saturation occurred, determined an instantaneous evapotranspiration rate after accounting for the chamber volume, area, and calibration factor (Stannard, 1988, p. 4-12).

Instantaneous evaporation rates for May 19, 1992, were needed to correspond with 10-minute instantaneous infiltration rates for May 19, 1992 (table 3). These were determined by interpolation from the graphs of the instantaneous evaporation rates for saturated stream sediments taken about once an hour for May 19, 1992.

Instantaneous evaporation and evapotranspiration rates varied over the 24-hour daily period. Rates generally were near zero early in the morning and late in the evening and assumed to be zero during the night without the sun to supply an energy source. During midday, instantaneous evaporation and evapotranspiration rates were usually at their peak. An example of this is the saturated stream sediments at Tijeras Arroyo 650 feet above Four Hills Bridge on July 31, 1991 (fig. 5). The peak instantaneous evaporation rate was about 18 millimeters per day or about 0.71 inch per day at 1430 hours.

Maximum instantaneous evaporation rates corresponded with high land-surface temperatures. The maximum instantaneous evaporation rates measured were 27 and 28 millimeters per day or 1.1 inches per day over saturated stream sediments at Grant Line Arroyo at Villa del Oso on June 26, 1990, at 1350; and at Tijeras Arroyo 3,000 feet above Four Hills Bridge on June 27, 1990, at 1314. The high air temperature for both days was more than 100 °F at the Albuquerque International Airport (U.S. Department of Commerce, June 1990, p. 15). In comparison, when the high temperature for the day was 46 °F on January 16, 1991, at 1325 at the Albuquerque International Airport (U.S. Department of Commerce, January 1991, p. 15) the maximum instantaneous evaporation rate for saturated stream sediments was 3 millimeters per day or 0.12 inch per day at Tijeras Arroyo at Four Hills Bridge.

Daily Evaporation and Evapotranspiration Rates

Daily evaporation and evapotranspiration rates were calculated from the instantaneous evaporation and evapotranspiration rates by the mathematical procedure of integrating the instantaneous rates over the 24-hour daily periods. During the night when no instantaneous rates were measured, the assumption was made that rates were 0. The assumption was reasonable because measured instantaneous rates were generally near 0 early in the morning and late in the evening.

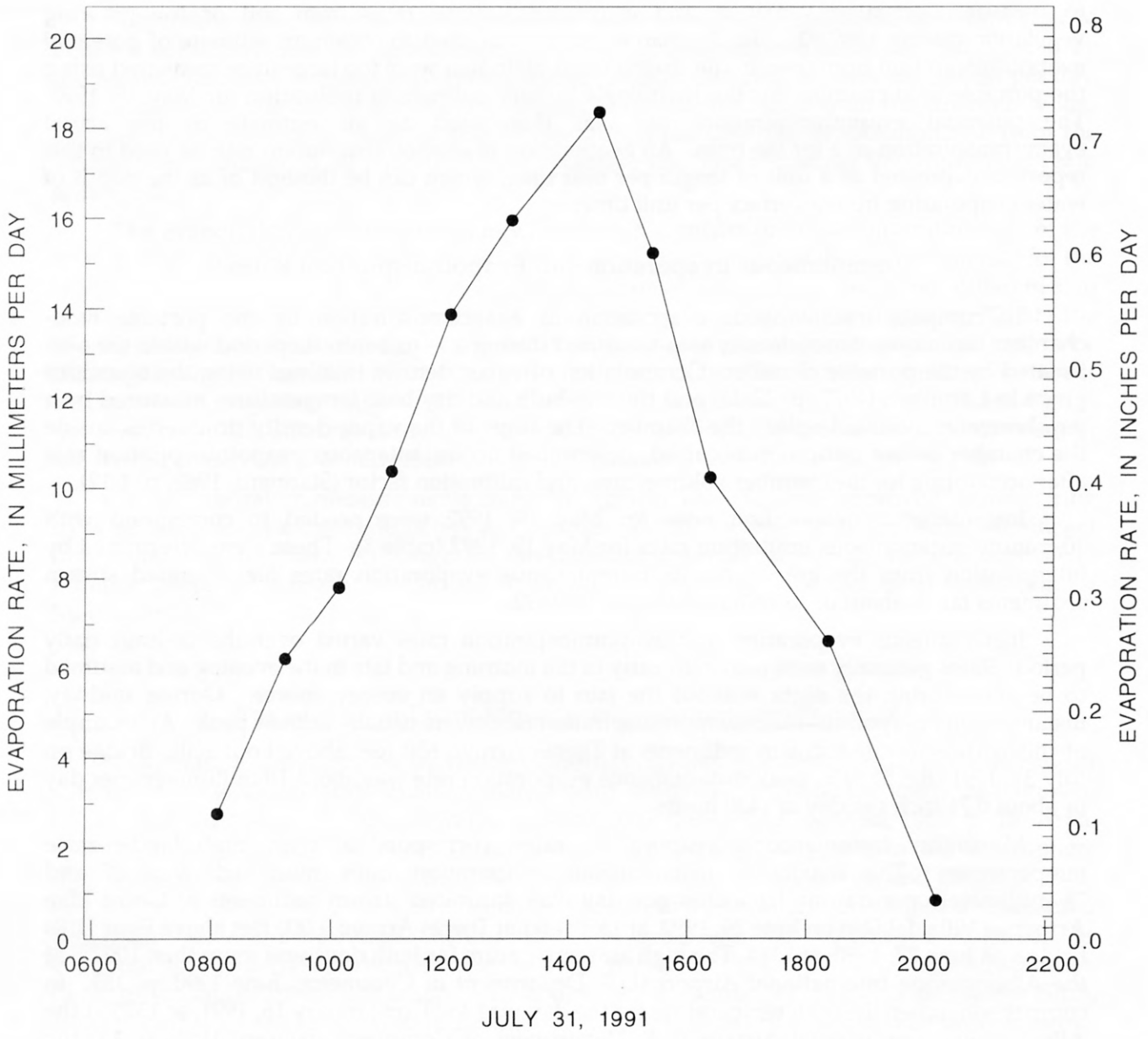


Figure 5.--Instantaneous evaporation rate over saturated stream sediments at Tijeras Arroyo 650 feet above Four Hills Bridge, July 31, 1991.

The daily evaporation rate was greatest for saturated stream sediments and ranged from about 0.3 to 7.2 millimeters per day or 0.01 to 0.28 inch per day (table 2). The daily evapotranspiration rate for grasses or shrubs or both ranged from about 0.1 to 4.6 millimeters per day or 0.004 to 0.18 inch per day (table 2). The daily evaporation rate for unsaturated, unvegetated soil ranged from about 0 to 3.0 millimeters per day or 0 to 0.12 inch per day (table 2).

Daily evaporation and evapotranspiration rates ranged from about 0.1 to 7.2 millimeters per day or 0.004 to 0.28 inch per day during the warmer months of May through September 1989-92, and from about 0 to 2.2 millimeters per day or 0 to 0.09 inch per day during the colder months of November through March 1989-92 (table 2). The seasonal variation in daily rates averaged by land-surface conditions is shown in figures 6 and 7.

Daily evaporation and evapotranspiration rates were similar when the same land-surface conditions were compared for the Grant Line Arroyo and Tijeras Arroyo drainage basins (figs. 6 and 7; table 2). Evaporation and evapotranspiration rates did not vary with geographic location within the study area.

Annual Evaporation and Evapotranspiration Rates

Annual evaporation and evapotranspiration rates were calculated to provide information about actual evaporation and evapotranspiration rates for the Albuquerque area. Most annual evaporation and evapotranspiration rates published for the Albuquerque area are potential rates.

Annual evaporation and evapotranspiration rates were calculated from daily evaporation and evapotranspiration rates for three land-surface conditions: unsaturated, unvegetated soil; grasses or shrubs or both; and saturated stream sediments. Calculations were combined for the Grant Line Arroyo and Tijeras Arroyo drainage basins. Daily rates for days not measured during each year were generated using a time series expansion of the actual measurements (SAS Institute, Inc., 1988, p. 261-268). Annual evaporation and evapotranspiration rates calculated for the 3 years--April 1989 through March 1990, April 1990 through March 1991, and April 1991 through March 1992--are listed in table 4.

The greatest annual evaporation rates occurred over saturated stream sediments: 802, 1,025, and 1,024 millimeters per year (or 31.57, 40.35, and 40.31 inches per year) (table 4). Evaporation rates over grasses or shrubs or both were about one-half the evaporation rates over saturated stream sediments: 438, 465, and 469 millimeters per year (or 17.24, 18.31, and 18.46 inches per year) (table 4). The evaporation rate was least over unsaturated, unvegetated soil: 174, 291, and 233 millimeters per year (or 6.85, 11.46, and 9.17 inches per year (table 4). Low annual precipitation at Albuquerque International Airport for April 1989 through March 1990 (U.S. Department of Commerce, 1989-92, p. 7) seems to correspond with a similar low evaporation rate measured over unsaturated, unvegetated soil for April 1989 through March 1990 (table 4).

The evaporation and evapotranspiration rates for the Albuquerque area measured with the portable field chamber (table 4) are less than potential evaporation and evapotranspiration rates reported in previous publications (Williams and McAllister, 1979; Williams, 1986). This is not unexpected because actual values commonly are smaller than potential values. Iven Bennett (Williams, 1986, p. 48-49) reported an annual potential evaporation rate of greater than 55 inches per year and less than 65 inches per year for the Albuquerque area on the basis of National Oceanic and Atmospheric Administration pan evaporation data for 1956-70. Fifty-five to 65 inches per year is about 1.5 to 2 times the evaporation rate measured over saturated stream sediments (table 4). Howard Morgan calculated an annual potential evapotranspiration rate over soil and vegetation combined of 30.4 inches per year for Albuquerque for 1931-55, using the Thornthwaite Formula (Williams and McAllister, 1979, p. 14-15). This is about twice the measured evapotranspiration computed for grasses or shrubs or both, and about three times that computed for unsaturated, unvegetated soil (table 4).

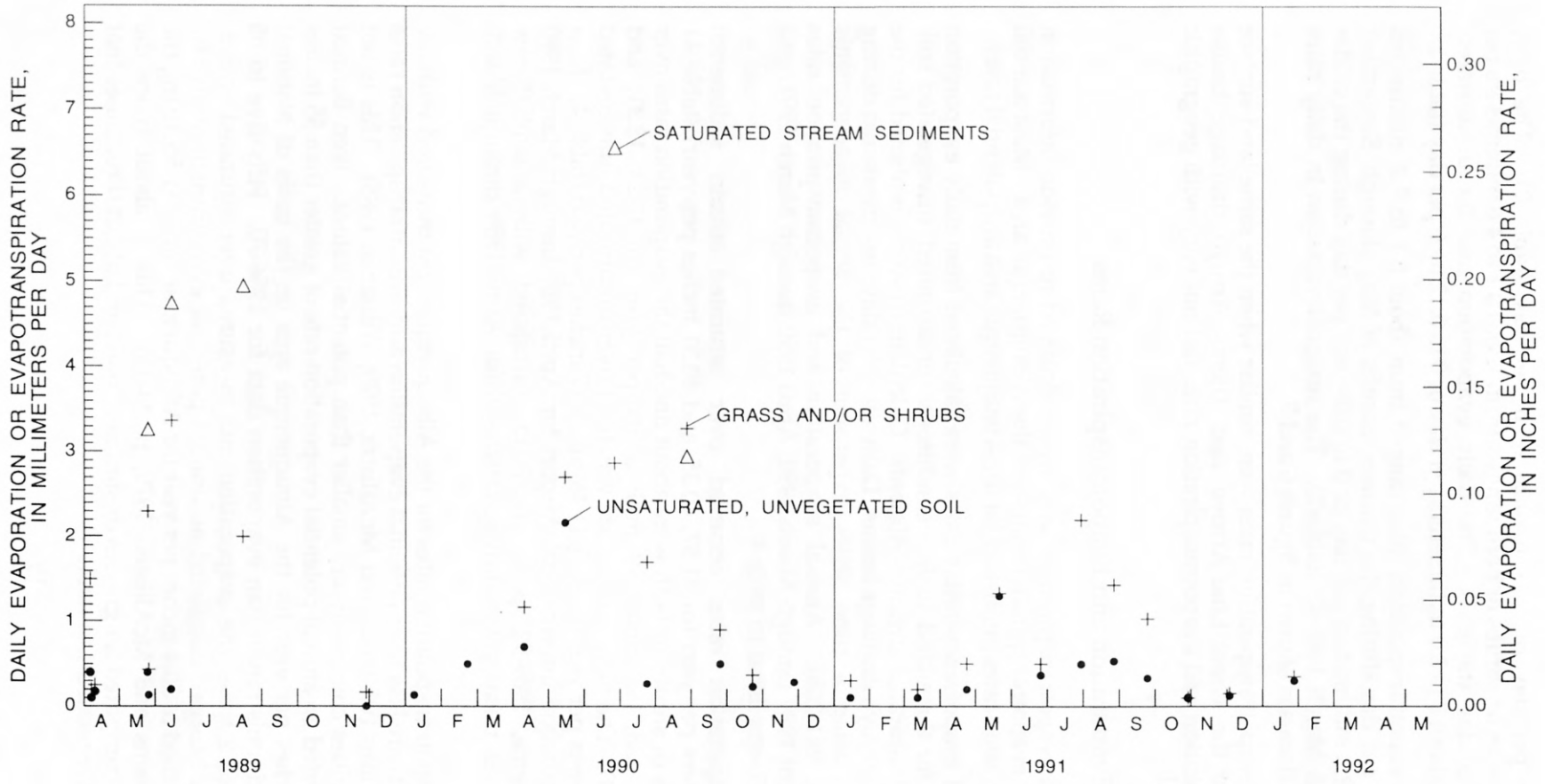


Figure 6.--Daily evaporation and evapotranspiration rates averaged by land-surface conditions for the Grant Line Arroyo drainage study sites.

