Evaluation of Tracer Tests Completed in 1999 and 2000 on the Upper Santa Clara River, Los Angeles and Ventura Counties, California

By Marisa H. Cox, Gregory O. Mendez, Charles R. Kratzer, *and* Eric G. Reichard

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CONVERSION FACTORS

Multiply	By	To obtain
foot (ft)	0.3048	meter
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
inch (in.)	25.4	millimeter
inch per year (in/yr)	25.4	millimeter per year
gallon (gal)	3.785	liter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer

Temperature in degrees Celsius (^oC) may be converted to degrees Fahrenheit (^oF) as follows:

$$^oF=1.8\ ^oC+32.$$

Temperature in degrees Fahrenheit (^oF) may be converted to degrees Celsius (^oC) as follows:

$$^oC=(^oF-32)/1.8.$$

Specific conductance is given microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25^{o}C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

VERTICAL DATUM

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

ABBREVIATIONS

B	boron
C	carbon
Ca	calcium
$CaCO_3$	calcium carbonate
Cl	chlorine
EWI	equal-width increment
F	fluoride
Fe	iron
g/L	grams per liter
Hg	mercury
K	potassium
km	kilometer
L	liter
Mg	magnesium
mL	milliliter
mm	millimeter
Mn	manganese
N	nitrogen
Na	sodium
NaBr	sodium bromide
P	phosphorus
SiO_2	silica
SO_4	sulfate
TDS	total dissolved solids
TMDL	total maximum daily load
µm	micrometer
WRP	water reclamation plant

Organizations

LACSD	Los Angeles County Sanitation Districts
NWIS	National Water Information System
NWQL	National Water Quality Laboratory
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey

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ABSTRACT

The interaction of surface water and hyporheic water along the Santa Clara River in Los Angeles and Ventura Counties, California, was evaluated by conducting tracer tests and analyzing water-quality data under different flow conditions in October 1999 and May 2000. Tracer and water-quality samples were collected at multiple river and hyporheic sites as well as at the Los Angeles County Sanitation Districts Saugus and Valencia Water Reclamation Plants. These water reclamation plants provide the main source of base flow in the river. Rhodamine WT dye was injected into the river to determine river traveltimes and to indicate when Lagrangian water-quality sampling could be performed at each site. Sodium bromide was injected into the river at a constant rate at the water reclamation plants to evaluate the surface-water and shallow ground-water interactions in the hyporheic zone.

In the upper reach of the study area, which extends 2.9 river miles downstream from the Saugus Water Reclamation Plant, traveltime was 3.2 hours during May 2000. In the lower reach, which extends 14.1 river miles downstream from the Valencia Water Reclamation Plant, traveltime was 9.6 hours during October 1999 and 7.1 hours during May 2000. The sodium bromide tracer was detected at both hyporheic locations sampled during October 1999, and at two of the three hyporheic locations sampled during May 2000.

On the basis of Rhodamine dye tests, flow curves were constructed from the discharge measurements in the Valencia reach. Flow-curve results indicate net gains in flow throughout most, but not all, of the upper parts of the reach and net losses in flow at the lower part of the reach.

Lagrangian water-quality sampling provides information on the changes in chemistry as the water flows downstream from the water reclamation plants. Along both reaches there is an increase in sulfate (40–60 mg/L in the Saugus reach and 160 mg/L in the Valencia reach) and a decrease in chloride (about 45 mg/L in the Saugus reach and about 10 mg/L in the Valencia reach). The increasing sulfate concentrations are consistent with discharge of higher sulfate ground water into the river. Along both reaches there is a trend of decreasing ammonia and slightly increasing nitrate concentrations. This trend is consistent with nitrification.

Samples were also analyzed for numerous compounds associated with wastewater, but analysis focused on four indicators. Concentrations of wastewater indicators in the Santa Clara River were low and decreased downstream from the reclamation plants.

There is general consistency between the chemical and tracer data collected from the hyporheic and the river-aquifer flow regime within a reach. The water quality at the hyporheic site in a gaining reach of the river resembled that of the local ground water and no wastewater indicators or injected tracers were observed; whereas, the water quality at the hyporheic sites in a losing reach of the river resembled the water quality of the river at the corresponding river site, and injected tracers were observed.

INTRODUCTION

The Santa Clara River is one of two remaining natural river systems in southern California. The river emanates from the headwaters on the western flank of the San Gabriel Mountains, then flows westward approximately 100 mi through Los Angeles and Ventura Counties to the Pacific Ocean (fig. 1). The U.S. Geological Survey (USGS) has recently completed several studies dealing with stream-aquifer interaction in the lower reaches of the Santa Clara River in Ventura County (Paybins and others, 1998; Nishikawa and others, 1999; Reichard and others, 1999; and Hanson and others, 2003). Without effluent from the Saugus and the Valencia Water Reclamation Plants, the upper reach of the Santa Clara River would be ephemeral. The Los Angeles County Sanitation Districts Water Reclamation Plants provide primary, secondary, tertiary, and disinfection treatment for a total of about 18 million gallons per day of effluent that is discharged into the river. For most of the year as the Santa Clara River flows through this reach, there is an opportunity for the effluent-dominated stream water to flow into streambed sediments or sand bars and either percolate down to the shallow water table or emerge back into the river downstream. These processes can result in changes in the downstream chemistry of both stream and hyporheic water (river water that leaves and re-enters the river within the study reach). During most of the year, all stream water percolates into the streambed before the beginning of the Dry Gap in eastern Ventura County (fig. 1). Below the Dry Gap, the Santa Clara River becomes perennial at the confluence with Piru Creek.

The Upper Santa Clara River is included in the 1998 U.S. Environmental Protection Agency (USEPA) 303(d) list for chloride, total ammonia, and nitrite plus nitrate (U.S. Environmental Protection Agency, 1998). Section 303(d) of the Clean Water Act requires States to identify water bodies that do not meet applicable water-quality standards; and for those impaired bodies, a Total Maximum Daily Load (TMDL) must be established. Currently, TMDLs are being established for the upper reach of the Santa Clara River. Water-quality objectives for total dissolved solids (TDS), chloride, sulfate, and nitrogen (nitrate nitrogen plus nitrite nitrogen) were set for the upper reach of the Santa Clara River by the Regional Water Quality Control Board, Los Angeles Region, in 1975 and later revised in 1978. The TDS and chloride objectives are 1,000 and 100 milligrams per liter (mg/L), respectively. The sulfate, and nitrogen objectives are 300 and 10 mg/L, respectively, for the upper reach of the study area, and 400 and 5 mg/L, respectively, for the lower reach of the study area (Los Angeles Regional Water Quality Control Board, 1994).

Purpose, Scope, and Approach

Improved understanding of the interactions between the effluent-dominated stream water and the hyporheic water can help quantify the influence of the effluent on downstream surface-water and shallow-ground-water quality. There is particular interest in the impacts of the constituents listed on the USEPA 303(d) list for this reach of the river. To address this need, the USGS in cooperation with the Los Angeles County Sanitation Districts (LACSD) conducted a study to evaluate the influence of the effluent from the Saugus and the Valencia Water Reclamation Plants (WRPs) on surface-water and hyporheic water quality and to characterize the chemical and hydraulic interactions between the Santa Clara River and the shallow ground-water system. The approach was to conduct two types of tracer tests during periods of different flow conditions in order to evaluate the influence of effluent from WRPs on flow and on water quality in the river. The first type of tracer test was a slug injection of Rhodamine WT dye; the second was a constant-rate injection of sodium bromide. Tracer concentrations were measured at multiple river and hyporheic sites along a 16-river-mile reach of the river. In addition to the tracer tests, flow and water quality were measured. Flow measurements were taken at the sampling locations during the tracer tests to help quantify gains and losses in flow. Water-quality samples were taken 3 hours after the peak of the Rhodamine WT dye at each site, observing water-quality changes in the same mass of water as it flowed downstream.

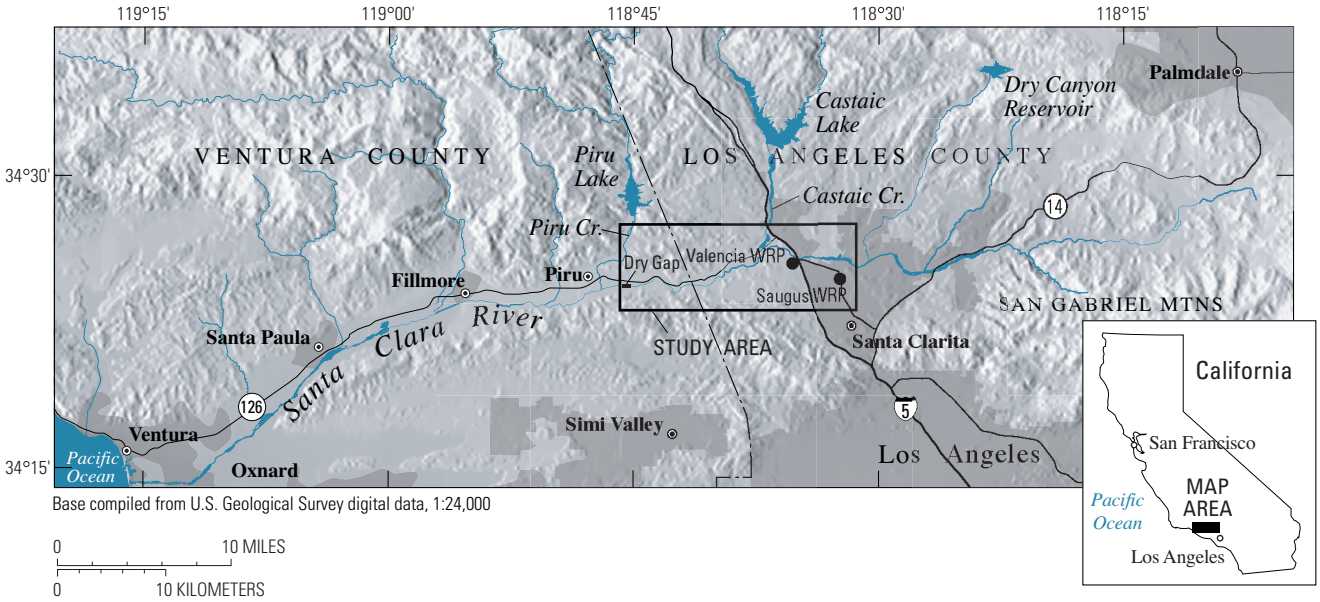

Figure 1. Location of the Santa Clara River, California. (WRP, water reclamation plant.)

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DESCRIPTION OF STUDY AREA

Hydrology

The Upper Santa Clara River hydrologic area, the focus of this study, has a drainage area of approximately 645 mi^2 (fig. 1). Annual precipitation varies with location in the study area and ranges from 7 to 22 in/yr. The Santa Clara River occupies a comparatively narrow, sinuous channel, and the river and its tributaries are underlain by an unconfined alluvial aquifer. The sandy channel is highly permeable over much of its length, and in places large quantities of water infiltrate through the streambed to the alluvial aquifer (California Department of Water Resources, 1993).

Streamflow in the Santa Clara River consists of stormflow and base flow. Base flow is composed of ground water, effluent from WRPs, bank seepage, and nonpoint discharge from uncontrolled agricultural and urban runoff. Streamflow was measured at the Los Angeles-Ventura County Line, USGS gaging station (11108500) (fig. 2), during water years 1953 to 1996. This gage was discontinued in 1996 because of unsafe conditions caused by bank erosion. Streamflows measured at this gage from 1953 to 1971 were less than 31 ft^3/s for 90 percent of the year and the mean flow was 36.2 ft^3/s. From 1972 to 1996, streamflows were less than 98 ft^3/s for 90 percent of the year and the mean flow was 68.7 ft^3/s (Rockwell and others, 1996). After 1972, higher low flows and lower high flows were observed in the Santa Clara River. Since January 1972 flow in the Santa Clara River has been partly regulated by the Castaic Dam on Castaic Creek, a tributary to the Santa Clara River (fig. 1). When the Los Angeles-Ventura County Line gage was discontinued, a gage was reestablished downstream at Santa Clara River near Piru. Streamflow was measured at the Santa Clara River near Piru, USGS gaging station 11109000 (fig. 2), from water years 1927 to 1932 and 1996 to present. Streamflows measured at this gage from 1928 to 2000 were less than 85 ft^3/s for 90 percent of the year and the mean flow was 59.3 ft^3/s (Anderson and others, 2001).

Land Use

Most of the study area consists of urban, range, forest, and agricultural lands (fig. 3). Crops such as citrus, vegetables, and grains are the predominant agricultural products. Oil has been produced from the hills adjacent to the Santa Clara Valley since the 1870s. Urban areas in the Santa Clara River Valley have significantly increased since 1990; Santa Clarita (fig. 1), the largest city, had more than 151,000 residents in 2000 (U.S. Census Bureau, 2000).

APPROACH

The study reach along the Santa Clara River extends approximately 16 river-miles from the Saugus WRP in Los Angeles County to where the river becomes ephemeral (Dry Gap), 6 river-miles west of the Los Angeles-Ventura County Line (fig. 2). The study reach was divided into two sections, the Saugus reach extending approximately 2.9 river-miles from the Saugus WRP to sampling site SCRA, and the Valencia reach extending approximately 14.1 river-miles from the Valencia WRP to the Dry Gap (fig. 2). The Saugus reach effectively represents Reach 6 identified by the Regional Water Quality Control Board, Los Angeles Region; the Valencia reach represents Reach 5 and a small portion of Reach 4 (Los Angeles Regional Water Quality Control Board, 1994).

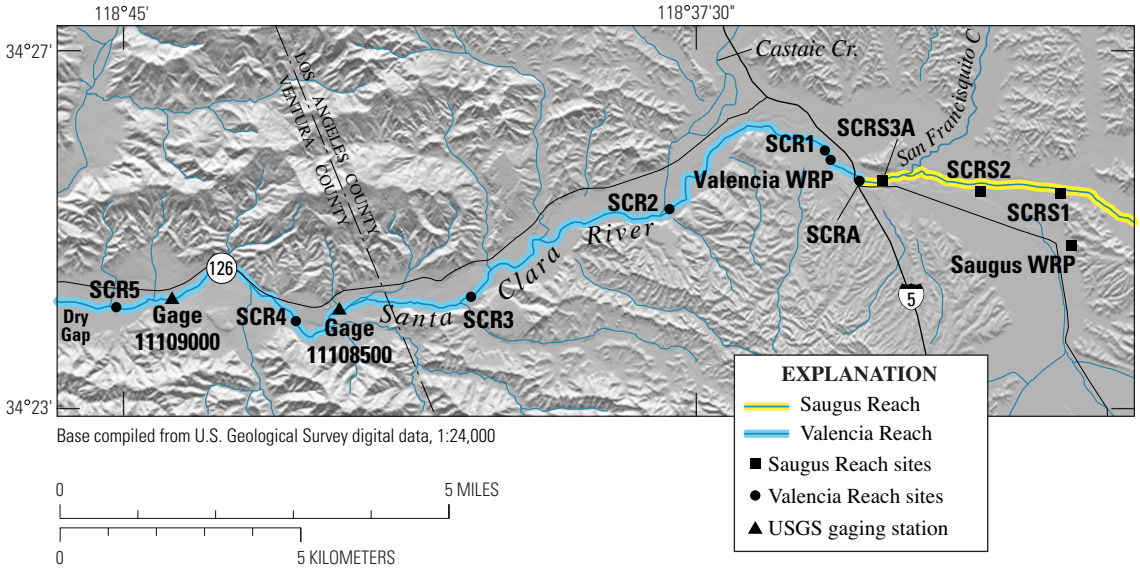

Figure 2. Surface-water sampling sites, Santa Clara River, California. (WRP, water reclamation plant.)

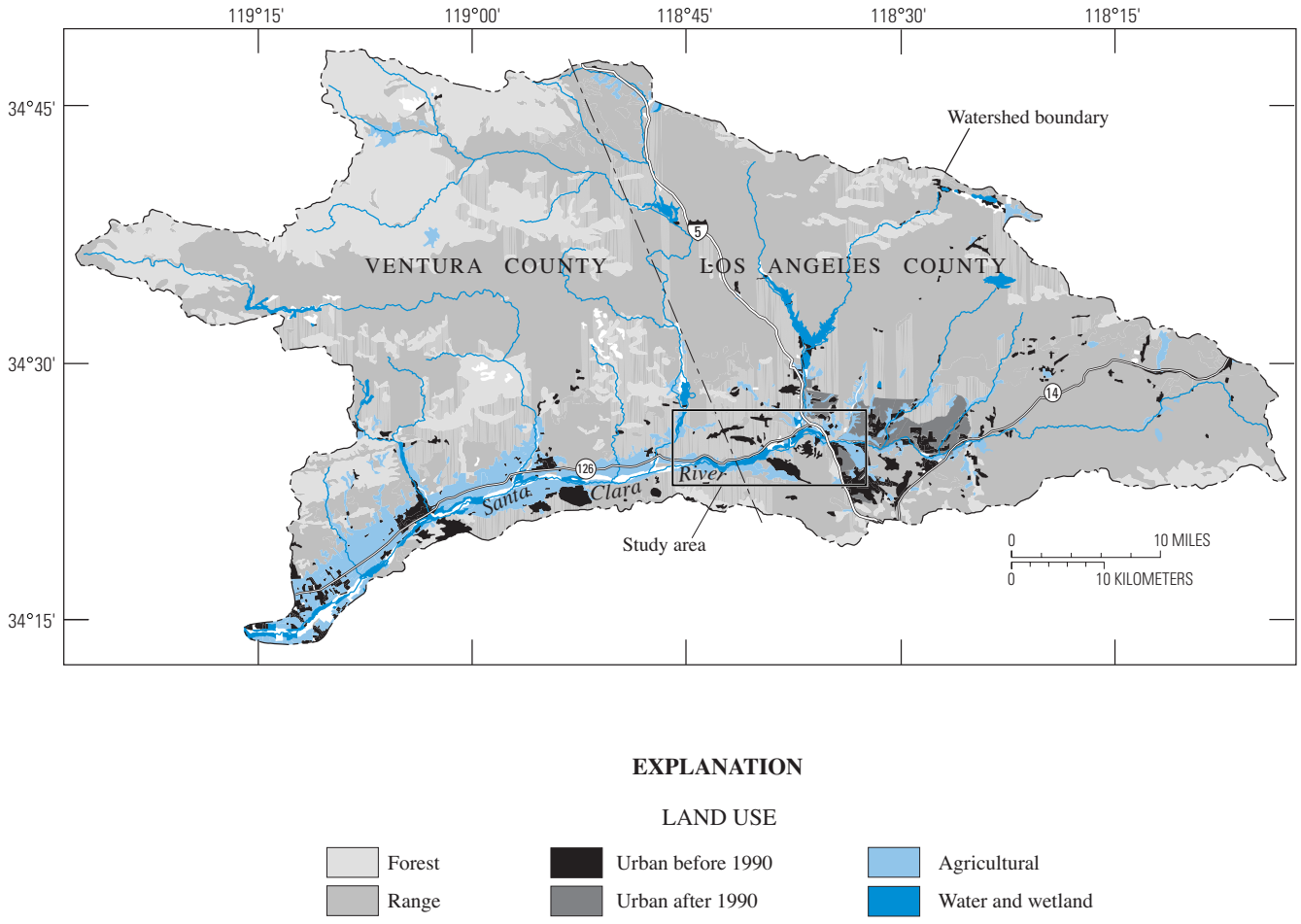

Figure 3. Land use map in the Santa Clara River Valley, California, 1990 (Anderson and others, 1976, and USGS, 1990).

Tracer tests were conducted in October 1999 and May 2000 under different flow conditions. For the Saugus reach tracer tests, the Rhodamine WT dye was injected into the river where the effluent is released into the river (SCRS1), and the sodium bromide tracer was injected into the effluent at the Saugus WRP. The effluent from the Saugus WRP travels approximately 0.3 mi by pipeline before it enters the river. The Saugus reach was sampled at Saugus WRP and SCRA in October 1999 and at SCRS1, SCRS2, SCRS3A, and SCRA in May 2000 (fig. 2, table 1). No hyporheic sites were established in the Saugus reach.

For the Valencia reach tracer tests, the Rhodamine WT dye was injected into the river 50 ft below where effluent is released into the river (SCR1), and the sodium bromide tracer was injected into the effluent at the Valencia WRP. The effluent travels approximately 0.1 river-mile in a channel before it enters the river. The Valencia reach in both October 1999 and May 2000 was sampled at five river locations (SCR1-SCR5), the Valencia WRP, and multiple hyporheic locations (figs. 2, 4; table 1). The hyporheic sites in the Valencia reach consisted of shallow piezometers that provide information about the interactions between surface water and hyporheic water. In October 1999, piezometers were installed in the sand bar at SCR3 and SCR5. The piezometers were open-ended 6-inch-diameter plastic pipes installed to depths of about 2 ft. They were configured in a triangle with the piezometers placed about 2 to 4 ft from each other. The closest piezometer was approximately 2.7 ft from the river at SCR3 and 1.5 ft from the river at SCR5 (fig. 4). The October 1999 hyporheic sites at SCR3 are SCR3H1, SCR3H2, and SCR3H3, and the sites at SCR5 are SCR5H1, SCR5H2, and SCR5H3 (table1). All piezometers were removed after the completion of the October 1999 tracer tests.

In May 2000, piezometers were installed in the sand bar and river at SCR2, SCR3, and SCR5 (fig. 4). The piezometers were open-ended 2-inch-diameter plastic pipes installed to depths of about 1.5 ft. They were configured in a straight line perpendicular to the flow of the river, with one piezometer in the river and two in the sand bar spaced approximately 12 ft apart at SCR2 and SCR3 and 6.6 ft apart at SCR5. The May 2000 hyporheic sites at SCR2 are identified as SCR2H1, SCR2H2, and SCR2H3; at SCR3 as SCR3H4, SCR3H5, and SCR3H6; and at SCR5 as SCR5H4, SCR5H5, and SCR5H6 (table1). During the May 2000 tracer tests, temperature-logging devices were installed at the bottom of each piezometer and in the stream. The temperature data are presented in Constantz and others (2003).

Tracer Techniques

Tracers were used to determine the transport and dispersion of the effluent from the water reclamation plants once it entered the Santa Clara River. The movement of conservative solutes in a stream is the net result of a series of physical processes, and the use of a conservative tracer is an effective means of following those processes with no changes owing to chemical reactions and sorption. Movement of nonconservative solutes is controlled by the same physical processes that affect conservative solutes, but it is affected in varying degrees by chemical reactions and sorption (Kennedy and others, 1984). The traveltime of solutes through a stream reach can be determined by injecting a tracer either as a slug or at a constant rate at the upstream end of the reach and measuring the concentration of the tracer downstream (Wilson and others, 1986; Kilpatrick and Wilson, 1989). Two different tracers were injected simultaneously for this study. Rhodamine WT dye is relatively conservative in most water environments but acts nonconservatively in the hyporheic zone due to possible sorption by sediments. Sodium bromide (NaBr), a soluble salt, was chosen as the conservative tracer to track river water through the hyporheic zone.

Table 1. Surface-water and hyporheic sites, Santa Clara River, California

[USGS, U.S. Geological Survey; WRP, water reclamation plant; *, discharge measurement only; #, location of dye release]

USGS station name	USGS station No.	Reference name	River mile from Saugus WRP outflow
October 1999			
Saugus Reach			
Saugus WRP effluent, at Saugus, California	342456118322001	Saugus WRP	–0.3
Santa Clara River, 0.1 mile below Saugus WRP, near Saugus, California#	342527118323001	SCRS1	.0
Santa Clara River, at Old Road, near Valencia, California	342535118350801	SCRA	2.9
October 1999			
Valencia Reach			
Valencia WRP effluent, at Valencia, California	342548118352401	Valencia WRP	3.4
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California#	342557118353801	SCR1	3.5
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	342507118380301	SCR2	6.9
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	342422118401701	SCR3	9.5
Santa Clara River hyporheic (F1), 0.2 mile above Potrero Canyon, California	342422118401702	SCR3H1	9.5
Santa Clara River hyporheic (F2),0.2 mile above Potrero Canyon, California	342422118401703	SCR3H2	9.5
Santa Clara River hyporheic (F3), 0.2 mile above Potrero Canyon, California	342422118401704	SCR3H3	9.5
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	342359118424501	SCR4	12.6
Santa Clara River, near Piru, California*	11109000	GAGE	14.7
Santa Clara River 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450101	SCR5	15.6
Santa Clara River hyporheic (F1), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450102	SCR5H1	15.6
Santa Clara River hyporheic (F2), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450103	SCR5H2	15.6
Santa Clara River hyporheic (F3), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450104	SCR5H3	15.6
May 2000			
Saugus Reach			
Saugus WRP effluent, at Saugus, California#	342456118322001	Saugus WRP	–.3
Santa Clara River, 0.1 mile below Saugus WRP, near Saugus, California	342527118323001	SCRS1	.0
Santa Clara River, above McBean Parkway Bridge, near Saugus, California	342530118332501	SCRS2	.9
Santa Clara River, at Old Trestle Bridge, near Saugus, California	342534118344101	SCRS3A	2.4
Santa Clara River, at Old Road, near Valencia, California	342535118350801	SCRA	2.9
May 2000			
Valencia Reach			
Valencia WRP effluent, at Valencia, California	342548118352401	Valencia WRP	3.4
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California#	342557118353801	SCR1	3.5
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	342507118380301	SCR2	6.9
Santa Clara River hyporheic (H1), 0.3 mile below Castaic Creek, near Valencia, California	342507118380302	SCR2H1	6.9
Santa Clara River hyporheic (H2), 0.3 mile below Castaic Creek, near Valencia, California	342507118380303	SCR2H2	6.9
Santa Clara River hyporheic (H3), 0.3 mile below Castaic Creek, near Valencia, California	342507118380304	SCR2H3	6.9

Table 1. Surface-water and hyporheic sites, Santa Clara River, California—Continued

USGS station name	USGS station No.	Reference name	River mile from Saugus WRP outflow
Santa Clara River,0.2 mile above Potrero Canyon, near Val Verde, California	342422118401701	SCR3	9.5
Santa Clara River hyporheic (H4), 0.2 mile above Potrero Canyon, near Val Verde, California	342420118402205	SCR3H4	9.5
Santa Clara River hyporheic (H5), 0.2 mile above Potrero Canyon, near Val Verde, California	342420118402201	SCR3H5	9.5
Santa Clara River hyporheic (H6), 0.2 mile above Potrero Canyon, near Val Verde, California	342420118402206	SCR3H6	9.5
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	342359118424501	SCR4	12.6
Santa Clara River, near Piru, California*	11109000	GAGE	14.7
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450101	SCR5	15.6
Santa Clara River hyporheic (H4), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450105	SCR5H4	15.6
Santa Clara River hyporheic (H5), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450106	SCR5H5	15.6
Santa Clara River hyporheic (H6), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450107	SCR5H6	15.6

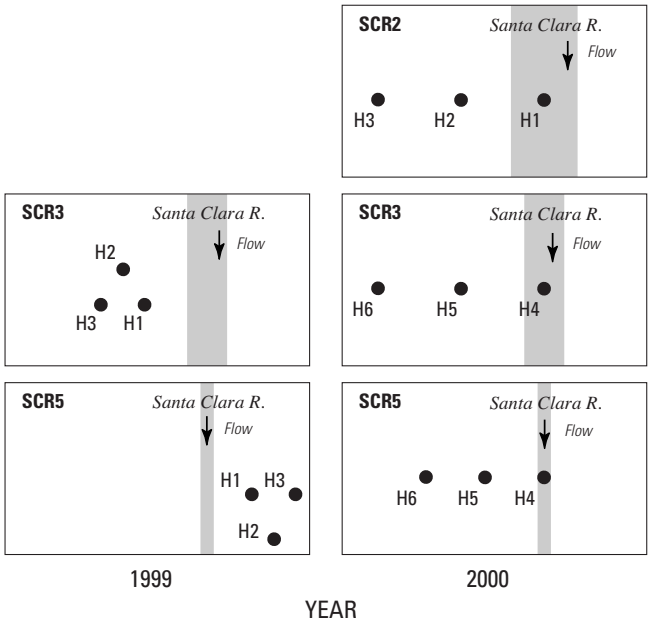

Figure 4. Configuration of hyporheic sampling sites (not to scale), Santa Clara River, California.

