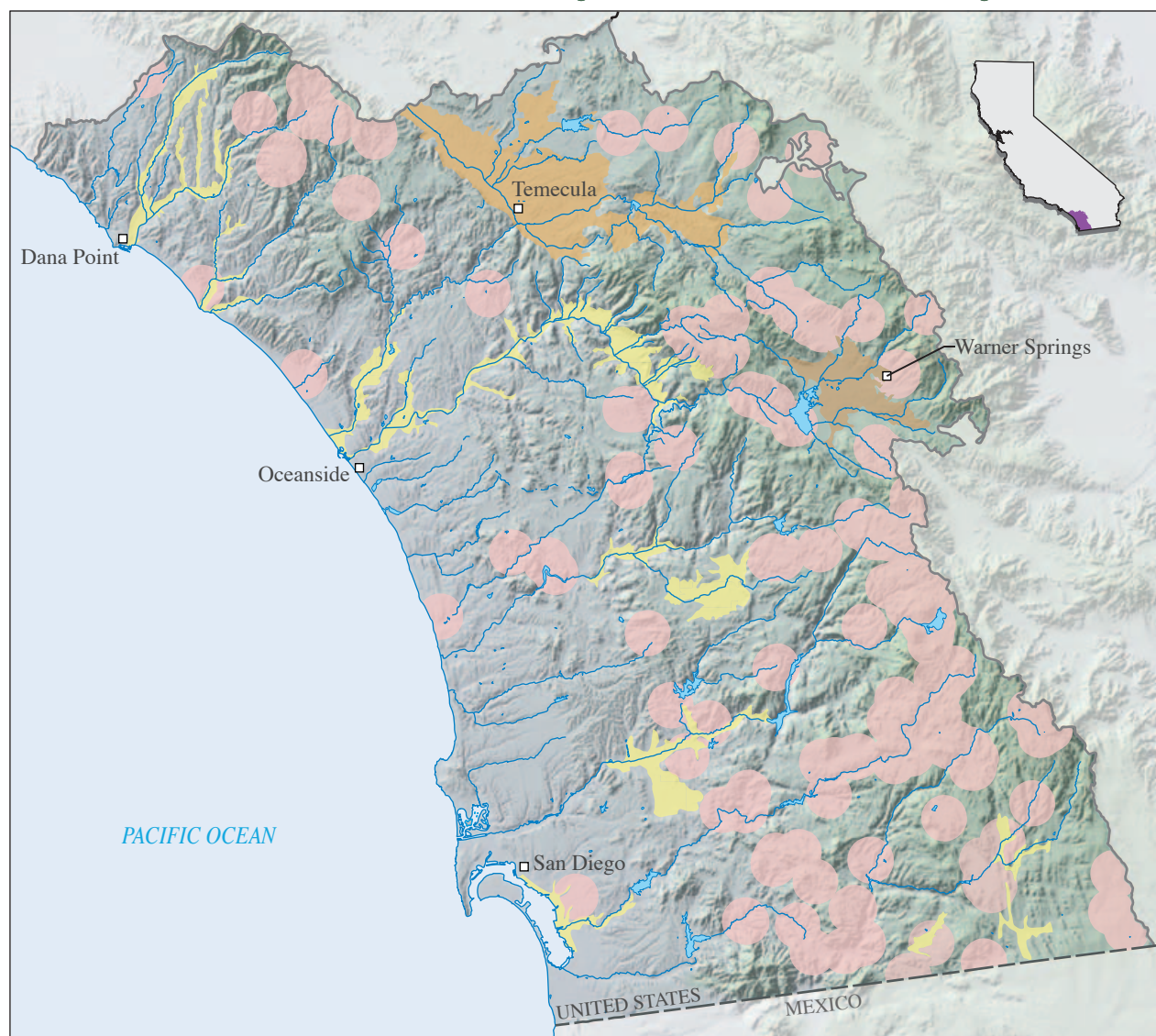


*In cooperation with the*  
**California State Water Resources Control Board**

## **California GAMA Program: Ground-Water Quality Data in the San Diego Drainages Hydrogeologic Province, California, 2004**

Data Series 129

### **Ground-Water Ambient Monitoring and Assessment (GAMA) Program**



# **California GAMA Program: Ground-Water Quality Data in the San Diego Drainages Hydrogeologic Province, California, 2004**

By Michael T. Wright, Kenneth Belitz, and Carmen A. Burton

In cooperation with the California State Water Resources Control Board

**Ground-Water Ambient Monitoring and Assessment (GAMA) Program**

Data Series 129

**U.S. Department of the Interior  
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## Conversion Factors, Abbreviations, and Acronyms

### Inch/Pound to SI

Multiply	By	To obtain
Length		
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
Area		
square mile (mi <sup>2</sup> )	259.0	hectare (ha)
square mile (mi <sup>2</sup> )	2.590	square kilometer (km <sup>2</sup> )
Pressure		
inch of mercury at 60°F (in Hg)	3.377	kilopascal (kPa)
Radioactivity		
picocurie per liter (pCi/L)	0.037	becquerel per liter (Bq/L)

## SI to Inch/Pound

Multiply	By	To obtain
Length		
kilometer (km)	0.6214	mile (mi)
Area		
square kilometer (km <sup>2</sup> )	247.1	acre
square kilometer (km <sup>2</sup> )	0.3861	square mile (mi <sup>2</sup> )
Volume		
liter (L)	33.82	ounce, fluid (fl. oz)
liter (L)	0.2642	gallon (gal)
liter (L)	61.02	cubic inch (in <sup>3</sup> )

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$^{\circ}\text{C}=(^{\circ}\text{F}-32)/1.8$$

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (μS/cm at 25°C).

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

## Abbreviations and Acronyms

mL	milliliter
μL	microliter
μm	micrometer
pCi/L	picocurie per liter
pCi/μg	picocurie per microgram
AMCL	alternative maximum contaminant level
CCV	continuing calibration verification
DLR	detection level for the purposes of reporting
DO	dissolved oxygen
DOC	dissolved organic carbon
GAMA	Ground-Water Ambient Monitoring and Assessment program
LRL	laboratory reporting level
LT-MDL	long-term method detection level
MCL	maximum contaminant level
MDL	method detection limit
MRL	minimum reporting level
MTBE	methyl <i>tert</i> -butyl ether

N	Normal
NAWQA	National Water Quality Assessment Program
NDMA	N-nitrosodimethylamine
NRP	National Research Program
NWIS	National Water Information System
PCE	tetrachloroethylene
QC	quality control
RSD	relative standard deviation
SC	specific conductance
SDALLV	Alluvial Basins study area
SDHDRK	Hard Rock study area
SDTEM	Temecula Valley study area
SDWARN	Warner Valley study area
SMCL	secondary maximum contaminant level
TCE	trichloroethylene
TDS	total dissolved solids
THM	trihalomethane
UCMR	unregulated chemical for which monitoring is required
VOC	volatile organic compound

### **Organizations**

DHS	California Department of Health Services
DWR	California Department of Water Resources
LLNL	Lawrence Livermore National Laboratory
NWQL	National Water Quality Laboratory
SWRCB	State Water Resources Control Board
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey





# California GAMA Program: Ground-Water Quality Data in the San Diego Drainages Hydrogeologic Province, California, 2004

By Michael T. Wright, Kenneth Belitz, and Carmen A. Burton

## Abstract

Because of concerns over ground-water quality, the California State Water Resources Control Board (SWRCB), in collaboration with the U.S. Geological Survey and Lawrence Livermore National Laboratory, has implemented the Ground-Water Ambient Monitoring and Assessment (GAMA) Program. A primary objective of the program is to provide a current assessment of ground-water quality in areas where public supply wells are an important source of drinking water. The San Diego GAMA study unit was the first region of the state where an assessment of ground-water quality was implemented under the GAMA program. The San Diego GAMA study unit covers the entire San Diego Drainages hydrogeologic province, and is broken down into four distinct hydrogeologic study areas: the Temecula Valley study area, the Warner Valley study area, the Alluvial Basins study area, and the Hard Rock study area.