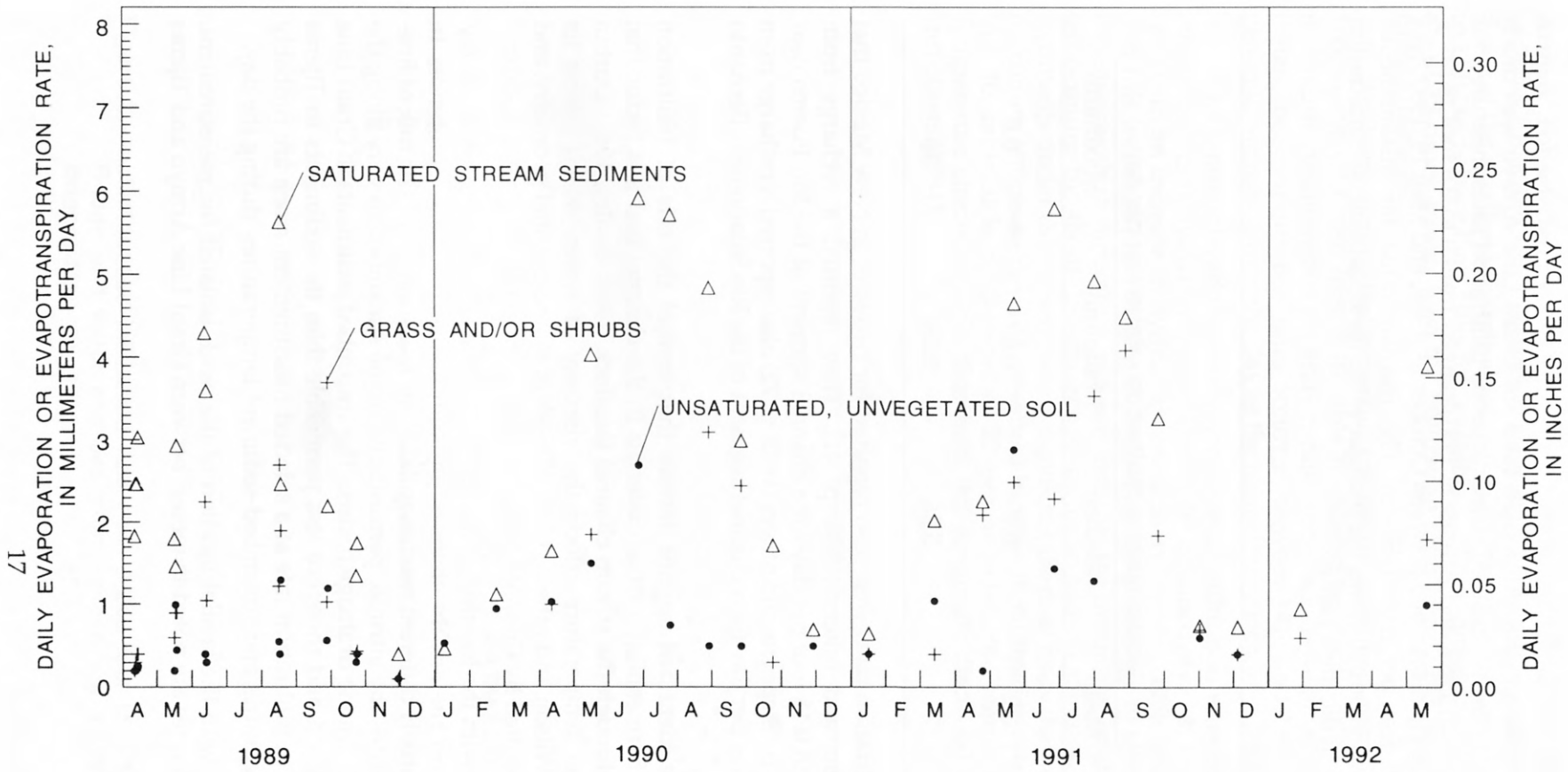


Figure 7.--Daily evaporation and evapotranspiration rates averaged by land-surface conditions for the Tijeras Arroyo drainage study sites.

Variation of Calculated Infiltration Rates

The range in measured instantaneous infiltration rates for Grant Line Arroyo was much smaller than the range for Tijeras Arroyo (table 3). Instantaneous infiltration rates measured for Grant Line Arroyo between July 25, 1989, and August 6, 1991, ranged from 0 to 0.6 foot per day (table 3). The range measured at Tijeras Arroyo between October 23, 1989, and May 19, 1992, was much larger, from 2.28 to 30 feet per day (table 3). The median value for instantaneous infiltration at Tijeras Arroyo was about 50 times the median value for instantaneous infiltration at Grant Line Arroyo as shown in the table below:

Drainage basin	Number of measure-ments in data set	Instantaneous infiltration rate, in feet per day			
		Mean	Median	Minimum	Maximum
Grant Line Arroyo	11	0.2	0.1	0.0	0.6
Tijeras Arroyo	160	7	5.86	2.28	30

Large differences in infiltration rates were also reported for two sites in New Mexico that were investigated by Stephens and others (1988, p. 41). They reported a recharge from streamflow infiltration of 0.05 to 0.18 foot per day for a channel segment of the Rio Puerco near Bernardo in central New Mexico. Stephens and others (1988, p. 72) also reported a recharge from streamflow infiltration of 9.1 feet per day for a channel segment of the Rio Salado near Bernardo in central New Mexico.

Several researchers have identified specific factors that control the rate of infiltration through the stream channel. Permeability of the materials in the channel bed is a factor that affects the rate of infiltration through the stream channel (Matlock, 1965; Cooley, 1968; Durbin and Hardt, 1974, p. 14). Water temperature affects the viscosity of water, which affects its infiltration rate (Cooley, 1968; Wilson and others, 1980). Depth of water, channel geometry, and critical capillary head were also cited by Cooley (1968) as affecting the infiltration rate of water.

Infiltration rates differed with the location of the reach measured and with the time of day. Permeability of the materials in the stream channel probably cause the large differences in infiltration rates among the spatially different reaches isolated for measurement. The mix of fine- to coarse-grained sediments causes the intrinsic permeability of the streambed to vary along the length of the channel, as well as among drainage basins. The streambed sediments in Grant Line Arroyo are generally finer grained and therefore less permeable than the sediments in Tijeras Arroyo. Temporal differences in infiltration rate at a selected measurement reach are probably due to variation of water temperatures and streambed-sediment temperatures during the day.

Infiltration rates differed with the spatial location of the reach isolated for measurement. Large differences in infiltration rates are noted in table 3 between Grant Line Arroyo and Tijeras

Arroyo. For selected reaches that were measured at Tijeras Arroyo the greatest infiltration rates of 30 feet per day were measured from 885 feet to 650 feet above Four Hills Bridge (table 3). Some of the smallest infiltration rates of 2.28 feet per day were measured for the reach 2,245 feet to 1,202 feet above Four Hills Bridge (table 3). The infiltration rates from 885 feet to 650 feet were about 13 times greater than the infiltration rates from 2,245 feet to 1,202 feet above Four Hills Bridge (table 3).

At Tijeras Arroyo instantaneous infiltration measured every 10 minutes from about 0830 to 1600 on May 19, 1992 (figs. 8-10; table 3), showed temporal variation of the infiltration rates. The minimum instantaneous infiltration rates occurred between 0830 and 0930 and the maximum instantaneous infiltration rates occurred between 1410 and 1500 (figs. 8-10). Infiltration rates generally increased over the day as the temperature increased (figs. 8-10).

The temporal variation in instantaneous infiltration rates could result from temperature effects on viscosity, which affects hydraulic conductivity. An increase in water temperature results in an increase in hydraulic conductivity (Cooley, 1968; Wilson and others, 1980, p. 5-2) and this increases the infiltration rate. Figures 8 through 10 show that the rate of infiltration increases as the temperature increases but that the maximum infiltration rate lags the maximum temperature by about 15 minutes to an hour and 15 minutes. This could be because the sediments under the stream have a significant thermal mass that requires some time to warm to maximum temperature. The measured increase in infiltration rate from 3.80 to 4.64 feet per day (fig. 10; table 3) is an increase of 22 percent when the temperature rose from 12 to 21 °C. Temperature effects on infiltration from this stream are discussed in further detail by Constantz and others (1994).

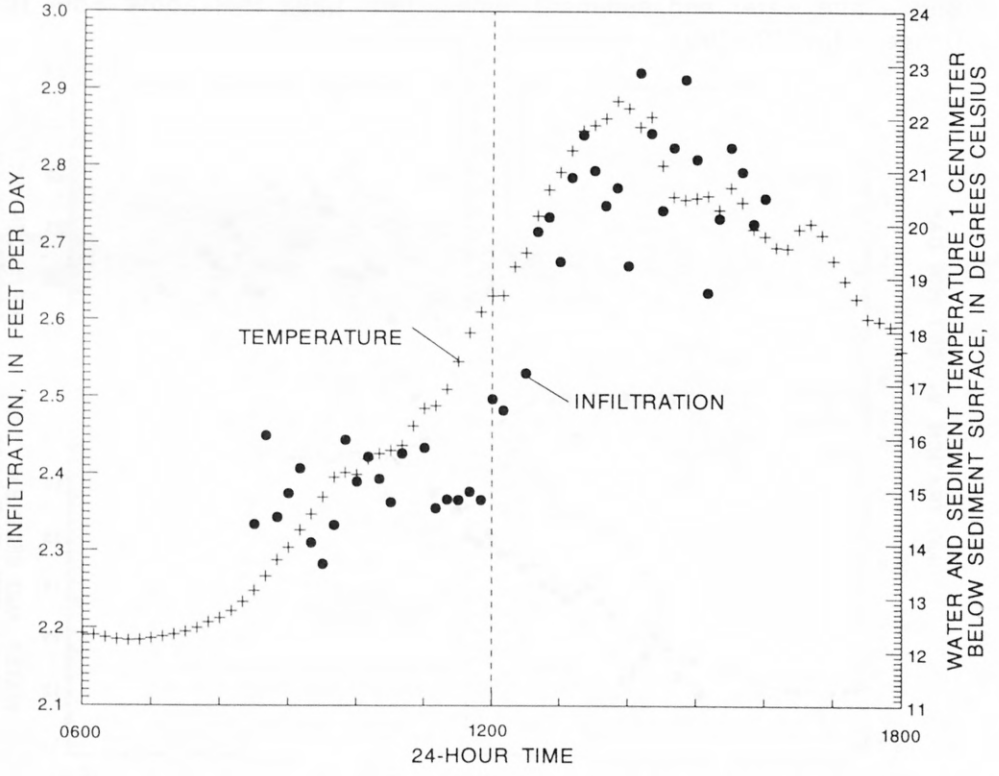


Figure 8.--Instantaneous infiltration rate from 2,245 feet to 1,202 feet above Four Hills Bridge and water and sediment temperature 1,202 feet above Four Hills Bridge, May 19, 1992.

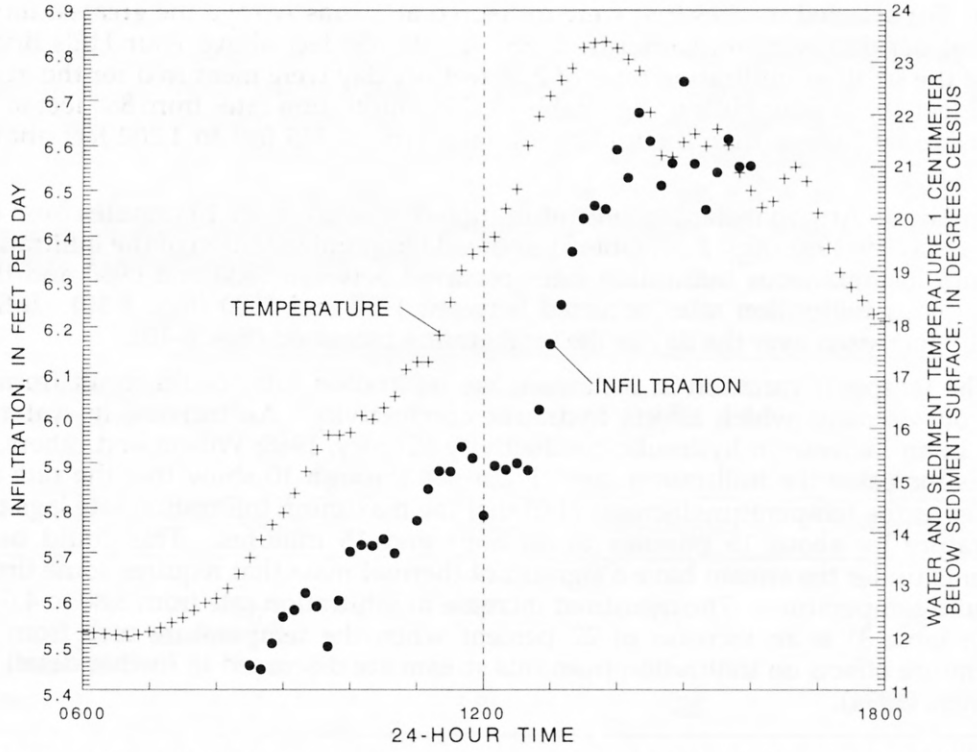


Figure 9.--Instantaneous infiltration rate from 1,202 feet to 100 feet above Four Hills Bridge and water and sediment temperature 1,202 feet above Four Hills Bridge, May 19, 1992.