Rhodamine WT 20-percent dye was added to the river as a slug injection by pouring a measured amount of dye into the center of flow downstream from where the WRPs discharge into the river. The dye was directly released into the river rather than being released within the WRP facilities because of its propensity to stain and adsorb onto surfaces. To minimize photochemical decay of Rhodamine WT dye, the dye injections were performed at night. The empirical equation used for estimating the quantity of dye is from Kilpatrick (1970). The dosage formula is

$$Vs = 3.4\text{x}10^{-4}(QmL/v)^{0.94}\ Cp,$$

where

Vs = volume of stock Rhodamine WT 20-percent dye, in liters;
Qm = maximum stream discharge at downstream site, in cubic feet per second;
L = distance to downstream site, in miles;
v = mean stream velocity, in feet per second; and
Cp = peak concentration at downstream sampling site, in micrograms per liter.

Rhodamine WT data were used to make time-concentration curves and to estimate traveltimes. Time-concentration curves are useful in illustrating the responses to a given slug injection and show the travel and dispersion of the dye plume as it moves downstream. Owing to dispersion, peak concentrations decrease and the dye curve broadens as the plume moves downstream.

A constant-rate injection method was selected for the NaBr tracer test because the tracer was injected into effluent at each WRP before it was discharged into the Santa Clara River. The empirical equation for estimating the downstream concentration of the NaBr tracer is modified from Kilpatrick and Cobb (1985). The formula is

$$c=(5.89\text{x}10^{-7}qC)/Q,$$

where

c = plateau concentration, in micrograms per liter;
q = rate of injection of the tracer, in milliliters per minute;
C = concentration of tracer solution injected into stream; and
Q = discharge of the stream, in cubic feet per second.

Without dispersion, a tracer injected at a constant rate would arrive at a downstream sampling location as a distinct concentration front. A plot of concentration against time would have a box-like shape, with the concentration abruptly increasing from the background to the plateau concentration. Likewise, a distinct decrease from plateau concentration to background after the injection stopped would be observed. As a result of dispersion and other processes, the arrival and departure of the tracer spreads out over time.

Water-Quality Sampling and Analysis

Numerous samples were collected at the monitoring sites to observe the arrival and departure of the tracers. Tracer samples were collected by the grab sample method at all river sites and at the October 1999 piezometer locations. River samples were taken at each location by wading into the main flow of the channel. In May 2000, water was pumped from the piezometer into bottles. Dye tracer samples were collected in amber glass bottles and NaBr tracer samples were collected in polyethylene bottles. Initial dye readings were taken by means of various fluorometers in the field. For the final dye concentrations, the field dye samples were reanalyzed in the laboratory using standards and one fluorometer at a constant temperature at a USGS Sacramento laboratory (Wilson and others, 1986). NaBr tracer samples were filtered through a 0.45-mm in-line capsule filter upon collection and analyzed for bromide, chloride, and sulfate using a Dionex DX 500 ion chromatograph with an AS4A column, a AG4A guard column, and conductivity detector at a USGS research laboratory in Menlo Park, Calif. (Fishman and Friedman, 1989).

By continuously monitoring Rhodamine WT dye in the field, one can track and sample a mass of water at various points along its flow path. Water-quality samples were collected at each site 3 hours after the dye peak, which allows for the direct comparison of water-quality samples. A sampling method that describes a dynamic state in terms of position and time is known as a Lagrangian method, and is useful in assessing changes in concentration with respect to position and time along the Santa Clara River. Water-quality samples were collected by the equal-width increment (EWI) method at the river sites and by the dip method (Wilde and others, 1999) at the WRPs and hyporheic sites. The water-quality samples were processed in the field upon collection in accordance with the National Field Manual (Wilde and others, 1999-2002) and were analyzed at the USGS National Water Quality Laboratory (NWQL) at Arvada, Colorado, using standard analytical methods described by Fishman and Friedman (1989), Fishman (1993), Patton and Truitt (1992), and Struzeski and others (1996). The wastewater indicator samples were processed and analyzed using the method described by Brown and others (1999).

Streamflow Analysis

Flow measurements on the tributaries along the Santa Clara River were made prior to the start of the tracer tests. During the tracer tests in October 1999 and May 2000, flow measurements were made at river sampling locations using the midsection method described by Rantz and others (1982). There are several sources of error associated with flow measurements made as part of this study and it is important to keep these in mind when interpreting the results. Flow measurements are rated on several criteria pertaining to the channel characteristics. Therefore, some of the apparent changes in flow along the river may not be as large as indicated. Most flow measurements during the tracer tests were rated "good" but some were rated "fair," indicating possible errors of ±5 to ±8 percent.

The Los Angeles County Sanitation Districts provided discharge data from the WRPs. The discharge at the Saugus WRP was measured using a propeller flow meter, which measures velocity and converts it to a flow rate based on the diameter of the pipe. The Saugus flow meter was a 30-inch Micrometer. The Valencia WRP measures discharge using a weir that has an ultrasonic level instrument to measure the water level on the upstream side of the weir and calculates flow. The Valencia ultrasonic flow meter is a Miltronics OCM II model. The uncertainty of the flow measurements made at the WRPs are estimated at ±5 percent (Brian Louie, LACSD, written commun., 2002)

FLOW CONDITIONS

October 1999

The Santa Clara River was dry upstream from the Saugus WRP outfall during the tracer tests. The discharge from the Saugus WRP fluctuated between 7.9 and 10.2 ft^3/s during the October 1999 tracer tests. One river-mile downstream from SCRS2 (fig. 2), San Francisquito Creek, although normally dry this time of year, contributed 3.9 ft^3/s to the Santa Clara River from a dewatering project. Father downstream, flow at SCRA (Oct. 21–22, 1999) varied between 5.1 and 6.3 ft^3/s (table 2).

The discharge from the Valencia WRP fluctuated between 14.6 and 19.6 ft^3/s during the October 1999 tracer tests (fig. 5). The flow at SCR1 fluctuated between 18 and 26 ft^3/s (table 2). Three tributaries between SCR1 and SCR2 had a combined flow of 0.56 ft^3/s and there was no flow in Castaic Creek. The flow at SCR2 fluctuated between 23 and 27 ft^3/s (table 2). Two tributaries between SCR2 and SCR3 had a combined flow of 0.5 ft^3/s. The flow at SCR3 fluctuated between 20 and 29 ft^3/s (table 2). Two tributaries between SCR3 and SCR4 had a combined flow of 1.5 ft^3/s. The flow at SCR4 fluctuated between 27 and 48 ft^3/s (table 2); SCR4 is near the discontinued USGS gage 11108500 (fig. 2). The mean monthly discharge at 11108500 from 1972 to 1996 for October was 26.1 ft^3/s (Rockwell and others, 1996). Four tributaries between SCR4 and the USGS gage 11109000 had a combined flow of 2.3 ft^3/s. Between SCR4 and the USGS gage 11109000, there are two diversions that can divert up to a maximum of 18 ft^3/s from the Santa Clara River (Brian Louie, LACSD, written commun., 2002). The estimated daily mean streamflow at USGS gage 11109000 during the October 1999 tracer tests fluctuated between 26 and 28 ft^3/s (Anderson and others, 2001). The flow at SCR5 fluctuated between 1.6 and 7.3 ft^3/s (table 2). All water infiltrated into the streambed within about 1,000 ft below SCR5.

Table 2. Discharge at selected surface-water sites, Santa Clara River, California, October 1999 and May 2000

[USGS, U.S. Geological Survey; WRP, water reclamation plant; ft^3/s, cubic foot per second; NF, no flow]

USGS station name	USGS station No.	Reference name	Date	Time	Discharge (ft^3/s)
Santa Clara River, above McBean Parkway Bridge, near Saugus, California	342530118332501	SCRS2	05/04/00	1230	1.0
			05/04/00	1325	1.2
			05/04/00	2050	1.3
			05/04/00	2250	1.3
			05/05/00	0200	1.3
			05/05/00	0600	NF
			05/05/00	0740	NF
Santa Clara River, at Old Trestle Bridge, near Saugus, California	342534118344101	SCRS3A	05/04/00	1135	13
			05/04/00	1415	13
			05/04/00	2230	13
			05/04/00	2300	14
			05/05/00	0015	14
			05/05/00	0200	15
			05/05/00	0620	13
Santa Clara River, at Old Road, near Valencia, California	342535118350801	SCRA	10/19/99	0001	5.6
			10/19/99	0100	5.6
			10/19/99	0210	5.4
			10/19/99	0300	5.4
			10/19/99	0400	5.4
			10/19/99	0505	5.6
			10/19/99	0605	5.5
			10/19/99	0705	5.4
			10/19/99	0810	5.2
			10/19/99	0900	5.6
			10/21/99	2030	6.2
			10/21/99	2205	5.3
			10/22/99	0025	5.1
			10/22/99	0230	5.5
			10/22/99	0430	5.3
			10/22/99	0700	5.4
			10/22/99	0910	5.4
			10/22/99	1100	5.2
			10/22/99	1405	6.3
			05/01/00	2320	18
			05/02/00	0125	18
			05/02/00	0330	18
			05/02/00	0520	19
			05/02/00	0720	16
			05/02/00	0915	16
			05/04/00	1250	15

Table 2 Discharge at selected surface-water sites, Santa Clara River, California, October 1999 and May 2000—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Discharge (ft^3/s)
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	342557118353801	SCR1	10/19/99	0045	23
			10/19/99	0230	26
			10/19/99	0430	23
			10/19/99	0620	23
			10/19/99	1015	18
			05/02/00	0000	35
			05/02/00	0200	31
			05/02/00	0400	33
			05/02/00	0600	34
			05/02/00	0800	31
			05/02/00	1000	24
			05/02/00	1940	41
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	342507118380301	SCR2	10/19/99	0150	23
			10/19/99	0710	27
			10/19/99	1245	23
			05/02/00	0650	38
			05/02/00	1035	36
			05/03/00	0450	40
			05/03/00	0840	37
			05/03/00	1205	40
			05/03/00	1530	39
			05/03/00	2050	41
			05/04/00	0800	36
			05/04/00	1700	43
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	342422118401701	SCR3	10/19/99	0400	25
			10/19/99	0955	25
			10/19/99	1740	29
			10/20/99	0100	28
			10/20/99	1750	21
			10/21/99	0420	20
			10/21/99	1015	23
			10/21/99	1720	25
			05/02/00	0245	38
			05/02/00	0505	42
			05/02/00	0850	40
			05/02/00	1140	34
			05/02/00	2140	47
			05/03/00	0105	40
			05/03/00	0615	38
			05/03/00	1000	39
			05/03/00	1335	37

Table 2 Discharge at selected surface-water sites, Santa Clara River, California, October 1999 and May 2000—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Discharge (ft^3/s)
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	342422118401701	SCR3	05/03/00	2340	50
			05/04/00	0615	44
			05/04/00	1430	43
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	342359118424501	SCR4	10/19/99	1320	27
			10/19/99	2305	48
			05/02/00	0720	45
			05/02/00	0925	44
			05/02/00	1300	40
			05/02/00	1700	40
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450101	SCR5	10/19/99	0900	4.1
			10/19/99	1140	6.0
			10/19/99	1540	4.5
			10/19/99	2210	7.3
			10/20/99	1610	1.7
			10/21/99	0215	3.0
			10/21/99	1420	1.6
			05/02/00	0830	37
			05/02/00	1045	34
			05/02/00	1400	30
			05/02/00	2355	46
			05/03/00	0200	36
			05/03/00	0600	38
			05/03/00	1000	31
			05/03/00	1400	35
			05/04/00	1120	30
			05/04/00	1810	31

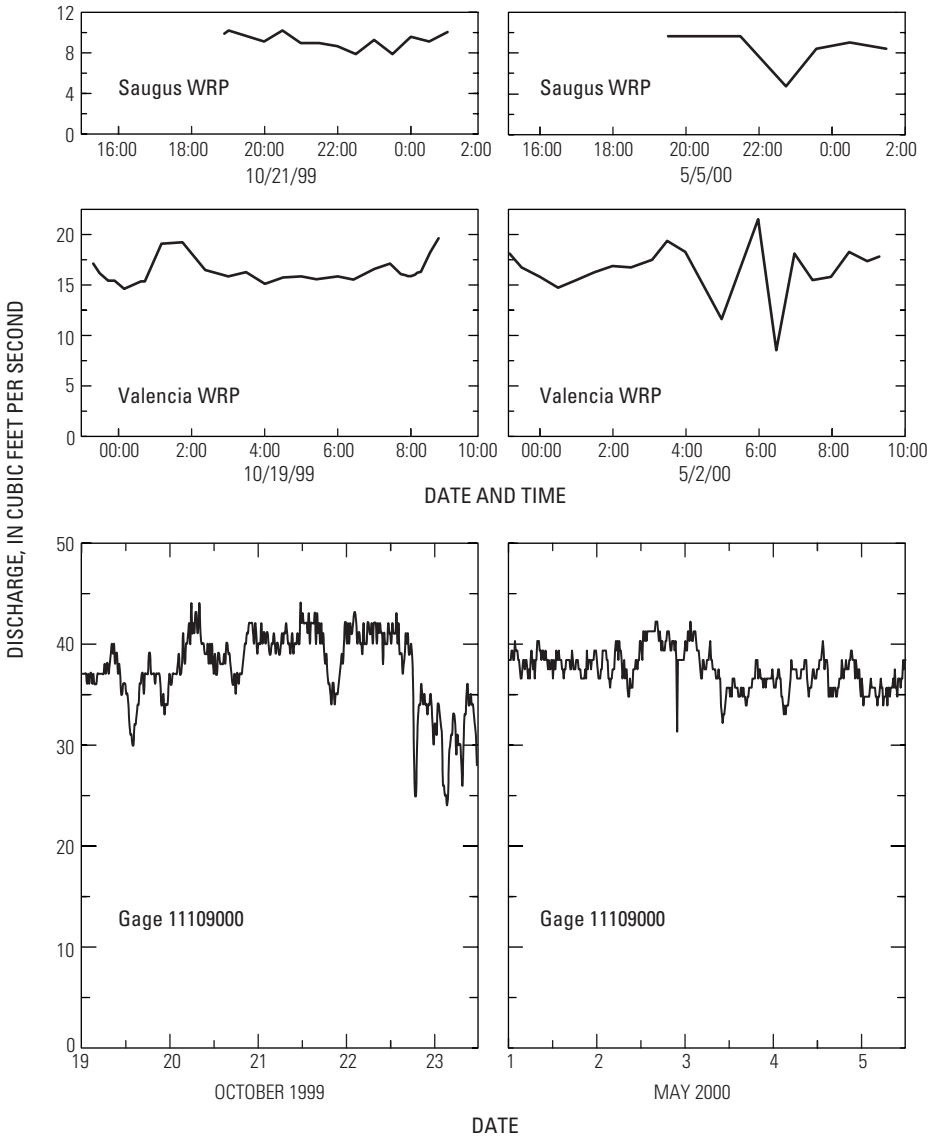

Figure 5. Discharge from the Los Angeles County Sanitation Districts Water Reclamation Plants (WRPs) and at the U.S. Geological Survey Santa Clara River near Piru (11109000), Santa Clara River, California.

May 2000

The Santa Clara River was dry upstream from the Saugus WRP outfall during the tracer tests. The discharge from the Saugus WRP fluctuated between about 4.6 and 9.6 ft^3/s during the tracer tests (fig. 5). The flow at SCRS2 was approximately 1.3 ft^3/s, except for 1.75 hours when there was no flow owing to the reduction in discharge from the Saugus WRP and infiltration into the streambed. Between SCRS2 and SCR3A, construction dewatering projects were releasing unregulated flow into the river. The flow at SCRS3A fluctuated between 13 and 15 ft^3/s (table 2). Flow at SCRA fluctuated between 15 and 19 ft^3/s (table 2).

The discharge from the Valencia WRP fluctuated between about 8.5 and 21.5 ft^3/s during the May 2000 tracer tests (fig. 5). The flow at SCR1 fluctuated between 24 and 41 ft^3/s (table 2). The flow at SCR2 fluctuated between 36 and 43 ft^3/s. There was no flow from Castaic Creek. The flow at SCR3 fluctuated between 34 ft^3/s and 50 ft^3/s. The only significant tributaries along the Valencia reach in May 2000 were four small tributaries between SCR2 and SCR3 that had combined flows of about 3 ft^3/s. The flow at SCR4 fluctuated between 40 and 45 ft^3/s. The mean monthly discharge at 11108500 from 1972 to 1996 for May was 45.1 ft^3/s (Rockwell and others, 1996). As noted for October 1999, there are two diversions between SCR4 and USGS gage 11109000. The daily mean streamflow at USGS gage 11109000 during the May 2000 tracer tests was 38 ft^3/s (Anderson and others, 2001). The flow at SCR5 fluctuated between 30 and 46 ft^3/s. All flow infiltrated into the streambed 0.5 river-mile below SCR5.

Comparison of October 1999 and May 2000 Data

The tracer tests were preformed in October 1999 and May 2000 under different flow regimes. In the Saugus reach, construction dewatering projects were active on the main tributaries during both tracer tests. The overall flow at the end of the Saugus reach at SCRA was higher in May 2000 than in October 1999. The higher flows at the end of the Saugus reach probably were due to increased flow from construction dewatering projects and ground-water inflow owing to higher aquifer water levels in May 2000.

In the Valencia reach no water was released from Castaic Dam into the Castaic Creek during either tracer test. The observed increase in flow between SCR2 and SCR4 in both October 1999 and May 2000 is likely due to ground water. The geology in this reach of the river shows that bedrock underlies the thinning alluvium, thus forcing ground water to rise (California Department of Water Resources, 1993; Winterer and Durham, 1962). The overall flow at the end of the Valencia reach at SCR5 was higher during May 2000 than during October 1999; this increase can be attributed, in part, to higher flows entering the reach from the Saugus reach at SCRA and to ground-water inflow owing to higher aquifer water levels. The discharge in the Santa Clara River during the October tracer tests was higher than the mean monthly October discharge for 1972 through 1996; during the May 2000 tracer tests, the river discharge was within the mean monthly May discharge.

SLUG INJECTION TRACER TEST RESULTS

Mean dye traveltime is defined as the time it takes the dye to travel from peak dye concentration at a site to peak dye concentration at the next downstream site. As the tracer moves downstream, the width of the dye plume broadens owing to dispersion and other physical processes. The dye concentrations at each site for the slug injection tracer tests are given in appendix A for October 1999 and appendix B for May 2000.

October 1999

In the Saugus reach, a slug of 325 milliliters (mL) of Rhodamine WT dye was released at SCRS1 on October 21, 1999, at 1905 hours. Dye was not observed at SCRA during 24 hours of sampling.

In the Valencia reach, a slug of 635 mL of Rhodamine WT dye was released at SCR1 on October 18, 1999, at 2348 hours. The traveltime from SCR1 to SCR5 was 9.6 hours (fig. 6*A*). At SCR3 dye was observed in two (SCR3H1 and SCR3H2) of the three hyporheic sites and at SCR5 in all three hyporheic sites. The traveltime from the start of the injection to SCR3, SCR3H1, and SCR3H2 was 4.4, 16.4, and 17.9 hours, respectively (figs. 6*A*, *B*). The traveltime from the start of the injection to SCR5, SCR5H1, SCR5H2, and SCR5H3 was 9.6, 13.5, 14.5, and 15.5 hours, respectively (figs. 6*A*, *C*).

May 2000

In the Saugus reach, a slug of 1,004 mL of Rhodamine WT dye was released at SCRS1 on May 4, 2000, at 1940 hours. The traveltime from SCRS1 to SCRS2 was 1.4 hours (fig. 7*A*). The traveltime between SCRS3A and SCRA was shorter than expected and the peak was missed during the tracer test. Therefore, to be able to calculate traveltimes between SCRS2 and SCRA, a slug of 770 mL of Rhodamine WT dye was released at SCRS2 on May 5, 2000, at 0015 hours (4.6 hours after the initial dye release at SCRS1). The traveltime from SCRS2 to SCRA was 1.8 hours (fig. 7*B*). By combining the information from the two slug injections, the traveltime from SCRS1 to SCRA was determined to be 3.2 hours.

In the Valencia reach, a slug of 589 mL of Rhodamine WT dye was released at SCR1 on May 1, 2000, at 2320 hours. The traveltime from SCR1 to SCR5 was 7.1 hours for the reach (fig. 8*A*). At SCR5 the actual dye peak probably occurred prior to sampling; therefore, to be able to calculate a traveltime, the first sample at SCR5 was assumed to be the dye peak. For the May 2000 hyporheic sites, only the first piezometer on shore (SCR2H2, SCR3H5, and SCR5H5) was sampled for dye (fig. 4). No dye peak was observed at SCR2H2. The traveltime from the dye injection to SCR3 and SCR3H5 was 3.4 and 10.2 hours, and traveltime to SCR5 and SCR5H5 was 7.1 and 11.3 hours, respectively (fig. 8*B*).

Comparison of October 1999 and May 2000 Data

In the Saugus reach during the October 1999 tracer tests, no dye was detected at SCRA. For the May 2000 tracer tests, approximately three times as much dye was released into the river to compensate for dilution by the construction dewatering projects and infiltration of the river into the streambed. The relatively short traveltime for the 2.9-river-mile Saugus reach in May 2000 was due to high flows from the dewatering operation and are not typical.

In the Valencia reach the traveltime in the river during the May 2000 tracer test was 2.5 hours shorter than during the October 1999 tracer tests. The increased flows in the river in May 2000 mostly can be attributed to higher flows from the Saugus reach. In both October 1999 and May 2000, the hyporheic waters at SCR3 and SCR5 had lower peak dye concentrations than did their corresponding river sites, and in May 2000 no dye was observed in the hyporheic waters at SCR2 (figs. 6, 8). The maximum concentration of dye observed in the hyporheic zone decreased with distance away from the river owing to possible adsorption and dispersion. The dye arrived in the hyporheic water at SCR5 before the dye arrived in the hyporheic water at SCR3 during the October 1999 tracer tests. The shorter traveltime in the hyporheic zone at SCR5 in October 1999 can be partially explained by the fact that piezometers at SCR5 were closer to the river than were those at SCR3.

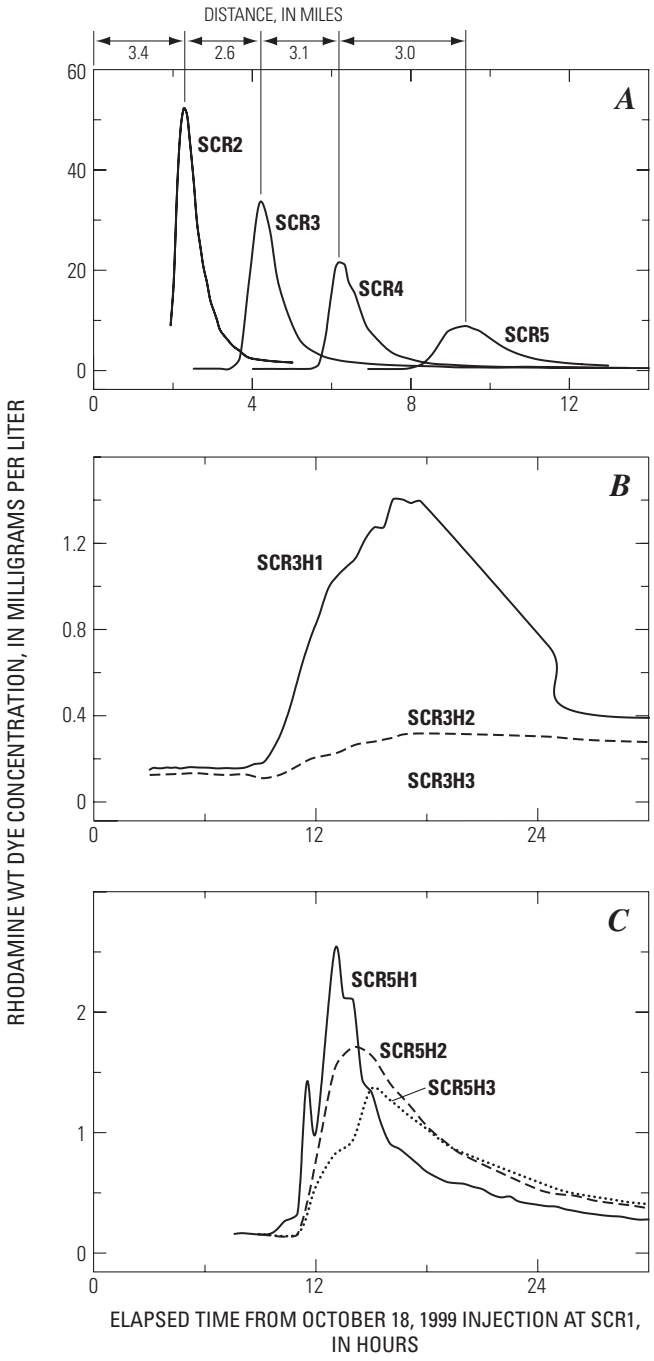

Figure 6. Time-concentration curves at surface-water and hyporheic sites in the Valencia reach of the Santa Clara River, California, October 1999. *A.* River sites, *B.* Hyporheic sites at SCR3, and *C.* Hyporheic sites at SCR5.