A total of 58 ground-water samples were collected from public supply wells in the San Diego GAMA study unit: 19 wells were sampled in the Temecula Valley study area, 9 in the Warner Valley study area, 17 in the Alluvial Basins study area, and 13 in the Hard Rock study area. Over 350 chemical and microbial constituents and water-quality indicators were analyzed for in this study. However, only select wells were measured for all constituents and water-quality indicators. Results of analyses were calculated as detection frequencies by constituent classification and by individual constituents for the entire San Diego GAMA study unit and for the individual study areas. Additionally, concentrations of constituents that are routinely monitored were compared to maximum contaminant levels (MCL) and secondary maximum contaminant levels (SMCL). Concentrations of constituents classified as “unregulated chemicals for which monitoring is required” (UCMR) were compared to the “detection level for the purposes of reporting” (DLR).

Eighteen of the 88 volatile organic compounds (VOCs) and gasoline oxygenates analyzed for were detected in ground-water samples. Twenty-eight wells sampled in the San Diego

GAMA study had at least a single detection of VOCs or gasoline oxygenates. These constituents were most frequently detected in the Alluvial Basin study area (11 of 17 wells), and least frequently detected in the Warner Valley study area (one of nine wells). Trihalomethanes (THMs) were the most frequently detected class of VOCs (18 of 58 wells). The most frequently detected VOCs were chloroform (18 of 58 wells), bromodichloromethane (8 of 58 wells), and methyl *tert*-butyl ether (MTBE) (7 of 58 wells). Three VOCs were detected at concentrations greater than their MCLs. Tetrachloroethylene (PCE) and trichloroethylene (TCE) were detected in one well in the Hard Rock study area at concentrations of 9.75 and 7.27 micrograms per liter ( $\mu\text{g/L}$ ), respectively; the MCL for these compounds is 5  $\mu\text{g/L}$ . MTBE was detected in one well in the Alluvial Basins study area at a concentration of 28.3  $\mu\text{g/L}$ ; the MCL for MTBE is 13  $\mu\text{g/L}$ .

Twenty-one of the 122 pesticides and pesticide degradates analyzed for were detected in ground-water samples. Pesticide or pesticide degradates were detected in 33 of 58 wells sampled, and were most frequently detected in the Temecula Valley study area wells (9 of 14 wells), and least frequently in the Warner Valley study area wells (3 of 9 wells). Herbicides were the most frequently detected class of pesticides (31 of 58 wells), and simazine was the most frequently detected compound (27 of 58 wells), followed by deethylatrazine (14 of 58 wells), prometon (10 of 58 wells), and atrazine (9 of 58 wells). None of the pesticides detected in ground-water samples had concentrations that exceeded MCLs.

Eight waste-water indicator compounds were detected in ground-water samples. Twenty-one of 47 wells sampled for waste-water indicator compounds had at least a single detection. Waste-water indicator compounds were detected most frequently in the Alluvial Basins study area (9 of 17 wells), and least frequently in the Temecula Valley study area (2 of 6 wells). Phenol was the most frequently detected waste-water indicator compound (14 of 47 wells). Perchlorate was detected in 14 of 50 wells in the San Diego GAMA study; it was most frequently detected in Temecula Valley study area (7 of 11 wells).

Nitrate was detected in 17 of 24 wells at concentrations (0.1 to 9.14 mg/L) less than the MCL of 10 mg/L. Total dissolved solids (TDS) concentrations (148 to 1,800 milligrams per liter, or mg/L) exceeded the recommended secondary maximum contaminant level (SMCL) of 500 mg/L in 12 of the 24 wells in which it was measured. The sample with the highest TDS also had concentrations of chloride (540 mg/L) and sulfate (421 mg/L) that exceeded recommended SMCL levels.

Arsenic and uranium were detected in all 24 wells where they were measured. Arsenic concentrations ranged from less than 0.5 µg/L to 7.8 µg/L, and uranium concentrations ranged from 0.06 µg/L to 17.8 µg/L. The MCLs for these compounds are 50 and 30 µg/L, respectively. The MCL for arsenic will be reduced to 10 µg/L in 2006. Total dissolved chromium (total chromium) was detected in 44 of 50 wells, and hexavalent chromium in 36 of 50 wells. Total chromium concentrations did not exceed 5.7 µg/L, which is well below the 50 µg/L MCL for total chromium. However, hexavalent chromium was detected in 7 of 50 wells at concentrations greater than the detection level for the purposes of reporting (DLR); the DLR for hexavalent chromium is 1 µg/L. Boron was detected at concentrations (6 to 1,054 µg/L) greater than its DLR in 15 of 24 wells, and vanadium was detected at concentrations (1 to 69 µg/L) greater than its DLR in 14 of 24 wells. Concentrations of iron (4 to 2,120 µg/L) and manganese (0.2 to 492 µg/L) exceeded the SMCL in two and four wells, respectively. Mercury was not detected in any samples.

Radon-222 was detected in every ground-water sample in which it was analyzed for, with activities ranging from 180 to 4,820 picoCuries per liter (pCi/L). The proposed MCL and alternative MCL for radon-222 is 300 and 4,000 pCi/L, respectively. Tritium was detected in nearly all samples; the highest activity detected was 23.7 pCi/L, which is well below the tritium MCL of 20,000 pCi/L. Radium-226 and radium-228 were detected together in all but four ground-water samples. Activities detected for radium isotopes in ground water were low; radium-228 activities were below quantification levels in all but one sample. The combined MCL of 5 pCi/L for radium-226 and radium-228 was not exceeded.

Microbial constituents were analyzed in 24 ground-water samples. Total and *Escherichia coli* form were not detected in any samples. F-specific coliphage was detected in one sample collected in the Alluvial Basins study area. Somatic coliphage was detected in two ground-water samples, one in the Temecula Valley study area and one in the Warner Valley study area.