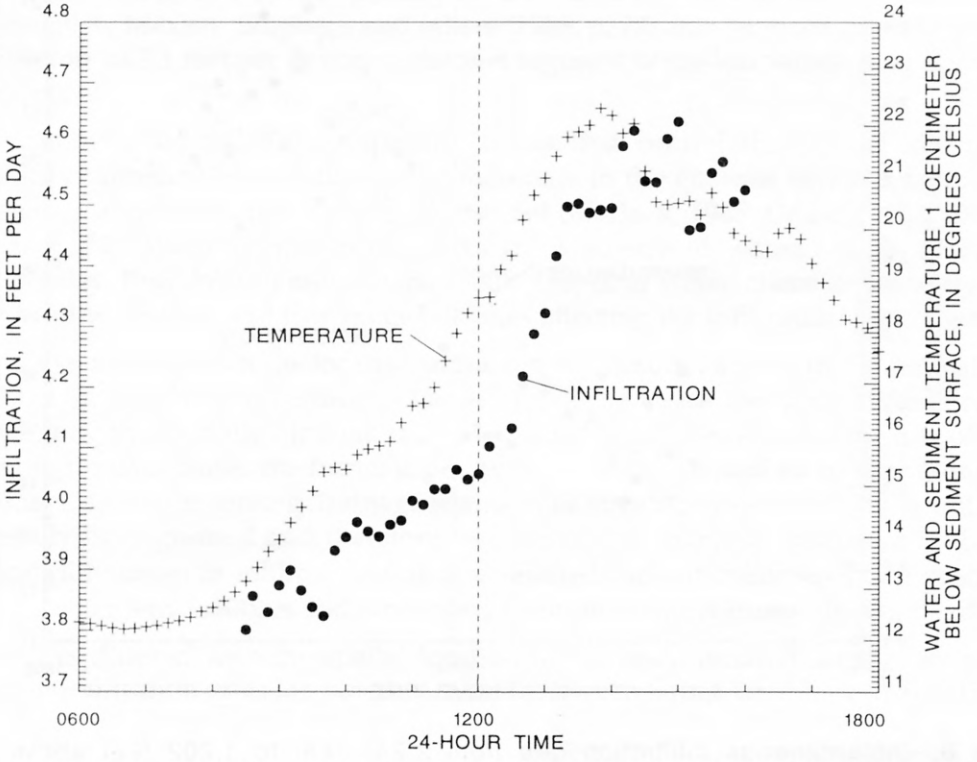


Figure 10.--Instantaneous infiltration rate from 2,245 feet to 100 feet above Four Hills Bridge and water and sediment temperature 1,202 feet above Four Hills Bridge, May 19, 1992.

EVIDENCE OF INFILTRATION FROM SOIL-TEMPERATURE AND SOIL-MATRIC-POTENTIAL SENSORS

Data from ceramic soil-temperature and soil-matric-potential sensors installed at Grant Line Arroyo and Tijeras Arroyo confirm that infiltration occurs. A soil-temperature increase or decrease was recorded by the soil-temperature sensors depending on whether the temperature of the infiltrating water was warmer or colder than the ambient temperature in the ground. A response in the soil-matric-potential sensors also was recorded with the influx of infiltrating water under unsaturated flow conditions. For example, Grant Line Arroyo above San Pedro Boulevard on September 19, 1989, shows the infiltration of a cool water pulse at the soil-temperature sensors from the surface downward to the 0.5-, 1.0-, 2.0-, and 3.5-foot depths, but not to the 5.0- and 10-foot depths (fig. 11).

An example for Tijeras Arroyo above Four Hills Bridge on July 13, 1990, shows the infiltration of a warm water pulse at the soil-temperature sensors from the surface downward to the 1.0-, 2.0-, 3.5-, 5.0-, and 10-foot depths (fig. 12). The pulse of infiltrating water also was recorded by the soil-matric-potential sensor at a 1.0-foot depth, but not at the 2.0- and 3.5-foot depths because the soils already were at saturation as indicated by the soil-matric potential.

Examination of the soil-temperature data collected from 1989 through 1992 showed that vertical movement in the first 5 feet of sediments at Grant Line Arroyo was slower than at Tijeras Arroyo. The estimated rate of vertical movement of the infiltrating water ranged from 4 feet per hour at Grant Line Arroyo to 9 feet per hour at Tijeras Arroyo based on measurement of the arrival of the cool or hot water pulse at successive depths.

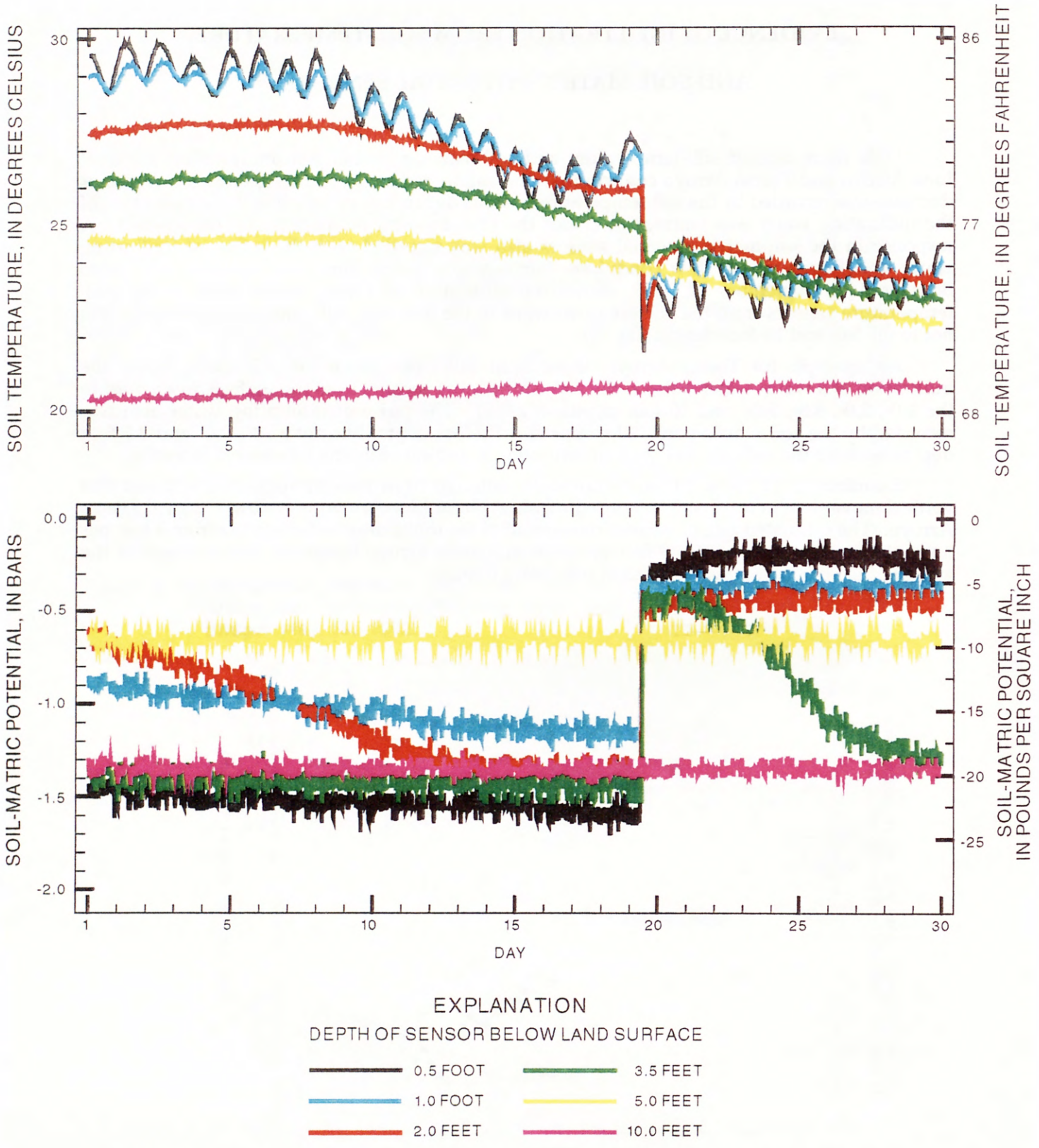


Figure 11.--Soil temperature and soil-matric potential at Grant Line Arroyo above San Pedro Boulevard, September 1989.

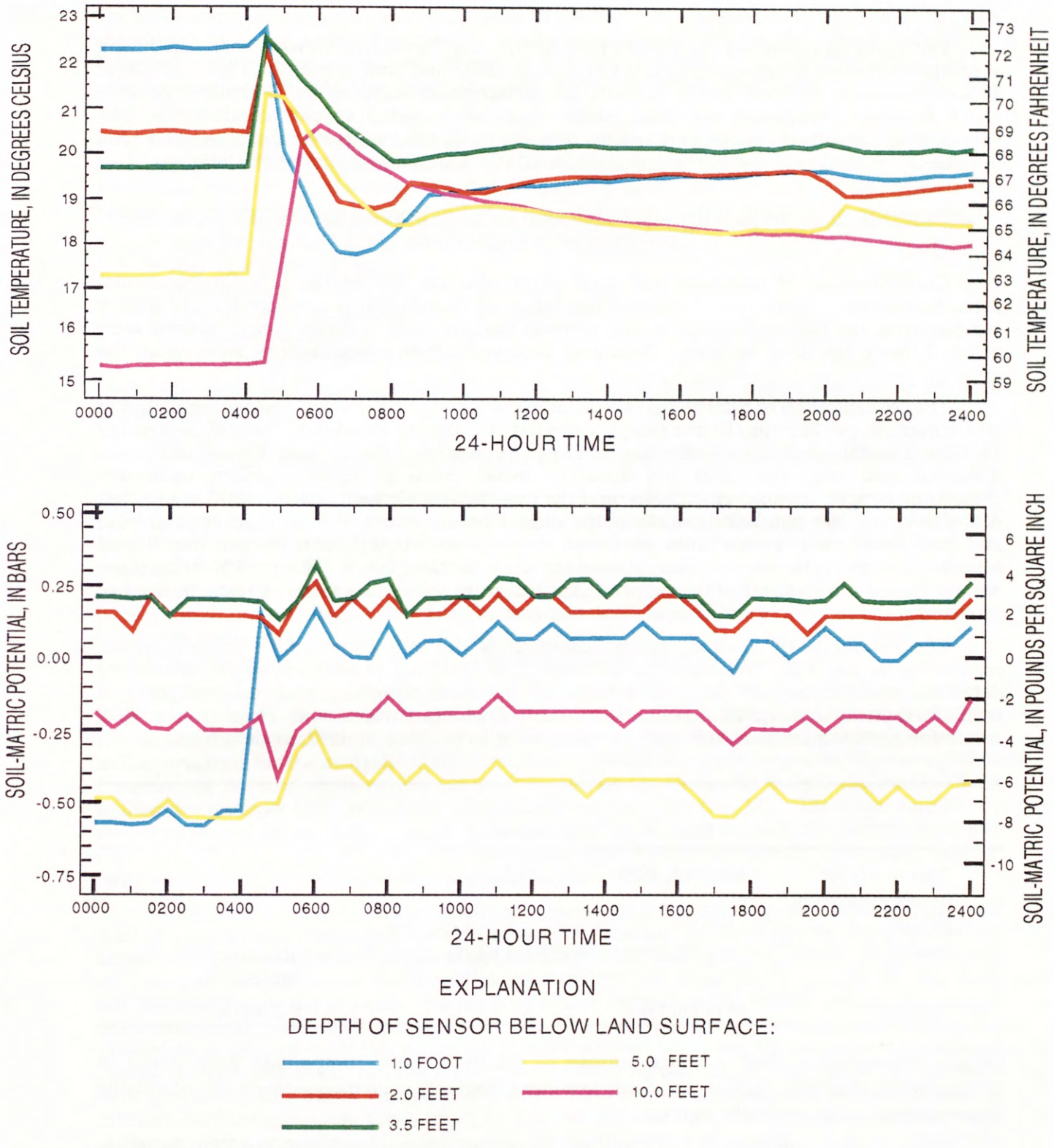


Figure 12.--Soil temperature and soil-matric potential at Tijeras Arroyo above Four Hills Bridge, July 13, 1990.

QUALITY OF WATER

Water samples collected from Grant Line Arroyo and Tijeras Arroyo were analyzed during a sample-collection program beginning October 28, 1988, and ending May 20, 1992. A total of 28 samples were collected, which included 25 surface-water samples and 3 shallow ground-water samples. Properties and constituents analyzed included specific conductance, pH, temperature, dissolved cations and anions, dissolved and total nutrients, dissolved and total trace elements, and total volatile organic compounds (U.S. Geological Survey, 1990-93).

Comparison of Analytical Results to Selected U.S. Environmental Protection Agency Drinking-Water Regulations

Concentrations of dissolved and total nitrate did not exceed the U.S. Environmental Protection Agency (EPA) drinking-water regulation of 10 milligrams per liter (mg/L) in any samples from the four surface-water sites or three shallow wells. Nitrate concentrations were below 2 mg/L for all of the sites. Total and dissolved-nitrate concentrations were about the same.

The concentration of total recoverable lead exceeded the EPA drinking-water regulation of 50 micrograms per liter (µg/L) in a sample collected at Tramway Floodway Channel, September 19, 1989. This sample had a concentration of 55 µg/L of total recoverable lead. Concentrations of dissolved lead and other total and dissolved metals, such as arsenic, barium, cadmium, chromium, copper, iron, silver, and zinc and the non-metallic element selenium did not exceed EPA drinking-water regulations at any of the sites. Concentrations of chromium, copper, lead, and zinc were often several times greater in the unfiltered (total) form than in the filtered (dissolved) form for the surface-water sites as shown in the table below. This indicates that these metals usually are attached to the suspended sediment in the surface water. Concentrations of total and dissolved-chromium, copper, lead, and zinc are shown in table 5.