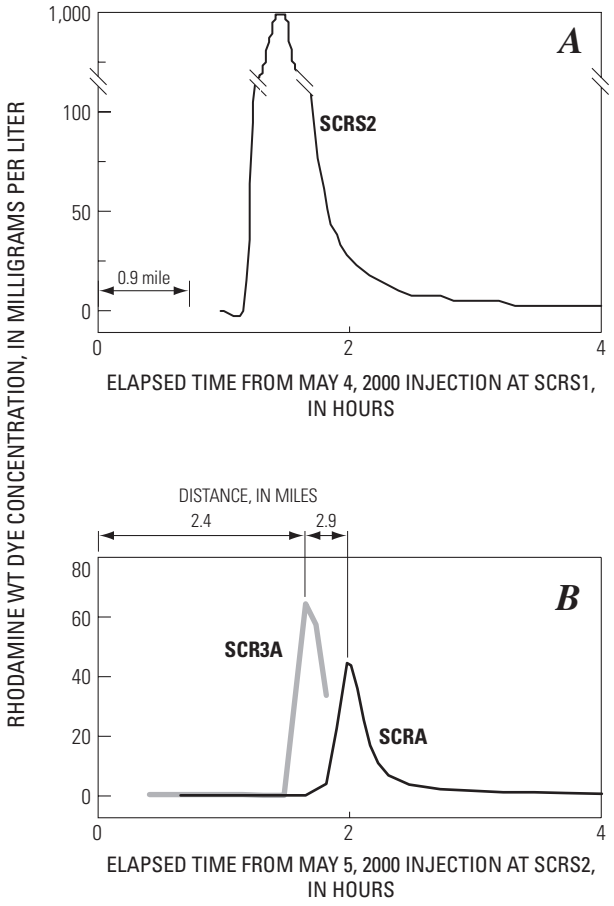

Figure 7. Time-concentration curves for first and second dye releases at surface-water and hyporheic sites in the Saugus reach of the Santa Clara River, California, May 2000: *A*. River sites at SCRS2 and *B*. Hyporheic sites at SCR3A and SCRA.

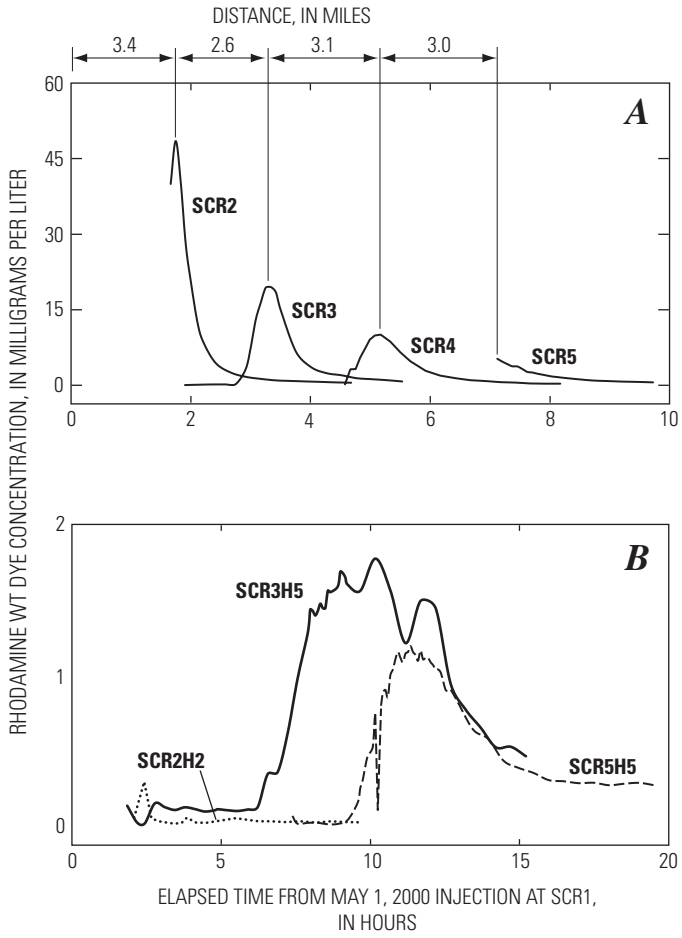

Figure 8. Time-concentration curves at surface-water and hyporheic sites in the Valencia reach of the Santa Clara River, California, May 2000. *A*. River sites and *B*. Hyporheic sites at SCR2, SCR3, and SCR5.

Flow Curves

Flow curves can be used to estimate gains or losses between sites in a reach by tracing the mass of water as it travels downstream. Flow curves for the Valencia reach were made by first plotting flow from a specified upstream site, and then plotting the flow from the next downstream site for the time at which the mass of water from the upstream site would arrive at this site. Traveltimes between sites were calculated from the Rhodamine WT dye tracer tests. These steps are repeated moving downstream from site to site (table 3). If a flow measurement was not taken at the estimated arrival time, flow was interpolated from measurements that bracket the arrival time. The times on the flow curves correspond to the time when flow measurements were made at SCR1, and each line tracks the mass of water as it traveled downstream.

Four flow curves were constructed from discharge measurements made during the October 1999 tracer tests (fig. 9*A*). The average flow indicates net gains from SCR1 to SCR2 (3.0 ft^3/s), SCR3 to SCR4 (3.4 ft^3/s), and SCR4 to the USGS gage 11109000 (6.2 ft^3/s), and a net loss from USGS gage 11109000 to SCR5 (30 ft^3/s). Flow-curve results for the reach from SCR2 to SCR3 are not consistent. One curve indicates gains, whereas the other three indicate slight losses.

Four flow curves were constructed from discharge measurements made during the May 2000 tracer tests (fig.9*B*). The average flow indicates net gains from SCR1 to SCR2 (5.6ft^3/s) and from SCR3 to SCR4 (3.8 ft^3/s) and net losses from SCR4 to USGS gage 11109000 (5.0 ft^3/s) and from USGS gage 11109000 to SCR5 (4.3 ft^3/s). As in 1999, flow-curve results for the reach from SCR2 to SCR3 are not consistent, with the curves indicating both gains and losses.

Net gains in flow generally indicate ground-water discharge in a reach, and net losses generally indicate ground-water recharge. Several differences in flow conditions can be observed from the flow curves for October 1999 and May 2000. The reach from SCR1 to SCR2 gains almost twice as much flow during May 2000 than during October 1999. The reach from SCR4 to the USGS gage 11109000 gains flow in October 1999 but loses flow in May 2000. This is the reach in which two diversions can divert as much as 18 ft^3/s of water from the river. It is possible that more water was being diverted in May 2000 than in October 1999. In addition, there was 2.3 ft^3/s tributary inflow in this reach in October 1999 and none in May 2000. The reach from the USGS gage 11109000 to SCR5 loses almost seven times more flow in October 1999 than in May 2000. Note that with the exception of the reach between SCR2 and SCR3, the gains and losses estimated from the flow curves are greater than the ±5 to ±8 percent potential error in the flow measurements.

CONSTANT-RATE INJECTION TRACER RESULTS

The arrival time for the constant-rate injection tracer is defined as the time at which the tracer concentration is half of the plateau concentration (Zellweger and others, 1988). Because constant-rate injection tracer samples were taken hourly, some of the arrival times are interpolated between two sampling times. Breakthrough time is defined as the time at which the in-stream tracer concentration is double the background concentration at the sampling location. The chemical analyses for the constant-rate injection tracer are given in appendix C for October 1999 and appendix D for May 2000.

October 1999

For the Saugus reach, a tracer solution of sodium bromide [NaBr; 111 grams per liter (g/L)] was introduced into the Santa Clara River using a constant-rate injection method. The tracer was injected into the effluent at the Saugus WRP for 6 hours beginning October 21, 1999, at 1902 hours. The NaBr tracer was not detected at SCRA during the 24 hours of sampling.

Table 3. Flow data used to construct flow curves at selected sites on the Santa Clara River, California, using traveltimes from Rhodamine WT dye data for October 1999 and May 2000

[Flow values in bold type are measured (table 2); all other flow values are interpolated from measured discharges that bracket associated time; ft^3/s, cubic feet per second; FC, traveltime curve; nc, not computed; —, no data; *,traveltime calculated from ratio of distance and traveltime from SCR4 to SCR5]

Reference name	Date	Traveltime between sites (hours:minutes)	Flow curve time	Flow (ft^3/s)	Net gain or loss (ft^3/s)	Flow curve time	Flow (ft^3/s)	Net gain or loss (ft^3/s)	Flow curve time	Flow (ft^3/s)	Net gain or loss (ft^3/s)	Flow curve time	Flow (ft^3/s)	Net gain or loss (ft^3/s)	Average net gain or loss
			FC at 0230			FC at 0430			FC at 0620			FC at 1015			
SCR1	10/19/1999	0:00	0230	25.5		0430	22.7		0620	23.0		1015	17.7		
SCR2	10/19/1999	2:45	0515	25.5	0.0	0715	26.9	4.2	0905	25.6	2.6	1300	22.9	5.2	3.0
SCR3	10/19/1999	1:55	0710	24.7	**–.8**	0910	24.6	**–2.3**	1100	25.2	**–.4**	1455	27.6	4.7	.3
SCR4	10/19/1999	2:00	0910	nc	—	1110	nc	—	1300	26.7	1.5	1655	32.9	5.3	3.4
Gage 11109000	10/19/1999	2:15*	1125	35.0	—	1325	32.0	—	1515	35.0	8.3	1910	37.0	4.1	6.2
SCR5	10/19/1999	1:00	1225	5.30	**–29.7**	1425	5.00	**–27.0**	1615	4.76	**–30.2**	2010	5.38	**–31.6**	**–30**
			FC at 0200			FC at 0400			FC at 0600			FC at 0800			
SCR1	05/02/2000	0:00	0200	30.8		0400	32.6		0600	34.1		0800	30.9		
SCR2	05/02/2000	1:50	0350	nc	—	0550	38	5.4	0750	37.9	3.8	0950	38.4	7.5	5.6
SCR3	05/02/2000	1:35	0525	42.1	—	0725	40.6	2.6	0925	37.5	**–.4**	1125	34.4	**–4.0**	**–.6**
SCR4	05/02/2000	1:50	0715	45.2	3.1	0915	43.6	3.0	1115	41.7	4.2	1315	39.3	4.9	3.8
Gage 11109000	05/02/2000	1:10*	0825	40.0	**–5.2**	1025	37.0	**–6.6**	1225	35.0	**–6.7**	1425	38.0	**–1.3**	**–5.0**
SCR5	05/02/2000	0:45	0910	36.4	**–3.6**	1110	33.4	**–3.6**	1310	30.8	**–4.2**	1510	32.1	**–5.9**	**–4.3**

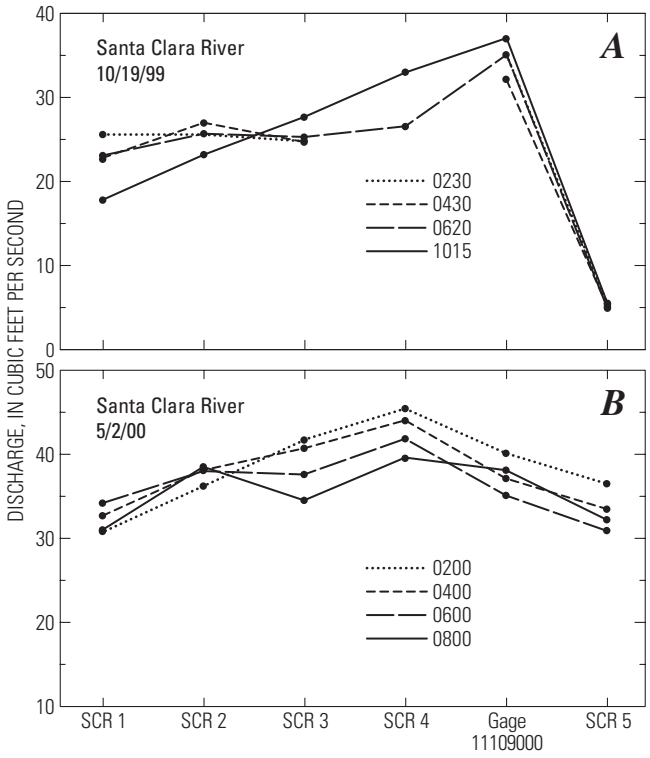

Figure 9. Flow curves at surface-water sites in the Valencia reach of the Santa Clara River, California, *A*. October 1999 and *B*. May 2000.

For the Valencia reach a tracer solution of sodium bromide (108 g/L) was injected at the Valencia WRP following the same procedures used for the Saugus WRP injection. The tracer was continuously injected into the effluent at the Valencia WRP for 9 hours beginning October 18, 1999, at 2343 hours. The plateau concentration in the effluent at the WRP varied from 1.25 to 1.52 mg/L (fig. 10*A*; app. C) owing to the changes in the discharge of the effluent by the WRP (fig. 5). The traveltime from the Valencia WRP to SCR5 was 9.3 hours (fig. 10). At SCR3, the NaBr tracer was observed in one of the three hyporheic sites but the tracer never reached a steady-state concentration; therefore, no tracer plateau was observed. At SCR5 in all three hyporheic sites, the NaBr tracer reached steady state and a plateau was observed. The traveltime from the start of the injection to SCR3 was 5 hours, and the breakthrough time from the start of the injection to SCR3H1 was 15 hours (fig. 10*D*). The traveltime from the start of the injection to SCR5, SCR5H1, SCR5H2, and SCR5H3 was 9.3, 12.3, 14.3, and 15.3 hours, respectively (fig. 10*F*).

May 2000

For the Saugus reach, the NaBr (295 g/L) tracer was continuously injected into the effluent for 6 hours starting May 4, 2000, at 1931 hours. The constant-rate injection tracer in May 2000 was identical in procedure to the October 1999 tracer injection at the Saugus WRP. The fluctuation in discharge at the Saugus WRP (fig. 5) altered the concentration of the tracer solution introduced into the Santa Clara River. The plateau concentration in the effluent at the Saugus WRP varied between 1.78 and 4.18 mg/L (fig.11*A*). The amount of bromide in the river from the NaBr tracer injection decreases considerably from the start of the injection to SCRA. However, a small increase above the background bromide concentration can be seen in fig. 11*D*. The traveltime from the Saugus WRP to SCRA was estimated to be 3.5 hours (fig. 11).

For the Valencia reach, the NaBr (215 g/L) tracer was continuously injected into the effluent of the Valencia WRP for 10 hours starting May 1, 2000, at 2320 hours. The constant-rate injection tracer in May 2000 was identical in procedure to the October 1999 tracer injection at the Valenica WRP. The plateau concentration in the effluent at the Valencia WRP varied from 2.11 to 3.98 mg/L (fig. 12*A*) owing to the fluctuations in the discharge rates of the effluent from the Valencia WRP (fig. 5).

The traveltime from the Valencia WRP to SCR5 was 7.2 hours (fig. 12). At SCR2, the NaBr tracer was not observed in the hyporheic sites. At SCR3, the NaBr tracer was observed in all three hyporheic sites. The traveltime from the start of the injection to SCR3 was 3.7 hours, and the breakthrough time from the start of the injection to SCR3H4 and SCR3H5 was 11.7 and 15.7 hours, respectively (fig. 12*D*). At SCR3H6, several higher than background bromide concentrations were observed for 4 hours starting 10.7 hours after the injection, but there was no distinct signal from which to estimate a breakthrough time. The NaBr tracer was observed at SCR5 in all three hyporheic sites. The traveltime from the start of the injection to SCR5, SCR5H4, SCR5H5, and SCR5H6 was 7.2, 11.4, 12.4, and 12.5 hours, respectively (fig. 12*F*).

Comparison of October 1999 and May 2000 Data

Because no bromide concentrations above background concentrations were detected at the end of the Saugus reach in October 1999, almost three times as much NaBr tracer was injected into the river during the May 2000 tracer test than during the October 1999 tracer test.

In the Valencia reach during the May 2000 test, the tracer arrived at the end of the reach 2.1 hours earlier than during the October 1999 test. During both the 1999 and 2000 tracer tests, an increase in background bromide concentration (values measured either before or after the tracer test) was observed downstream from SCR3. In October 1999 the background bromide concentration increased from 0.25 mg/L at SCR3 to 0.30 mg/L at SCR4 (app. C) and in May 2000 from 0.25 mg/L at SCR3 to 0.32 mg/L at SCR4, and to 0.35 mg/L at SCR5 (app. D). The correlation between increase of flow (fig. 9) and background bromide concentration implies that the ground water has a higher concentration of bromide than does the river.

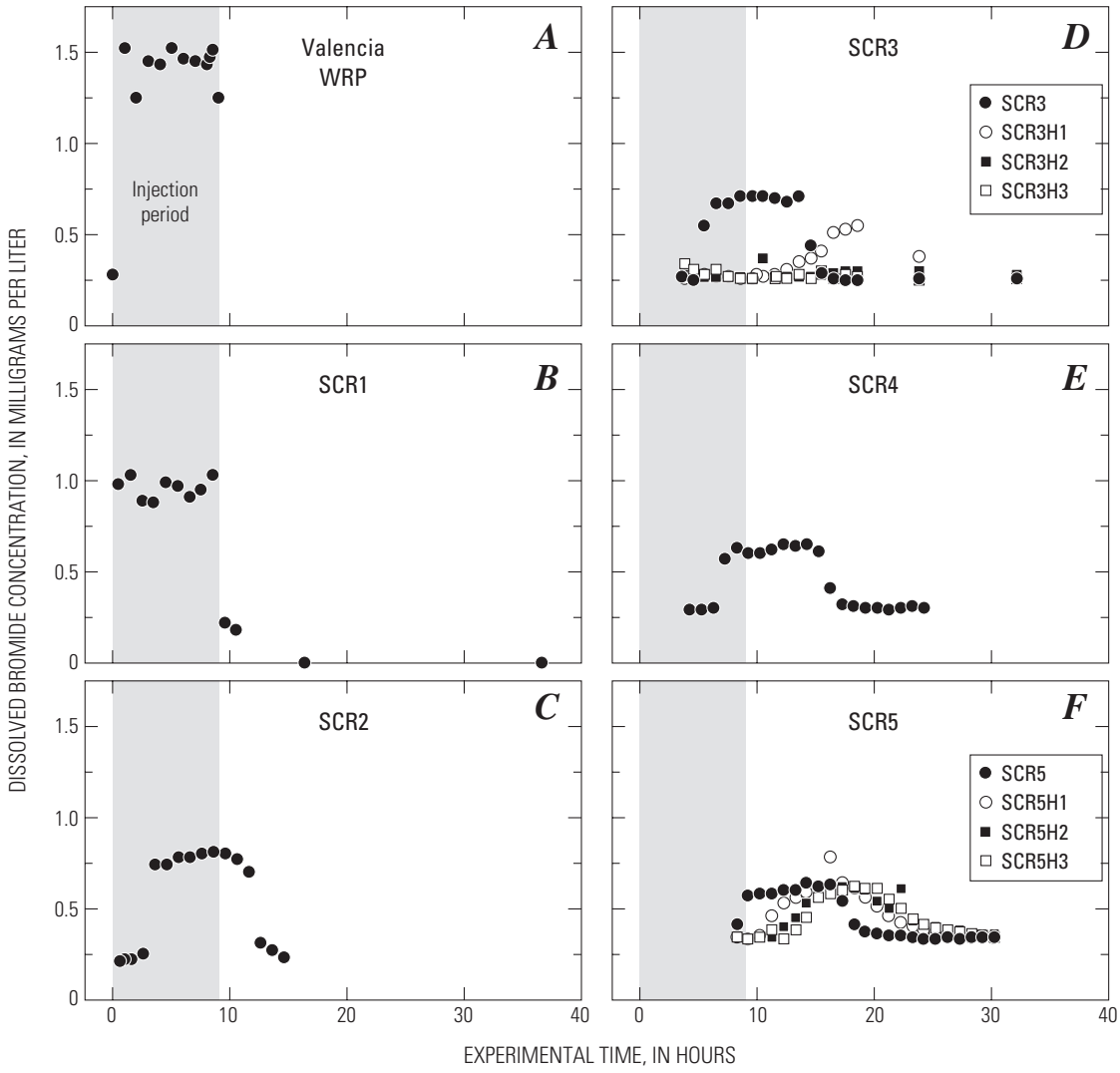

Figure 10. Concentration profiles of dissolved bromide at surface-water and hyporheic sites in the Valencia reach of the Santa Clara River, California, October 1999. *A*. Valencia WRP, *B*. SCR1, *C*. SCR2, *D*. SCR3, *E*. SCR4, and *F*. SCR5. (WRP, water reclamation plant.)

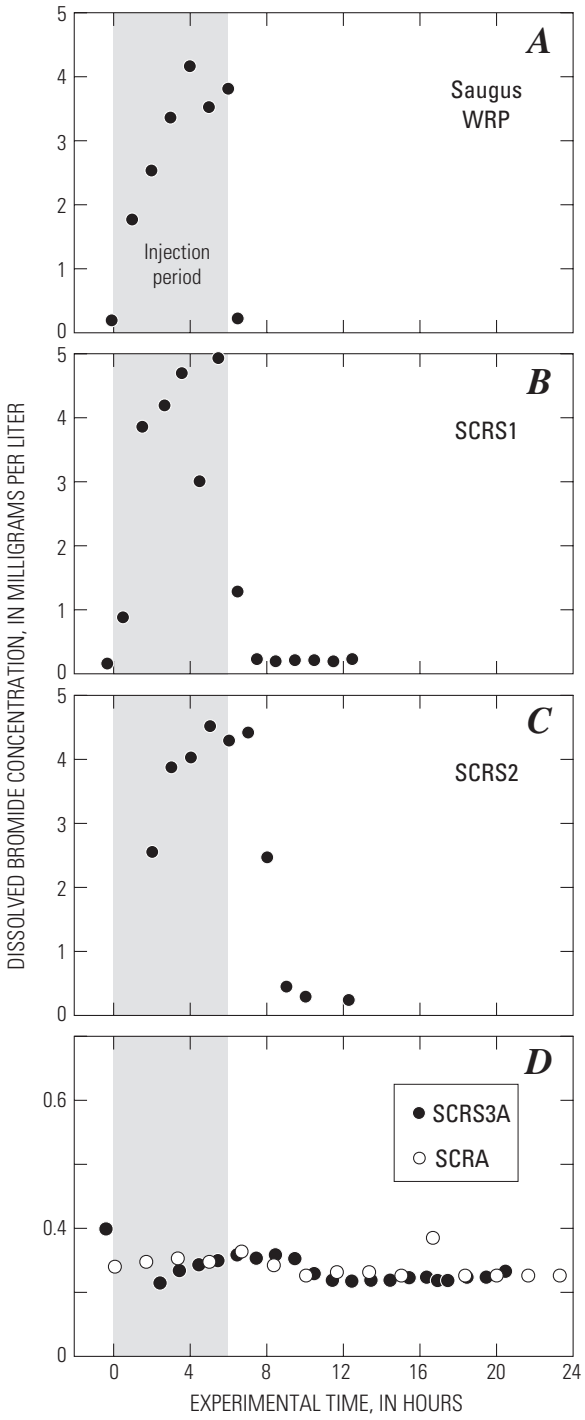

Figure 11. Concentration profiles of dissolved bromide at surface-water sites in the Saugus reach of the Santa Clara River, California, May 2000. *A.* Saugus WRP, *B.* SCRS1, *C.* SCRS2, *D.* SCRS3A and SCRA. (WRP, water reclamation plant.)

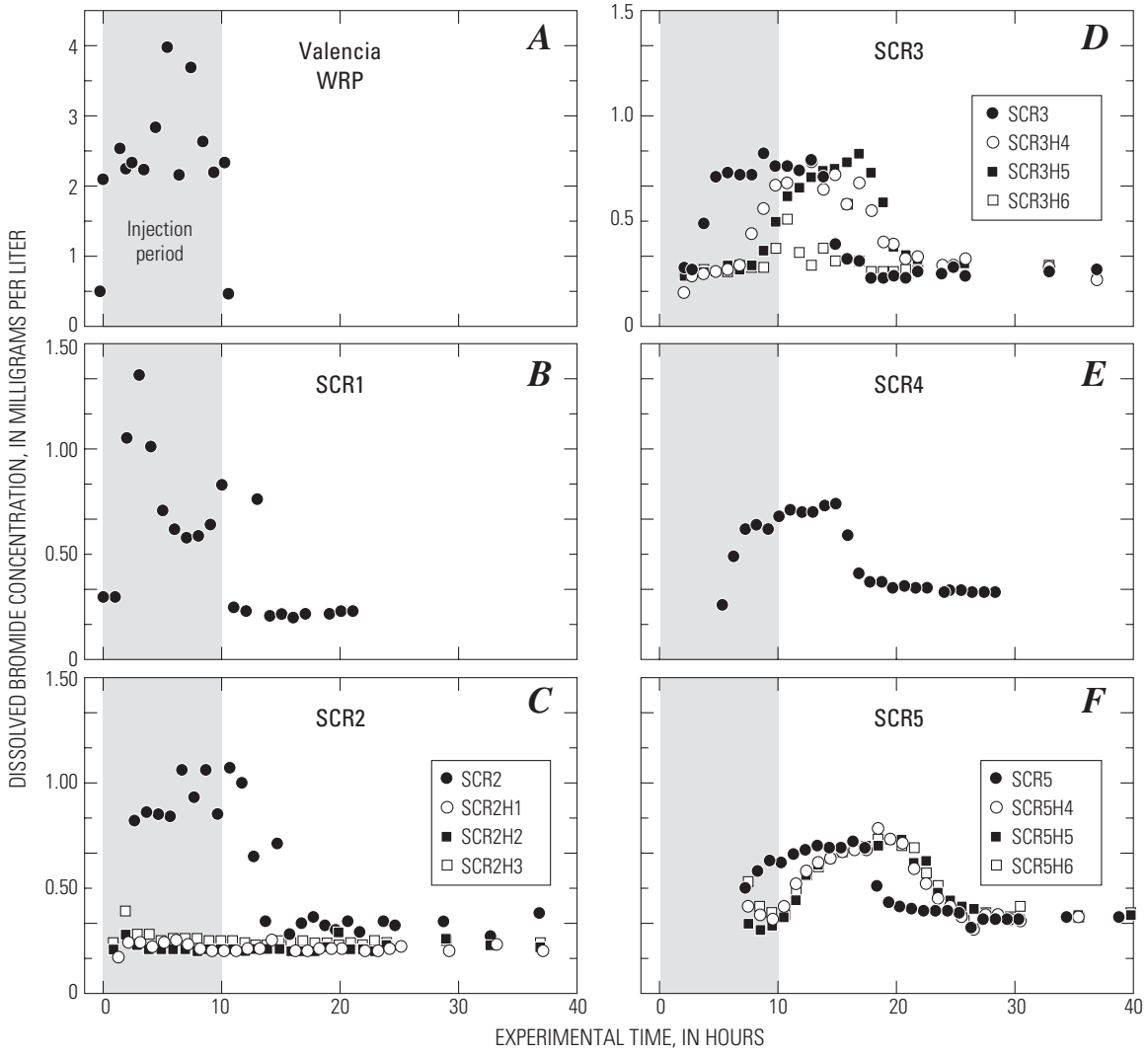

Figure 12. Concentration profiles of dissolved bromide at surface-water and hyporheic sites in the Valencia reach of the Santa Clara River, California, May 2000. *A*. Valencia WRP, *B*. SCR1, *C*. SCR2, *D*. SCR3, *E*. SCR4, and *F*. SCR5. (WRP, water reclamation plant.)