## Introduction

Because of growing concerns over ground-water quality, the California State Water Resources Control Board (SWRCB) created the Ground-Water Ambient Monitoring and Assessment (GAMA) program. The GAMA program falls under the California Ground-Water Quality Monitoring Act of 2001 (Sections 10780-10782.3 of the Water Code): a public mandate to assess and monitor the quality of ground water used as public supply for municipalities in California. The GAMA program is a comprehensive assessment of California's ground-water quality that is designed to help identify and understand risks to ground-water resources (Belitz and others, 2003). The U.S. Geological Survey (USGS) is cooperating with the SWRCB, and partnering with the California Department of Health Services (DHS) and Lawrence Livermore National Laboratories (LLNL) in the implementation of the GAMA program. The three main objectives of GAMA are (1) to provide a current status of ground-water quality, (2) to detect changes in ground-water quality, and (3) to understand how anthropogenic and natural factors affect ground-water quality (Kulongoski and Belitz, 2004). Additionally, the GAMA program will analyze a broader suite of compounds at detection limits that are lower than those currently required by the DHS. The resulting information about chemical compounds and constituents, which is not normally available, may help in the early identification of contaminants that can impact ground-water quality. This early identification is a key aspect in the long-term management of ground-water resources.

An assessment of ground-water quality needs to be representative of the range of hydrologic, geologic, and climatic conditions that exist in California. Therefore, the state was divided into 10 hydrogeologic provinces (Belitz and others, 2003). Areas making up each hydrologic province have relatively similar hydrologic, geologic, and climatic characteristics (*fig. 1*). Each of these hydrogeologic provinces contains ground-water basins, which are generally composed of relatively permeable, unconsolidated deposits of alluvial or volcanic origin (California Department of Water Resources, 2003). The GAMA program focuses primarily on ground-water basins that have public supply wells as an important source of drinking water. Eighty percent of the public supply wells in California are located in ground-water basins. The other 20 percent of public supply wells are located outside of ground-water basins in relatively low permeability rock (Belitz and others, 2003). The non-basin areas are also targeted by the GAMA program, thus allowing for a full assessment of the quality of ground water used for drinking-water supply.



Base from U.S Geological Survey digital elevation data,  
1999, Albers Equal Area Conic Projection

Provinces from Belitz and others, 2004

**Figure 1.** Hydrogeologic provinces of California.



## Purpose and Scope

The purpose of this report is to present the results of analyses for organic and inorganic constituents and compounds, microbial constituents, and general water-quality indicators for ground-water samples collected for the San Diego GAMA study unit (*fig. 2*). The chemical and microbial data presented in this report are meant to characterize the quality of the untreated ground-water resources in this study unit and not the treated drinking water delivered to consumers by water purveyors. The chemical and microbial composition of treated drinking water may differ from untreated ground water in that treated drinking water might be subjected to disinfection, filtration, mixing with other waters, and exposure to the atmosphere prior to being delivered to the consumer.

Fifty-eight public-supply wells were sampled in San Diego, Riverside, and Orange Counties from May to July 2004. Three different sampling schedules (expanded, basic plus, and basic) were used in this study to collect chemical and microbial constituents (*table 1*). The following chemical and microbial constituents were analyzed for in this study: 88 volatile organic compounds or VOCs (*table 2A*) and gasoline oxygenates (*table 2B*), 122 pesticides and pesticide degradates (*table 2C and D*), 63 waste-water indicator compounds (*table 2E*), 24 pharmaceutical compounds (*table 2F*), 3 emerging contaminants [N-nitrosodimethylamine (NDMA), 1,4-dioxane, and perchlorate] (*table 2G*), 5 nutrients and dissolved organic carbon (*table 2H*), 9 major ions (*table 2I*), 25 trace elements, including reduction/oxidation speciation of arsenic, iron, and chromium (*table 2I and J*), 9 isotopic compounds (*table 2K*), 5 noble gases (*table 2L*), and the microbial constituents coliform and coliphage (*table 2M*). The following general water-quality indicators were determined: dissolved oxygen (DO), pH, specific conductance (SC), alkalinity, turbidity, and temperature.

Concentrations detected in ground-water samples for constituents that are regularly monitored by the DHS are compared to State and Federal drinking water standards. Any constituents exceeding either primary (MCL) or secondary maximum contaminant levels (SMCL) are highlighted in this report. MCLs are established with regard to the protection of human health, whereas SMCLs are established with regard to the aesthetic qualities of drinking water such as taste, odor, and color. In addition, detections of constituents classified by DHS as “unregulated chemicals for which monitoring is required” (UCMR) are highlighted if concentrations in ground water exceed the “detection level for the purposes of reporting” (DLR). The DLR is used for reporting constituents on the UCMR list because MCLs have yet to be determined for these

chemicals. DLRs help in establishing MCLs by determining the extent of detections for the constituents of concern.

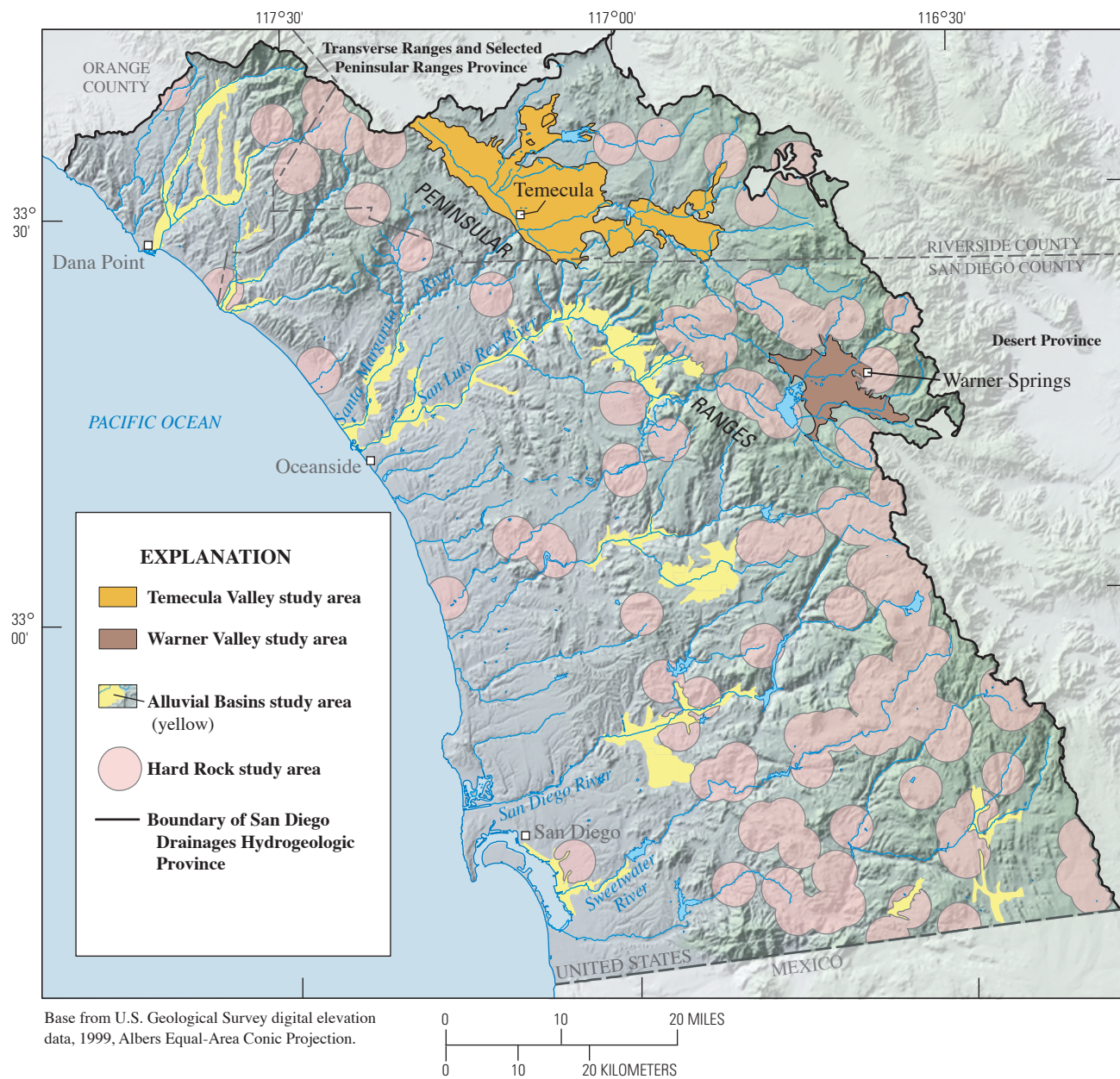
Detection frequencies are reported for each anthropogenic, or man-made, constituent (VOCs, pesticides and pesticide degradates, waste-water indicator compounds, perchlorate, NDMA, and 1,4-dioxane) that is detected in at least one ground-water sample. Regulated, anthropogenic, and UCMR-classified constituents detected at a frequency greater than, or equal to, 10 percent are highlighted. Frequently detected constituents may be predictive of future changes in ground-water quality.