Concentrations of volatile organic compounds did not exceed EPA drinking-water regulations at any site. Volatile organic compounds were not present above the laboratory detection levels at any of the sites for any of the dates sampled, with the exception of trichloroethylene and 1,2-transdichloroethylene. Trichloroethylene was close to the EPA maximum contaminant level of 5 µg/L in a sample collected May 20, 1992, as shown below:

Site	Date	Total trichloroethylene	Total 1,2-transdichloroethylene
Tijeras Arroyo above Four Hills Bridge	March 8, 1989	0.2 µg/L	Below laboratory detection limits
Well 5	May 20, 1992	0.3 µg/L	Below laboratory detection limits
Well 11	May 20, 1992	4.9 µg/L	0.3 µg/L

Greater concentrations and a larger number of volatile organic compounds were found in ground water than in surface water. Surface-water turbulence encourages the release of volatile organic compounds to the atmosphere.

Concentrations of dissolved chloride and dissolved sulfate were below the EPA drinking-water regulations of 250 mg/L at all sites, whereas the dissolved-solids concentration exceeded

the EPA drinking-water regulation of 500 mg/L at the Tijeras Arroyo above Four Hills Bridge surface-water and ground-water sites. Concentrations of dissolved solids, computed from summing individual anions and cations, ranged from 500 to 600 mg/L in nine of the samples collected at the surface-water sites and ranged from 500 to 700 mg/L in samples collected at the ground-water sites. At the other sites, the dissolved-solids concentration was less than 500 mg/L.

Water-quality data collected August 7, 1980, at Grant Line Arroyo at Villa del Oso include herbicide and pesticide concentrations. Of 26 herbicides and pesticides that were quantified, none were present with the exception of the following, which were present at the concentration listed:

- Total lindane, 0.09 µg/L
- Total chlordane, 0.2 µg/L
- Total malathion, 0.27 µg/L
- Total diazinon, 0.24 µg/L
- Total 2,4-D, 0.10 µg/L
- Total silvex, 0.01 µg/L

Herbicide and pesticide concentrations did not exceed EPA drinking-water maximum contaminant levels.

Comparison of Water Flowing in Arroyos and Shallow Ground Water

Hem (1985, p. 166) suggested that water be separated into categories for comparative purposes according to the predominant cation and anion when expressed in milliequivalents per liter. A cation or anion is predominant if it comprises 50 percent or more of the cations or anions, respectively (Hem, 1985, p. 166). Classification of water in a category or categories conveys general information about the similarities and origin of the water. Water from the study sites can be separated into two categories--Grant Line Arroyo at Villa del Oso, Grant Line Arroyo above San Pedro Boulevard, and Tramway Floodway Channel form one category; Tijeras Arroyo above Four Hills Bridge and wells 3, 5, and 11 form the second category (fig. 13).

In the first category, the predominant cation is calcium and the predominant anion is bicarbonate (fig. 13). Magnesium, sodium, potassium, chloride, sulfate, fluoride, and nitrite plus nitrate are also present in the water in quantities greater than or equal to 1 percent of the total milliequivalents for the analysis. Only constituents present in quantities greater than or equal to 1 percent of the total milliequivalents for the analysis are shown in the pie diagrams. Total milliequivalents per liter range from 1.0 to 5.2 for this category (fig. 13). The larger number of milliequivalents per liter indicates water containing a larger dissolved-solids concentration. The origin of the water for this category is precipitation and overland runoff. These sites usually have water flowing only in response to precipitation.

In the second category, the predominant cation also is calcium (fig. 13). However, because it takes two anions to make up 50 percent or more of the anion milliequivalents, the predominant anions are bicarbonate and chloride (fig. 13). Magnesium, sodium, potassium, and sulfate are also present in the water in quantities greater than or equal to 1 percent of the total milliequivalents for the analysis. Nitrite plus nitrate comprises less than 1 percent of the total milliequivalents. Total milliequivalents per liter for this group range from 12.7 to 23.2 (fig. 13). The origin of the water for this group is generally ground-water seepage to the deeply incised Tijeras Arroyo and flood plain. When precipitation occurs, as on July 23, 1991, the total milliequivalents for Tijeras Arroyo above Four Hills Bridge decrease and the proportion of calcium and bicarbonate increases (fig. 13). The similarity of the pie diagrams for surface water at Tijeras Arroyo above Four Hills Bridge and for ground water from wells 3, 5, and 11 (fig. 13) is consistent with the conclusion that infiltration from the stream replenishes the ground-water table.

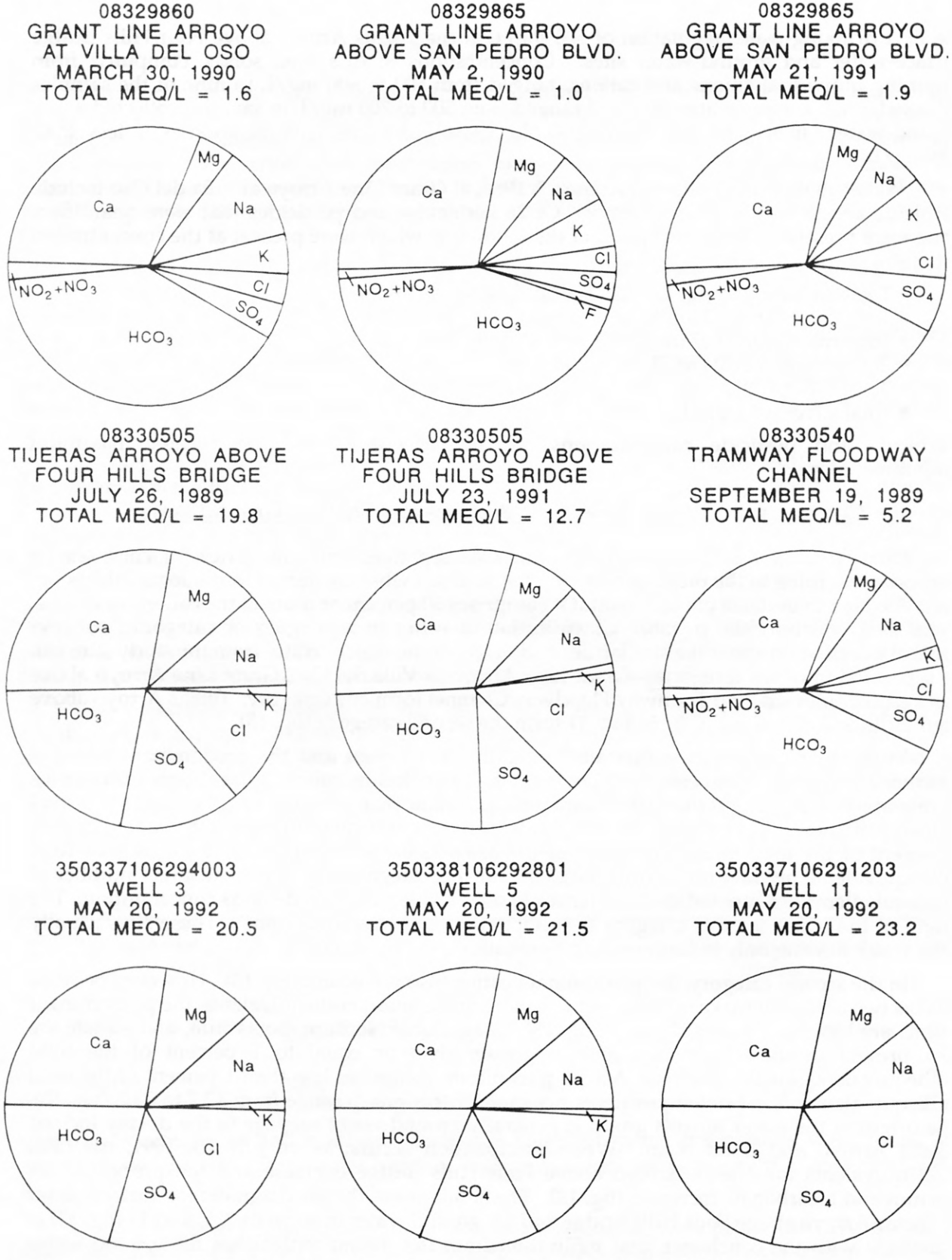


Figure 13.--Proportion of common ions, in milliequivalents per liter (MEQ/L), for water-quality data-collection sites at Albuquerque, New Mexico.

SUMMARY

The quantity and quality of water infiltrated through Grant Line Arroyo between Louisiana and San Pedro Boulevards and selected reaches of Tijeras Arroyo upstream from Four Hills Road Bridge were investigated. Estimated ranges in infiltration were calculated on the basis of instantaneous streamflow-loss volumes, instantaneous evaporation, and instantaneous evapotranspiration rates. Water quality was estimated from surface-water and shallow ground-water samples collected at sites at the two arroyos. Data were collected from October 1988 to August 1992.

Annual evaporation and evapotranspiration rates were estimated from evaporation and evapotranspiration rates measured about once a month for the 3-year period April 1989 through March 1992. Rates were greatest over saturated stream sediments and ranged from 802 to 1,025 millimeters per year or 31.57 to 40.35 inches per year. Rates were least over unsaturated, unvegetated soil and ranged from 174 to 291 millimeters per year or 6.85 to 11.46 inches per year. Rates over grasses or shrubs or both were about one-half the rates over saturated stream sediments and ranged from 438 to 469 millimeters per year or 17.24 to 18.46 inches per year.

Evaporation and evapotranspiration rates varied seasonally, daily, and with land-surface cover, but not with geographic location within the study area. Daily evaporation and evapotranspiration rates varied seasonally from a minimum of about 0 millimeter per day over unsaturated, unvegetated soil during very cold months to a maximum of about 7.2 millimeters per day or 0.28 inch per day over saturated stream sediments on June 26, 1990. Instantaneous evaporation and evapotranspiration rates measured throughout the day varied from a minimum of about 0 millimeter per day to a maximum of about 28 millimeters per day or 1.1 inches per day. Rates were similar for Grant Line and Tijeras Arroyos. The land-surface vegetation, availability of water at the land surface, availability of energy to enable a change of state from water to vapor, existence of a vapor concentration gradient, and a turbulent atmosphere to carry the vapor away may be the factors that determine the amount of evaporation and evapotranspiration.

Infiltration rates adjusted for evaporative water loss from the stream surface varied with the length and location of the reach isolated for measurement and also with the daily, 24-hour variation in temperature. Sediment intrinsic permeability probably was a factor affecting spatial variations in infiltration. Infiltration rates at Grant Line Arroyo ranged from 0 to 0.6 foot per day, and at Tijeras Arroyo from 2.28 to 30 feet per day. Eleven measurements were made for Grant Line Arroyo and 160 measurements for Tijeras Arroyo. The median infiltration rate measured at Grant Line Arroyo between July 25, 1989, and August 6, 1991, was 0.1 foot per day. The median infiltration rate measured at Tijeras Arroyo between October 23, 1989, and May 19, 1992, was 5.86 feet per day. The instantaneous infiltration rate for Tijeras Arroyo from 2,245 feet to 100 feet above Four Hills Bridge on May 19, 1992, increased 22 percent when the temperature rose from 12 to 21 °C.

Calculation of infiltration rates was not sensitive to the evaporative water loss from the stream surface because evaporative losses were small in comparison to the infiltration rates and ranged from one-tenth of 1 percent to 2 percent of the infiltration rates. Calculation of the infiltration rate was sensitive to the wetted channel area where infiltration occurs.

Infiltrating water in Grant Line Arroyo and Tijeras Arroyo met EPA drinking-water regulations for nitrate, volatile organic compounds, dissolved-lead, and dissolved- and total arsenic, barium, cadmium, chromium, copper, iron, silver, zinc, selenium, chloride, and sulfate concentrations. Total lead concentration in one sample from Tramway Floodway Channel, a tributary to Tijeras Arroyo, was 55 µg/L, exceeding the EPA drinking-water regulation of 50 µg/L. Dissolved-solids concentrations calculated from the sum of cations and anions usually exceeded the EPA drinking-water regulation of 500 mg/L at Tijeras Arroyo above Four Hills Bridge.