The bromide concentration measured in the May 2000 hyporheic sites at SCR2 did not indicate a distinct signal from the NaBr tracer injection. But a small difference was observed in the average background bromide concentration in the water: the farthest site from the river, SCR2H3, had a slightly higher average background bromide concentration in comparison with the other SCR2 hyporheic sites. The higher background bromide concentration in the hyporheic waters at SCR2 indicates that the hyporheic water consists of water not originating from the river. According to the flow curves (fig. 9), the reach between SCR1 to SCR2 gains flow. During the October 1999 tracer tests, the NaBr tracer arrived at SCR5, SCR5H1, and SCR5H2 before the tracer arrived at SCR3H1. During May 2000, the tracer arrived at the first hyporheic sites at SCR3H4 and SCR5H4 simultaneously. The difference in distances between the hyporheic sites at SCR3 and SCR5 does not fully account for the greater traveltime of the tracer to reach the hyporheic sites at SCR3. Some other factors that can affect traveltime are flow path and interaction between the river and hyporheic zone. The NaBr tracer in the hyporheic waters at SCR3 for both October 1999 and May 2000 never reached a steady-state plateau, unlike the results for all river sites and the SCR5 hyporheic site. According to the flow curves for October 1999 and May 2000, the reach between SCR2 to SCR3 neither gains nor loses flow (fig. 9), whereas the reach between USGS gage 11109000 and SCR5 loses flow. At SCR5 the hyporheic water composition closely mimicked the river's composition, whereas at SCR3 the hyporheic water is a mixture of both shallow ground water and river water.

Although the Rhodamine WT dye tracer and the NaBr tracer tests used different injection methods and sampling intervals, the river traveltimes calculated using both tracers were approximately the same for both the Saugus (3.2 versus 3.5 hours in May, 2000) and the Valencia reaches (9.6 versus 9.3 hours in October 1999 and 7.1 versus 7.2 hours in May, 2000). Differences in the computed hyporheic traveltimes were observed, however. The dye arrived after the NaBr tracer at SCR3H1 and SCR5H1 during the October 1999 tests and before the NaBr tracer at SCR3H5 and SCR5H5 during the May 2000. Dye samples were taken at 5-minute intervals near the peak of the dye curves, whereas NaBr samples were taken hourly. This time difference in sampling intervals accounts for some of the traveltime differences between the dye and NaBr tracer. The only significant difference (greater than 1 hour) between the dye and NaBr tracer calculated traveltimes for the hyporheic sites was at SCR3H5 during the May 2000 tracer tests. At SCR3H5 the dye arrived 5.5 hours before the NaBr tracer. During the May 2000 constant-rate injection of the NaBr tracer at the Valencia WRP, the concentration of the Br varied from 2.11 to 3.98 mg/L owing to fluctuations in effluent discharge. The effect of this varying Br concentration can be seen in the tracer plateaus from SCR1 to SCR3 (fig. 12) and to some extent might explain the later computed arrival time based on the NaBr tracer.

WATER QUALITY

The use of Lagrangian sampling for collecting water-quality samples allows for the direct comparison of the samples down the river. Ideally, with Lagrangian sampling the same mass of water is sampled as it travels downstream. To ensure that the same mass of water was sampled for this study, water-quality samples were collected 3 hours after the peak of the Rhodamine WT dye at every site. The water-quality results for a suite of constituents are presented in appendix E for October 1999 and appendix F for May 2000. The water-quality samples were collected during the sodium bromide tracer tests; therefore, the sodium values obtained from the water-quality analyses are biased by the addition of the sodium bromide tracer. During both October 1999 and May 2000, only the closest hyporheic site to the river (fig. 4) was sampled for water-quality parameters.

The major-ion composition of water on a charge-equivalent basis was evaluated using Stiff (polygon) and Piper (trilinear) diagrams. A modified Stiff diagram indicates the relative abundance of specific cations and anions expressed in milliequivalents per liter and plotted on one of three parallel horizontal axes (Stiff, 1951). The resulting polygon indicates similarities or differences in general major-ion chemistry, and the width of the polygon is an approximation of the total ionic content. One of the distinctive features of a Stiff diagram is the tendency of the pattern to maintain its characteristic shape as the sample becomes dilute. The availability of various scales makes it possible to select one that emphasizes the differences and similarities of the waters, thereby making direct comparison and correlation between these waters possible. A modified Piper trilinear diagram (Piper, 1944) depicts water in terms of three cation-variables (calcium, magnesium, and sodium plus potassium) and three anion-variables (sulfate, chloride, and carbonate plus bicarbonate); therefore, a single point on a trilinear diagram can depict graphically the overall chemical characteristic of the water. Percentage scales along the sides of the diagram indicate major-ion percentage, in milliequivalents per liter. Cations are shown in the left triangle, anions are shown in the right triangle, and the central diamond integrates the data. The central diamond indicates the overall chemical characteristics of the water, and the two smaller triangles indicate the relative concentrations of the several dissolved constituents in the water.

October 1999

In 1999 in the Saugus reach, there is an increase in sulfate, bicarbonate, and calcium concentrations and a decrease in chloride and sodium concentrations from the Saugus WRP to SCRA (figs. 13, 14*A*, and 15). Ammonia concentrations decrease from the Saugus WRP to SCRA. The trends for nitrite plus nitrate are not definitive owing to two very different values measured at SCRA on two different days (fig. 15). This variability may be due to the variable discharge from the Saugus WRP and construction dewatering.

In 1999 in the Valencia reach, there is an increase in chloride concentration from the water entering the reach (SCRA) to that at SCR1, just downstream from the Valencia WRP (fig. 15). The water sampled at SCR1 is very similar in character to that observed at the WRP (figs. 13, 14*A*). Along the Valencia reach between SCR1 and SCR5, there is a decrease in chloride and an increase in sulfate and calcium concentrations. There is a consistent decrease in ammonia and a general increase in nitrite plus nitrate concentrations, although values decrease slightly between SCR3 and SCR4 (fig. 15).

In 1999, the hyporheic water at SCR3H1 has generally similar chemical character to that at the river site SCR3, but it has slightly higher sulfate concentrations and lower ammonia and nitrate concentrations. The hyporheic water at SCR5H1 is similar chemically to that at the river site SCR5 (figs. 13, 14*A*, 15).

May 2000

In 2000 in the Saugus reach, there is an increase in sulfate and calcium concentrations and a decrease in chloride and sodium concentrations from SCRS1 to SCRA (see figs. 13, 14*B*, and 15). There is a decrease in ammonia and an increase in nitrate between these sites.

In 2000 in the Valencia reach, there is an increase in chloride from the water entering the reach (SCRA) to that at SCR1 (fig. 15). Along the Valencia reach between SCR1 and SCR5 there is an increase in sulfate and a decrease in chloride. There is a consistent decrease in ammonia and an increase in nitrate (fig. 15).

In 2000, the hyporheic site SCR2H2 has higher sulfate and lower chloride, ammonia, and nitrate concentrations relative to that of the river site SCR2. The compositions at hyporheic sites SCR3H5 and SCR5H5 are generally similar to the compostions at the adjacent river sites (SCR3 and SCR5) (figs. 13 and 14*B*). At SCR3H5, ammonia concentrations are higher and nitrate concentrations are lower than those at SCR3.

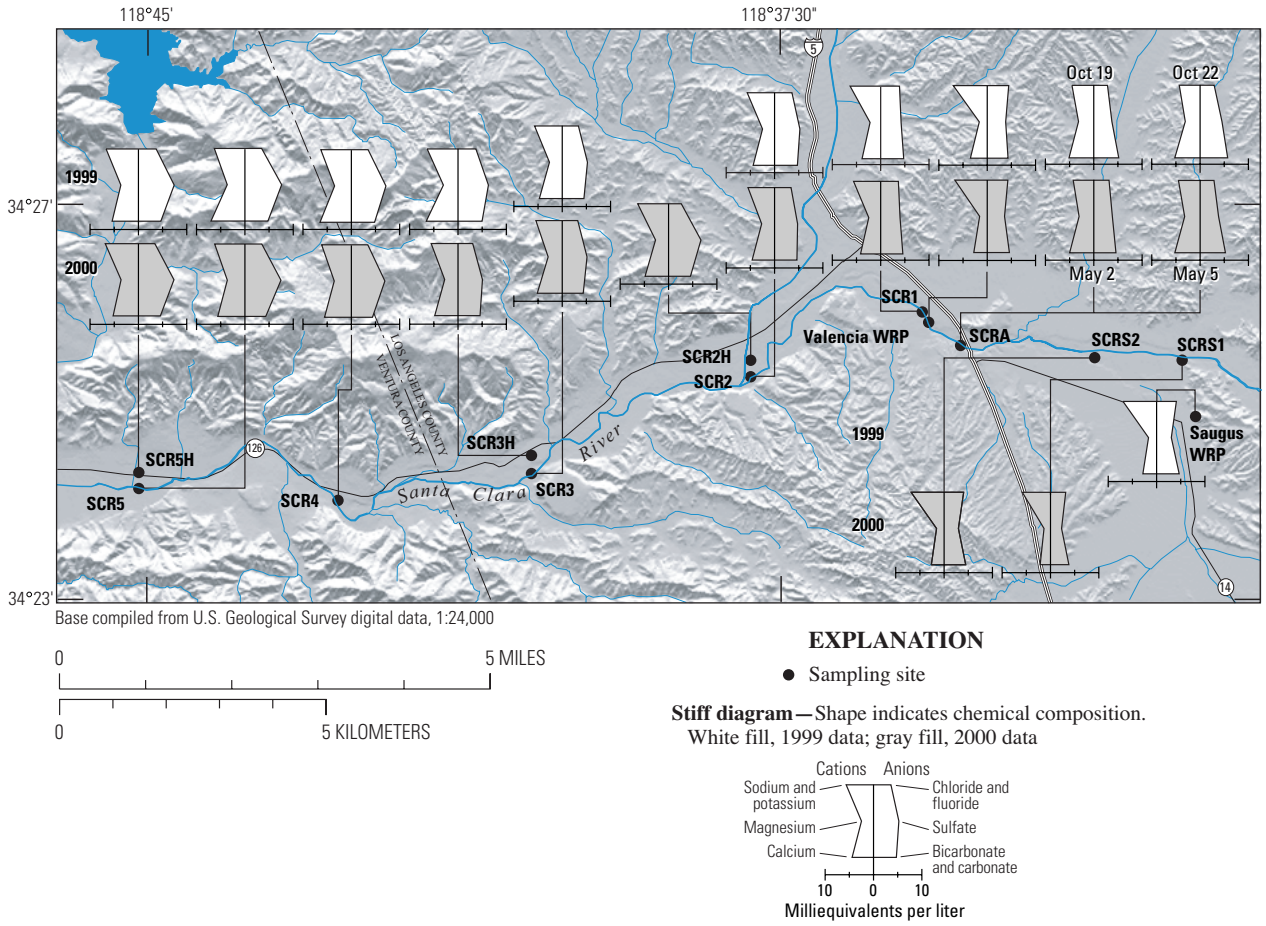

Figure 13. Stiff diagrams from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999 and May 2000. (Sites with an H after the site name indicate that the data are from the corresponding hyporheic site sampled that year.)

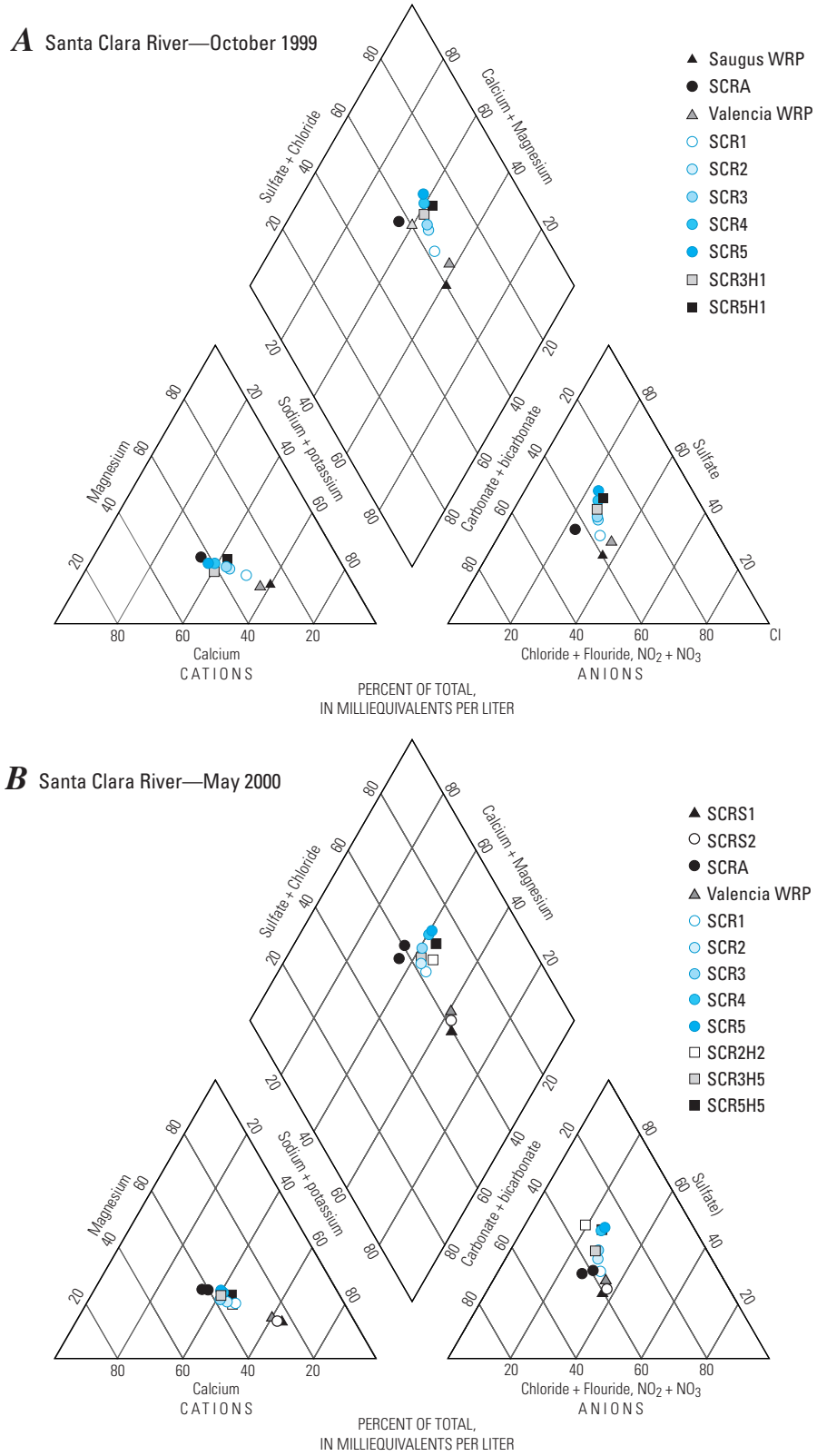

Figure 14. Major-ion composition for selected surface-water and hyporheic sites, Santa Clara River, California. *A.* October 1999 and *B.* May 2000.

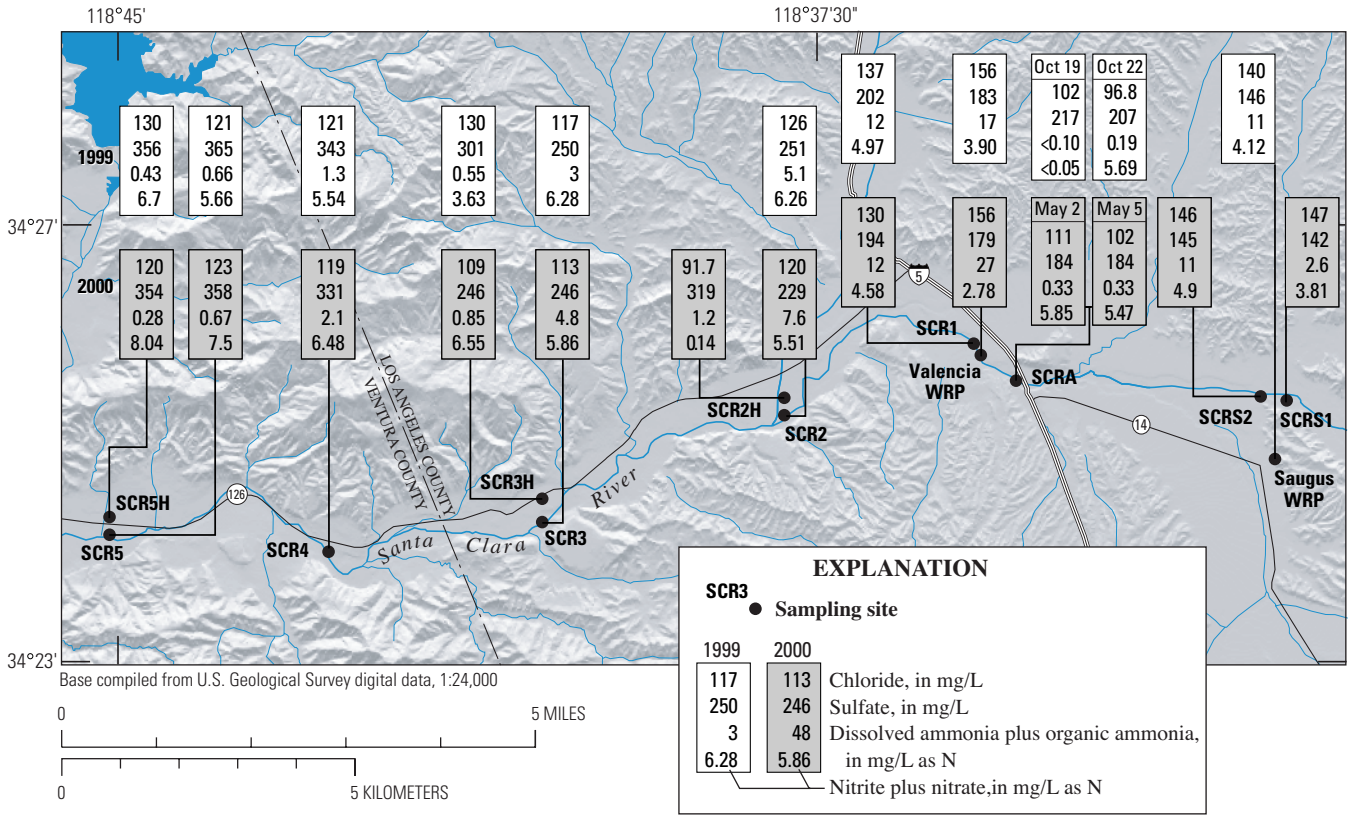

Figure 15. Concentrations of chloride, sulfate, nitrite plus nitrate, and ammonia for selected surface-water and hyporheic sites, Santa Clara River, California, October 1999 and May 2000. (Sites with an H after the site name indicate that the data are from the corresponding hyporheic site sampled that year.)

Comparison of October 1999 and May 2000 Data

Overall, the same chemical trends along the two reaches were present during both sampling periods. Along each reach there is a consistent shift toward higher sulfate and lower chloride concentrations. There also is a general decrease in ammonia and increase in nitrate concentrations moving downstream from each WRP. This is likely the result of nitrification, an aerobic microbial process that forms nitrite or nitrate from compounds containing reduced nitrogen, such as ammonia (Alexander, 1991).

The chloride concentration within the Saugus reach decreased by approximately 45 mg/L during both the October 1999 and May 2000 tracer tests. The sulfate concentration within the Saugus reach increased by approximately 60 mg/L and 40 mg/L in October 1999 and May 2000, respectively. These gradients are likely due to mixing of the Saugus WRP effluent with water from the dewatering projects and to discharging ground water. Data from 1989 show that a ground water sample from a well located near the end of the Saugus reach (4N/16W-21D01) had a chloride concentration of 24 mg/L and a sulfate concentration of 255 mg/L (California Department of Water Resources, 1993).

The chloride concentration in the river increased between SCRA and SCR1 by about 35 mg/L in October 1999 and 20 mg/L in May 2000 owing to the discharge of the Valencia WRP into the river. The smaller chloride increase in May 2000 is due to the greater flows at SCRA (15 to 18 ft^3/s in May 2000 versus 5 to 6 ft^3/s in October 1999; see table 2). During both the October 1999 and May 2000 tracer tests, the chloride concentrations in the river decreased by approximately 10 mg/L between SCR1 and SCR5. During both tests, the sulfate concentrations in the river increased by approximately 160 mg/L between SCR1 and SCR5. Data from ground-water wells along the Valencia reach in 1989 showed sulfate concentrations above 350 mg/L and chloride concentrations below 100 mg/L (e.g., wells 4N/17W-13E02 and-22E01) (California Department of Water Resources, 1993). This sulfate gradient, along with the higher background bromide concentrations observed during the constant-rate injection tracer, is indicative of ground-water discharge.

The higher sulfate concentrations measured at hyporheic site SCR3H1 in 1999 and at hyporheic site SCR2H2 in 2000 are indicative of ground-water discharge. The higher nitrate plus nitrite concentrations and lower ammonia concentrations at several of the hyporheic sites (SCR3 in 2000 and SCR5 in 1999 and 2000) are similar to those observed by Triska and others (1990, 1993a,b) in a third-order stream in northwest California and indicate that biotic processes such as nitrification affect nitrogen concentrations in the streambed sediments. The capacity of nitrification to affect water chemistry is dependent on dissolved oxygen, reduced nitrogen availability, and maintenance of a suitable bacteria population. Keeny (1973) found that as little as 0.3 mg/L of dissolved oxygen sustains nitrification. Note that the hyporeic sites at SCR3 in 1999 and SCR2 in 2000 have lower values of both nitrate and ammonia than do the corresponding river sites.

WASTEWATER INDICATORS

Treated wastewater effluent is discharged into the upper Santa Clara River from the Los Angeles County Sanitation Districts Water Reclamation Plants in Saugus and Valencia. Treated wastewater effluent can contain compounds that commonly are found in human waste, including caffeine from coffee and soft drinks, cholesterol from meat by-products, and medicines such as codeine, as well as compounds from pesticides and other sources (table 4). Little is known about the extent of environmental occurrence, and the transport and fate of pharmaceuticals, hormones, and other wastewater contaminants. Until recently there have been few analytical methods capable of detecting low concentrations of these compounds (Kolpin and others, 2002).

Table 4. Wastewater compound names and possible compound uses

[Brown and others (1999); Kolpin and others (2002); Zaugg and others (2002)]

Compound name	Uses
1,4-dichlorobenzene	Fumigant
2,6-di-tert-butylbenzoquinone	Antioxidant
3-beta-coprostanol	Fecal sterol
5-methyl-1H-benzotriazle	Anticorrosive
Acetophenone	Fragrance
Benzaldehyde	Flavor
Butylatedhydroxytoluene (BHT)	Antioxidant
Bis-(2-ethlyhexyl) phthalate	Plasticizer
Bisphenol A	Polymers
Caffeine	Stimulant
Chlorpyrifos	Pesticide
Cholesterol	Fecal sterol
Codeine	Analgesic
Cotinine	Nicotine metabolite
Diazinon	Pesticide
Diethylphthalate	Plasticizer
Ethanol, 2-butoxyphosate	Plasticizer
Fluoranthene	Hydrocarbon
N, N-diethyltoluamide (DEET)	Insect repellant
Nonylphenol monoethoxylate (total, NPEO1)	Nonionic detergent metabolite
Nonylphenol diethoxylate (total, NPEO2)	Nonionic detergent metabolite
Octylphenol monoethoxylate (OPEO1)	Nonionic detergent metabolite
Octylphenol diethoxylate (OPEO2)	Nonionic detergent metabolite
para-Cresol	Wood preservative
para-nonylphenol (total)	Nonionic detergent metabolite
Phenanthrene	Gasoline
Phenol	Disinfectant
Phthalic anhydride	Plastics
Pyrene	Hydrocarbon
Tetrachloroethylene	Solvent
Tributyl phosphate	Plasticizer
Triclosan	Antimicrobial disinfectant
Triphenyl phosphate	Plasticizer
Tri-(2-chloroethyl) phosphate	Flame retardant

The whole-water wastewater method analyzes for a diverse range of compounds, many of which are common in the environment. It is a custom method that is under development and is not yet approved as an official USGS method. A few of the compounds in this method did not perform well as demonstrated by low or variable recoveries and were not included in the analyses during the May 2000 tracer tests. Also, some compounds were added to the method and were analyzed in May 2000. The nonylphenols are good indicators of wastewater, but they have been detected a few times at low concentrations (less than 0.7 mg/L) in the blanks. As a result, the reporting limits were raised for some compounds detected in blanks at low levels in an effort to report only environmentally significant concentrations. The compound 3-beta coprostanol is very good wastewater indicator, but the whole-water wastewater method is not particularly sensitive or reproducible for this compound. Caffeine is easily detected in surface waters, but is not a good indicator of wastewater in ground water because it acts nonconservatively in ground water (Seiler and others, 1999).

Numerous wastewater indicators were detected in both the Saugus and the Valencia WRPs effluent during the tracer tests (apps. G, H). For the purpose of this discussion, four compounds were selected from the suite of wastewater compounds to examine their interactions with the river water and hyporheic water. The four compounds are 1,4 dichlorobenzene (lavatory fumigants), diazinon (insecticide), triclosan (antimicrobial agent), and tri(2-chloroethyl) phosphate (fire retardant). These compounds were present in the effluent from both plants during both tracer tests, with the exception that diazinon was not detected in the Saugus WRP effluent in October 1999 (fig. 16). In figure 16, values reported that are below the method reporting limit for a compound are considered estimates.

October 1999

In the Saugus reach the wastewater indicators were not detected at SCRA. In the Valencia reach the concentration of 1,4 dichlorobenzene decreased between SCR1 to SCR2, and the compound was not detected downstream from SCR2 (fig. 16). The concentrations of diazinon, triclosan, and tri(2-chloroethyl) phosphate in the river decreased as the water traveled from SCR1 to SCR5. In the case of diazinon, the concentration at SCR3 through SCR5 decreased to levels at or below the method reporting limit (.03mg/L). Wastewater indicators were also detected at the two hyporheic sites (SCR3 and SCR5) at levels similar to those in the river (fig. 16).