Also presented in this report are the results and analysis of quality-control (QC) samples collected during the San Diego GAMA study. Results for pharmaceutical analyses of ground-water and quality-control samples will not be presented here, but instead will be published in a later report. This is because the pharmaceutical analytical method is still in the development stage and more quality-control data need to be collected in order to verify results. It is beyond the scope of this report to present a discussion of the factors that influence the distribution and occurrence of the chemical and microbial constituents detected in ground-water samples.

## Acknowledgments

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**Figure 2.** San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study unit with locations of study areas.



## Hydrologic Setting of the San Diego GAMA Study Unit

The San Diego GAMA study unit was the first region where an assessment of ground-water quality was implemented under the GAMA program. The geographic boundaries of the study unit (*fig. 2*) are the same as those of the San Diego Drainages hydrogeologic province (Belitz and others, 2003). The San Diego Drainages hydrogeologic province is described by the California Department of Water Resources (DWR) as the San Diego sub-hydrologic region, which corresponds to the southern portion of the South Coast hydrologic region (California Department of Water Resources, 2003). The San Diego GAMA study unit covers approximately 3,900 square miles (mi<sup>2</sup>) of the southwestern corner of California, and includes most of San Diego County, and southwestern Orange and Riverside Counties. Twenty-seven ground-water basins are located within the San Diego GAMA study unit; these basins underlie approximately 433 mi<sup>2</sup>, or 11 percent, of the land surface. Boundaries of the San Diego GAMA study unit are the Transverse and Selected Peninsular Ranges province to the north, the Desert province to the east, the country of Mexico to the south, and the Pacific Ocean to the west.

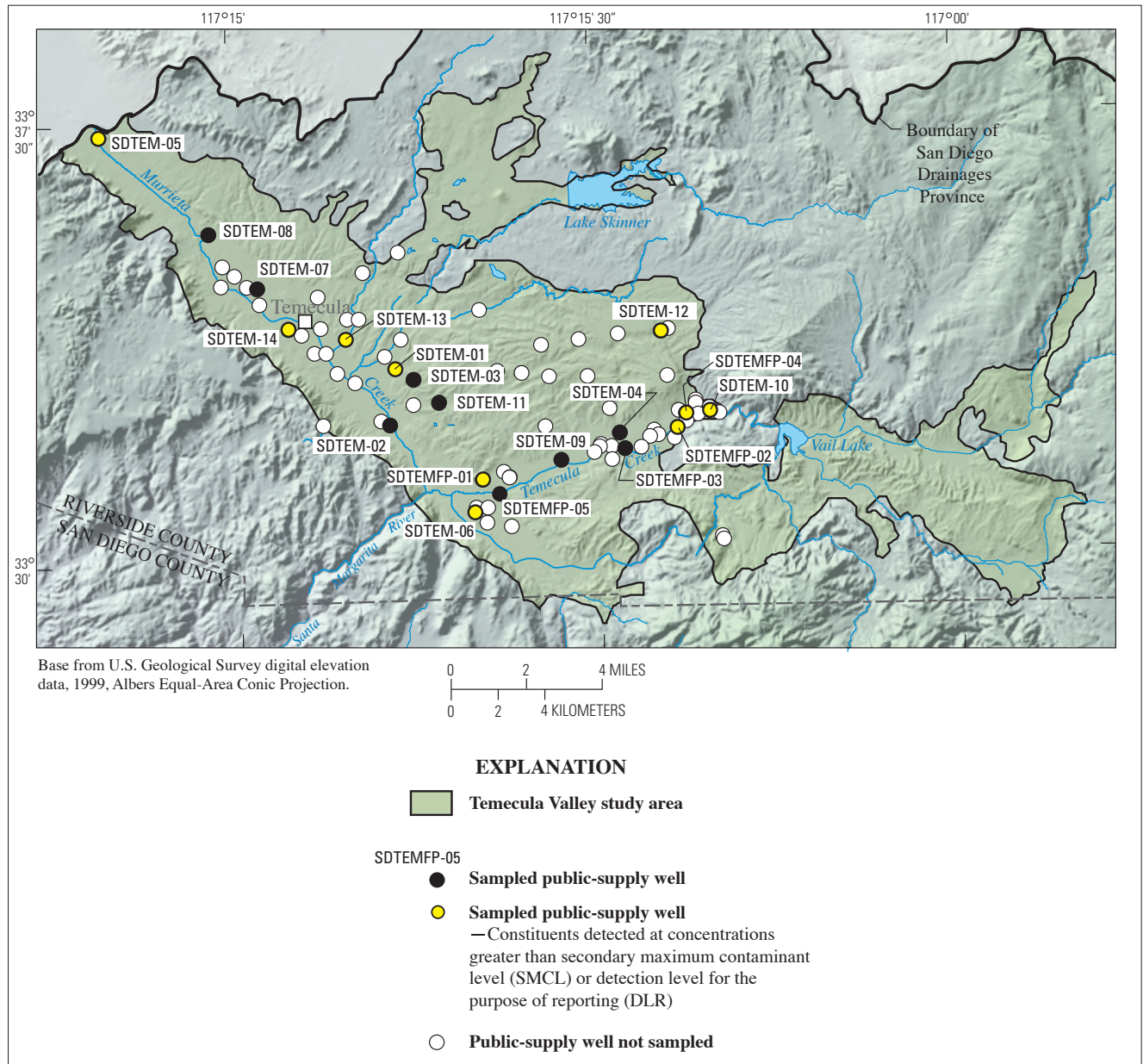
The climate in the coastal area of the San Diego GAMA study unit is generally mild, with temperatures averaging 65 °F and average annual precipitation ranging from 10 to 13 inches (in.) (California Regional Water Quality Control Board, San Diego Region, 1994). In the eastern portion of the study unit, annual temperatures in the Peninsular Ranges average in the mid fifties and average annual precipitation is approximately 45 in. The San Diego GAMA study unit is drained by a number of creeks and rivers, including the Santa Margarita and San Luis Rey Rivers in the north, and the San Diego and Sweetwater Rivers in the south. Runoff in the study unit is mainly due to rainfall; however, smaller amounts of runoff can be attributed to urban water use, snowmelt, and artesian springs. Ground- and surface-water flow primarily is from the mountainous east towards the west and the Pacific Ocean. For the purposes of this study, the San Diego GAMA study unit consists of four study areas: the Temecula Valley study area, the Warner Valley study area, the Alluvial Basins study area, and the Hard Rock study area (*fig. 2*).