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Table 1.--Type, frequency, and dates of data collection at sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins

Site location or number and name	Type of data collected	Measurement unit of data	Frequency of collection	Dates of record
		Grant Line Arroyo drainage basin		
08329860, Grant Line Arroyo at Villa del Oso	Evaporation and evapotranspiration	Millimeters per day	Hourly	4-6-89, 5-25-89, 6-14-89, 8-15-89; 6-26-90
	Streamflow	Cubic feet per second	Every 5 minutes	1988-92
	Water quality	Milligrams per liter	Once	3-20-90
Grant Line Arroyo 1,000 feet above San Pedro Boulevard	Evaporation and evapotranspiration	Millimeters per day	Hourly	4-10-89
08329865, Grant Line Arroyo above San Pedro Boulevard	Evaporation and evapotranspiration	Millimeters per day	Hourly	4-7-89, 5-26-89, 11-28-89; 1-8-90, 2-21-90, 4-10-90, 5-15-90, 7-24-90, 8-28-90, 9-25-90, 10-23-90, 11-27-90; 1-15-91, 3-12-91, 4-23-91, 5-21-91, 6-25-91, 7-30-91, 8-27-91, 9-24-91, 10-29-91, 12-3-91; 1-28-92
	Streamflow	Cubic feet per second	Every 15 minutes	1989-91
	Soil-matric potential	Bars	Every 30 minutes	1-1-89 - 4-6-92
	Soil temperature	Degrees Celsius	Every 30 minutes	1-1-89 - 4-6-92
	Water quality	Generally milligrams per liter	Irregular	7-25-89, 9-19-89, 5-2-89; 7-14-90; 5-21-91, 12-11-91

Table 1.--Type, frequency, and dates of data collection at sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Site location or number and name	Type of data collected	Measurement unit of data	Frequency of collection	Dates of record
		Tijeras Arroyo drainage basin		
Tijeras Arroyo 3,000 feet above Four Hills Bridge	Evaporation and evapotranspiration	Millimeters per day	Hourly	8-17-18-89, 9-28-89; 6-27-90, 7-25-90, 8-29-90; 4-24-91
Tijeras Arroyo 2,741 feet above Four Hills Bridge	Evaporation and evapotranspiration	Millimeters per day	Hourly	6-26-91
Tijeras Arroyo 2,245 feet above Four Hills Bridge	Streamflow	Cubic feet per second	Every 10 minutes	5-19-92
Tijeras Arroyo 1,600 feet above Four Hills Bridge	Evaporation and evapotranspiration	Millimeters per day	Hourly	9-26-90
Tijeras Arroyo 1,500 feet above Four Hills Bridge	Streamflow	Cubic feet per second	Once	9-26-90
Tijeras Arroyo 1,202 feet above Four Hills Bridge	Streamflow	Cubic feet per second	Every 10 minutes	5-19-92
Tijeras Arroyo 885 feet above Four Hills Bridge	Streamflow	Cubic feet per second	Every 30 minutes	7-31-91
Tijeras Arroyo 650 feet above Four Hills Bridge	Evaporation and evapotranspiration	Millimeters per day	Hourly	6-12-13-89; 7-31-91
Tijeras Arroyo 445 feet above Four Hills Bridge	Streamflow	Cubic feet per second	Hourly	10-24-90
Tijeras Arroyo 410 feet above Four Hills Bridge	Streamflow	Cubic feet per second	Hourly	9-25-91

Table 1.--Type, frequency, and dates of data collection at sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Site location or number and name	Type of data collected	Measurement unit of data	Frequency of collection	Dates of record
Tijeras Arroyo 400 feet above Four Hills Bridge	Streamflow	Cubic feet per second	Once	3-12-91
Tijeras Arroyo 370 feet above Four Hills Bridge	Streamflow	Cubic feet per second	Once	10-23-89
Tijeras Arroyo 334 feet above Four Hills Bridge	Streamflow	Cubic feet per second	Every 30 minutes	8-28-91
Tijeras Arroyo 325 feet above Four Hills Bridge	Streamflow	Cubic feet per second	Every 30 minutes	5-22-91
Tijeras Arroyo 324 feet above Four Hills Bridge	Streamflow	Cubic feet per second	Hourly	10-24-89
Tijeras Arroyo 110 feet above Four Hills Bridge	Streamflow	Cubic feet per second	Hourly	9-25-91
08330505, Tijeras Arroyo above Four Hills Bridge	Evaporation and evapotranspiration	Millimeters per day	Hourly	4-11-14-89, 5-16-18-89, 10-23-24-89, 11-29-89; 1-9-90, 2-22-90, 4-11-90, 5-16-90, 10-24-90, 11-28-90; 1-16-91, 3-13-91, 5-22-91, 8-28-91, 9-25-91, 11-1-91, 12-4-91; 1-29-92, 5-19-92
	Streamflow	Cubic feet per second	Every 15 minutes	5-11-89 - 9-30-91
	Water temperature	Degrees Celsius	Every 10 minutes	5-19-92
	Soil-matric potential	Bars	Every 30 minutes	1-1-89 - 7-8-92
	Soil temperature	Degrees Celsius	Every 30 minutes	1-1-89 - 7-8-92
	Water quality	Generally milligrams per liter	Irregular	10-28-88, 11-30-88, 12-30-88; 1-30-89, 3-8-89, 3-22-89, 3-31-89, 5-8-89, 7-26-89, 10-5-89; 3-30-90, 5-3-90, 8-14-90; 8-5-91, 9-6-91; 5-20-92

Table 1.--Type, frequency, and dates of data collection at sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Site location or number and name	Type of data collected	Measurement unit of data	Frequency of collection	Dates of record
Tijeras Arroyo 20 feet above Four Hills Bridge	Streamflow	Cubic feet per second	Every 30 minutes	8-28-91
Tijeras Arroyo 107 feet below Four Hills Bridge	Streamflow	Cubic feet per second	Once	1-9-90
350337106294003, 10N. 04E. 26.332, well 3	Water quality	Milligrams per liter	Once	5-20-92
	Water level	Feet	Biweekly	5-14-92 - 9-30-92
350337106294004, 10N. 04E. 26.332, well 4	Water level	Feet	Biweekly	5-14-92 - 9-30-92
350338106292801, 10N. 04E. 26.341, well 5	Water quality	Milligrams per liter	Once	5-20-92
	Water level	Feet	Biweekly	5-14-92 - 9-30-92
350338106292802, 10N. 04E. 26.341, well 6	Water level	Feet	Biweekly	5-14-92 - 9-30-92
350338106292802, 10N. 04E. 26.341, well 7	Water level	Feet	Biweekly	5-14-92 - 9-30-92
350337106291201, 10N. 04E. 26.431, well 9	Water level	Feet	Biweekly	5-14-92 - 9-30-92
350337106291202, 10N. 04E. 26.431, well 10	Water level	Feet	Biweekly	5-14-92 - 9-30-92
350337106291203, 10N. 04E. 26.431, well 11	Water quality	Milligrams per liter	Once	5-20-92
	Water level	Feet	Biweekly	5-14-92 - 9-30-92

Table 1.--Type, frequency, and dates of data collection at sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Concluded

Site location or number and name	Type of data collected	Measurement unit of data	Frequency of collection	Dates of record
08330540, Tramway Floodway Channel	Water quality	Milligrams per liter	Once	9-19-89
08330580, Tijeras Arroyo at Montessa Park near Albuquerque	Evaporation and evapotranspiration	Millimeters per day	Hourly	8-16-89, 9-27-89

Table 2.--Daily evaporation or evapotranspiration rates for sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins

Site location or number and name	Date	Land cover	Evaporation or evapotranspiration rate (millimeters per day)	Evaporation or evapotranspiration rate (inches per day)
		Grant Line Arroyo drainage basin		
08329860 Grant Line Arroyo at Villa del Oso at Albuquerque	4-6-89	Unsaturated, unvegetated soil	0.4	0.02
		Grasses or shrubs or both	0.5	0.02
		Grasses or shrubs or both	1.3	0.05
		Grasses or shrubs or both	2.0	0.08
		Grasses or shrubs or both	1.8	0.07
		Grasses or shrubs or both	1.9	0.07
	5-25-89	Unsaturated, unvegetated soil	0.4	0.02
		Unsaturated, unvegetated soil	0.4	0.02
		Grasses or shrubs or both	2.3	0.09
		Saturated stream sediments	4.4	0.17
		Saturated stream sediments	3.2	0.13
		Saturated stream sediments	2.2	0.09
	6-14-89	Unsaturated, unvegetated soil	0.2	0.01
		Grasses or shrubs or both	3.9	0.15
		Grasses or shrubs or both	1.8	0.07
		Grasses or shrubs or both	4.4	0.17
		Saturated stream sediments	5.4	0.21
		Saturated stream sediments	4.1	0.16
	8-15-89	Grasses or shrubs or both	2.0	0.08
		Grasses or shrubs or both	2.0	0.08
		Saturated stream sediments	5.2	0.20
		Saturated stream sediments	4.8	0.19
		Saturated stream sediments	4.9	0.19
		Saturated stream sediments	4.9	0.19

Table 2.--Daily evaporation or evapotranspiration rates for sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Site location or number and name	Date	Land cover	Evaporation or evapotranspiration rate (millimeters per day)	Evaporation or evapotranspiration rate (inches per day)
08329860 Grant Line Arroyo at Villa del Oso at Albuquerque	6-26-90	Grasses or shrubs or both	2.5	0.10
		Grasses or shrubs or both	2.3	0.09
		Grasses or shrubs or both	3.8	0.15
		Saturated stream sediments	6.2	0.24
		Saturated stream sediments	6.3	0.25
		Saturated stream sediments	7.2	0.28
Grant Line Arroyo 1,000 feet above San Pedro Boulevard at Albuquerque	4-10-89	Unsaturated, unvegetated soil	0.2	0.01
		Unsaturated, unvegetated soil	0.2	0.01
		Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.2	0.01
		Grasses or shrubs or both	0.2	0.01
		Grasses or shrubs or both	0.3	0.01
08329865 Grant Line Arroyo above San Pedro Boulevard at Albuquerque	4-7-89	Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.1	0.00
		Grasses or shrubs or both	0.2	0.01
		Grasses or shrubs or both	0.2	0.01
	5-26-89	Unsaturated, unvegetated soil	0.2	0.01
		Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.1	0.00
		Grasses or shrubs or both	0.3	0.01
		Grasses or shrubs or both	0.6	0.02
		Grasses or shrubs or both	0.4	0.02

Table 2.--Daily evaporation or evapotranspiration rates for sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Site location or number and name	Date	Land cover	Evaporation or evapotranspiration rate (millimeters per day)	Evaporation or evapotranspiration rate (inches per day)
08329865 Grant Line	11-28-89	Unsaturated, unvegetated soil	0.0	0.00
Arroyo above San		Unsaturated, unvegetated soil	0.0	0.00
Pedro Boulevard at		Unsaturated, unvegetated soil	0.0	0.00
Albuquerque		Grasses or shrubs or both	0.2	0.01
		Grasses or shrubs or both	0.2	0.01
		Grasses or shrubs or both	0.1	0.00
	1-8-90	Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.2	0.01
		Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.2	0.01
		Unsaturated, unvegetated soil	0.1	0.00
	2-21-90	Unsaturated, unvegetated soil	0.3	0.01
		Unsaturated, unvegetated soil	0.4	0.02
		Unsaturated, unvegetated soil	0.4	0.02
		Unsaturated, unvegetated soil	0.7	0.03
		Unsaturated, unvegetated soil	0.7	0.03
		Unsaturated, unvegetated soil	0.5	0.02
	4-10-90	Unsaturated, unvegetated soil	0.7	0.03
		Unsaturated, unvegetated soil	0.8	0.03
		Unsaturated, unvegetated soil	0.6	0.02
		Grasses or shrubs or both	1.4	0.06
		Grasses or shrubs or both	1.2	0.05
		Grasses or shrubs or both	0.9	0.04

Table 2.--Daily evaporation or evapotranspiration rates for sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Site location or number and name	Date	Land cover	Evaporation or evapotranspiration rate (millimeters per day)	Evaporation or evapotranspiration rate (inches per day)
08329865 Grant Line Arroyo above San Pedro Boulevard at Albuquerque	5-15-90	Unsaturated, unvegetated soil	2.0	0.08
		Unsaturated, unvegetated soil	2.2	0.09
		Unsaturated, unvegetated soil	2.3	0.09
		Grasses or shrubs or both	2.6	0.10
		Grasses or shrubs or both	2.6	0.10
		Grasses or shrubs or both	2.9	0.11
	7-24-90	Unsaturated, unvegetated soil	0.3	0.01
		Unsaturated, unvegetated soil	0.2	0.01
		Unsaturated, unvegetated soil	0.3	0.01
		Grasses or shrubs or both	1.2	0.05
		Grasses or shrubs or both	2.2	0.09
		Grasses or shrubs or both	1.7	0.07
	8-28-90	Grasses or shrubs or both	4.0	0.16
		Grasses or shrubs or both	3.7	0.15
		Grasses or shrubs or both	2.9	0.11
		Grasses or shrubs or both	2.5	0.10
		Saturated stream sediments	1.8	0.07
		Saturated stream sediments	4.1	0.16
	9-25-90	Unsaturated, unvegetated soil	0.6	0.02
		Unsaturated, unvegetated soil	0.4	0.02
		Grasses or shrubs or both	0.7	0.03
		Grasses or shrubs or both	0.8	0.03
		Grasses or shrubs or both	1.2	0.05
		Grasses or shrubs or both	0.9	0.04

Table 2.--Daily evaporation or evapotranspiration rates for sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Site location or number and name	Date	Land cover	Evaporation or evapotranspiration rate (millimeters per day)	Evaporation or evapotranspiration rate (inches per day)
08329865 Grant Line Arroyo above San Pedro Boulevard at Albuquerque	10-23-90	Unsaturated, unvegetated soil	0.2	0.01
		Unsaturated, unvegetated soil	0.3	0.01
		Unsaturated, unvegetated soil	0.2	0.01
		Grasses or shrubs or both	0.3	0.01
		Grasses or shrubs or both	0.3	0.01
		Grasses or shrubs or both	0.5	0.02
	11-27-90	Unsaturated, unvegetated soil	0.2	0.01
		Unsaturated, unvegetated soil	0.2	0.01
		Unsaturated, unvegetated soil	0.2	0.01
		Unsaturated, unvegetated soil	0.4	0.02
		Unsaturated, unvegetated soil	0.4	0.02
		Unsaturated, unvegetated soil	0.3	0.01
	1-15-91	Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.1	0.00
		Grasses or shrubs or both	0.2	0.01
		Grasses or shrubs or both	0.4	0.02
	3-12-91	Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.1	0.00
		Grasses or shrubs or both	0.3	0.01
		Grasses or shrubs or both	0.2	0.01
		Grasses or shrubs or both	0.1	0.00