May 2000

In the Saugus reach, the concentrations of 1,4 dichlorobenzene, diazinon, and tri(2-chloroethyl) phosphate were below detection limits at SCRA. In the Valencia reach, the concentration of 1,4 dichlorobenzene decreased between SCR1 to SCR2 and was below the method reporting limit downstream from SCR2. The concentrations of diazinon, triclosan, and tri(2-chloroethyl) phosphate in the river decreased as the water traveled from SCR1 to SCR5 but remained above detection limits. At SCR3 and SCR5, the hyporheic waters had concentrations of diazinon, triclosan, and tri(2-chloroethyl) phosphate similar to those of the river (fig. 16). At SCR2, the concentrations of 1,4 dichlorobenzene, diazinon, triclosan, and tri (2-chloroethyl) phosphate were lower in the hyporheic water than in the river.

Comparison of October 1999 and May 2000 Data

Concentrations of wastewater indicators in the Santa Clara River during both the October 1999 and May 2000 tracer tests were low. The concentrations of wastewater indicators in the surface and hyporheic waters decreased as the water traveled downstream in both the Saugus and the Valencia reaches during the October 1999 and May 2000 tracer tests. For both tests, wastewater indicators were present in the hyporheic water at concentrations that were similar to (at SCR3 and SCR5 in 1999 and 2000) or lower than (at SCR2 in 2000) concentrations in the river.

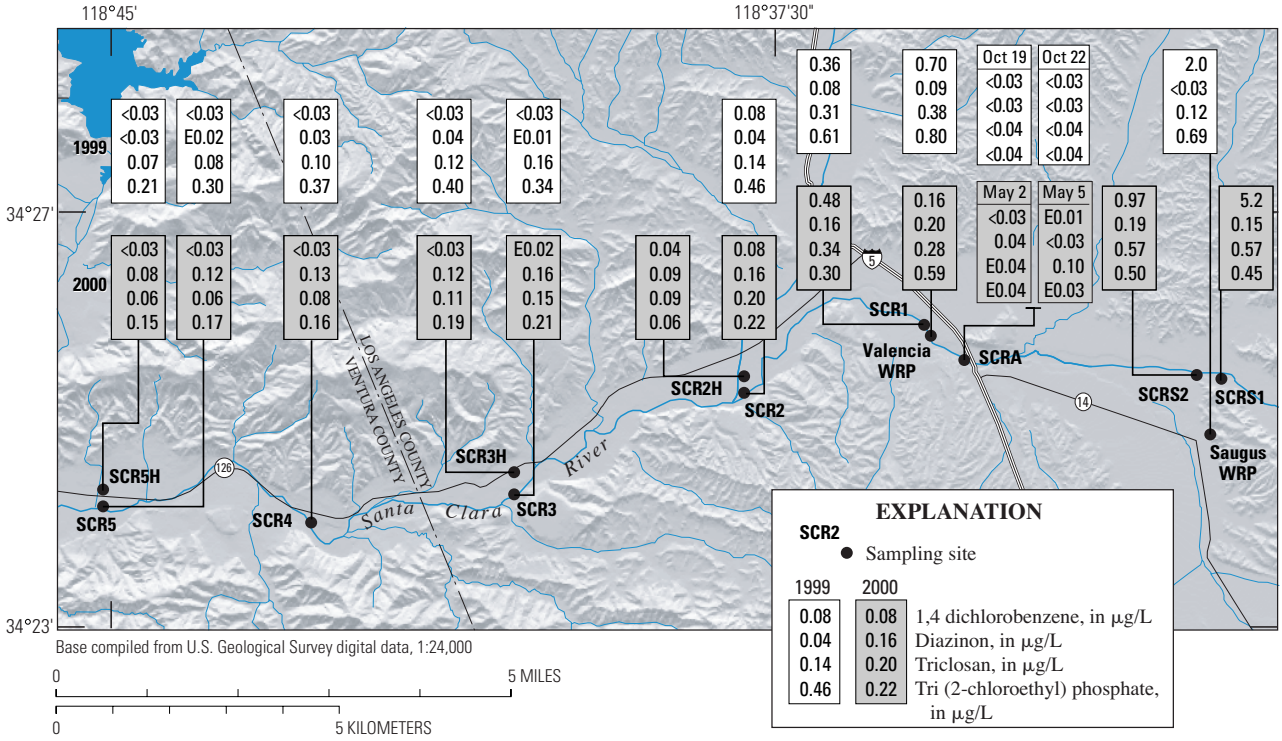

Figure 16. Concentrations of 1,4 dichlorobenzene, diazinon, triclosan, and tri(2-chloroethyl) phosphate for selected surface-water and hyporheic sites, Santa Clara River, California, October 1999 and May 2000. (Sites with an H after the site name indicate that the data are from the corresponding hyporheic site sampled that year; <, less than indicated method limit; E, value reported is below the method reporting limit and is considered an estimate.)

SUMMARY

Surface-water discharge and water-quality data were compiled and analyzed in order to gain an improved understanding of the chemical and hydraulic interactions between the Santa Clara River and the hyporheic zone during October 1999 and May 2000. In the Saugus reach, the Saugus Water Reclamation Plant is the main perennial source of base flow but, during the tracer tests, construction dewatering projects and ground water were contributors to the overall water quality at the end of the reach. In the Valencia reach, the major sources of flow were inflow from the Saugus reach, discharge from the Valencia Water Reclamation Plant, and ground-water discharge. The Valencia reach had both gains and losses of flow during the tracer tests. The gaining reaches are SCR1 to SCR2, SCR3 to the USGS gage 11109000 in October 1999 and SCR1 to SCR2 and SCR3 to SCR4 in May 2000. The losing reaches are the USGS gage 11109000 to SCR5 in October 1999 and SCR4 to SCR5 in May 2000. All water infiltrates into the streambed downstream from SCR5.

The traveltime computed from the Rhodamine WT dye in the Saugus reach was 3.2 hours in May 2000. The traveltime in the river for the Valencia reach was 9.6 hours in October 1999 and 7.1 hours in May 2000. The shorter traveltime in May 2000 was mostly due to the increased flow into the reach from the Saugus reach. The differences between the Rhodamine WT dye and sodium bromide traveltimes in the river for all reaches during both the October 1999 and May 2000 tracer tests were less than 1 hour.

During both tests, chloride concentrations decreased by about 45 mg/L within the Saugus reach and by about 10 mg/L in the Valencia reach. Sulfate concentrations increased by about 40 (May 2000) to 60 mg/L (October 1999) within the Saugus reach and by 160 mg/L within the Valencia reach. The increased sulfate concentrations are indicative of ground-water discharge. Within both reaches there was a trend of increasing nitrate concentrations and decreasing ammonia concentrations, indicating probable nitrification.

In the Saugus reach during the May 2000 tracer tests, 1,4 dichlorobenzene, diazinon, triclosan, and tri (2-chloroethyl) phosphate were not detected at the end of the reach. In the Valencia reach, 1,4 dichlorobenzene was below the method reporting limit downstream from SCR2 in both October 1999 and May 2000, and the other wastewater indicators were observed in the river at diminished concentrations as the water traveled downstream.

Analyses of the surface-water and hyporheic water-quality data provide insight into the chemical and hydraulic interactions between the Santa Clara River and the hyporheic zone. There is general consistency between the hyporheic chemical and tracer results and the identification of gaining and losing reaches based on the flow-curve analysis. At SCR2, which is at the end of a gaining reach, the May 2000 hyporheic sites showed no rhodamine or bromide from the tracer tests. In addition, the hyporheic site SCR2H2 in May 2000 had higher concentrations of sulfate, lower concentrations of nitrate and ammonia, and lower concentrations of wastewater indicators than did the river. In contrast, at SCR5, which is within a losing reach, the water chemistry in the hyporheic sites is similar to that in the river, and both rhodamine and bromide were observed in all sampled hyporheic sites. Finally, at SCR3, which is at the end of a reach that is not clearly gaining or losing, the hyporheic data also are not conclusive. In October 1999, the hyporheic site at SCR3H1 had higher sulfate and lower nitrate and ammonia concentrations relative to those of the river, suggesting gaining conditions. However, rhodamine and bromide were detected in some but not all of the hyporheic sites at SCR3. In May 2000, hyporheic site SCR3H5 had very similar chemistry to that of the river site; rhodamine was present at the one site for which it was sampled; and bromide was present in the three sites for which it was sampled. These results indicate losing conditions. It is important to emphasize that the exchange of river and hyporheic water can occur at different scales from the interaction between the river and the regional ground-water system; river water may move into the hyporheic zone within gaining reaches and hyporheic water many move into the river within losing reaches.

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APPENDIXES

Appendix A. Rhodamine WT dye concentrations for slug injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999

[USGS, U.S. Geological Survey; µg/L, microgram per liter]

USGS station name	USGS station No.	Reference name	Date	Time	Concentration (µg/L)
Santa Clara River, 0.3 miles below Castaic Creek, near Valencia, California	342507118380301	SCR2	10/19/1999	0000	0.01
			10/19/1999	0005	.01
			10/19/1999	0015	.00
			10/19/1999	0020	.00
			10/19/1999	0030	.01
			10/19/1999	0035	.01
			10/19/1999	0040	.01
			10/19/1999	0045	.00
			10/19/1999	0055	.00
			10/19/1999	0105	.00
			10/19/1999	0115	.00
			10/19/1999	0125	.02
			10/19/1999	0135	.01
			10/19/1999	0145	.14
			10/19/1999	0150	1.61
			10/19/1999	0155	8.62
			10/19/1999	0200	18.1
			10/19/1999	0205	36.4
			10/19/1999	0210	47.6
			10/19/1999	0215	52.0
			10/19/1999	0220	50.5
			10/19/1999	0225	44.4
			10/19/1999	0230	37.3
			10/19/1999	0235	29.2
			10/19/1999	0240	24.4
			10/19/1999	0245	20.1
			10/19/1999	0250	17.3
			10/20/1999	0255	13.7
			10/21/1999	0300	11.7
			10/22/1999	0305	9.86
			10/23/1999	0310	7.69
			10/24/1999	0320	5.96
			10/25/1999	0330	4.47
			10/26/1999	0340	3.50
			10/27/1999	0350	2.41
			10/28/1999	0400	1.94
			10/29/1999	0430	1.43
			10/30/1999	0500	1.19
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	342422118401701	SCR3	10/19/1999	0230	.00
			10/19/1999	0255	.00
			10/19/1999	0310	.00

Appendix A. Rhodamine WT dye concentrations for slug injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Concentration (µg/L)
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	342422118401701	SCR3	10/19/1999	0325	0.01
			10/19/1999	0340	2.15
			10/19/1999	0355	18.4
			10/19/1999	0410	33.0
			10/19/1999	0425	28.1
			10/19/1999	0440	16.4
			10/19/1999	0510	5.99
			10/19/1999	0540	2.88
			10/19/1999	0610	1.68
			10/19/1999	0640	1.18
			10/19/1999	0710	.85
			10/19/1999	0740	.67
			10/19/1999	0810	.54
			10/19/1999	0840	.45
			10/19/1999	0910	.27
			10/19/1999	0940	.26
			10/19/1999	1010	.21
			10/19/1999	1040	.25
			10/19/1999	1140	.18
			10/19/1999	1210	.17
			10/19/1999	1240	.14
			10/19/1999	1310	.15
			10/19/1999	1340	.13
			10/19/1999	1410	.12
Santa Clara River hyporheic (F1), 0.2 mile above Potrero Canyon, California	342422118401702	SCR3H1	10/19/1999	0300	.00
			10/19/1999	0312	.01
			10/19/1999	0325	.01
			10/19/1999	0340	.01
			10/19/1999	0355	.01
			10/19/1999	0410	.01
			10/19/1999	0425	.01
			10/19/1999	0440	.01
			10/19/1999	0510	.02
			10/19/1999	0540	.01
			10/19/1999	0610	.01
			10/19/1999	0640	.01
			10/19/1999	0710	.01
			10/19/1999	0740	.01
			10/19/1999	0810	.01
			10/19/1999	0840	.03
			10/19/1999	0910	.04
			10/19/1999	0940	.10
			10/19/1999	1010	.19

Appendix A. Rhodamine WT dye concentrations for slug injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Concentration (µg/L)
Santa Clara River hyporheic (F1), 0.2 mile above Potrero Canyon, California	342422118401702	SCR3H1	10/19/1999	1040	0.32
			10/19/1999	1110	.49
			10/19/1999	1140	.63
			10/19/1999	1210	.74
			10/19/1999	1240	.87
			10/19/1999	1310	.93
			10/19/1999	1340	.98
			10/19/1999	1410	1.02
			10/19/1999	1440	1.11
			10/19/1999	1510	1.17
			10/19/1999	1540	1.17
			10/19/1999	1610	1.30
			10/19/1999	1640	1.30
			10/19/1999	1710	1.28
			10/19/1999	1740	1.29
			10/20/1999	0035	.60
			10/20/1999	0350	.26
			10/21/1999	0920	.36
			10/21/1999	1635	.20
			10/21/1999	1830	.31
Santa Clara River hyporheic (F2), 0.2 mile above Potrero Canyon, California	342422118401703	SCR3H2	10/19/1999	0300	.01
			10/19/1999	0440	.02
			10/19/1999	0510	.02
			10/19/1999	0540	.02
			10/19/1999	0610	.02
			10/19/1999	0710	.01
			10/19/1999	0810	.02
			10/19/1999	0910	.00
			10/19/1999	1010	.02
			10/19/1999	1140	.09
			10/19/1999	1210	.10
			10/19/1999	1310	.12
			10/19/1999	1410	.16
			10/19/1999	1510	.17
			10/19/1999	1610	.19
			10/19/1999	1740	.21
			10/20/1999	0035	.19
			10/20/1999	0350	.17
			10/21/1999	0920	.10
			10/21/1999	1635	.13
			10/21/1999	1830	.14

Appendix A. Rhodamine WT dye concentrations for slug injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Concentration (µg/L)
Santa Clara River hyporheic (F3), 0.2 mile above Potrero Canyon, California	342422118401704	SCR3H3	10/19/1999	0300	0.01
			10/19/1999	0440	.01
			10/19/1999	0510	.01
			10/19/1999	0540	.01
			10/19/1999	0610	.01
			10/19/1999	0710	.01
			10/19/1999	0810	.02
			10/19/1999	0910	.00
			10/19/1999	1010	.00
			10/19/1999	1140	.03
			10/19/1999	1210	.03
			10/19/1999	1310	.03
			10/19/1999	1410	.04
			10/19/1999	1510	.04
			10/19/1999	1610	.04
			10/19/1999	1740	.06
			10/20/1999	0035	.07
			10/20/1999	0350	.05
			10/21/1999	0920	.05
			10/21/1999	1635	.08
			10/21/1999	1830	.04
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	342359118424501	SCR4	10/19/1999	0400	.00
			10/19/1999	0415	.00
			10/19/1999	0430	.02
			10/19/1999	0445	.00
			10/19/1999	0500	.01
			10/19/1999	0510	.00
			10/19/1999	0520	.01
			10/19/1999	0530	.11
			10/19/1999	0540	.92
			10/19/1999	0550	6.19
			10/19/1999	0555	11.0
			10/19/1999	0600	15.5
			10/19/1999	0605	19.9
			10/19/1999	0610	21.2
			10/19/1999	0615	21.1
			10/19/1999	0620	20.7
			10/19/1999	0625	17.6
			10/19/1999	0630	16.1
			10/19/1999	0635	15.0
			10/19/1999	0650	9.25
			10/19/1999	0700	7.19
			10/19/1999	0730	3.39

Appendix A. Rhodamine WT dye concentrations for slug injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Concentration (µg/L)
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	342359118424501	SCR4	10/19/1999	0800	1.94
			10/19/1999	0830	1.10
			10/19/1999	0900	.83
			10/19/1999	0930	.62
			10/19/1999	1000	.48
			10/19/1999	1030	.40
			10/19/1999	1100	.43
			10/19/1999	1130	.35
			10/19/1999	1200	.33
			10/19/1999	1230	.30
			10/19/1999	1300	.24
			10/19/1999	1330	.21
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450101	SCR5	10/19/1999	0655	.01
			10/19/1999	0715	.00
			10/19/1999	0735	.00
			10/19/1999	0755	.10
			10/19/1999	0815	.85
			10/19/1999	0825	1.87
			10/19/1999	0835	3.38
			10/19/1999	0855	7.35
			10/19/1999	0905	8.04
			10/19/1999	0915	8.42
			10/19/1999	0925	8.54
			10/19/1999	0935	8.03
			10/19/1999	0945	7.55
			10/19/1999	1025	4.05
			10/19/1999	1105	2.15
			10/19/1999	1145	1.35
			10/19/1999	1220	.96
			10/19/1999	1300	.70
Santa Clara River hyporheic (F1), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450102	SCR5H1	10/19/1999	0735	.00
			10/19/1999	0800	.01
			10/19/1999	0930	.00
			10/19/1999	1020	.11
			10/19/1999	1100	.17
			10/19/1999	1130	1.25
			10/19/1999	1200	.85
			10/19/1999	1300	2.34
			10/19/1999	1330	1.96
			10/19/1999	1400	1.94
			10/19/1999	1430	1.28

Appendix A. Rhodamine WT dye concentrations for slug injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Concentration (µg/L)
Santa Clara River hyporheic (F1), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450102	SCR5H1	10/19/1999	1500	1.17
			10/19/1999	1530	.92
			10/19/1999	1600	.75
			10/19/1999	1630	.71
			10/19/1999	1700	.64
			10/19/1999	1730	.58
			10/19/1999	1800	.51
			10/19/1999	1900	.44
			10/19/1999	1930	.42
			10/19/1999	2000	.41
			10/19/1999	2030	.39
			10/19/1999	2100	.37
			10/19/1999	2130	.33
			10/19/1999	2200	.30
			10/19/1999	2230	.31
			10/19/1999	2300	.27
			10/20/1999	0000	.24
			10/20/1999	0030	.23
			10/20/1999	0100	.23
			10/20/1999	0130	.20
			10/20/1999	0200	.19
			10/20/1999	0230	.17
			10/20/1999	0300	.16
			10/20/1999	0330	.15
			10/20/1999	0400	.15
			10/20/1999	0430	.14
			10/20/1999	0500	.13
			10/20/1999	0530	.12
			10/20/1999	0600	.12
			10/20/1999	0630	.11
			10/20/1999	0700	.11
			10/20/1999	1530	.11
			10/21/1999	0200	.04
			10/21/1999	1400	.09
Santa Clara River hyporheic (F2), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450103	SCR5H2	10/19/1999	0855	.00
			10/19/1999	1100	.00
			10/19/1999	1300	1.38
			10/19/1999	1400	1.55
			10/19/1999	1500	1.48
			10/19/1999	1600	1.25
			10/19/1999	1700	1.08
			10/19/1999	1800	.89
			10/19/1999	1900	.76

Appendix A. Rhodamine WT dye concentrations for slug injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Concentration (µg/L)
Santa Clara River hyporheic (F2), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450103	SCR5H2	10/19/1999	2000	0.65
			10/20/1999	0000	.37
			10/20/1999	0100	.34
			10/20/1999	0200	.32
			10/20/1999	0300	.28
			10/20/1999	0500	.24
			10/20/1999	0600	.22
			10/20/1999	0700	.21
			10/20/1999	1530	.11
			10/21/1999	0200	.11
			10/21/1999	1400	.07
Santa Clara River hyporheic (F3), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450104	SCR5H3	10/19/1999	0855	.00
			10/19/1999	1100	.00
			10/19/1999	1200	.40
			10/19/1999	1300	.66
			10/19/1999	1400	.78
			10/19/1999	1500	1.20
			10/19/1999	1600	1.11
			10/19/1999	1700	.99
			10/19/1999	1800	.87
			10/19/1999	1900	.75
			10/19/1999	2000	.67
			10/20/1999	0100	.38
			10/20/1999	0200	.34
			10/20/1999	0400	.29
			10/20/1999	0500	.26
			10/20/1999	0600	.25
			10/20/1999	0700	.23
			10/20/1999	1530	.12
			10/21/1999	0200	.11
			10/21/1999	1400	.06

Appendix B. Rhodamine WT dye concentrations for slug injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000

[USGS, U.S. Geological Survey; µg/L, microgram per liter]

USGS station name	USGS station No.	Reference name	Date	Time	Concentration (µg/L)
Santa Clara River, above McBean Parkway Bridge, near Saugus, California	342530118332501	SCRS2	05/04/2000	2040	0.02
			05/04/2000	2050	.09
			05/04/2000	2055	93.7
			05/04/2000	2100	254
			05/04/2000	2105	965
			05/04/2000	2110	965
			05/04/2000	2115	276
			05/04/2000	2120	150
			05/04/2000	2125	75.1
			05/04/2000	2130	49.6
			05/04/2000	2135	36.2
			05/04/2000	2140	25.8
			05/04/2000	2150	16.3
			05/04/2000	2200	10.9
			05/04/2000	2210	7.61
			05/04/2000	2220	6.24
			05/04/2000	2230	5.16
			05/04/2000	2245	3.51
			05/04/2000	2300	2.89
			05/04/2000	2315	2.40
			05/04/2000	2330	2.05
			05/04/2000	2345	1.78
			05/05/2000	0000	1.55
			05/05/2000	0015	1.32
			05/05/2000	0130	.69
			05/05/2000	0230	.52
			05/05/2000	0330	.39
			05/05/2000	0400	.36
			05/05/2000	0430	.33
Santa Clara River, at old Trestle Bridge, near Saugus, California	342534118344101	SCRS3A	05/04/2000	2150	.02
			05/04/2000	2200	.89
			05/04/2000	2210	5.08
			05/04/2000	2220	3.81
			05/04/2000	2225	3.26
			05/04/2000	2230	2.06
			05/04/2000	2235	1.67
			05/04/2000	2240	1.13
			05/04/2000	2250	.82
			05/04/2000	2300	.55
			05/04/2000	2310	.44
			05/04/2000	2320	.39

Appendix B. Rhodamine WT dye concentrations for slug injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Concentration (μg/L)
Santa Clara River, at old Trestle Bridge, near Saugus, California	342534118344101	SCRS3A	05/04/2000	2330	0.32
			05/04/2000	2340	.26
			05/04/2000	2355	.23
			05/05/2000	0010	.20
			05/05/2000	0025	.18
			05/05/2000	0040	.16
			05/05/2000	0050	.14
			05/05/2000	0100	.13
			05/05/2000	0110	.13
			05/05/2000	0120	.12
			05/05/2000	0130	.12
Santa Clara River, at Old Road, near Valencia, California	342535118350801	SCRA	05/05/2000	0100	.06
			05/05/2000	0120	.03
			05/05/2000	0140	.02
			05/05/2000	0150	3.91
			05/05/2000	0155	22.3
			05/05/2000	0200	44.2
			05/05/2000	0202	43.5
			05/05/2000	0205	35.8
			05/05/2000	0208	25.2
			05/05/2000	0211	16.7
			05/05/2000	0215	10.8
			05/05/2000	0220	6.79
			05/05/2000	0230	3.71
			05/05/2000	0245	2.05
			05/05/2000	0300	1.46
			05/05/2000	0315	1.08
			05/05/2000	0330	.93
			05/05/2000	0345	.75
			05/05/2000	0400	.62
			05/05/2000	0415	.55
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	342507118380301	SCR2	05/02/2000	0100	40.1
			05/02/2000	0105	48.7
			05/02/2000	0110	40.6
			05/02/2000	0115	28.2
			05/02/2000	0120	20.8
			05/02/2000	0127	12.2
			05/02/2000	0133	8.38
			05/02/2000	0145	4.38
			05/02/2000	0200	2.51
			05/02/2000	0215	1.65
			05/02/2000	0230	1.23

Appendix B. Rhodamine WT dye concentrations for slug injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Concentration (μg/L)
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	342507118380301	SCR2	05/02/2000	0245	.94
			05/02/2000	0300	0.83
			05/02/2000	0315	.73
			05/02/2000	0330	.64
			05/02/2000	0345	.55
			05/02/2000	0400	.48
Santa Clara River hyporheic (H2), 0.3 mile below Castaic Creek, near Valencia, California	342507118380303	SCR2H2	05/02/2000	0125	.06
			05/02/2000	0145	.29
			05/02/2000	0200	.05
			05/02/2000	0215	.03
			05/02/2000	0230	.03
			05/02/2000	0245	.02
			05/02/2000	0300	.02
			05/02/2000	0310	.06
			05/02/2000	0330	.03
			05/02/2000	0350	.02
			05/02/2000	0420	.04
			05/02/2000	0450	.05
			05/02/2000	0535	.03
			05/02/2000	0600	.03
			05/02/2000	0630	.03
			05/02/2000	0700	.03
			05/02/2000	0730	.03
			05/02/2000	0800	.03
			05/02/2000	0830	.03
			05/02/2000	0900	.02
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	342422118401701	SCR3	05/02/2000	0115	.02
			05/02/2000	0135	.12
			05/02/2000	0145	.14
			05/02/2000	0155	.15
			05/02/2000	0205	.18
			05/02/2000	0215	3.14
			05/02/2000	0220	7.42
			05/02/2000	0225	13.0
			05/02/2000	0230	16.5
			05/02/2000	0235	19.5
			05/02/2000	0240	19.5
			05/02/2000	0245	18.5
			05/02/2000	0250	14.8
			05/02/2000	0305	6.60
			05/02/2000	0320	3.57

Appendix B. Rhodamine WT dye concentrations for slug injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Concentration (μg/L)
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	342422118401701	SCR3	05/02/2000	0335	2.40
			05/02/2000	0350	1.97
			05/02/2000	0405	1.39
			05/02/2000	0420	1.18
			05/02/2000	0435	.99
			05/02/2000	0450	.74
Santa Clara River hyporheic (H5), 0.2 mile above Potrero Canyon, near Val Verde, California	342420118402201	SCR3H5	05/02/2000	0115	.13
			05/02/2000	0135	.02
			05/02/2000	0150	.02
			05/02/2000	0210	.15
			05/02/2000	0230	.13
			05/02/2000	0250	.11
			05/02/2000	0310	.12
			05/02/2000	0330	.11
			05/02/2000	0350	.10
			05/02/2000	0410	.10
			05/02/2000	0415	.11
			05/02/2000	0435	.10
			05/02/2000	0455	.10
			05/02/2000	0515	.11
			05/02/2000	0535	.13
			05/02/2000	0555	.34
			05/02/2000	0615	.36
			05/02/2000	0635	.62
			05/02/2000	0655	.98
			05/02/2000	0715	1.28
			05/02/2000	0720	1.44
			05/02/2000	0725	1.43
			05/02/2000	0730	1.40
			05/02/2000	0735	1.43
			05/02/2000	0740	1.48
			05/02/2000	0745	1.45
			05/02/2000	0750	1.45
			05/02/2000	0755	1.56
			05/02/2000	0800	1.55
			05/02/2000	0815	1.59
			05/02/2000	0820	1.69
			05/02/2000	0825	1.68
			05/02/2000	0830	1.65
			05/02/2000	0835	1.60
			05/02/2000	0900	1.56
			05/02/2000	0930	1.78
			05/02/2000	1000	1.56