## Temecula Valley Study Area

The boundaries of the Temecula Valley study area (*fig. 3*) are the same as those of the Temecula Valley Ground-water Basin (California Department of Water Resources, 2004a). The Temecula Valley study area is located principally in southwestern Riverside County with a very small portion of the basin extending into northern San Diego County. The Temecula Valley study area covers 137 mi<sup>2</sup>, and is bounded by the crystalline rock of the Peninsular Ranges on all sides, except in the northwest where it is bounded by the Elsinore ground-water basin. Average annual precipitation ranges from 7 to 15 in. Surface-water drainage occurs by way of several creeks, including the ephemeral Temecula and Murrieta Creeks that discharge into the Santa Margarita River, which then flows westward out of the valley. The main water-bearing unit is Quaternary alluvium that is estimated to be up to 2,500 feet (ft) thick; it is generally unconfined except at deeper depths where it is semi-confined to confined (California Department of Water Resources, 1956). Sources of ground-water recharge in the basin include percolation of precipitation, infiltration of agricultural and domestic irrigation returns, and engineered recharge via spreading basins on Temecula Creek.

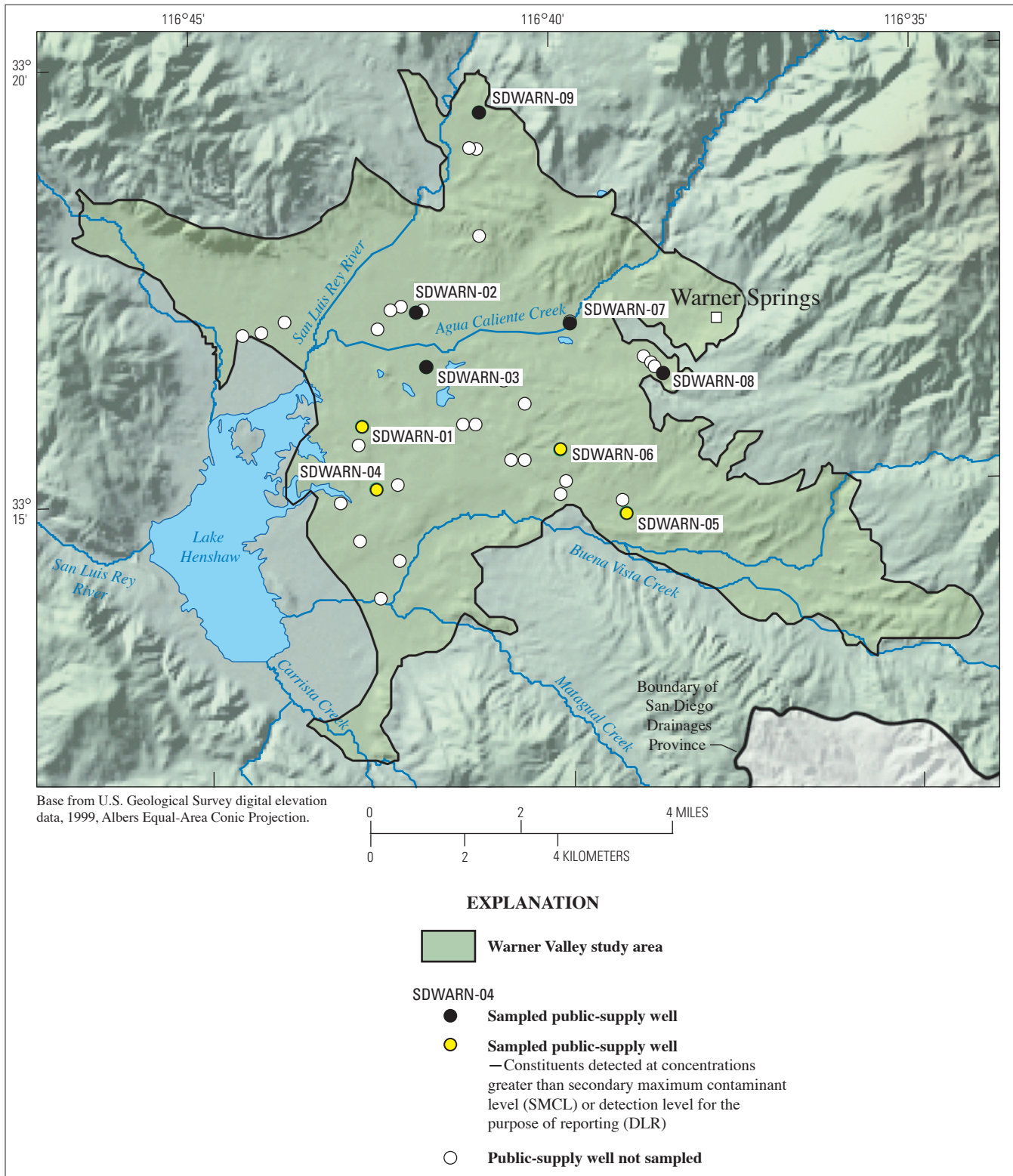
## Warner Valley Study Area

The boundaries of the Warner Valley study area (*fig. 4*) are the same as those of the Warner Valley Ground-water Basin, which is located in northeastern San Diego County (California Department of Water Resources, 2004b). The Warner Valley study area has a surface area of 37.5 mi<sup>2</sup>; it is bounded on the west by Lake Henshaw and on all other sides by the crystalline rocks of the Peninsular Ranges. Annual precipitation ranges from 15 to 21 in. The Warner Valley study area is drained by the ephemeral Agua Caliente and Buena Vista Creeks, as well as the San Luis Rey River, all of which flow westward into Lake Henshaw. The main water-bearing unit consists of residuum and alluvium (California Department of Water Resources, 1971). The alluvium is up to 900 ft thick and is generally unconsolidated. Sources of ground-water recharge include percolation of precipitation, and river and stream infiltration.



**Figure 3.** Temecula Valley study area and location of public-supply wells, San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study unit, California.





**Figure 4.** Warner Valley study area and location of public-supply wells, San Diego Ground-Water Ambient and Assessment (GAMA) study unit, California.