Table 2.--Daily evaporation or evapotranspiration rates for sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Site location or number and name	Date	Land cover	Evaporation or evapotranspiration rate (millimeters per day)	Evaporation or evapotranspiration rate (inches per day)
08329865 Grant Line Arroyo above San Pedro Boulevard at Albuquerque	4-23-91	Unsaturated, unvegetated soil	0.2	0.01
		Unsaturated, unvegetated soil	0.2	0.01
		Unsaturated, unvegetated soil	0.2	0.01
		Grasses or shrubs or both	0.7	0.03
		Grasses or shrubs or both	0.6	0.02
		Grasses or shrubs or both	0.2	0.01
	5-21-91	Unsaturated, unvegetated soil	1.4	0.06
		Unsaturated, unvegetated soil	1.3	0.05
		Unsaturated, unvegetated soil	1.2	0.05
		Grasses or shrubs or both	1.4	0.06
		Grasses or shrubs or both	1.3	0.05
		Grasses or shrubs or both	1.3	0.05
	6-25-91	Unsaturated, unvegetated soil	0.4	0.02
		Unsaturated, unvegetated soil	0.4	0.02
		Unsaturated, unvegetated soil	0.3	0.01
		Grasses or shrubs or both	0.7	0.03
		Grasses or shrubs or both	0.3	0.01
		Grasses or shrubs or both	0.5	0.02
	7-30-91	Unsaturated, unvegetated soil	0.6	0.02
		Unsaturated, unvegetated soil	0.4	0.02
		Grasses or shrubs or both	1.0	0.04
		Grasses or shrubs or both	3.2	0.13
		Grasses or shrubs or both	3.2	0.13
		Grasses or shrubs or both	1.4	0.06

Table 2.--Daily evaporation or evapotranspiration rates for sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Site location or number and name	Date	Land cover	Evaporation or evapotranspiration rate (millimeters per day)	Evaporation or evapotranspiration rate (inches per day)
08329865 Grant Line Arroyo above San Pedro Boulevard at Albuquerque	8-27-91	Unsaturated, unvegetated soil	0.6	0.02
		Unsaturated, unvegetated soil	0.6	0.02
		Unsaturated, unvegetated soil	0.4	0.02
		Grasses or shrubs or both	1.5	0.06
		Grasses or shrubs or both	0.9	0.04
		Grasses or shrubs or both	1.9	0.07
	9-24-91	Unsaturated, unvegetated soil	0.4	0.02
		Unsaturated, unvegetated soil	0.3	0.01
		Unsaturated, unvegetated soil	0.3	0.01
		Grasses or shrubs or both	1.1	0.04
		Grasses or shrubs or both	1.1	0.04
		Grasses or shrubs or both	0.9	0.04
	10-29-91	Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.1	0.00
		Grasses or shrubs or both	0.1	0.00
	12-3-91	Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.2	0.01
		Grasses or shrubs or both	0.2	0.01
		Grasses or shrubs or both	0.1	0.00

Table 2.--Daily evaporation or evapotranspiration rates for sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Site location or number and name	Date	Land cover	Evaporation or evapotranspiration rate (millimeters per day)	Evaporation or evapotranspiration rate (inches per day)
08329865 Grant Line	1-28-92	Unsaturated, unvegetated soil	0.3	0.01
Arroyo above San		Unsaturated, unvegetated soil	0.3	0.01
Pedro Boulevard at		Unsaturated, unvegetated soil	0.3	0.01
Albuquerque		Unsaturated, unvegetated soil	0.3	0.01
		Grasses or shrubs or both	0.2	0.01
		Grasses or shrubs or both	0.5	0.02
		Tijeras Arroyo drainage basin		
Tijeras Arroyo	8-17-89	Unsaturated, unvegetated soil	0.4	0.02
3,000 feet above		Grasses or shrubs or both	1.3	0.05
Four Hills Bridge		Grasses or shrubs or both	4.1	0.16
at Albuquerque		Saturated stream sediments	5.4	0.21
		Saturated stream sediments	5.7	0.22
		Saturated stream sediments	5.8	0.23
	8-18-89	Unsaturated, unvegetated soil	1.3	0.05
		Grasses or shrubs or both	1.6	0.06
		Grasses or shrubs or both	2.2	0.09
		Saturated stream sediments	2.0	0.08
		Saturated stream sediments	2.5	0.10
		Saturated stream sediments	2.9	0.11
	9-28-89	Unsaturated, unvegetated soil	1.1	0.04
		Unsaturated, unvegetated soil	0.5	0.02
		Unsaturated, unvegetated soil	1.7	0.07
		Unsaturated, unvegetated soil	1.5	0.06
		Grasses or shrubs or both	3.7	0.15
		Saturated stream sediments	2.2	0.09

Table 2.--Daily evaporation or evapotranspiration rates for sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Site location or number and name	Date	Land cover	Evaporation or evapotranspiration rate (millimeters per day)	Evaporation or evapotranspiration rate (inches per day)
Tijeras Arroyo	6-27-90	Unsaturated, unvegetated soil	2.4	0.09
3,000 feet above		Unsaturated, unvegetated soil	3.0	0.12
Four Hills Bridge		Saturated stream sediments	5.2	0.20
at Albuquerque		Saturated stream sediments	5.9	0.23
		Saturated stream sediments	6.5	0.26
		Saturated stream sediments	6.1	0.24
	7-25-90	Unsaturated, unvegetated soil	0.9	0.04
		Unsaturated, unvegetated soil	0.6	0.02
		Saturated stream sediments	6.1	0.24
		Saturated stream sediments	6.1	0.24
		Saturated stream sediments	5.6	0.22
		Saturated stream sediments	5.1	0.20
	8-29-90	Unsaturated, unvegetated soil	0.5	0.02
		Grasses or shrubs or both	3.1	0.12
		Saturated stream sediments	5.8	0.23
		Saturated stream sediments	4.7	0.19
		Saturated stream sediments	4.8	0.19
		Saturated stream sediments	4.1	0.16
	4-24-91	Unsaturated, unvegetated soil	0.2	0.01
		Unsaturated, unvegetated soil	0.2	0.01
		Grasses or shrubs or both	2.1	0.08
		Saturated stream sediments	2.7	0.11
		Saturated stream sediments	2.4	0.09
		Saturated stream sediments	1.7	0.07

Table 2.--Daily evaporation or evapotranspiration rates for sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Site location or number and name	Date	Land cover	Evaporation or evapotranspiration rate (millimeters per day)	Evaporation or evapotranspiration rate (inches per day)
Tijeras Arroyo	6-26-91	Unsaturated, unvegetated soil	2.7	0.11
2,500 feet above		Unsaturated, unvegetated soil	0.2	0.01
Four Hills Bridge		Grasses or shrubs or both	2.3	0.09
at Albuquerque		Saturated stream sediments	7.0	0.28
		Saturated stream sediments	5.0	0.20
		Saturated stream sediments	5.4	0.21
Tijeras Arroyo	9-26-90	Unsaturated, unvegetated soil	0.5	0.02
1,600 feet above		Grasses or shrubs or both	3.0	0.12
Four Hills Bridge		Grasses or shrubs or both	1.9	0.07
at Albuquerque		Saturated stream sediments	2.0	0.08
		Saturated stream sediments	3.6	0.14
		Saturated stream sediments	3.4	0.13
Tijeras Arroyo	5-12-89	Unsaturated, unvegetated soil	0.3	0.01
650 feet above		Unsaturated, unvegetated soil	0.5	0.02
Four Hills Bridge		Grasses or shrubs or both	2.7	0.11
at Albuquerque		Grasses or shrubs or both	1.8	0.07
		Saturated stream sediments	4.3	0.17
		Saturated stream sediments	4.3	0.17
	5-13-89	Unsaturated, unvegetated soil	0.3	0.01
		Grasses or shrubs or both	1.2	0.05
		Grasses or shrubs or both	0.9	0.04
		Saturated stream sediments	3.4	0.13
		Saturated stream sediments	3.9	0.15
		Saturated stream sediments	3.5	0.14

Table 2.--Daily evaporation or evapotranspiration rates for sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Site location or number and name	Date	Land cover	Evaporation or evapotranspiration rate (millimeters per day)	Evaporation or evapotranspiration rate (inches per day)
Tijeras Arroyo	7-31-91	Unsaturated, unvegetated soil	1.3	0.05
650 feet above		Grasses or shrubs or both	3.3	0.13
Four Hills Bridge		Grasses or shrubs or both	3.8	0.15
at Albuquerque		Saturated stream sediments	4.4	0.17
		Saturated stream sediments	5.3	0.21
		Saturated stream sediments	5.1	0.20
08330505 Tijeras	4-11-89	Unsaturated, unvegetated soil	0.2	0.01
Arroyo above Four		Unsaturated, unvegetated soil	0.2	0.01
Hills Bridge		Grasses or shrubs or both	0.2	0.01
at Albuquerque		Saturated stream sediments	1.5	0.06
		Saturated stream sediments	1.8	0.07
		Saturated stream sediments	2.2	0.09
	4-12-89	Unsaturated, unvegetated soil	0.2	0.01
		Unsaturated, unvegetated soil	0.2	0.01
		Grasses or shrubs or both	0.3	0.01
		Saturated stream sediments	1.9	0.07
		Saturated stream sediments	2.7	0.11
		Saturated stream sediments	2.8	0.11
	4-13-89	Unsaturated, unvegetated soil	0.2	0.01
		Unsaturated, unvegetated soil	0.3	0.01
		Grasses or shrubs or both	0.4	0.02
		Saturated stream sediments	2.6	0.10
		Saturated stream sediments	2.7	0.11
		Saturated stream sediments	2.1	0.08

Table 2.--Daily evaporation or evapotranspiration rates for sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Site location or number and name	Date	Land cover	Evaporation or evapotranspiration rate (millimeters per day)	Evaporation or evapotranspiration rate (inches per day)
08330505	4-14-89	Unsaturated, unvegetated soil	0.2	0.01
Tijeras Arroyo		Unsaturated, unvegetated soil	0.3	0.01
above Four Hills Bridge		Grasses or shrubs or both	0.4	0.02
at Albuquerque		Saturated stream sediments	3.1	0.12
		Saturated stream sediments	3.3	0.13
		Saturated stream sediments	2.7	0.11
	5-16-89	Unsaturated, unvegetated soil	0.2	0.01
		Unsaturated, unvegetated soil	0.2	0.01
		Grasses or shrubs or both	0.6	0.02
		Saturated stream sediments	1.3	0.05
		Saturated stream sediments	2.3	0.09
		Saturated stream sediments	1.8	0.07
	5-17-89	Unsaturated, unvegetated soil	1.2	0.05
		Unsaturated, unvegetated soil	0.8	0.03
		Grasses or shrubs or both	0.9	0.04
		Saturated stream sediments	2.5	0.10
		Saturated stream sediments	1.0	0.04
		Saturated stream sediments	0.9	0.04
	5-18-89	Unsaturated, unvegetated soil	0.5	0.02
		Unsaturated, unvegetated soil	0.4	0.02
		Grasses or shrubs or both	0.9	0.04
		Saturated stream sediments	3.0	0.12
		Saturated stream sediments	3.1	0.12
		Saturated stream sediments	2.7	0.11

Table 2.--Daily evaporation or evapotranspiration rates for sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Site location or number and name	Date	Land cover	Evaporation or evapotranspiration rate (millimeters per day)	Evaporation or evapotranspiration rate (inches per day)
08330505	10-23-89	Unsaturated, unvegetated soil	0.3	0.01
Tijeras Arroyo		Unsaturated, unvegetated soil	0.3	0.01
above Four Hills Bridge		Grasses or shrubs or both	0.4	0.02
at Albuquerque		Grasses or shrubs or both	0.3	0.01
		Grasses or shrubs or both	0.5	0.02
		Saturated stream sediments	1.6	0.06
		Saturated stream sediments	1.1	0.04
	10-24-89	Unsaturated, unvegetated soil	0.4	0.02
		Unsaturated, unvegetated soil	0.4	0.02
		Grasses or shrubs or both	0.4	0.02
		Grasses or shrubs or both	0.4	0.02
		Grasses or shrubs or both	0.5	0.02
		Saturated stream sediments	2.3	0.09
		Saturated stream sediments	1.2	0.05
	11-29-89	Unsaturated, unvegetated soil	0.1	0.00
		Unsaturated, unvegetated soil	0.1	0.00
		Grasses or shrubs or both	0.1	0.00
		Saturated stream sediments	0.5	0.02
		Saturated stream sediments	0.4	0.02
		Saturated stream sediments	0.3	0.01
	1-9-90	Unsaturated, unvegetated soil	0.6	0.02
		Unsaturated, unvegetated soil	0.5	0.02
		Unsaturated, unvegetated soil	0.5	0.02
		Saturated stream sediments	0.5	0.02
		Saturated stream sediments	0.4	0.02
		Saturated stream sediments	0.5	0.02

Table 2.--Daily evaporation or evapotranspiration rates for sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Site location or number and name	Date	Land cover	Evaporation or evapotranspiration rate (millimeters per day)	Evaporation or evapotranspiration rate (inches per day)
08330505	2-22-90	Unsaturated, unvegetated soil	0.9	0.04
Tijeras Arroyo above		Unsaturated, unvegetated soil	1.0	0.04
Four Hills Bridge		Saturated stream sediments	0.9	0.04
at Albuquerque		Saturated stream sediments	1.1	0.04
		Saturated stream sediments	1.4	0.06
		Saturated stream sediments	1.1	0.04
	4-11-90	Unsaturated, unvegetated soil	0.8	0.03
		Unsaturated, unvegetated soil	1.2	0.05
		Unsaturated, unvegetated soil	1.1	0.04
		Grasses or shrubs or both	1.0	0.04
		Saturated stream sediments	1.7	0.07
		Saturated stream sediments	1.6	0.06
	5-16-90	Unsaturated, unvegetated soil	1.5	0.06
		Grasses or shrubs or both	1.6	0.06
		Grasses or shrubs or both	2.1	0.08
		Saturated stream sediments	3.8	0.15
		Saturated stream sediments	4.0	0.16
		Saturated stream sediments	4.3	0.17
	10-24-90	Grasses or shrubs or both	0.3	0.01
		Grasses or shrubs or both	0.3	0.01
		Saturated stream sediments	2.0	0.08
		Saturated stream sediments	1.2	0.05
		Saturated stream sediments	1.9	0.07
		Saturated stream sediments	1.8	0.07