Appendix B. Rhodamine WT dye concentrations for slug injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Concentration (μg/L)
Santa Clara River hyporheic (H5), 0.2 mile above Potrero Canyon, near Val Verde, California	342420118402201	SCR3H5	05/02/2000	1030	1.21
			05/02/2000	1100	1.50
			05/02/2000	1130	1.45
			05/02/2000	1200	.94
			05/02/2000	1230	.77
			05/02/2000	1300	.65
			05/02/2000	1330	.52
			05/02/2000	1400	.53
			05/02/2000	1430	.46
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	342359118424501	SCR4	05/02/2000	0355	.64
			05/02/2000	0400	3.32
			05/02/2000	0405	3.42
			05/02/2000	0410	5.66
			05/02/2000	0415	7.64
			05/02/2000	0420	9.19
			05/02/2000	0425	10.1
			05/02/2000	0430	10.3
			05/02/2000	0440	8.88
			05/02/2000	0450	6.72
			05/02/2000	0500	4.98
			05/02/2000	0515	3.14
			05/02/2000	0530	2.14
			05/02/2000	0545	1.61
			05/02/2000	0600	1.24
			05/02/2000	0615	1.00
			05/02/2000	0630	.85
			05/02/2000	0645	.74
			05/02/2000	0700	.62
			05/02/2000	0715	.58
			05/02/2000	0730	.50
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450101	SCR5	05/02/2000	0625	5.28
			05/02/2000	0630	4.70
			05/02/2000	0635	4.20
			05/02/2000	0640	3.76
			05/02/2000	0645	3.73
			05/02/2000	0650	3.20
			05/02/2000	0655	2.62
			05/02/2000	0700	2.50
			05/02/2000	0705	2.26
			05/02/2000	0710	2.07
			05/02/2000	0715	1.87

Appendix B. Rhodamine WT dye concentrations for slug injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Concentration (μg/L)
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450101	SCR5	05/02/2000	0720	1.68
			05/02/2000	0725	1.58
			05/02/2000	0730	1.46
			05/02/2000	0745	1.15
			05/02/2000	0800	.89
			05/02/2000	0815	.78
			05/02/2000	0830	.67
			05/02/2000	0845	.60
			05/02/2000	0900	.52
Santa Clara River hyporheic (H5), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450106	SCR5H5	05/02/2000	0645	.07
			05/02/2000	0655	.02
			05/02/2000	0715	.03
			05/02/2000	0735	.03
			05/02/2000	0755	.02
			05/02/2000	0815	.02
			05/02/2000	0835	.05
			05/02/2000	0855	.16
			05/02/2000	0900	.26
			05/02/2000	0905	.31
			05/02/2000	0910	.40
			05/02/2000	0915	.47
			05/02/2000	0925	.53
			05/02/2000	0930	.75
			05/02/2000	0940	.79
			05/02/2000	0945	.89
			05/02/2000	0950	.91
			05/02/2000	0955	.86
			05/02/2000	1000	1.01
			05/02/2000	1005	1.05
			05/02/2000	1010	1.11
			05/02/2000	1015	1.16
			05/02/2000	1020	1.12
			05/02/2000	1025	1.09
			05/02/2000	1030	1.15
			05/02/2000	1035	1.16
			05/02/2000	1040	1.20
			05/02/2000	1045	1.16
			05/02/2000	1050	1.14
			05/02/2000	1055	1.10
			05/02/2000	1100	1.17
			05/02/2000	1105	1.11
			05/02/2000	1110	1.12
			05/02/2000	1115	1.12

Appendix B. Rhodamine WT dye concentrations for slug injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Concentration (μg/L)
Santa Clara River hyporheic (H5), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450106	SCR5H5	05/02/2000	1120	1.09
			05/02/2000	1125	1.08
			05/02/2000	1130	1.05
			05/02/2000	1135	1.05
			05/02/2000	1140	1.03
			05/02/2000	1145	.97
			05/02/2000	1150	.91
			05/02/2000	1155	.90
			05/02/2000	1200	.91
			05/02/2000	1215	.82
			05/02/2000	1245	.65
			05/02/2000	1315	.58
			05/02/2000	1345	.44
			05/02/2000	1415	.39
			05/02/2000	1445	.36
			05/02/2000	1515	.31
			05/02/2000	1545	.30
			05/02/2000	1615	.29
			05/02/2000	1645	.29
			05/02/2000	1715	.28
			05/02/2000	1745	.29
			05/02/2000	1815	.29
			05/02/2000	1845	.28

Appendix C. Bromide, chloride, and sulfate analyses for the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999

[USGS, U.S. Geological Survey; these analyses were run at a USGS research laboratory in Menlo Park, California, and are not in the USGS computerized National Water Information System (NWIS); WRP, water reclamation plant; mg/L, milligram per liter; —, no data]

USGS station name	USGS station No.	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Santa Clara River at Old Road, near Valencia, California	342535118350801	SCRA	10/18/1999	2330	0.23	95	207
			10/19/1999	0001	.24	99	219
			10/19/1999	0100	.24	100	222
			10/19/1999	0400	.24	101	218
			10/19/1999	0500	.24	101	219
			10/19/1999	0600	.24	100	218
			10/19/1999	0700	.24	100	219
			10/19/1999	0800	.24	100	219
			10/19/1999	0900	.24	100	219
			10/19/1999	1600	.22	95	248
			10/20/1999	1410	.23	99	230
			10/20/1999	1900	.23	98	218
			10/21/1999	0900	.23	97	218
			10/21/1999	1930	.20	74	241
			10/21/1999	2030	.22	86	240
			10/21/1999	2130	.26	91	226
			10/21/1999	2230	.22	94	221
			10/21/1999	2330	.24	95	220
			10/22/1999	0030	.29	96	221
			10/22/1999	0130	.23	95	219
			10/22/1999	0230	.25	96	219
			10/22/1999	0330	.28	96	220
			10/22/1999	0430	.29	96	220
			10/22/1999	0600	.24	96	219
			10/22/1999	0700	.31	96	220
			10/22/1999	0800	.25	97	221
			10/22/1999	0900	.25	98	216
			10/22/1999	1000	.23	98	219
			10/22/1999	1100	.28	95	214
			10/22/1999	1200	.25	97	220
			10/22/1999	1300	.22	91	227
			10/22/1999	1400	.29	85	236
			10/22/1999	1500	.21	88	236
			10/22/1999	1600	.22	75	268
			10/22/1999	1800	.49	77	272
			10/22/1999	1900	.21	—	—
Valencia WRP effluent at Valencia, California	342548118352401	Valencia WRP	10/18/1999	2325	.28	151	190
			10/19/1999	0045	1.52	153	189
			10/19/1999	0145	1.25	153	191

Appendix C. Bromide, chloride, and sulfate analyses or the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Valencia WRP effluent at Valencia, California	342548118352401	Valencia WRP	10/19/1999	0245	1.45	152	190
			10/19/1999	0345	1.43	149	188
			10/19/1999	0445	1.52	146	187
			10/19/1999	0545	1.46	144	186
			10/19/1999	0645	1.45	144	185
			10/19/1999	0745	1.43	146	184
			10/19/1999	0800	1.47	142	184
			10/19/1999	0815	1.51	148	185
			10/19/1999	0845	1.25	146	185
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	342557118353801	SCR1	10/19/1999	0015	1.00	137	223
			10/19/1999	0115	1.05	135	210
			10/19/1999	0215	.91	132	214
			10/19/1999	0315	.90	130	214
			10/19/1999	0415	1.01	126	215
			10/19/1999	0515	.99	126	214
			10/19/1999	0620	.93	127	212
			10/19/1999	0715	.97	127	210
			10/19/1999	0815	1.06	127	211
			10/19/1999	0915	.22	130	207
			10/19/1999	1015	.19	132	212
			10/19/1999	1610	.09	152	210
			10/20/1999	1420	.11	176	219
			10/20/1999	1910	.19	150	208
			10/21/1999	0910	.19	141	209
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	342507118380301	SCR2	10/19/1999	0020	.21	120	241
			10/19/1999	0045	.22	124	247
			10/19/1999	0120	.22	123	247
			10/19/1999	0220	.25	119	253
			10/19/1999	0320	.74	116	253
			10/19/1999	0420	.74	121	247
			10/19/1999	0520	.78	118	248
			10/19/1999	0620	.78	114	249
			10/19/1999	0720	.80	113	249
			10/19/1999	0820	.81	114	249
			10/19/1999	0920	.80	111	248
			10/19/1999	1020	.77	113	248
			10/19/1999	1120	.70	115	244
			10/19/1999	1220	.31	119	242
			10/19/1999	1320	.27	116	251
			10/19/1999	1420	.23	134	237

Appendix C. Bromide, chloride, and sulfate analyses or the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	342422118401701	SCR3	10/19/1999	0240	—	121	258
			10/19/1999	0350	.25	116	257
			10/19/1999	0450	.55	115	261
			10/19/1999	0550	.67	118	260
			10/19/1999	0650	.67	116	258
			10/19/1999	0750	.71	114	259
			10/19/1999	0750	.71	113	259
			10/19/1999	0955	.71	113	259
			10/19/1999	1050	.70	111	258
			10/19/1999	1150	.68	111	257
			10/19/1999	1250	.71	112	255
			10/19/1999	1350	.44	116	254
			10/19/1999	1450	.29	113	258
			10/19/1999	1550	.26	125	250
			10/19/1999	1650	.25	135	248
			10/19/1999	1750	.25	140	249
			10/20/1999	0035	.26	123	261
			10/20/1999	0920	.26	110	272
			10/20/1999	1830	.38	131	259
			10/21/1999	0355	.24	126	264
Santa Clara River hyporheic (F1), 0.2 mile above Potrero Canyon, California	342422118401702	SCR3H1	10/19/1999	0305	.26	136	294
			10/19/1999	0350	.29	146	308
			10/19/1999	0450	.28	138	292
			10/19/1999	0550	.27	135	287
			10/19/1999	0650	.27	134	285
			10/19/1999	0750	.26	133	283
			10/19/1999	0850	.26	135	280
			10/19/1999	0920	.28	138	267
			10/19/1999	0955	.27	132	281
			10/19/1999	1050	.28	139	285
			10/19/1999	1150	.31	137	282
			10/19/1999	1250	.35	133	276
			10/19/1999	1350	.37	131	273
			10/19/1999	1450	.41	130	272
			10/19/1999	1550	.51	133	277
			10/19/1999	1650	.53	133	268
			10/19/1999	1750	.55	131	266
			10/20/1999	0035	.38	140	278
			10/20/1999	1830	.26	126	254
			10/21/1999	0355	.26	125	260
			10/21/1999	1630	.30	132	264

Appendix C. Bromide, chloride, and sulfate analyses or the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Santa Clara River hyporheic (F2), 0.2 mile above Potrero Canyon, California	342422118401703	SCR3H2	10/19/1999	0305	0.28	133	286
			10/19/1999	0355	.27	136	292
			10/19/1999	0450	.27	135	292
			10/19/1999	0550	.27	136	292
			10/19/1999	0650	.27	136	293
			10/19/1999	0750	.27	135	291
			10/19/1999	0850	.26	134	290
			10/19/1999	0955	.37	133	286
			10/19/1999	1050	.27	134	288
			10/19/1999	1150	.27	132	288
			10/19/1999	1250	.27	131	284
			10/19/1999	1350	.27	132	283
			10/19/1999	1450	.28	131	284
			10/19/1999	1550	.29	131	283
			10/19/1999	1650	.30	131	284
			10/19/1999	1750	.30	131	282
			10/20/1999	0035	.30	125	277
			10/20/1999	0920	.28	130	289
			10/20/1999	1830	.28	123	272
			10/21/1999	0350	.27	124	271
Santa Clara River Hyporheic (F3), 0.2 mile above Potrero Canyon, California	342422118401704	SCR3H3	10/19/1999	0305	.34	131	275
			10/19/1999	0355	.31	130	271
			10/19/1999	0450	.28	126	269
			10/19/1999	0555	.31	125	268
			10/19/1999	0650	.27	125	268
			10/19/1999	0750	.26	125	267
			10/19/1999	0850	.26	124	266
			10/19/1999	0955	.26	122	266
			10/19/1999	1050	.26	124	266
			10/19/1999	1055	.27	124	266
			10/19/1999	1150	.26	124	266
			10/19/1999	1250	.28	124	266
			10/19/1999	1350	.26	124	266
			10/19/1999	1450	.30	123	266
			10/19/1999	1550	.26	126	266
			10/19/1999	1650	.28	127	267
			10/19/1999	1750	.27	127	268
			10/20/1999	0035	.27	126	269
			10/20/1999	1830	.25	116	253
			10/21/1999	0350	.24	101	226

Appendix C. Bromide, chloride, and sulfate analyses or the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	342359118424501	SCR4	10/19/1999	0400	0.29	124	333
			10/19/1999	0500	.29	125	338
			10/19/1999	0600	.30	120	340
			10/19/1999	0700	.57	121	337
			10/19/1999	0800	.63	120	336
			10/19/1999	0900	.60	115	335
			10/19/1999	1000	.60	113	334
			10/19/1999	1100	.62	111	339
			10/19/1999	1200	.65	116	338
			10/19/1999	1300	.64	113	335
			10/19/1999	1400	.65	117	332
			10/19/1999	1500	.61	114	334
			10/19/1999	1600	.41	114	334
			10/19/1999	1700	.32	112	321
			10/19/1999	1800	.31	121	327
			10/19/1999	1900	.30	132	323
			10/19/1999	2000	.30	133	319
			10/19/1999	2100	.29	132	317
			10/19/1999	2200	.30	124	318
			10/19/1999	2300	.31	123	319
			10/20/1999	0001	.30	123	319
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450101	SCR5	10/19/1999	0900	.41	127	374
			10/19/1999	1000	.57	125	381
			10/19/1999	1100	.58	125	376
			10/19/1999	1200	.58	121	375
			10/19/1999	1300	.60	121	375
			10/19/1999	1400	.60	120	379
			10/19/1999	1500	.64	121	380
			10/19/1999	1600	.62	121	373
			10/19/1999	1700	.63	120	371
			10/19/1999	1800	.54	121	371
			10/19/1999	1900	.41	121	365
			10/19/1999	2000	.37	121	362
			10/19/1999	2100	.36	127	359
			10/19/1999	2200	.35	131	358
			10/19/1999	2300	.35	134	356
			10/20/1999	0001	.34	130	351
			10/20/1999	0100	.33	130	356
			10/20/1999	0200	.33	126	357
			10/20/1999	0300	.34	—	—
			10/20/1999	0400	.33	124	366

Appendix C. Bromide, chloride, and sulfate analyses or the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450101	SCR5	10/20/1999	0500	0.34	124	369
			10/20/1999	0600	.34	123	369
			10/20/1999	0700	.34	124	369
			10/20/1999	1530	.36	120	400
			10/21/1999	0200	.34	132	373
Santa Clara River hyporheic (F1), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450102	SCR5H1	10/19/1999	0900	.34	128	377
			10/19/1999	1000	.33	127	379
			10/19/1999	1100	0.35	127	380
			10/19/1999	1200	.46	126	378
			10/19/1999	1300	.53	124	376
			10/19/1999	1400	.56	121	372
			10/19/1999	1500	.59	119	373
			10/19/1999	1600	.62	120	375
			10/19/1999	1700	.78	120	374
			10/19/1999	1800	.64	119	371
			10/19/1999	1900	.61	124	368
			10/19/1999	2000	.56	122	367
			10/19/1999	2100	.51	123	365
			10/19/1999	2200	.46	123	364
			10/19/1999	2300	.42	125	360
			10/20/1999	0001	.40	129	358
			10/20/1999	0100	.38	131	357
			10/20/1999	0200	.36	133	354
			10/20/1999	0300	.35	133	354
			10/20/1999	0400	.34	134	352
			10/20/1999	0500	.34	129	353
			10/20/1999	0600	.34	127	358
			10/20/1999	0700	.34	125	361
			10/20/1999	1530	.37	123	407
			10/21/1999	0200	.27	106	285
Santa Clara River hyporheic (F2), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450103	SCR5H2	10/19/1999	0900	.35	126	382
			10/19/1999	1000	.33	124	381
			10/19/1999	1100	.34	125	382
			10/19/1999	1200	.34	125	383
			10/19/1999	1300	.40	124	383
			10/19/1999	1400	.45	122	383
			10/19/1999	1600	.61	118	379
			10/19/1999	1700	.61	118	380

Appendix C. Bromide, chloride, and sulfate analyses or the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999—Continued

USGS station name	USGS station No.	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Santa Clara River hyporheic (F2), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450103	SCR5H2	10/19/1999	1800	0.62	118	379
			10/19/1999	1900	.61	118	375
			10/19/1999	2000	.60	120	374
			10/19/1999	2100	.54	120	371
			10/19/1999	2200	.50	119	368
			10/19/1999	2300	.61	118	378
			10/20/1999	0001	.43	122	366
			10/20/1999	0100	.41	121	365
			10/20/1999	0200	.40	126	365
			10/20/1999	0300	.38	127	365
			10/20/1999	0400	.38	131	367
			10/20/1999	0500	.36	128	361
			10/20/1999	0600	.36	128	361
			10/20/1999	0700	.36	126	363
			10/20/1999	1530	.37	122	399
			10/21/1999	0200	.35	128	390
Santa Clara River hyporheic (F3), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450104	SCR5H3	10/19/1999	0900	.34	127	382
			10/19/1999	1000	.33	126	379
			10/19/1999	1100	.34	126	377
			10/19/1999	1200	.38	125	378
			10/19/1999	1300	.33	127	378
			10/19/1999	1400	.38	124	379
			10/19/1999	1500	.45	123	376
			10/19/1999	1600	.56	119	373
			10/19/1999	1700	.58	121	375
			10/19/1999	1800	.60	117	373
			10/19/1999	1900	.62	118	373
			10/19/1999	2000	.61	119	371
			10/19/1999	2100	.61	120	369
			10/19/1999	2200	.55	119	367
			10/19/1999	2300	.50	122	368
			10/20/1999	0001	.44	121	362
			10/20/1999	0100	.41	123	359
			10/20/1999	0200	.39	125	359
			10/20/1999	0300	.38	128	356
			10/20/1999	0400	.37	129	353
			10/20/1999	0500	.36	130	354
			10/20/1999	0600	.35	137	359
			10/20/1999	0700	.34	129	353
			10/20/1999	1530	.35	124	389
			10/21/1999	0200	.35	127	385

Appendix D. Bromide, chloride, and sulfate analyses for the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000

[USGS, U.S. Geological Survey; these analyses were run at a USGS research laboratory in Menlo Park, California, and are not in the USGS computerized National Water Information System (NWIS); WRP, water reclamation plant; mg/L, milligram per liter; —, no data]

USGS station name	USGS station No,	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Saugus WRP effluent at Saugus, California	342456118322001	Saugus WRP	05/04/2000	1925	0.20	—	—
			05/04/2000	2030	1.78	—	—
			05/04/2000	2130	2.55	—	—
			05/04/2000	2230	3.37	—	—
			05/04/2000	2330	4.18	—	—
			05/05/2000	0030	3.53	—	—
			05/05/2000	0130	3.82	—	—
			05/05/2000	0200	.22	—	—
Santa Clara River, 0.1 mile below Saugus WRP, near Saugus, California	342527118323001	SCRS1	05/04/2000	1910	.16	155	162
			05/04/2000	2000	.88	154	160
			05/04/2000	2100	3.86	152	160
			05/04/2000	2210	4.19	—	—
			05/04/2000	2305	4.70	145	157
			05/05/2000	0001	3.01	143	157
			05/05/2000	0100	4.93	139	159
			05/05/2000	0200	1.28	135	157
			05/05/2000	0300	.24	132	158
			05/05/2000	0400	.20	128	159
			05/05/2000	0500	.22	127	151
			05/05/2000	0600	.22	126	153
			05/05/2000	0700	.20	127	150
			05/05/2000	0800	.23	132	158
Santa Clara River, above McBean Parkway Bridge, near Saugus, California	342530118332501	SCRS2	05/04/2000	1345	.19	159	152
			05/04/2000	2130	2.55	157	154
			05/04/2000	2230	3.87	154	153
			05/04/2000	2330	4.02	151	150
			05/05/2000	0030	4.51	148	151
			05/05/2000	0130	4.29	145	150
			05/05/2000	0230	4.42	145	155
			05/05/2000	0330	2.46	136	148
			05/05/2000	0430	.45	132	148
			05/05/2000	0530	.29	130	151
			05/05/2000	0745	.24	129	161
Santa Clara River, at Old Trestle Bridge, near Saugus, California	342534118344101	SCRS3A	05/04/2000	1215	.39	—	—
			05/04/2000	2200	.22	102	178
			05/04/2000	2300	.26	101	176
			05/05/2000	0001	.28	102	177
			05/05/2000	0100	.29	102	178
Santa Clara River, at Old Trestle Bridge, near Saugus, California	342534118344101	SCRS3A	05/05/2000	0200	0.31	102	178

Appendix D. Bromide, chloride, and sulfate analyses for the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No,	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
			05/05/2000	0300	.30	103	178
			05/05/2000	0400	.31	103	178
			05/05/2000	0500	.30	102	178
			05/05/2000	0600	.25	103	179
			05/05/2000	0700	.23	102	178
			05/05/2000	0800	.23	101	179
			05/05/2000	0375	.23	104	180
			05/05/2000	1000	.23	103	179
			05/05/2000	1100	.24	103	178
			05/05/2000	1155	.24	103	179
			05/05/2000	1230	.23	101	185
			05/05/2000	1300	.23	100	184
			05/05/2000	1400	.24	102	184
			05/05/2000	1500	.24	103	184
			05/05/2000	1600	.26	103	184
Santa Clara River, at Old Road, near Valencia, California	342535118350801	SCRA	05/01/2000	2320	.25	113	188
			05/02/2000	0010	.25	111	184
			05/02/2000	0215	.25	108	180
			05/02/2000	0405	.25	105	185
			05/02/2000	0600	.25	105	186
			05/02/2000	0805	.26	104	187
			05/02/2000	1000	.26	105	187
			05/02/2000	1220	.27	103	198
			05/02/2000	1420	.25	101	186
			05/02/2000	1520	.25	102	186
			05/02/2000	1620	.26	104	191
			05/02/2000	1820	.26	104	188
			05/02/2000	2020	.25	105	183
			05/04/2000	1245	.28	99	182
			05/04/2000	2300	.27	102	180
			05/05/2000	0005	.30	101	182
			05/05/2000	0100	.31	101	179
			05/05/2000	0200	.32	102	179
			05/05/2000	0300	.31	101	179
			05/05/2000	0400	.33	100	177
			05/05/2000	0500	.30	101	180
			05/05/2000	0600	.27	103	185
			05/05/2000	0700	.28	101	183
			05/05/2000	0800	.27	102	183
			05/05/2000	0900	.26	102	185
			05/05/2000	1000	.38	102	183
Santa Clara River, at Old Road, near Valencia, California	342535118350801	SCRA	05/05/2000	1100	0.26	103	184

Appendix D. Bromide, chloride, and sulfate analyses for the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No,	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
			05/05/2000	1200	.26	102	182
			05/05/2000	1300	.26	103	187
			05/05/2000	1400	.27	104	187
			05/05/2000	1500	.26	105	187
			05/05/2000	1600	.26	105	186
Valencia WRP effluent at Valencia, California	342548118352401	Valencia WRP	05/01/2000	2255	.50	158	184
			05/01/2000	2305	2.11	152	182
			05/02/2000	0030	2.55	157	190
			05/02/2000	0100	2.26	156	188
			05/02/2000	0130	2.34	157	183
			05/02/2000	0230	2.25	156	188
			05/02/2000	0330	2.84	155	189
			05/02/2000	0430	3.98	153	197
			05/02/2000	0530	2.17	151	183
			05/02/2000	0630	3.70	150	194
			05/02/2000	0730	2.65	150	187
			05/02/2000	0830	2.20	153	185
			05/02/2000	0920	2.34	155	185
			05/02/2000	0940	.46	156	184
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	342557118353801	SCR1	05/01/2000	2220	.30	119	207
			05/01/2000	2320	.30	123	205
			05/02/2000	0120	1.05	127	203
			05/02/2000	0220	1.35	117	156
			05/02/2000	0320	1.01	131	188
			05/02/2000	0420	.71	115	200
			05/02/2000	0520	.62	113	208
			05/02/2000	0620	.58	111	208
			05/02/2000	0720	.59	113	208
			05/02/2000	0820	.64	112	208
			05/02/2000	0920	.83	117	207
			05/02/2000	1020	.25	120	205
			05/02/2000	1120	.23	148	183
			05/02/2000	1220	.76	123	206
			05/02/2000	1320	.21	173	184
			05/02/2000	1420	.22	164	185
			05/02/2000	1520	.20	176	179
			05/02/2000	1620	.22	167	178
			05/02/2000	1720	.22	153	186
			05/02/2000	1920	.23	152	183
			05/02/2000	2020	.23	129	200

Appendix D. Bromide, chloride, and sulfate analyses for the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No,	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	342507118380301	SCR2	05/02/2000	0100	0.24	115	228
			05/02/2000	0300	.86	105	225
			05/02/2000	0400	.85	108	219
			05/02/2000	0500	.84	114	239
			05/02/2000	0600	1.06	113	240
			05/02/2000	0700	.93	112	238
			05/02/2000	0800	1.06	113	236
			05/02/2000	0375	.85	110	240
			05/02/2000	1000	1.07	111	239
			05/02/2000	1100	1.00	114	237
			05/02/2000	1200	.65	113	238
			05/02/2000	1300	.34	122	228
			05/02/2000	1400	.71	129	223
			05/02/2000	1500	.28	132	231
			05/02/2000	1600	.33	134	228
			05/02/2000	1700	.36	133	228
			05/02/2000	1800	.32	133	225
			05/02/2000	1900	.30	130	226
			05/02/2000	2000	.34	126	228
			05/02/2000	2100	.29	129	225
			05/02/2000	2300	.34	124	230
			05/03/2000	0001	.32	125	228
			05/03/2000	0400	.34	118	233
			05/03/2000	0800	.27	107	245
			05/03/2000	1200	.38	117	237
			05/03/2000	1600	.31	138	235
			05/03/2000	2000	.29	128	232
			05/03/2000	2300	.34	126	227
			05/04/2000	0001	.29	121	233
			05/04/2000	0400	.27	116	233
			05/04/2000	0800	.26	106	246
			05/04/2000	1200	.25	116	233
			05/04/2000	1600	.25	137	230
Santa Clara River hyporheic (H1), 0.3 mile below Castaic Creek, near Valencia, California	342507118380302	SCR2H1	05/02/2000	0030	.17	59	288
			05/02/2000	0130	.24	80	393
			05/02/2000	0230	.24	79	381
			05/02/2000	0330	.22	79	380
			05/02/2000	0430	.24	80	376
			05/02/2000	0530	.25	80	375
			05/02/2000	0630	.23	78	387
			05/02/2000	0730	.21	77	385