## Alluvial Basins Study Area

The Alluvial Basins study area (*fig. 5*) consists of those DWR-defined alluvial basins in the San Diego Drainages study unit having one or more public supply wells. The 12 ground-water basins composing this study area are the San Juan, San Mateo, Santa Margarita, San Luis Rey, San Pasqual, Santa Maria, San Diego River, El Cajon, Sweetwater, Cottonwood, Campo, and Potrero Valleys (California Department of Water Resources, 2003). The total surface area of the study area is approximately 166 mi<sup>2</sup>, with individual basins ranging in area from Potrero Valley, covering as little as 3.2 mi<sup>2</sup> (California Department of Water Resources, 2004c), to the San Luis Rey Valley, covering as much as 46 mi<sup>2</sup> (California Department of Water Resources, 2004d). Average annual precipitation ranges from 7 to 21 in. Runoff from precipitation primarily is drained to the southwest towards the Pacific Ocean, but some basins are internally drained. The main water-bearing units are Quaternary age alluvium and residuum, with an average thickness of alluvium that ranges from approximately 50 ft in the San Mateo Valley ground-water basin (California Department of Water Resources, 1991) to 200 ft in the San Luis Rey ground-water basin (Izbicki, 1985). Sources of ground-water recharge include percolation of precipitation, river and stream infiltration, irrigation returns, spreading basins, discharge of waste water to rivers, and septic systems.

## Hard Rock Study Area

The Hard Rock study area (*fig. 6*) consists of areas outside of ground-water basins that are within 3 kilometers (km) of a public-supply well. The study area covers approximately 865 mi<sup>2</sup>, with the vast majority of the study area located in the inland areas of the study unit. Well completion reports for public-supply wells sampled in this study area show that wells are withdrawing water primarily from fractured granite. Sources of ground-water recharge include percolation of precipitation, and river and stream infiltration.