Table 2.--Daily evaporation or evapotranspiration rates for sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Site location or number and name	Date	Land cover	Evaporation or evapotranspiration rate (millimeters per day)	Evaporation or evapotranspiration rate (inches per day)
08330505	11-28-90	Unsaturated, unvegetated soil	0.5	0.02
Tijeras Arroyo above		Unsaturated, unvegetated soil	0.5	0.02
Four Hills Bridge		Unsaturated, unvegetated soil	0.5	0.02
at Albuquerque		Saturated stream sediments	0.7	0.03
		Saturated stream sediments	0.7	0.03
		Saturated stream sediments	0.7	0.03
	1-16-91	Unsaturated, unvegetated soil	0.5	0.02
		Unsaturated, unvegetated soil	0.3	0.01
		Grasses or shrubs or both	0.4	0.02
		Grasses or shrubs or both	0.4	0.02
		Saturated stream sediments	0.6	0.02
		Saturated stream sediments	0.7	0.03
	3-13-91	Unsaturated, unvegetated soil	1.7	0.07
		Unsaturated, unvegetated soil	0.4	0.02
		Grasses or shrubs or both	0.4	0.02
		Saturated stream sediments	1.8	0.07
		Saturated stream sediments	2.2	0.09
		Saturated stream sediments	2.1	0.08
	5-22-91	Unsaturated, unvegetated soil	2.9	0.11
		Grasses or shrubs or both	3.3	0.13
		Grasses or shrubs or both	1.7	0.07
		Saturated stream sediments	4.2	0.17
		Saturated stream sediments	4.9	0.19
		Saturated stream sediments	4.9	0.19

Table 2.--Daily evaporation or evapotranspiration rates for sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Site location or number and name	Date	Land cover	Evaporation or evapotranspiration rate (millimeters per day)	Evaporation or evapotranspiration rate (inches per day)
08330505	8-28-91	Grasses or shrubs or both	4.6	0.18
Tijeras Arroyo above		Grasses or shrubs or both	3.6	0.14
Four Hills Bridge		Saturated stream sediments	5.1	0.20
at Albuquerque		Saturated stream sediments	4.4	0.17
		Saturated stream sediments	4.3	0.17
		Saturated stream sediments	4.2	0.17
	9-25-91	Grasses or shrubs or both	1.8	0.07
		Grasses or shrubs or both	1.9	0.07
		Saturated stream sediments	2.5	0.10
		Saturated stream sediments	3.2	0.13
		Saturated stream sediments	3.9	0.15
		Saturated stream sediments	3.5	0.14
	11-1-91	Unsaturated, unvegetated soil	0.6	0.02
		Grasses or shrubs or both	0.7	0.03
		Saturated stream sediments	0.8	0.03
		Saturated stream sediments	0.5	0.02
		Saturated stream sediments	0.8	0.03
		Saturated stream sediments	0.9	0.04
	12-4-91	Unsaturated, unvegetated soil	0.4	0.02
		Grasses or shrubs or both	0.4	0.02
		Grasses or shrubs or both	0.4	0.02
		Saturated stream sediments	0.6	0.02
		Saturated stream sediments	0.7	0.03
		Saturated stream sediments	0.9	0.04

Table 2.--Daily evaporation or evapotranspiration rates for sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Concluded

Site location or number and name	Date	Land cover	Evaporation or evapotranspiration rate (millimeters per day)	Evaporation or evapotranspiration rate (inches per day)
08330505	1-29-92	Grasses or shrubs or both	0.6	0.02
Tijeras Arroyo above		Grasses or shrubs or both	0.6	0.02
Four Hills Bridge		Saturated stream sediments	1.0	0.04
at Albuquerque		Saturated stream sediments	0.9	0.04
		Saturated stream sediments	0.9	0.04
		Saturated stream sediments	1.0	0.04
	5-19-92	Unsaturated, unvegetated soil	1.0	0.04
		Grasses or shrubs or both	2.3	0.09
		Grasses or shrubs or both	1.3	0.05
		Saturated stream sediments	3.9	0.15
		Saturated stream sediments	4.1	0.16
		Saturated stream sediments	3.7	0.15
08330580	8-16-89	Unsaturated, unvegetated soil	0.6	0.02
Tijeras Arroyo		Unsaturated, unvegetated soil	0.5	0.02
at Montessa Park near		Grasses or shrubs or both	1.8	0.07
Albuquerque		Grasses or shrubs or both	0.9	0.04
		Grasses or shrubs or both	0.8	0.03
		Grasses or shrubs or both	1.4	0.06
	9-27-89	Unsaturated, unvegetated soil	0.5	0.02
		Unsaturated, unvegetated soil	0.5	0.02
		Unsaturated, unvegetated soil	0.7	0.03
		Grasses or shrubs or both	1.1	0.04
		Grasses or shrubs or both	0.7	0.03
		Grasses or shrubs or both	1.3	0.05

Table 3.--Instantaneous evaporation and infiltration rates for selected reaches in the Grant Line Arroyo and Tijeras Arroyo drainage basins
[--, not available]

Reach	Date	Time	Water temperature, in degrees Celsius	Instantaneous evaporation over saturated, stream sediments, in millimeters per day (inches per day)		Instantaneous infiltration, in feet per day[1]
Grant Line Arroyo drainage basin						
Grant Line Arroyo from Villa del Oso to San Pedro Boulevard[2]	7-25-89	1435	--	--		0.1
	9-19-89	1225	--	--		0.5
	10-4-89	2100	--	--		0.4
	7-5-90	0500	--	--		0.1
	8-14-90	0500	--	--		0.6
	8-27-90	2000	--	--		0.3
	5-21-91	0955	--	--		0.1
	7-21-91	2040	--	--		0.1
	7-24-91	2000	--	--		0.0
	7-26-91	2010	--	--		0.0
	8-2-91	2200	--	--		0.1
Tijeras Arroyo drainage basin						
Tijeras Arroyo from 370 feet to 100 feet above Four Hills Bridge	10-23-89	0942	11.5	5.8	(0.23)	9.0
Tijeras Arroyo from 324 feet to 100 feet above Four Hills Bridge	10-24-89	0820	7.5	1.2	(.05)	10
	10-24-89	0850	8.5	1.2	(.05)	10
	10-24-89	0917	9.5	1.5	(.06)	10
	10-24-89	1117	17.0	5.8	(.23)	10
	10-24-89	1218	19.0	8.0	(.31)	20
	10-24-89	1419	21.5	7.1	(.28)	10

Table 3.--Instantaneous evaporation and infiltration rates for selected reaches in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Reach	Date	Time	Water temperature, in degrees Celsius	Instantaneous evaporation over saturated, stream sediments, in millimeters per day (inches per day)	Instantaneous infiltration, in feet per day
Tijeras Arroyo from 100 feet above Four Hills Bridge to 1,070 feet below Four Hills Bridge	11-29-89	1115	6.0	1.2 (0.05)	3
	11-29-89	1430	7.0	1.5 (.06)	5
Tijeras Arroyo from 107 feet to 1,156 feet below Four Hills Bridge	1-9-90	1021	6.2	1.0 (.04)	3
Tijeras Arroyo from 100 feet above Four Hills Bridge to 798 feet below Four Hills Bridge	2-22-90	0930	3.9	1.4 (.06)	8
Tijeras Arroyo from 100 feet above Four Hills Bridge to 989 feet below Four Hills Bridge	4-11-90	0856	9.0	1.4 (.06)	9
Tijeras Arroyo from 100 feet above Four Hills Bridge to 346 feet below Four Hills Bridge	5-16-90	0648	8.0	1.1 (.04)	8
Tijeras Arroyo from 1,500 feet above Four Hills Bridge to 221 feet below Four Hills Bridge	9-26-90	0935	15.9	3.5 (.14)	7
Tijeras Arroyo from 445 feet to 100 feet above Four Hills Bridge	10-24-90	0935	8.1	2.6 (.10)	6
	10-24-90	0955	10.6	3.3 (.13)	6
	10-24-90	1100	13.9	5.7 (.22)	5
	10-24-90	1200	16.3	7.6 (.30)	6
	10-24-90	1300	18.2	8.1 (.32)	5
Tijeras Arroyo from 100 feet above Four Hills Bridge to 153 feet below Four Hills Bridge	11-28-90	0950	4.6	1.4 (.06)	10

Table 3.--Instantaneous evaporation and infiltration rates for selected reaches in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Reach	Date	Time	Water temperature, in degrees Celsius	Instantaneous evaporation over saturated, stream sediments, in millimeters per day (inches per day)	Instantaneous infiltration, in feet per day
Tijeras Arroyo from 100 feet above Four Hills Bridge to 437 feet below Four Hills Bridge	1-16-91	1000	4.3	1.4 (0.06)	9
	1-16-91	1250	7.9	2.1 (.08)	9
	1-16-91	1350	9.2	2.3 (.09)	8
	1-16-91	1445	7.7	2.1 (.08)	9
	1-16-91	1535	6.4	1.7 (.07)	10
Tijeras Arroyo from 400 feet to 100 feet above Four Hills Bridge	3-12-91	1155	18.0	6.2 (.24)	3
Tijeras Arroyo from 325 feet above Four Hills Bridge to 81 feet below Four Hills Bridge	5-22-91	0915	16.0	2.1 (.08)	9
	5-22-91	0945	18.0	2.8 (.11)	9
	5-22-91	1020	21.0	4.6 (.18)	10
	5-22-91	1044	22.5	6.6 (.26)	9
	5-22-91	1112	24.3	7.9 (.31)	9
Tijeras Arroyo from 3,000 feet to 2,741 feet above Four Hills Bridge	6-26-91	0835	17.3	5.2 (.20)	4
	6-26-91	0930	19.3	6.4 (.25)	4
	6-26-91	0956	20.3	7.5 (.30)	5
	6-26-91	1028	21.4	8.6 (.34)	4
	6-26-91	1055	22.6	11 (.43)	4
Tijeras Arroyo from 3,000 feet to 2,741 feet above Four Hills Bridge	6-26-91	1125	24.1	12 (.47)	4
	6-26-91	1155	25.9	14 (.55)	4
	6-26-91	1225	26.6	16 (.63)	4
	6-26-91	1255	28.1	18 (.71)	5
	6-26-91	1400	29.4	19 (.75)	4
Tijeras Arroyo from 885 feet to 650 feet above Four Hills Bridge	7-31-91	0810	18.0	3.0 (.12)	30
	7-31-91	0851	19.0	4.9 (.19)	30
	7-31-91	0918	19.4	6.5 (.26)	30
	7-31-91	1010	22.2	8.2 (.32)	30
	7-31-91	1038	23.4	9.4 (.37)	30

Table 3.--Instantaneous evaporation and infiltration rates for selected reaches in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Reach	Date	Time	Water temperature, in degrees Celsius	Instantaneous evaporation over saturated, stream sediments, in millimeters per day (inches per day)	Instantaneous infiltration, in feet per day
Tijeras Arroyo from 885 feet to	7-31-91	1105	24.6	11 (0.43)	30
650 feet above Four Hills Bridge	7-31-91	1135	26.0	13 (.51)	30
	7-31-91	1205	26.8	14 (.55)	30
	7-31-91	1235	28.0	16 (.63)	30
	7-31-91	1305	28.6	17 (.67)	30
Tijeras Arroyo from 334 feet to	8-28-91	0800	15.5	3.2 (.13)	7
20 feet above Four Hills Bridge	8-28-91	0850	16.9	3.8 (.15)	7
	8-28-91	0940	18.4	5.6 (.22)	7
	8-28-91	1000	20.0	6.7 (.26)	7
	8-28-91	1035	20.7	8.8 (.35)	6
	8-28-91	1100	21.8	11 (.43)	5
	8-28-91	1135	22.0	13 (.51)	6
	8-28-91	1200	23.1	14 (.55)	5
	8-28-91	1230	24.8	16 (.63)	6
	8-28-91	1255	26.8	17 (.67)	6
Tijeras Arroyo from 410 feet to	9-25-91	1031	16.7	7.5 (.30)	5
110 feet above Four Hills Bridge	9-25-91	1130	19.4	11 (.43)	6
	9-25-91	1230	21.6	14 (.55)	6
	9-25-91	1330	23.5	16 (.63)	8
	9-25-91	1430	25.5	15 (.59)	8
	9-25-91	1530	25.2	13 (.51)	9
	9-25-91	1630	23.8	10 (.39)	10
	9-25-91	1730	22.5	6.0 (.24)	10
	9-25-91	1830	20.5	4.0 (.16)	10
	9-25-91	1900	19.3	2.0 (.08)	10
Tijeras Arroyo from 2,245 feet	5-19-92	0830	13.1	4.4 (.17)	3.80
to 100 feet above Four	5-19-92	0840	13.4	4.8 (.19)	3.86
Hills Bridge	5-19-92	0850	13.7	5.1 (.20)	3.83
	5-19-92	0900	13.9	5.2 (.20)	3.87
	5-19-92	0910	14.3	5.3 (.21)	3.90