Appendix D. Bromide, chloride, and sulfate analyses for the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No,	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Santa Clara River hyporheic (H1), 0.3 mile below Castaic Creek, near Valencia, California	342507118380302	SCR2H1	05/02/2000	0830	0.20	74	374
			05/02/2000	0930	.20	75	384
			05/02/2000	1030	.20	76	386
			05/02/2000	1130	.21	77	390
			05/02/2000	1230	.21	77	385
			05/02/2000	1330	.25	79	380
			05/02/2000	1430	.21	77	392
			05/02/2000	1530	.20	79	390
			05/02/2000	1630	.20	83	385
			05/02/2000	1730	.21	96	365
			05/02/2000	1830	.21	82	388
			05/02/2000	1930	.21	76	387
			05/02/2000	2130	.20	78	392
			05/02/2000	2230	.20	78	393
			05/02/2000	2330	.21	78	393
			05/03/2000	0030	.22	77	392
			05/03/2000	0430	.20	80	388
			05/03/2000	0830	.23	81	386
			05/03/2000	1630	.20	80	391
			05/03/2000	2000	.22	79	394
			05/04/2000	0001	.20	80	395
			05/04/2000	0415	.20	81	394
			05/04/2000	0805	.21	81	394
			05/04/2000	1200	.22	81	395
			05/04/2000	1600	.21	82	393
Santa Clara River hyporheic (H2), 0.3 mile below Castaic Creek, near Valencia, California	342507118380303	SCR2H2	05/02/2000	0015	.21	98	360
			05/02/2000	0115	.28	88	352
			05/02/2000	0215	.23	—	421
			05/02/2000	0315	.21	93	363
			05/02/2000	0415	.21	93	357
			05/02/2000	0515	.21	95	362
			05/02/2000	0615	.21	95	361
			05/02/2000	0715	.20	96	362
			05/02/2000	0815	.21	97	363
			05/02/2000	0915	.21	98	363
			05/02/2000	1015	.21	98	362
			05/02/2000	1115	.20	97	363
			05/02/2000	1215	.21	101	359
			05/02/2000	1315	.21	100	363
			05/02/2000	1415	.21	100	363

Appendix D. Bromide, chloride, and sulfate analyses for the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No,	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Santa Clara River hyporheic (H2), 0.3 mile below Castaic Creek, near Valencia, California	342507118380303	SCR2H2	05/02/2000	1515	0.20	93	370
			05/02/2000	1615	.20	86	379
			05/02/2000	1715	.20	93	368
			05/02/2000	1815	.22	102	358
			05/02/2000	1915	.29	104	358
			05/02/2000	2015	.21	99	366
			05/02/2000	2115	.21	106	359
			05/02/2000	2215	.20	101	364
			05/02/2000	2315	.23	95	326
			05/03/2000	0415	.26	97	319
			05/03/2000	0805	.23	99	319
			05/03/2000	1215	.22	100	325
			05/03/2000	1615	.22	96	322
			05/03/2000	2000	.22	95	323
			05/04/2000	0001	.23	97	321
			05/04/2000	0415	.25	96	325
			05/04/2000	0805	.28	99	313
			05/04/2000	1200	.22	100	314
			05/04/2000	1600	.22	99	319
Santa Clara River hyporheic (H3), 0.3 mile below Castaic Creek, near Valencia, California	342507118380304	SCR2H3	05/02/2000	0015	.24	101	318
			05/02/2000	0115	.39	94	316
			05/02/2000	0215	.28	99	316
			05/02/2000	0315	.28	99	317
			05/02/2000	0415	.25	100	313
			05/02/2000	0515	.26	99	323
			05/02/2000	0615	.26	100	314
			05/02/2000	0715	.26	101	313
			05/02/2000	0815	.25	100	312
			05/02/2000	0915	.25	102	318
			05/02/2000	1015	.25	99	318
			05/02/2000	1115	.24	100	315
			05/02/2000	1215	.23	98	321
			05/02/2000	1315	.23	95	327
			05/02/2000	1415	.25	89	344
			05/02/2000	1515	.24	99	320
			05/02/2000	1615	.25	101	318
			05/02/2000	1715	.24	102	314
			05/02/2000	1815	.24	102	313
			05/02/2000	1915	.23	101	318
			05/02/2000	2015	.24	102	320

Appendix D. Bromide, chloride, and sulfate analyses for the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No,	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Santa Clara River hyporheic (H3), 0.3 mile below Castaic Creek, near Valencia, California	342507118380304	SCR2H3	05/02/2000	2115	0.23	98	329
			05/02/2000	2215	.25	102	314
			05/02/2000	2315	.24	102	314
			05/03/2000	0415	.25	103	316
			05/03/2000	0805	.24	103	311
			05/03/2000	1215	.24	104	318
			05/03/2000	1615	.24	103	318
			05/03/2000	2000	.25	105	331
			05/04/2000	0001	.24	104	316
			05/04/2000	0415	.24	104	314
			05/04/2000	0805	.25	105	311
			05/04/2000	1200	.25	105	310
			05/04/2000	1600	.25	105	309
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	342422118401701	SCR3	05/02/2000	0120	.28	117	247
			05/02/2000	0200	.27	118	248
			05/02/2000	0300	.49	115	254
			05/02/2000	0400	.71	113	253
			05/02/2000	0500	.73	114	254
			05/02/2000	0600	.72	110	253
			05/02/2000	0700	.72	112	257
			05/02/2000	0800	.82	111	255
			05/02/2000	0900	.76	111	252
			05/02/2000	1000	.76	112	256
			05/02/2000	1100	.74	101	237
			05/02/2000	1200	.79	112	255
			05/02/2000	1300	.71	112	255
			05/02/2000	1400	.39	114	252
			05/02/2000	1500	.32	122	246
			05/02/2000	1600	.31	124	246
			05/02/2000	1700	.23	—	—
			05/02/2000	1800	.23	128	246
			05/02/2000	1900	.24	126	246
			05/02/2000	2000	.23	124	245
			05/02/2000	2100	.26	—	—
			05/02/2000	2300	.25	122	244
			05/03/2000	0001	.28	118	245
			05/03/2000	0100	.24	120	245
			05/03/2000	0800	.26	110	255
			05/03/2000	1200	.27	114	249
			05/03/2000	1600	.25	120	255
			05/03/2000	2000	.25	126	248

Appendix D. Bromide, chloride, and sulfate analyses for the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No,	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	342422118401701	SCR3	05/04/2000	0001	0.25	118	252
			05/04/2000	0400	.26	114	250
			05/04/2000	0800	.25	110	253
			05/04/2000	1200	.27	112	250
Santa Clara River hyporheic (H4), 0.2 mile above Potrero Canyon, near Val Verde, California	342420118402205	SCR3H4	05/02/2000	0120	.16	63	147
			05/02/2000	0200	.24	111	233
			05/02/2000	0300	.25	118	247
			05/02/2000	0400	.26	118	247
			05/02/2000	0500	.27	118	250
			05/02/2000	0600	.29	116	249
			05/02/2000	0700	.44	115	253
			05/02/2000	0800	.56	114	255
			05/02/2000	0900	.67	113	254
			05/02/2000	1000	.68	114	256
			05/02/2000	1100	.74	113	259
			05/02/2000	1200	.78	111	256
			05/02/2000	1300	.65	112	256
			05/02/2000	1400	.72	110	255
			05/02/2000	1500	.58	113	256
			05/02/2000	1600	.68	113	257
			05/02/2000	1700	.55	115	258
			05/02/2000	1800	.40	117	253
			05/02/2000	1900	.39	121	251
			05/02/2000	2000	.32	126	249
			05/02/2000	2100	.33	129	250
			05/02/2000	2300	.29	129	248
			05/03/2000	0001	.29	128	249
			05/03/2000	0100	.32	123	249
			05/03/2000	0800	.28	117	252
			05/03/2000	1200	.22	93	212
			05/03/2000	1600	.25	110	244
			05/03/2000	2000	—	121	252
			05/04/2000	0001	.26	125	253
			05/04/2000	0400	.26	124	252
			05/04/2000	0800	.25	116	252
			05/04/2000	1200	.25	109	259
			05/04/2000	1600	.28	116	257
Santa Clara River hyporheic (H5), 0.2 mile above Potrero Canyon, near Val Verde, California	342420118402201	SCR3H5	05/02/2000	0120	.24	111	226
			05/02/2000	0200	.25	120	241

Appendix D. Bromide, chloride, and sulfate analyses for the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No,	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Santa Clara River hyporheic (H5), 0.2 mile above Potrero Canyon, near Val Verde, California	342420118402201	SCR3H5	05/02/2000	0300	0.26	124	251
			05/02/2000	0400	.26	123	250
			05/02/2000	0500	.29	122	251
			05/02/2000	0600	.27	120	253
			05/02/2000	0700	.29	119	253
			05/02/2000	0800	.36	117	254
			05/02/2000	0900	.50	116	256
			05/02/2000	1000	.62	116	258
			05/02/2000	1100	.66	115	256
			05/02/2000	1200	.71	117	260
			05/02/2000	1300	.74	114	256
			05/02/2000	1400	.75	113	256
			05/02/2000	1500	.78	112	255
			05/02/2000	1600	.82	112	257
			05/02/2000	1700	.73	115	261
			05/02/2000	1800	.59	115	255
			05/02/2000	1900	.38	117	253
			05/02/2000	2000	.34	122	253
			05/02/2000	2100	.32	128	253
			05/03/2000	0001	.28	130	250
			05/03/2000	0100	.30	130	250
			05/03/2000	0800	.27	123	247
			05/03/2000	1200	.24	89	200
			05/03/2000	1600	.25	110	244
			05/03/2000	2000	.25	120	253
			05/04/2000	0001	.27	129	253
			05/04/2000	0400	.28	126	252
			05/04/2000	0800	.27	118	250
			05/04/2000	1200	.26	114	251
			05/04/2000	1600	.25	111	255
Santa Clara River hyporheic (H6), 0.2 mile above Potrero Canyon, near Val Verde, California	342420118402206	SCR3H6	05/02/2000	0120	.26	93	208
			05/02/2000	0200	.26	111	242
			05/02/2000	0300	.27	119	256
			05/02/2000	0400	.26	117	253
			05/02/2000	0500	.26	118	255
			05/02/2000	0600	.29	119	255
			05/02/2000	0700	.28	119	256
			05/02/2000	0800	.28	118	255
			05/02/2000	0900	.37	118	255
			05/02/2000	1000	.51	117	255

Appendix D. Bromide, chloride, and sulfate analyses for the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No,	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Santa Clara River hyporheic (H6), 0.2 mile above Potrero Canyon, near Val Verde, California	342420118402206	SCR3H6	05/02/2000	1100	0.35	121	258
			05/02/2000	1200	.29	119	256
			05/02/2000	1300	.37	120	259
			05/02/2000	1400	.31	120	258
			05/02/2000	1500	.58	116	256
			05/02/2000	1600	.31	119	257
			05/02/2000	1700	.26	119	255
			05/02/2000	1800	.26	119	256
			05/02/2000	1900	.26	120	257
			05/02/2000	2000	.27	122	255
			05/02/2000	2100	.27	121	256
			05/03/2000	0001	—	121	250
			05/03/2000	0800	.29	118	253
			05/03/2000	1200	.26	115	247
			05/03/2000	1600	.20	95	209
			05/03/2000	2000	.26	118	250
			05/04/2000	0001	.24	118	250
			05/04/2000	0400	.26	119	254
			05/04/2000	0800	.26	119	252
			05/04/2000	1200	.29	119	252
			05/04/2000	1600	.30	119	252
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	342359118424501	SCR4	5/2/2001	0400	.26	108	289
			05/02/2000	0500	.49	119	324
			05/02/2000	0600	.62	119	325
			05/02/2000	0700	.64	119	324
			05/02/2000	0800	.62	117	326
			05/02/2000	0900	.68	116	323
			05/02/2000	1000	.71	117	323
			05/02/2000	1100	.70	118	324
			05/02/2000	1200	.70	118	327
			05/02/2000	1300	.73	118	329
			05/02/2000	1400	.74	119	331
			05/02/2000	1500	.59	119	327
			05/02/2000	1600	.41	122	319
			05/02/2000	1700	.37	127	317
			05/02/2000	1800	.37	131	318
			05/02/2000	1900	.34	132	40
			05/02/2000	2000	.35	—	—
			05/02/2000	2100	.34	131	314
			05/02/2000	2200	.34	129	314

Appendix D. Bromide, chloride, and sulfate analyses for the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No,	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	342359118424501	SCR4	05/02/2000	2300	0.32	128	310
			05/03/2000	0100	.33	128	309
			05/03/2000	0100	.33	127	315
			05/03/2000	0200	.32	125	315
			05/03/2000	0300	.32	123	303
			05/03/2000	0400	.32	124	317
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450101	SCR5	05/02/2000	0630	.50	122	356
			05/02/2000	0730	.58	120	355
			05/02/2000	0830	.63	121	358
			05/02/2000	0930	.62	120	358
			05/02/2000	1030	.66	121	363
			05/02/2000	1130	.68	120	362
			05/02/2000	1230	.70	122	363
			05/02/2000	1330	.69	123	368
			05/02/2000	1430	.69	121	367
			05/02/2000	1530	.72	123	369
			05/02/2000	1630	.69	123	364
			05/02/2000	1730	.51	124	358
			05/02/2000	1830	.43	126	354
			05/02/2000	1930	.41	130	354
			05/02/2000	2030	.40	132	354
			05/02/2000	2130	.39	133	354
			05/02/2000	2230	.39	133	357
			05/02/2000	2330	.39	132	354
			05/03/2000	0030	.38	—	—
			05/03/2000	0130	.31	107	293
			05/03/2000	0230	.35	130	351
			05/03/2000	0330	.35	129	353
			05/03/2000	0430	.35	128	355
			05/03/2000	0530	.35	128	358
			05/03/2000	1030	.36	126	374
			05/03/2000	1500	.36	126	370
			05/03/2000	1800	.37	129	391
			05/03/2000	2215	.34	136	365
			05/04/2000	0030	.36	132	350
			05/04/2000	0200	.35	128	370
			05/04/2000	0620	.36	128	372
			05/04/2000	1100	.35	124	376
			05/04/2000	1440	.35	123	374

Appendix D. Bromide, chloride, and sulfate analyses for the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No,	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Santa Clara River hyporheic (H4),0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450105	SCR5H4	05/02/2000	0640	0.41	121	337
			05/02/2000	0740	.37	124	349
			05/02/2000	0840	.35	124	354
			05/02/2000	0940	.41	124	360
			05/02/2000	1040	.52	123	361
			05/02/2000	1140	.58	123	364
			05/02/2000	1240	.62	121	362
			05/02/2000	1340	.64	122	366
			05/02/2000	1440	.67	122	365
			05/02/2000	1540	.68	123	369
			05/02/2000	1640	.68	124	372
			05/02/2000	1740	.78	124	376
			05/02/2000	1840	.73	125	376
			05/02/2000	1940	.71	125	375
			05/02/2000	2040	.59	126	370
			05/02/2000	2140	.52	—	—
			05/02/2000	2240	.45	—	—
			05/02/2000	2340	.41	135	354
			05/03/2000	0040	.36	—	—
			05/03/2000	0140	.30	—	—
			05/03/2000	0240	.37	132	358
			05/03/2000	0340	.37	133	359
			05/03/2000	0440	.35	132	354
			05/03/2000	0540	.34	132	358
			05/03/2000	1030	.36	128	362
			05/03/2000	1500	.38	126	380
			05/03/2000	1800	.36	125	374
			05/03/2000	2230	.35	129	380
			05/04/2000	0200	.36	132	377
			05/04/2000	0620	.35	131	378
			05/04/2000	1100	.33	128	372
			05/04/2000	1430	.32	—	—
Santa Clara River hyporheic (H5), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450106	SCR5H5	05/02/2000	0640	.33	127	352
			05/02/2000	0740	.30	122	343
			05/02/2000	0840	.32	125	351
			05/02/2000	0940	.36	125	359
			05/02/2000	1040	.44	122	356
			05/02/2000	1140	.56	122	358
			05/02/2000	1240	.61	122	361
			05/02/2000	1340	.64	122	362

Appendix D. Bromide, chloride, and sulfate analyses for the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No,	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Santa Clara River hyporheic (H5), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450106	SCR5H5	05/02/2000	1440	0.68	122	364
			05/02/2000	1540	.70	122	363
			05/02/2000	1640	.70	122	371
			05/02/2000	1740	.70	123	371
			05/02/2000	1840	.73	125	376
			05/02/2000	1940	.73	124	373
			05/02/2000	2040	.62	126	370
			05/02/2000	2140	.63	125	368
			05/02/2000	2240	.48	128	363
			05/02/2000	2340	.44	130	359
			05/03/2000	0040	.41	133	361
			05/03/2000	0140	.40	133	358
			05/03/2000	0240	.37	133	361
			05/03/2000	0340	.37	132	357
			05/03/2000	0440	.35	132	355
			05/03/2000	0540	.35	132	355
			05/03/2000	1030	.37	129	369
			05/03/2000	1500	.37	127	378
			05/03/2000	1800	.36	125	377
			05/03/2000	2230	.37	129	387
			05/04/2000	0200	.36	132	380
			05/04/2000	0620	.36	130	376
			05/04/2000	1100	.35	127	371
Santa Clara River hyporheic (H6), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450107	SCR5H6	05/02/2000	0640	.53	121	349
			05/02/2000	0740	.41	125	350
			05/02/2000	0840	.38	131	367
			05/02/2000	0940	.37	125	358
			05/02/2000	1040	.48	125	366
			05/02/2000	1140	.56	122	363
			05/02/2000	1240	.60	123	366
			05/02/2000	1340	.64	122	366
			05/02/2000	1440	.67	122	368
			05/02/2000	1540	.70	125	376
			05/02/2000	1640	.69	126	378
			05/02/2000	1740	.73	125	376
			05/02/2000	1940	.70	125	373
			05/02/2000	2040	.69	126	374
			05/02/2000	2140	.57	126	367
			05/02/2000	2240	.51	133	377
			05/03/2000	0040	.37	133	362

Appendix D. Bromide, chloride, and sulfate analyses for the constant-rate injection tracer tests from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	USGS station No,	Reference name	Date	Time	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
Santa Clara River hyporheic (H6), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450107	SCR5H6	05/03/2000	0140	0.35	111	301
			05/03/2000	0240	.38	127	345
			05/03/2000	0340	.36	131	354
			05/03/2000	0440	.36	132	356
			05/03/2000	0540	.41	131	356
			05/03/2000	1030	.36	127	364
			05/03/2000	1500	.38	126	381
			05/03/2000	1800	.37	126	376
			05/03/2000	2230	.37	131	381
			05/04/2000	0200	.36	133	382
			05/04/2000	0620	.36	130	374
			05/04/2000	1100	.35	128	373
			05/04/2000	1430	.36	126	383

Appendix E. Chemical analyses from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999

[Parameter code, in brackets, is a 5-digit number used in the U.S. Geological Survey (USGS) computerized National Water Information System (NWIS); WRP, water reclamation plant; mm of Hg, millimeters of mercury; µS/cm, microsiemen per centimeter at 25°C; mg/L, milligram per liter; °C, degree Celsius; —, no data; M, measurable but not quantifiable; <, less than]

USGS station name	USGS station No.	Reference name	Date	Time	Barometric pressure (mm of Hg) [00025]	Oxygen, dissolved (mg/L) [00300]	Oxygen, dissolved (percent saturation) [00301]	pH water whole field (standard units) [00400]	Specific conductance (µS/cm) [00095]
Saugus WRP effluent, at Saugus, California	342456118322001	Saugus WRP	10/21/1999	2200	—	—	—	7.7	1,190
Santa Clara River, at Old Road, near Valencia, California	342535118350801	SCRA	10/22/1999	1210	—	—	—	7.9	1,160
Santa Clara River, at Old Road near Valencia, California	342535118350801	SCRA	10/19/1999	0200	—	—	—	6.7	1,110
Valencia WRP effluent, at Valencia, California	342548118352401	Valencia WRP	10/19/1999	0230	735	—	—	6.6	1,180
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	342557118353801	SCR1	10/19/1999	0305	735	4.7	54	6.6	1,170
Santa Clara River 0.3 mile below Castaic Creek near Valencia, California	342507118380301	SCR2	10/19/1999	0530	738	3.7	40	7.9	1,150
Santa Clara River 0.2 miles above Potrero Canyon near Val Verde, California	342422118401701	SCR3	10/19/1999	0800	741	—	—	6.6	1,160
Santa Clara River hyporheic (F1) 0.2 mile above Potrero Canyon, California	342422118401702	SCR3H1	10/19/1999	1530	—	—	—	7.8	1,310
Santa Clara River 200 feet below Tapo Canyon East Road near Val Verde, California	342359118424501	SCR4	10/19/1999	0930	743	7.7	80	7.8	1,270
Santa Clara River 0.9 mile below bridge crossing at Newhall Farms near Piru, California	342404118450101	SCR5	10/19/1999	1230	745	7.3	81	8.2	1,400
Santa Clara River hyporheic (F1) 0.9 mile below bridge Newhall Farms, California	342404118450102	SCR5H1	10/20/1999	0705	—	—	—	8.2	1,390

Appendix E. Chemical analyses from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999—Continued

USGS station name	Reference name	Date	Time	Temperature water (°C) [00010]	Hardness non-carbonate, dissolved field as $CaCO_3$ (mg/L) [00904]	Hardness, total (mg/L as $CaCO_3$) [00900]	Calcium, dissolved (mg/L as Ca) [00915]	Magnesium, dissolved (mg/L as Mg) [00925]	Potassium, dissolved (mg/L as K) [00935]	Sodium[1], dissolved (mg/L as Na) [00930]	Sodium, (percent) [00932]
Saugus WRP effluent, at Saugus, California	Saugus WRP	10/21/1999	2200	—	—	230	57.0	20.0	17.2	150	57
Santa Clara River, at Old Road, near Valencia, California	SCRA	10/22/1999	1210	—	140	420	107	36.5	3.71	98.1	34
Santa Clara River, at Old Road, near Valencia, California	SCRA	10/19/1999	0200	—	130	420	105	37.3	3.88	96.8	33
Valencia WRP effluent, at Valencia, California	Valencia WRP	10/19/1999	0230	26.0	42	260	69.8	20.3	18.9	150	54
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	SCR1	10/19/1999	0305	20.0	65	300	77.2	26.7	14.1	137	48
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	SCR2	10/19/1999	0530	17.5	110	350	88.9	30.3	10.5	124	43
Santa Clara River, 0.2 miles above Potrero Canyon, near Val Verde, California	SCR3	10/19/1999	0800	16.0	150	370	94.9	32.2	10.8	125	42
Santa Clara River hyporheic (F1), 0.2 mile above Potrero Canyon, California	SCR3H1	10/19/1999	1530	—	230	480	132	36.8	10.1	141	38
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	SCR4	10/19/1999	0930	16.0	260	500	130	42.2	9.34	140	37
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5	10/19/1999	1230	19.0	300	530	141	44.4	9.33	140	36
Santa Clara River hyporheic (F1), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5H1	10/20/1999	0705	—	220	450	108	43.8	9.05	148	41

See footnote at end of appendix.