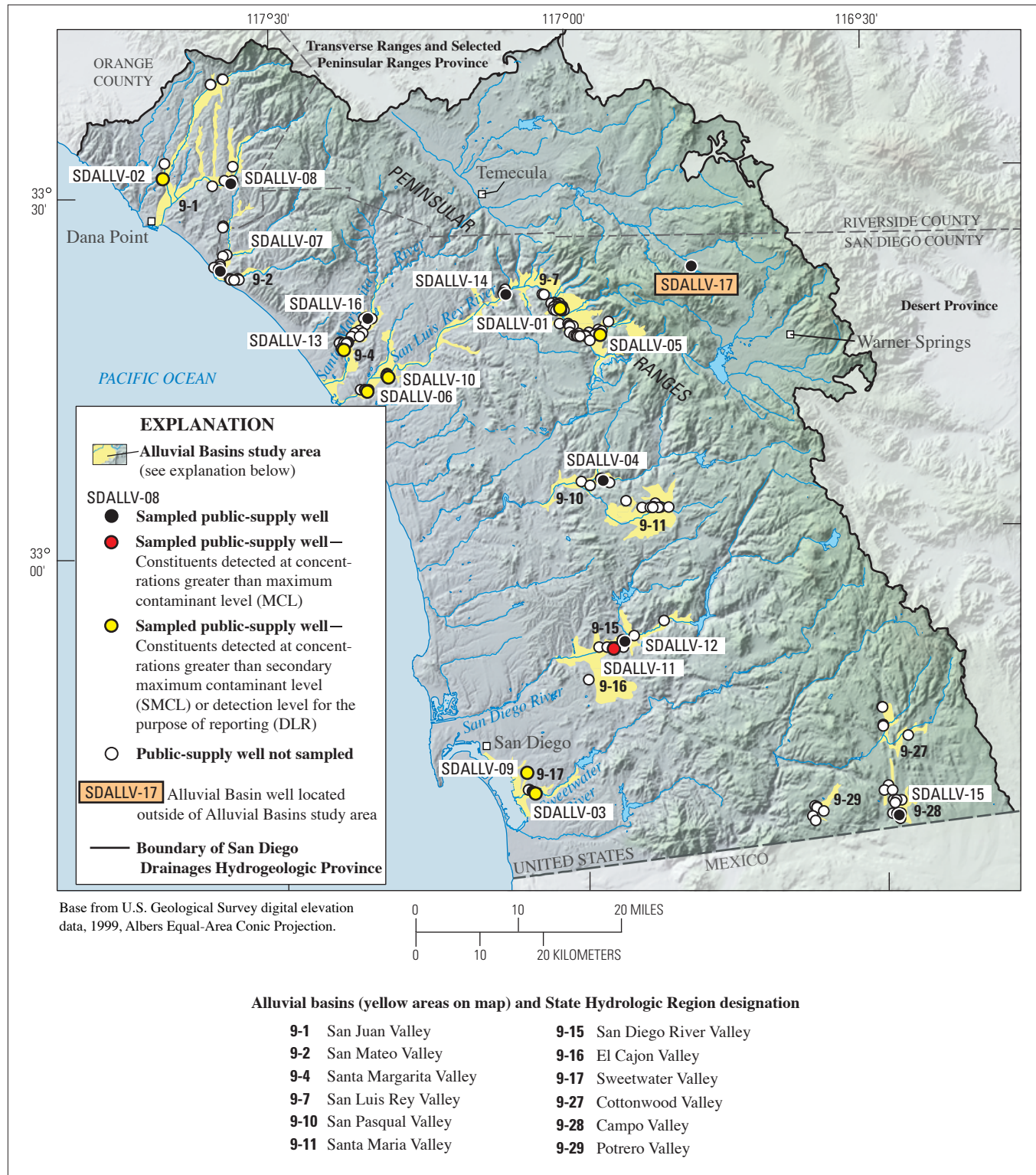
## Methods

### Sampling Design

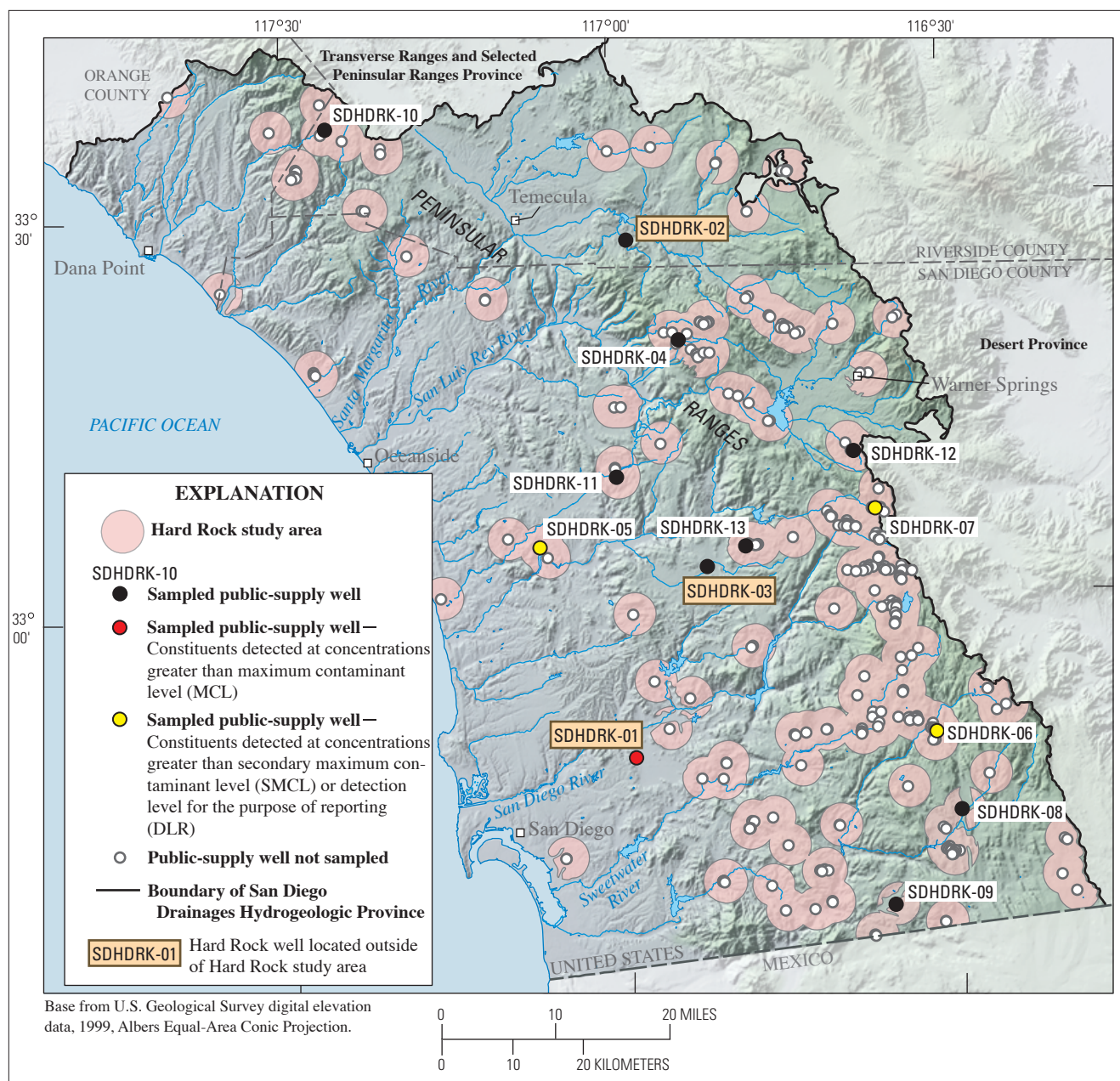
Wells in the four study areas (*figs. 3–6*) of the San Diego GAMA study unit were designated with the following nomenclature: The Temecula Valley study area (SDTEM), the Warner Valley study area (SDWARN), the Alluvial Basins study area (SDALLV), and the Hard Rock study area (SDHDRK). Additional wells were sampled in the Temecula Valley study area to ascertain how ground-water quality is affected as it moves along two flow paths; these wells were given the designation SDTEMFP. Ground-water basins, as defined by DWR, were used for study area boundaries, except for the Hard Rock study area. A boundary for the Hard Rock study area was created by placing a 3-km radius buffer around public-supply wells that did not fall within any ground-water basin. A 3-km radius was chosen because it would roughly equal one well per 25 square kilometers (km<sup>2</sup>), which is the desired sampling density for this study.

The Temecula Valley ground-water basin was chosen as a study area because it is the largest basin, with the most public supply wells, of any basin in the San Diego Drainages hydrogeologic province. The Warner Valley ground-water basin was chosen as a study area because of its relatively pristine condition, isolated location, small population, and scant development. The Alluvial Basins study area consists of 12 small to medium alluvial ground-water basins. By themselves, each alluvial ground-water basin has a small number of public supply wells that tap a small portion of the ground-water resources, but aggregated as one study area, the alluvial ground-water basins have a relatively large number of public supply wells that tap a large portion of the ground-water resources. Because there are a relatively large number of public supply wells outside ground-water basins in the San Diego GAMA study unit, the Hard Rock study area was created to assess water quality in fractured rock aquifers.





**Figure 5.** Alluvial Basins study area and location of public-supply wells, San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study unit, California.



**Figure 6.** Hard Rock study area and location of public-supply wells, San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study unit, California.



The primary objectives in the selection of wells for GAMA study-area assessments are (1) to attain a sampling density of approximately one well per 25 km<sup>2</sup>, (2) randomly select at least 10 wells per study area whenever possible, and (3) minimize variability in well type (Gilliom and others, 1995). These objectives will help to assure an adequate and unbiased assessment of the quality of ground-water resources used for public supply. Additionally, since the GAMA program focuses on ground water used as a drinking-water resource (Belitz and others, 2003), public supply wells that are used for drinking water are the primary focus of sampling efforts. The GAMA framework does allow irrigation, domestic, and/or monitoring wells to be sampled if needed to obtain adequate spatial coverage in a study unit. In the San Diego GAMA study unit, public supply wells provide good spatial coverage; therefore, domestic, irrigation, or monitoring wells were not part of the selection process. Wells with available construction information (well depth, depth of perforations, date constructed) were given priority for sampling.

Wells were selected for each study area using a grid-based program that produced random, equal-area cells (Scott, 1990). The program was used to generate 20 cells in the Temecula Valley study area, 10 cells in the Warner Valley study area, 20 cells in the Alluvium Basins study area, and 10 cells in the Hard Rock study area. Where a cell had multiple wells, each well in that cell was randomly assigned a rank. For each particular cell with multiple wells, the lowest ranked well was given priority for sampling. An attempt was made to select one well per cell, but this was not always possible. Wells from adjacent cells were used to populate cells that either had no active wells or contained wells that did not meet the selection criteria, such as those lacking well-construction data. The exception to the one well sampled per cell criterion was in the Temecula Valley study area where additional wells were sampled in cells that were important to the flow path study.

Wells were sampled for either an “expanded,” “basic plus,” or “basic” schedule (*table 1*). Expanded schedule sampling entails collecting samples for analysis of a large number of chemical and microbial constituents and field measurable water-quality indicators. Consequently, sampling wells for an expanded schedule requires a substantial investment of time and labor. Wells that were located in areas of interest, such as along flow paths, were given priority for expanded schedule sampling. Initially, approximately 50 percent of the wells in the San Diego GAMA study were to be sampled for an expanded schedule, and 50 percent for the basic schedule. However, after completion of sampling in the first study area, the Temecula Valley, it was apparent that sampling 50 percent of the wells for an expanded schedule would be too time consuming. Therefore, for the other three study areas, the number of wells sampled for the expanded schedule was decreased to approximately 30 percent. To help adjust for the smaller number of wells sampled for the expanded schedule, the basic

schedule was enhanced to include some compounds that were previously only collected for the expanded schedule. This basic-plus schedule did not significantly increase sampling time, yet allowed for a greater number of constituents to be collected than if the basic schedule had been used.

## Sample Collection

*Table 2A–M* shows the names of chemical and microbial constituents analyzed for in the ground-water samples from wells in the San Diego GAMA study unit. *Table 3* gives the date and time that each well was sampled, along with the type of sampling schedule and well construction information. Samples were collected from 58 public supply wells from May to July 2004. Of the 58 wells sampled, 19 were in the Temecula Valley study area, 17 in the Alluvial Basins study area, 13 in the Hard Rock study area, and 9 in the Warner Valley study area. Twenty wells were scheduled to be sampled in the Alluvial Basins study area, but a review of the well completion reports showed that three of the wells sampled in this study area were withdrawing water from fractured rock, so these wells were reassigned to the Hard Rock study area (*fig. 6*). Additionally, a well that was originally located in the Hard Rock study area was switched to the Alluvial Basins study area (*fig. 5*) when a review of the well completion report showed that the well was withdrawing from an alluvial aquifer. Neither of these changes significantly affected the target sampling density for either the Alluvial Basins or Hard Rock study areas. Because of well availability, only nine wells were sampled in the Warner Valley study area. These nine wells provided good spatial distribution (*fig. 4*).