Table 3.--Instantaneous evaporation and infiltration rates for selected reaches in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Reach	Date	Time	Water temperature, in degrees Celsius	Instantaneous evaporation over saturated, stream sediments, in millimeters per day (inches per day)	Instantaneous infiltration, in feet per day
Tijeras Arroyo from 2,245 feet to 100 feet above Four Hills Bridge	5-19-92	0920	14.6	5.5 (0.22)	3.86
	5-19-92	0930	14.9	5.6 (.22)	3.84
	5-19-92	0940	15.3	5.7 (.22)	3.83
	5-19-92	0950	15.4	5.9 (.23)	3.93
	5-19-92	1000	15.3	6.1 (.24)	3.95
	5-19-92	1010	15.6	6.3 (.25)	3.98
	5-19-92	1020	15.7	6.6 (.26)	3.96
	5-19-92	1030	15.8	6.8 (.27)	3.95
	5-19-92	1040	15.9	7.0 (.28)	3.97
	5-19-92	1050	16.2	7.3 (.29)	3.98
	5-19-92	1100	16.6	7.7 (.30)	4.01
	5-19-92	1110	16.6	7.7 (.30)	4.01
	5-19-92	1120	16.9	7.9 (.31)	4.03
	5-19-92	1130	17.4	8.1 (.32)	4.03
	5-19-92	1140	18.0	8.3 (.33)	4.06
	5-19-92	1150	18.4	9.0 (.35)	4.05
	5-19-92	1200	18.7	10 (.39)	4.06
	5-19-92	1210	18.7	11 (.43)	4.10
	5-19-92	1220	19.2	13 (.51)	--
	5-19-92	1230	19.5	14 (.55)	4.13
	5-19-92	1240	20.2	15 (.59)	4.22
	5-19-92	1250	20.7	16 (.63)	4.29
	5-19-92	1300	21.0	16 (.63)	4.32
	5-19-92	1310	21.4	16 (.63)	4.42
	5-19-92	1320	21.8	16 (.63)	4.50

Table 3.--Instantaneous evaporation and infiltration rates for selected reaches in the Grant Line Arroyo and Tijeras Arroyo drainage basins --Continued

Reach	Date	Time	Water temperature, in degrees Celsius	Instantaneous evaporation over saturated, stream sediments, in millimeters per day (inches per day)	Instantaneous infiltration, in feet per day
Tijeras Arroyo from 2,245 feet to	5-19-92	1330	21.9	16 (0.63)	4.50
100 feet above	5-19-92	1340	22.0	16 (.63)	4.49
Four Hills Bridge	5-19-92	1350	22.3	15 (.59)	4.49
	5-19-92	1400	22.2	14 (.55)	4.49
	5-19-92	1410	21.8	13 (.51)	4.60
	5-19-92	1420	22.0	12 (.47)	4.62
	5-19-92	1430	21.1	10 (.39)	4.54
	5-19-92	1440	20.5	9.1 (.36)	4.54
	5-19-92	1450	20.5	8.6 (.34)	4.61
	5-19-92	1500	20.5	8.9 (.35)	4.64
	5-19-92	1510	20.5	9.1 (.36)	4.46
	5-19-92	1520	20.3	9.4 (.37)	4.47
	5-19-92	1530	20.7	9.6 (.38)	4.55
	5-19-92	1540	20.4	9.3 (.37)	4.57
	5-19-92	1550	19.9	9.0 (.35)	4.51
	5-19-92	1600	19.8	8.7 (.34)	4.52
Tijeras Arroyo	5-19-92	0830	13.5	4.4 (.17)	5.45
From 1,202 feet to 100 feet	5-19-92	0840	13.9	4.8 (.19)	5.44
above Four Hills Bridge	5-19-92	0850	14.1	5.1 (.20)	5.50
	5-19-92	0900	14.4	5.2 (.20)	5.56
	5-19-92	0910	14.8	5.3 (.20)	5.57
	5-19-92	0920	15.2	5.5 (.22)	5.61
	5-19-92	0930	15.6	5.6 (.22)	5.58
	5-19-92	0940	15.9	5.7 (.22)	5.50
	5-19-92	0950	15.9	5.9 (.23)	5.60
	5-19-92	1000	15.9	6.1 (.24)	5.70

Table 3.--Instantaneous evaporation and infiltration rates for selected reaches in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Reach	Date	Time	Water temperature, in degrees Celsius	Instantaneous evaporation over saturated, stream sediments, in millimeters per day (inches per day)	Instantaneous infiltration, in feet per day
Tijeras Arroyo	5-19-92	1010	16.2	6.3 (0.25)	5.72
from 1,202 feet to 100 feet	5-19-92	1020	16.2	6.6 (.26)	5.72
above Four Hills Bridge	5-19-92	1030	16.4	6.8 (.27)	5.73
	5-19-92	1040	16.6	7.0 (.28)	5.70
	5-19-92	1050	17.1	7.3 (.29)	--
	5-19-92	1100	17.3	7.7 (.30)	5.77
	5-19-92	1110	17.3	7.7 (.30)	5.84
	5-19-92	1120	17.8	7.9 (.31)	5.88
	5-19-92	1130	18.4	8.1 (.32)	5.88
	5-19-92	1140	19.0	8.3 (.33)	5.94
	5-19-92	1150	19.3	9.0 (.35)	5.91
	5-19-92	1200	19.5	10 (.39)	5.78
	5-19-92	1210	19.7	11 (.43)	5.90
	5-19-92	1220	20.2	13 (.51)	5.89
	5-19-92	1230	20.6	14 (.55)	5.90
	5-19-92	1240	21.4	15 (.59)	5.89
	5-19-92	1250	22.0	16 (.63)	6.02
	5-19-92	1300	22.4	16 (.63)	6.16
	5-19-92	1310	22.7	16 (.63)	6.25
	5-19-92	1320	22.9	16 (.63)	6.37
	5-19-92	1330	23.3	16 (.63)	6.44
	5-19-92	1340	23.4	16 (.63)	6.47
	5-19-92	1350	23.4	15 (.59)	6.46
	5-19-92	1400	23.3	14 (.55)	6.59
	5-19-92	1410	23.1	13 (.51)	6.53

Table 3.--Instantaneous evaporation and infiltration rates for selected reaches in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Reach	Date	Time	Water temperature, in degrees Celsius	Instantaneous evaporation over saturated, stream sediments, in millimeters per day (inches per day)	Instantaneous infiltration, in feet per day
Tijeras Arroyo	5-19-92	1420	22.8	12 (0.47)	6.67
from 1,202 feet to 100 feet	5-19-92	1430	22.0	10 (.39)	6.61
above Four Hills Bridge	5-19-92	1440	21.2	9.1 (.36)	6.51
	5-19-92	1450	21.2	8.6 (.34)	6.56
	5-19-92	1500	21.5	8.9 (.35)	6.74
	5-19-92	1510	21.6	9.1 (.36)	6.56
	5-19-92	1520	21.4	9.4 (.37)	6.46
	5-19-92	1530	21.7	9.6 (.38)	6.54
	5-19-92	1540	21.4	9.3 (.37)	6.61
	5-19-92	1550	20.9	9.0 (.35)	6.55
	5-19-92	1600	20.5	8.7 (.34)	6.56
Tijeras Arroyo from 2,245 feet to	5-19-92	0830	13.1	4.4 (.17)	2.33
1,202 feet above Four Hills	5-19-92	0840	13.4	4.8 (.19)	2.45
Bridge	5-19-92	0850	13.7	5.1 (.20)	2.34
	5-19-92	0900	13.9	5.2 (.20)	2.38
	5-19-92	0910	14.3	5.3 (.21)	2.40
	5-19-92	0920	14.6	5.5 (.22)	2.31
	5-19-92	0930	14.9	5.6 (.22)	2.28
	5-19-92	0940	15.3	5.7 (.22)	2.33
	5-19-92	0950	15.4	5.9 (.23)	2.44
	5-19-92	1000	15.3	6.1 (.24)	2.39
	5-19-92	1010	15.6	6.3 (.25)	2.42
	5-19-92	1020	15.7	6.6 (.26)	2.39
	5-19-92	1030	15.8	6.8 (.27)	2.36
	5-19-92	1040	15.9	7.0 (.28)	2.43
	5-19-92	1050	16.2	7.3 (.29)	--

Table 3.--Instantaneous evaporation and infiltration rates for selected reaches in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Continued

Reach	Date	Time	Water temperature, in degrees Celsius	Instantaneous evaporation over saturated, stream sediments, in millimeters per day (inches per day)	Instantaneous infiltration, in feet per day
Tijeras Arroyo from 2,245 feet to	5-19-92	1100	16.6	7.7 (0.30)	2.43
1,202 feet above Four Hills	5-19-92	1110	16.6	7.7 (.30)	2.36
Bridge	5-19-92	1120	16.9	7.9 (.31)	2.37
	5-19-92	1130	17.4	8.1 (.32)	2.37
	5-19-92	1140	18.0	8.3 (.33)	2.38
	5-19-92	1150	18.4	9.0 (.35)	2.37
	5-19-92	1200	18.7	10 (.39)	2.50
	5-19-92	1210	18.7	11 (.43)	2.48
	5-19-92	1220	19.2	13 (.51)	--
	5-19-92	1230	19.5	14 (.55)	2.53
	5-19-92	1240	20.2	15 (.59)	2.71
	5-19-92	1250	20.7	16 (.63)	2.73
	5-19-92	1300	21.0	16 (.63)	2.67
	5-19-92	1310	21.4	16 (.63)	2.79
	5-19-92	1320	21.8	16 (.63)	2.84
	5-19-92	1330	21.9	16 (.63)	2.79
	5-19-92	1340	22.0	16 (.63)	2.75
	5-19-92	1350	22.3	15 (.59)	2.77
	5-19-92	1400	22.2	14 (.55)	2.67
	5-19-92	1410	21.8	13 (.51)	2.92
	5-19-92	1420	22.0	12 (.47)	2.84
	5-19-92	1430	21.1	10 (.39)	2.74
	5-19-92	1440	20.5	9.1 (.36)	2.82
	5-19-92	1450	20.5	8.6 (.34)	2.91
	5-19-92	1500	20.5	8.9 (.35)	2.81

Table 3.--Instantaneous evaporation and infiltration rates for selected reaches in the Grant Line Arroyo and Tijeras Arroyo drainage basins--Concluded

Reach	Date	Time	Water temperature, in degrees Celsius	Instantaneous evaporation over saturated, stream sediments, in millimeters per day (inches per day)	Instantaneous infiltration, in feet per day
Tijeras Arroyo from 2,245 feet to	5-19-92	1510	20.5	9.1 (0.36)	2.63
1,202 feet above Four Hills	5-19-92	1520	20.3	9.4 (.37)	2.73
Bridge	5-19-92	1530	20.7	9.6 (.38)	2.82
	5-19-92	1540	20.4	9.3 (.37)	2.79
	5-19-92	1550	19.9	9.0 (.35)	2.72
	5-19-92	1600	19.8	8.7 (.34)	2.76

[1] Instantaneous infiltration measurements taken between 7-25-89 and 9-25-91 are considered to be accurate to one significant digit. Instantaneous infiltration measurements taken on 5-19-92 are considered to be accurate to three significant digits.

[2] Length of reach is 2,510 feet.

Table 4.--Annual evaporation or evapotranspiration rates for three land-surface conditions at Grant Line Arroyo and Tijeras Arroyo

Land-surface conditions	Annual evaporation or evapotranspiration, in millimeters per year (inches per year)		
	April 1989 through March 1990	April 1990 through March 1991	April 1991 through March 1992
Unsaturated, unvegetated soil	174 (6.85)	291 (11.46)	233 (9.17)
Grasses or shrubs or both	438 (17.24)	465 (18.31)	469 (18.46)
Saturated stream sediments	802 (31.57)	1,025 (40.35)	1,024 (40.31)
	Annual precipitation, in inches per year		
	4.70	9.94	11.52

Table 5.--Concentrations of total and dissolved chromium, copper, lead, and zinc for samples collected at study sites in the Grant Line Arroyo and Tijeras Arroyo drainage basins

[µg/L, micrograms per liter]

Site location number and name	Date	Chromium, total recoverable (µg/L as chromium)	Chromium, dissolved (µg/L as chromium)	Copper, total recoverable (µg/L as copper)	Copper, dissolved (µg/L as copper)	Lead, total recoverable (µg/L as lead)	Lead, dissolved (µg/L as lead)	Zinc, total recoverable (µg/L as zinc)	Zinc, dissolved (µg/L as zinc)
08329860 Grant Line Arroyo at Villa del Oso	03-30-90	3	<5	8	10	<10	9	40	25
08329865 Grant Line Arroyo above San Pedro Boulevard	07-25-89	13	2	25	5	1	1	40	17
	09-19-89	8	<1	15	5	37	1	100	13
	05-02-90	4	1	7	4	12	1	40	4
	07-14-90	8	2	14	3	19	<1	110	4
	05-21-91	7	<1	9	6	21	1	60	19
	12-11-91	<1	<1	17	4	3	<1	20	12
08330505 Tijeras Arroyo above Four Hills Bridge	10-28-88	4	2	6	1	11	<5	50	6
	01-30-89	4	2	9	1	6	<5	40	16
	05-08-89	3	2	3	1	1	<5	<10	6
	07-26-89	8	2	5	2	3	1	70	<3
	10-05-89	4	2	8	2	4	<1	20	4
	03-30-90	3	<5	4	<10	1	<10	10	6
	05-03-90	4	2	13	2	6	<1	30	<3
	08-14-90	28	<1	14	4	33	<1	230	7
	07-23-91	11	<1	21	5	17	<1	50	4
	08-05-91	10	1	20	2	No data	<1	70	<3
	09-06-91	24	<1	30	3	40	<1	190	<3
	05-20-92	2	<1	<1	<1	<1	<1	<10	<3
08330540 Tramway Floodway Channel	09-19-89	1	1	9	5	55	1	140	25
350337106294003 10N. 04E. 26.332, well 3	05-20-92	<1	<1	1	<1	<1	<1	<10	6
350338106292801 10N. 04E. 26.341, well 5	05-20-92	<1	2	<1	<1	<1	<1	<10	<3
350337106291203 10N. 04E. 26.431, well 11	05-20-92	1	1	<1	<1	<1	<1	<10	<3