Appendix E. Chemical analyses from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999—Continued

USGS station name	Reference name	Date	Time	Alkalinity, water, dissolved, Gran Titration, field, $CaCO_3$ (mg/L) [29802]	Alkalinity, field (mg/L as $CaCO_3$) [39086]	Chloride, dissolved (mg/L as Cl) [00940]	Fluoride, dissolved (mg/L as F) [00950]	Silica, dissolved (mg/L as SiO_2) [00955]	Sulfate, dissolved (mg/L as SO_4) [00945]	Solids, residue at 180°C dissolved (mg/L) [70300]
Saugus WRP effluent, at Saugus, California	Saugus WRP	10/21/1999	2200	—	234	140	0.4	21.7	146	722
Santa Clara River, at Old Road, near Valencia, California	SCRA	10/22/1999	1210	—	276	96.8	.6	25.5	207	800
Santa Clara River, at Old Road, near Valencia, California	SCRA	10/19/1999	0200	280	—	102	.5	24.7	217	820
Valencia WRP effluent, at Valencia, California	Valencia WRP	10/19/1999	0230	220	—	156	.4	25.2	183	750
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	SCR1	10/19/1999	0305	240	—	137	.5	23.7	202	784
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	SCR2	10/19/1999	0530	240	—	126	.5	19.9	251	814
Santa Clara River, 0.2 miles above Potrero Canyon, near Val Verde, California	SCR3	10/19/1999	0800	220	—	117	.5	21.4	250	850
Santa Clara River hyporheic (F1), 0.2 mile above Potrero Canyon, California	SCR3H1	10/19/1999	1530	250	—	130	.5	22.2	301	908
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	SCR4	10/19/1999	0930	240	—	121	.6	20.8	343	960
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5	10/19/1999	1230	240	—	121	.6	18.0	365	1,030
Santa Clara River hyporheic (F1), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5H1	10/20/1999	0705	230	—	130	.5	15.0	356	1,010

Appendix E. Chemical analyses from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999—Continued

USGS station name	Reference name	Date	Time	Solids, sum of constituents dissolved (mg/L) [70301]	Nitrogen, Ammonia, dissolved (mg/L as N) [00608]	Nitrogen, Ammonia, + organic, dissolved (mg/L as N) [00623]	Nitrogen, Ammonia, + organic, total (mg/L as N) [00625]	Nitrogen, dissolved (mg/L as N) [00602]	Nitrogen, Nitrate dissolved (mg/L as N) [00618]	Nitrogen, $NO_2 + NO_3$, dissolved (mg/L as N) [00631]
Saugus WRP effluent, at Saugus, California	Saugus WRP	10/21/1999	2200	729	9.51	11	13	15	0.921	4.12
Santa Clara River, at Old Road, near Valencia, California	SCRA	10/22/1999	1210	767	<.020	.19	.22	5.9	5.67	5.69
Santa Clara River, at Old Road, near Valencia, California	SCRA	10/19/1999	0200	758	<.020	<.10	.30	—	—	<.050
Valencia WRP effluent, at Valencia, California	Valencia WRP	10/19/1999	0230	794	15.1	17	18	21	2.85	3.90
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	SCR1	10/19/1999	0305	799	9.60	12	12	17	4.25	4.97
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	SCR2	10/19/1999	0530	830	4.32	5.1	6.0	11	5.32	6.26
Santa Clara River, 0.2 miles above Potrero Canyon, near Val Verde, California	SCR3	10/19/1999	0800	818	2.31	3	3.3	9.3	5.48	6.28
Santa Clara River hyporheic (F1), 0.2 mile above Potrero Canyon, California	SCR3H1	10/19/1999	1530	940	.107	.55	1.6	4.2	3.58	3.63
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	SCR4	10/19/1999	0930	978	.967	1.3	2.5	6.9	5.08	5.54
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5	10/19/1999	1230	1,010	.234	.66	.86	6.3	5.37	5.66
Santa Clara River hyporheic (F1), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5H1	10/20/1999	0705	981	.042	.43	.51	7.1	6.66	6.70

Appendix E. Chemical analyses from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999—Continued

USGS station name	Reference Name	Date	Time	Nitrogen, Nitrite, dissolved (mg/L as N) [00613]	Phosphorus, dissolved (mg/L as P) [00666]	Phosphorus, ortho, dissolved ,(mg/L as P) [00671]	Phosphorus, total (mg/L as P) [00665]	Carbon, organic dissolved (mg/L as C) [00681]	Boron, dissolved (mg/L as B) [01020]	Iron, dissolved (mg/L as Fe) [01046]	Manganese, dissolved (mg/L as Mn) [01056]
Saugus WRP effluent, at Saugus, California	Saugus WRP	10/21/1999	2200	3.19	0.300	0.251	0.393	10	879	22	12.2
Santa Clara River, at Old Road, near Valencia, California	SCRA	10/22/1999	1210	.021	.232	.199	.213	1.9	624	<10	24.7
Santa Clara River, at Old Road, near Valencia, California	SCRA	10/19/1999	0200	<.010	<.006	<.010	.201	1.9	623	<10	24.4
Valencia WRP effluent, at Valencia, California	Valencia WRP	10/19/1999	0230	1.04	1.200	1.00	1.27	9.1	890	60	41.0
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	SCR1	10/19/1999	0305	.724	.877	.752	.994	6.6	758	30	25.8
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	SCR2	10/19/1999	0530	.940	.622	.556	.615	5.0	698	30	30.8
Santa Clara River, 0.2 miles above Potrero Canyon, near Val Verde, California	SCR3	10/19/1999	0800	.797	.517	.452	.529	4.4	675	20	26.9
Santa Clara River hyporheic (F1), 0.2 mile above Potrero Canyon, California	SCR3H1	10/19/1999	1530	.050	.410	.414	.794	4.6	804	20	197
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	SCR4	10/19/1999	0930	.460	.420	.357	.626	3.6	737	20	39.3
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5	10/19/1999	1230	.290	.365	.338	.392	3.7	753	M	7.9
Santa Clara River hyporheic (F1), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5H1	10/20/1999	0705	.038	.420	.371	.406	3.5	691	M	<2.2

[1]Sodium values are biased by the sodium bromide tracer added to the river.

Appendix F. Chemical analyses from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000

[Parameter code, in brackets, is a 5-digit number used in the U.S. Geological Survey (USGS) computerized National Water Information System (NWIS); mm of Hg, millimeters of mercury; µS/cm, microsiemen per centimeter at 25°C; WRP, water reclamation plant; mg/L, milligram per liter; °C, degree Celsius; —, no data; M, measurable but not quantifiable; <, less than]

USGS station name	USGS station No.	Reference name	Date	Time	Barometric pressure (mm of Hg) [00025]	Oxygen, dissolved (mg/L) [00300]	Oxygen, dissolved (percent saturation) [00301]	pH water whole field (standard units) [00400]
Santa Clara River, 0.1 mile below Saugus WRP, near Saugus, California	342527118323001	SCRS1	05/04/2000	2230	—	—	—	7.7
Santa Clara River, above McBean Parkway Bridge, near Saugus, California	342530118332501	SCRS2	05/05/2000	0015	—	—	—	8.1
Santa Clara River, at Old Road, near Valencia, California		SCRA	05/05/2000	0300	731	7.7	83	8.2
Santa Clara River, at Old Road, near Valencia, California	342535118350801	SCRA	05/02/2000	0100	732	7.9	85	8.3
Valencia WRP effluent, at Valencia, California	342548118352401	Valencia WRP	05/02/2000	0200	—	—	—	7.9
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	342557118353801	SCR1	05/02/2000	0230	732	7.2	77	8.2
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	342507118380301	SCR2	05/02/2000	0400	735	6.7	72	8.2
Santa Clara River hyporheic (H2), 0.3 mile below Castaic Creek, near Valencia, California	342507118380303	SCR2H2	05/02/2000	0650	—	—	—	7.8
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	342422118401701	SCR3	05/02/2000	0600	736	7.2	75	8.2
Santa Clara River hyporheic (H5), 0.2 mile above Potrero Canyon, near Val Verde, California	342420118402201	SCR3H5	05/02/2000	1530	—	—	—	7.8
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	342359118424501	SCR4	05/02/2000	0900	739	7.8	87	8.3
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450101	SCR5	05/02/2000	1100	740	6.6	80	8.4
Santa Clara River hyporheic (H5), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450106	SCR5H5	05/02/2000	1620	—	—	—	7.8

Appendix F. Chemical analyses from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	Reference name	Date	Time	Specific conductance (µS/cm) [00095]	Temperature, water (°C) [00010]	Hardness non-carbonate, dissolved field (mg/L as $CaCO_3$) [00904]	Hardness, total (mg/L as $CaCO_3$) [00900]	Calcium, dissolved (mg/L as Ca) [00915]	Magnesium, dissolved (mg/L as Mg) [00925]	Potassium, dissolved (mg/L as K) [00935]	Sodium[1] dissolved (mg/L as Na) [00930]
Santa Clara River, 0.1 mile below Saugus WRP, near Saugus, California	SCRS1	05/04/2000	2230	1,280	25.0	—	210	52.6	19.6	17.1	159
Santa Clara River, above McBean Parkway Bridge, near Saugus, California	SCRS2	05/05/2000	0015	1,230	—	—	210	53.5	19.1	16.9	150
Santa Clara River, at Old Road, near Valencia, California	SCRA	05/05/2000	0300	1,220	17.0	150	410	103	38.1	3.60	101
Santa Clara River, at Old Road, near Valencia, California	SCRA	05/02/2000	0100	1,220	17.0	170	400	100	36.9	3.73	95.4
Valencia WRP effluent, at Valencia, California	Valencia WRP	05/02/2000	0200	1,400	24.5	—	230	58.0	20.0	19.1	149
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	SCR1	05/02/2000	0230	1,320	17.5	100	330	83.6	29.9	11.6	123
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	SCR2	05/02/2000	0400	1,300	17.5	130	370	93.0	32.5	9.50	121
Santa Clara River hyporheic (H2), 0.3 mile below Castaic Creek, near Valencia, California	SCR2H2	05/02/2000	0650	1,350	—	150	380	97.2	32.7	9.18	141
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	SCR3	05/02/2000	0600	1,320	16.0	180	400	103	35.1	9.41	119
Santa Clara River hyporheic (H5), 0.2 mile above Potrero Canyon, near Val Verde, California	SCR3H5	05/02/2000	1530	1,250	—	150	380	95.9	33.2	10.3	121
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	SCR4	05/02/2000	0900	1,460	19.0	240	450	111	43.0	8.99	136
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5	05/02/2000	1100	1,550	23.5	250	460	112	44.2	9.72	138
Santa Clara River hyporheic (H5), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5H5	05/02/2000	1620	1,540	—	220	440	105	43.7	9.02	153

See footnote at end of appendix.

Appendix F. Chemical analyses from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	Reference name	Date	Time	Sodium, (percent) [00932]	Alkalinity, water dissolved, Gran Titration, field (mg/L as $CaCO_3$) [29802]	Chloride, dissolved (mg/L as Cl) [00940]	Fluoride, dissolved (mg/L as F) [00950]	Silica, dissolved (mg/L as SiO_2) [00955]	Sulfate, dissolved (mg/L as SO_4) [00945]	Solids, residue at 180°C dissolved (mg/L) [70300]
Santa Clara River, 0.1 mile below Saugus WRP, near Saugus, California	SCRS1	05/04/2000	2230	60	240	147	.3	20.3	142	730
Santa Clara River, above McBean Parkway Bridge, near Saugus, California	SCRS2	05/05/2000	0015	58	230	146	.4	19	145	734
Santa Clara River, at Old Road, near Valencia, California	SCRA	05/05/2000	0300	35	260	102	.5	25.1	184	768
Santa Clara River, at Old Road, near Valencia, California	SCRA	05/02/2000	0100	34	230	111	.5	23.5	184	780
Valencia WRP effluent, at Valencia, California	Valencia WRP	05/02/2000	0200	56	240	156	.4	22.7	179	766
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	SCR1	05/02/2000	0230	43	230	130	.4	23.2	194	772
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	SCR2	05/02/2000	0400	41	230	120	.5	22.4	229	822
Santa Clara River hyporheic (H2), 0.3 mile below Castaic Creek, near Valencia, California	SCR2H2	05/02/2000	0650	44	220	91.7	.4	21.9	319	902
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	SCR3	05/02/2000	0600	39	220	113	.5	22.2	246	848
Santa Clara River hyporheic (H5), 0.2 mile above Potrero Canyon, near Val Verde, California	SCR3H5	05/02/2000	1530	40	230	109	.5	20.5	246	844
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	SCR4	05/02/2000	0900	39	220	119	.5	21	331	982
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5	05/02/2000	1100	39	220	123	.6	20.1	358	1,060
Santa Clara River hyporheic (H5), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5H5	05/02/2000	1620	42	230	120	.5	21.9	354	1,050

Appendix F. Chemical analyses from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	Reference name	Date	Time	Solids, sum of constituents dissolved (mg/L) [70301]	Nitrogen, Ammonia, dissolved (mg/L as N) [00608]	Nitrogen, Ammonia, + organic, dissolved (mg/L as N) [00623]	Nitrogen, Ammonia, + organic, total (mg/L as N) [00625]	Nitrogen, dissolved (mg/L as N) [00602]	Nitrogen, Nitrate dissolved (mg/L as N) [00618]	Nitrogen, $NO_2 + NO_3$, dissolved (mg/L as N) [00631]
Santa Clara River, 0.1 mile below Saugus WRP, near Saugus, California	SCRS1	05/04/2000	2230	738	11.7	2.6	14	6.4	1.66	3.81
Santa Clara River, above McBean Parkway Bridge, near Saugus, California	SCRS2	05/05/2000	0015	723	9.36	11	12	16	3.63	4.90
Santa Clara River, at Old Road, near Valencia, California	SCRA	05/05/2000	0300	740	.133	.33	.24	5.8	5.42	5.47
Santa Clara River, at Old Road, near Valencia, California	SCRA	05/02/2000	0100	719	.135	.33	.43	6.2	5.80	5.85
Valencia WRP effluent, at Valencia, California	Valencia WRP	05/02/2000	0200	792	24.8	27	30	30	1.61	2.78
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	SCR1	05/02/2000	0230	769	11.6	12	13	17	3.88	4.58
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	SCR2	05/02/2000	0400	802	6.83	7.6	7.9	13	4.61	5.51
Santa Clara River hyporheic (H2), 0.3 mile below Castaic Creek, near Valencia, California	SCR2H2	05/02/2000	0650	852	.999	1.2	1.7	1.4	—	.140
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	SCR3	05/02/2000	0600	812	3.88	4.8	5.0	11	5.08	5.86
Santa Clara River hyporheic (H5), 0.2 mile above Potrero Canyon, near Val Verde, California	SCR3H5	05/02/2000	1530	806	.491	.85	1.3	7.4	6.32	6.55
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	SCR4	05/02/2000	0900	932	1.54	2.1	2.5	8.6	5.65	6.48
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5	05/02/2000	1100	970	.183	.67	1.1	8.2	6.70	7.5
Santa Clara River hyporheic (H5), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5H5	05/02/2000	1620	981	<.020	.28	.31	8.3	—	8.04

Appendix F. Chemical analyses from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	Reference name	Date	Time	Nitrogen, Nitrite, dissolved (mg/L as N) [00613]	Phosphorus, dissolved (mg/L as P) [00666]	Phosphorus ortho, dissolved (mg/L as P) [00671]	Phosphorus, total (mg/L as P) [00665]	Carbon, organic dissolved (mg/L as C) [00681]	Boron, dissolved (mg/L as B) [01020]	Iron, dissolved (mg/L as Fe) [01046]	Manganese, dissolved (mg/L as Mn) [01056]
Santa Clara River, 0.1 mile below Saugus WRP, near Saugus, California	SCRS1	05/04/2000	2230	2.15	0.204	0.131	0.213	10	906	20	11.8
Santa Clara River, above McBean Parkway Bridge, near Saugus, California	SCRS2	05/05/2000	0015	1.27	.169	.113	.355	8.7	869	20	8.9
Santa Clara River, at Old Road, near Valencia, California	SCRA	05/05/2000	0300	.051	.151	.127	.207	1.7	609	<10	27.3
Santa Clara River, at Old Road, near Valencia, California	SCRA	05/02/2000	0100	.054	.146	.126	.216	1.9	573	<10	29.3
Valencia WRP effluent, at Valencia, California	Valencia WRP	05/02/2000	0200	1.17	.244	.185	.306	8.9	850	50	44.6
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	SCR1	05/02/2000	0230	.705	.210	.166	.337	5.1	712	20	32.5
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	SCR2	05/02/2000	0400	.901	.188	.193	.814	15	654	10	35.8
Santa Clara River hyporheic (H2), 0.3 mile below Castaic Creek, near Valencia, California	SCR2H2	05/02/2000	0650	<.010	.346	.319	4.56	3.0	540	<10	178
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	SCR3	05/02/2000	0600	.771	.183	.142	.298	3.6	644	M	29.9
Santa Clara River hyporheic (H5), 0.2 mile above Potrero Canyon, near Val Verde, California	SCR3H5	05/02/2000	1530	.233	.248	.219	45.1	5.2	649	<10	167
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	SCR4	05/02/2000	0900	.826	.171	.134	.403	3.4	672	<10	23.5
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5	05/02/2000	1100	.801	.171	.137	.448	3.6	684	<10	<2.2
Santa Clara River hyporheic (H5), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5H5	05/02/2000	1620	<.010	.182	.153	.189	2.7	742	<10	<2.2

[1]Sodium values are biased by the sodium bromide tracer added to the river.

Appendix G. Wastewater indicators from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999

[All concentrations are in micrograms per liter; USGS, U.S. Geological Survey; WRP, water reclamation plant; <,less than indicated detection limit; E, estimate; *, compound demonstrates poor or variable method performance, therefore any detected values are always estimated]

USGS station name	USGS station No.	Reference name	Date	Time	1,4-Dichloro-benzene	3-Beta coprostanol*
Saugus WRP effluent, at Saugus, California	342456118322001	Saugus WRP	10/21/1999	2200	2.0	E0.53
Santa Clara River, at Old Road, near Valencia, California	342535118350801	SCRA	10/22/1999	1210	<.03	<.60
Santa Clara River, at Old Road, near Valencia, California	342535118350801	SCRA	10/19/1999	0200	<.03	<.60
Valencia WRP effluent, at Valencia, California	342548118352401	Valencia WRP	10/19/1999	0230	.70	E.53
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	342557118353801	SCR1	10/19/1999	0305	.36	E.47
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	342507118380301	SCR2	10/19/1999	0530	.08	<.60
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	342422118401701	SCR3	10/19/1999	0800	<.03	<.60
Santa Clara River hyporheic (F1), 0.2 mile above Potrero Canyon, California	342422118401702	SCR3H1	10/19/1999	1530	<.03	<.60
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	342359118424501	SCR4	10/19/1999	0930	<.03	<.60
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450101	SCR5	10/19/1999	1230	<.03	<.60
Santa Clara River hyporheic (F1), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450102	SCR5H1	10/20/1999	1530	<.03	<.60

Appendix G. Wastewater indicators from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999—Continued

USGS station name	Reference name	Date	Time	Aceto-phenone	Caffeine	Cholesterol*	Codeine	Diazinon	Ethanol,2-butoxy-phosphate	Nonyl-phenol mono-ethoxylate* (total)
Saugus WRP effluent, at Saugus, California	Saugus WRP	10/21/1999	2200	0.48	0.31	E0.32	1.4	<0.03	6.3	E18
Santa Clara River, at Old Road, near Valencia, California	SCRA	10/22/1999	1210	<.15	<.06	<1.0	<.10	<.03	<.07	<.80
Santa Clara River, at Old Road, near Valencia, California	SCRA	10/19/1999	0200	<.15	<.06	<1.0	<.10	<.03	<.07	<.080
Valencia WRP effluent, at Valencia, California	Valencia WRP	10/19/1999	0230	.19	2.4	E.30	.78	.09	4.8	E12
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	SCR1	10/19/1999	0305	<.15	1.6	E.43	.78	.08	2.6	E7.8
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	SCR2	10/19/1999	0530	<.15	.44	<1.0	.50	.04	1.0	E2.0
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	SCR3	10/19/1999	0800	<.15	.22	E.74	.24	E.01	.60	E.76
Santa Clara River hyporheic (F1), 0.2 mile above Potrero Canyon, California	SCR3H1	10/19/1999	1530	<.15	1.2	E.62	<.10	.04	1.6	<.80
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	SCR4	10/19/1999	0930	<.15	.18	E.27	.34	.03	.80	E.72
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5	10/19/1999	1230	<.15	.17	E.30	<.10	E.02	.53	<.80
Santa Clara River hyporheic (F1), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5H1	10/20/1999	1530	<.15	.16	<1.0	<.10	<.03	<.07	E.37

Appendix G. Wastewater indicators from selected surface-water and hyporheic sites, Santa Clara River, California, October 1999—Continued

USGS station name	Reference name	Date	Time	Nonylphenol diethoxylate* (total)	Paranonyl phenol* (total)	Phenol	Phthalic anhydride	Tributyl phosphate	Triclosan	Tri (2 chloroethyl) phosphate
Saugus WRP effluent,at Saugus, California	Saugus WRP	10/21/1999	2200	E12	E1.8	0.37	0.98	1.3	0.12	0.69
Santa Clara River, at Old Road, near Valencia, California	SCRA	10/22/1999	1210	<1.0	<.50	.63	<.20	<.06	<.04	<.04
Santa Clara River, at Old Road, near Valencia, California	SCRA	10/19/1999	0200	<1.0	<.50	<.15	<.20	<.06	<.04	<.04
Valencia WRP effluent, at Valencia, California	Valencia WRP	10/19/1999	0230	E12	E3.2	.94	1.2	.94	.38	.80
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	SCR1	10/19/1999	0305	E8.5	E2.1	<.15	.94	.67	.31	.61
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	SCR2	10/19/1999	0530	E2.4	E1.3	<.15	.59	.30	.14	.46
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	SCR3	10/19/1999	0800	E.82	E.88	<.15	<.20	.12	.16	.34
Santa Clara River hyporheic (F1), 0.2 mile above Potrero Canyon, California	SCR3H1	10/19/1999	1530	<1.0	E2.1	<.15	.62	<.06	.12	.40
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	SCR4	10/19/1999	0930	<1.0	E.90	.31	<.20	.15	.10	.37
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5	10/19/1999	1230	<1.0	<.50	<.15	<.20	<.06	.08	.30
Santa Clara River hyporheic (F1), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5H1	10/20/1999	1530	E.56	E.55	<.15	<.20	<.06	.07	.21

Appendix H. Wastewater indicators from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000

[All concentrations are in micrograms per liter; USGS, U.S. Geological Survey; WRP, water reclamation plant; <,less than indicated detected limit; E, estimate; *, compound demonstrates poor or variable method performance, therefore any detected values are always estimated; na, not available]

USGS station name	USGS station No.	Reference name	Date	Time	1,4-dichloro-benzene	3-beta coprostanol*	5-methyl-1H-benzotriazle
Santa Clara River, 0.1 mile below Saugus WRP, near Saugus, California	342527118323001	SCRS1	05/04/2000	2230	5.2	E0.68	0.42
Santa Clara River, above McBean Parkway Bridge, near Saugus, California	342530118332501	SCRS2	05/05/2000	0015	.97	E.79	<.10
Santa Clara River, at Old Road, near Valencia, California	342535118350801	SCRA	05/05/2000	0300	E.01	<.60	<.10
Santa Clara River, at Old Road, near Valencia, California	342535118350801	SCRA	05/02/2000	0100	<.03	<.60	<.10
Valencia WRP effluent, at Valencia, California	342548118352401	Valencia WRP	05/02/2000	0200	.16	E1.03	1.5
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	342557118353801	SCR1	05/02/2000	0230	.48	E.43	.90
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	342507118380301	SCR2	05/02/2000	0400	.08	<.60	.50
Santa Clara River hyporheic (H2), 0.3 mile below Castaic Creek, near Valencia, California	342507118380303	SCR2H2	05/02/2000	0650	.04	<.60	<.10
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	342422118401701	SCR3	05/02/2000	0600	E.02	E.24	.55
Santa Clara River hyporheic (H5), 0.2 mile above Potrero Canyon, near Val Verde, California	342420118402201	SCR3H5	05/02/2000	1530	<.03	<.60	.37
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	342359118424501	SCR4	05/02/2000	0900	<.03	<.60	.45
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450101	SCR5	05/02/2000	1100	<.03	<.60	.45
Santa Clara River hyporheic (H5), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	342404118450106	SCR5H5	05/02/2000	1620	<.03	<.60	<.10

Appendix H. Wastewater indicators from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	Reference name	Date	Time	Aceto-phenone	Caffeine	Choles-terol*	Codeine	Diazinon	Ethanol,2-butoxy-phosphate	N,N-diethyl toluamide	Nonylphenol -mono-ethoxylate* (total)
Santa Clara River, 0.1 mile below Saugus WRP, near Saugus, California	SCRS1	05/04/2000	2230	.21	.18	E1.1	0.70	.15	1.1	0.34	E16
Santa Clara River, above McBean Parkway Bridge, near Saugus, California	SCRS2	05/05/2000	0015	.25	.17	E1.1	.76	.19	.89	.4	E12
Santa Clara River, at Old Road, near Valencia, California	SCRA	05/05/2000	0300	<.10	E.03	E.83	<.10	<.03	.41	E.02	E.67
Santa Clara River, at Old Road, near Valencia, California	SCRA	05/02/2000	0100	<.10	E.05	<1.5	<.10	.04	.12	E.03	E.70
Valencia WRP effluent, at Valencia, California	Valencia WRP	05/02/2000	0200	.29	.73	E1.8	.49	.20	2.7	.43	E4.8
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	SCR1	05/02/2000	0230	<.10	.34	E1.1	.34	.16	1.7	.29	E6.7
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	SCR2	05/02/2000	0400	<.10	.30	<1.5	.32	.16	.76	.19	E3.0
Santa Clara River hyporheic (H2), 0.3 mile below Castaic Creek, near Valencia, California	SCR2H2	05/02/2000	0650	<.10	.10	<1.5	<.10	.09	11	E.02	<1.0
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	SCR3	05/02/2000	0600	<.10	.30	E.72	.19	.16	.45	.18	E2.2
Santa Clara River hyporheic (H5), 0.2 mile above Potrero Canyon, near Val Verde, California	SCR3H5	05/02/2000	1530	.25	.31	E1.1	<.10	.12	5.3	.14	<1.0
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	SCR4	05/02/2000	0900	<.10	.24	<1.5	<.10	.13	.29	.15	E1.4
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5	05/02/2000	1100	<.10	.33	<1.5	.11	.12	.24	.13	E.99
Santa Clara River hyporheic (H5), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5H5	05/02/2000	1620	.24	E.03	<1.5	<.10	.08	3.5	E.03	<1.0

Appendix H. Wastewater indicators from selected surface-water and hyporheic sites, Santa Clara River, California, May 2000—Continued

USGS station name	Reference name	Date	Time	Nonylphenol diethoxylate* (total)	Para-nonyl phenol* (total)	Phenol	Phthalic anhydride	Tributyl phosphate	Triclosan	Tri(2-chloroethyl) phosphate
Santa Clara River, 0.1 mile below Saugus WRP, near Saugus, California	SCRS1	05/04/2000	2230	E12	E1.9	0.80	<0.15	na	0.57	0.45
Santa Clara River, above McBean Parkway Bridge, near Saugus, California	SCRS2	05/05/2000	0015	E11	E.93	.53	<.15	na	.57	.50
Santa Clara River, at Old Road, near Valencia, California	SCRA	05/05/2000	0300	<1.1	<.50	.49	<.15	na	.10	E.03
Santa Clara River, at Old Road, near Valencia, California	SCRA	05/02/2000	0100	E.52	<.50	.58	E.42	na	E.04	E.04
Valencia WRP effluent, at Valencia, California	Valencia WRP	05/02/2000	0200	E4.2	E2.1	.82	E1.2	na	.28	.59
Santa Clara River, 0.1 mile below Valencia WRP, at Valencia, California	SCR1	05/02/2000	0230	E4.7	E1.3	.44	E.57	na	.34	.30
Santa Clara River, 0.3 mile below Castaic Creek, near Valencia, California	SCR2	05/02/2000	0400	E2.4	E.69	<.08	<.15	na	.20	.22
Santa Clara River hyporheic (H2), 0.3 mile below Castaic Creek, near Valencia, California	SCR2H2	05/02/2000	0650	<1.1	E3.1	<.08	<.15	na	.09	.06
Santa Clara River, 0.2 mile above Potrero Canyon, near Val Verde, California	SCR3	05/02/2000	0600	E1.5	E.85	.70	<.15	na	.15	.21
Santa Clara River hyporheic (H5), 0.2 mile above Potrero Canyon, near Val Verde, California	SCR3H5	05/02/2000	1530	<1.1	E.88	.36	<.15	na	.11	.19
Santa Clara River, 200 feet below Tapo Canyon East Road, near Val Verde, California	SCR4	05/02/2000	0900	E.99	E.60	.50	E.26	na	.08	.16
Santa Clara River, 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5	05/02/2000	1100	E.71	<.50	.40	E.27	na	.06	.17
Santa Clara River hyporheic (H5), 0.9 mile below bridge crossing, at Newhall Farms, near Piru, California	SCR5H5	05/02/2000	1620	<1.1	<.50	1.6	<.15	na	.06	.15