Sampling procedures utilized by the USGS National Water Quality Assessment (NAWQA) program were implemented in this study to mitigate the potential for airborne contamination of samples and (or) cross contamination between wells (Koterba and others, 1995; U.S. Geological Survey, 1998; U.S. Geological Survey, 1999). Before the onset of sample collection, a set procedure was followed to help assure that a representative sample of ground water would be collected at each site; the procedure used was dependent on the sampling schedule employed at each particular site. If a site was to be sampled for a basic or basic-plus schedule, then the well was pumped continuously for a minimum of 20 minutes in order to purge the well of at least three casing-volumes of water. If a site was to be sampled for the expanded schedule, then ground water was pumped through a flow-through chamber fitted with a multi-probe meter that is able to simultaneously measure these water-quality indicators: dissolved oxygen (DO), temperature, pH, turbidity, and electrical conductivity (EC). Measurements were taken at 5-minute intervals; sampling did not begin until the water-quality indicators remained stable for at least 20 minutes.

Samples were collected by affixing Teflon tubing to the sampling point closest to the well head using stainless steel fittings. If a site was sampled for a basic, or basic-plus schedule, the sample was collected at the well head using a foot-long section of Teflon tubing. If a site was sampled for the expanded schedule, the sample was collected inside an enclosed chamber that was located in a mobile water-quality laboratory. The length of the Teflon tubing used for the expanded schedule ranged from 10 to 50 ft. All but two samples at a well were collected before any type of filtration or chemical treatment, such as chlorination, was done to the ground water. Chlorination of ground water that contains DOC may form trihalomethanes (THMs). Ground water from one well, SDHDRK-05, was passed through a sediment filter before the sampling port. This was not considered to have a significant effect on the water-quality assessment of this site. Two wells, SDHDRK-05 and SDALLV-16, had chlorination equipment in the well bore. The chlorinator for SDHDRK-05 was shut off, and the well was pumped for eight hours prior to sampling. Before sampling SDALLV-16, the well was pumped for one hour with the chlorinator shut off. The samples from both SDHDRK-05 and SDALLV-16 had THM detections.

Filtering of samples in the field was done using a 0.45- $\mu$ m capsule or disk filter. Polyethylene bottles were pre-rinsed with native water before sample collection. Samples requiring preservation with acid had the pH lowered to 2 or below. All samples were kept on ice and shipped immediately to the laboratory for analyses, except for samples collected for the analysis of chromium species, tritium, noble gases, stable isotopes of water, and carbon isotopes. Radium isotopes, gross alpha/beta radiation, and radon-222 samples were not kept on ice, but were shipped immediately after collection.

Volatile organic compounds and gasoline oxygenates were collected in 40-mL sample vials that were purged using three vial volumes of sample water and then bottom filled to eliminate headspace. Six normal (N) hydrochloric acid (HCl) was added to the VOC samples, but not the gasoline oxygenate samples, as a preservative. Samples for stable isotopes of water were collected by filling a 60-mL clear glass bottle with unfiltered water, sealing with a conical cap, and securing with electrical tape to prevent leakage and evaporation. Samples for pesticides, pesticide degradation products, waste-water indicator compounds, pharmaceuticals, NDMA, and 1,4-dioxane were collected in 1-L baked amber bottles; these samples were not filtered in the field, but at their respective laboratories prior to analysis. Samples for major ions and trace elements were collected by filtering ground water into two 250-mL polyethylene bottles, and then preserving (the trace elements sample bottle only) with 7.5N nitric acid. Radium isotopes and gross alpha/beta samples were collected and preserved in the same manner as for trace elements, except 2- and 1-L aliquots of ground water were collected, respectively. Mercury samples

were collected by filtering ground water into a 250-mL glass bottle and preserving with 6N HCl. Arsenic and iron speciation samples were filtered into a 250-mL polyethylene bottle that was taped so the sample was not exposed to light; the sample was preserved with 6N HCl. Nutrient and perchlorate samples were each filtered into 125-mL polyethylene bottles. Carbon isotope samples were filtered and bottom filled into two 500-mL baked glass containers that were first purged using three bottle volumes of ground water. These samples had no headspace, and were sealed with a conical cap to resist evaporation. Samples for alkalinity were collected by filtering ground water into a 500-mL polyethylene bottle. Tritium samples were collected by bottom filling two 1-L bottles with unfiltered ground water, after first purging the bottle of three volumes of water.

Four constituents (chromium, DOC, radon-222, and noble gases) were collected at the well head, regardless of the sampling schedule (expanded, basic-plus, or basic). Samples collected for total dissolved chromium (total chromium) and hexavalent chromium were taken directly from the sampling port. For total chromium, a 10-mL syringe that had a small 0.45- $\mu$ m disk filter connected directly to it was filled with ground water and 2 mL of the ground water was filtered into a small centrifuge tube. To collect the hexavalent chromium sample, a small ion-exchange column was attached to the disk filter and 2 mL of ground water was filtered into a second centrifuge vial. Both vials were preserved with 10  $\mu$ L of 7.5N nitric acid (Ball and McClesky, 2003a).

DOC was collected by filling a 50-mL syringe, that had a 0.45- $\mu$ m disk filter connected directly to it, with ground water directly from the sampling port at the well head. The ground water was then filtered into a 125-mL baked glass bottle and preserved with 4.5N sulfuric acid. For the collection of radon-222, a stainless steel and Teflon valve assembly was attached to the sampling port at the well head. The valve was partially closed, and a 10-mL sample was taken through a Teflon septum on the valve assembly using a glass syringe affixed with a stainless steel needle. The sample was then injected into a 25-mL vial partially filled with scintillation cocktail. The vial was then placed in a cardboard tube in order to shield it from light during shipping (U.S. Geological Survey, 1999).

To collect noble gases, reinforced nylon tubing was attached to the sampling port at the well head. The reinforced tubing was attached to an approximately 12-in.-long, 3/8-in. ID copper tube with a back pressure valve attached to the other end. The copper tube was affixed to a metal plate with two clamps. Ground water was run through the copper tube, while it was firmly tapped for approximately 45 seconds. This was done to remove any gas bubbles that may have been trapped inside the tube. The back pressure valve was then closed almost completely, and the clamps tightened down in order to trap a sample of ground water with its associated noble gases (Weiss, 1968).

Samples for microbial constituents also were collected at the well head. Prior to the collection of samples, the sampling port was sterilized with isopropyl alcohol, and ground water was run through the sampling port for at least three minutes to remove any traces of the sterilizing agent. Two 250-mL sterilized bottles were then filled for the coliform samples (total and *Escherichia* coliform determinations), and one 3-liter sterilized carboy was filled for the coliphage samples (F-specific and somatic coliphage determinations).

## Sample Analysis

Nine laboratories performed chemical and microbial analyses for the San Diego GAMA study. The following analytical methods were used for the determination of organic and inorganic constituents by the USGS National Water-Quality Laboratory (NWQL): VOCs by purge and trap capillary gas chromatography/mass spectrometry (Conner and others, 1998); gasoline oxygenates by heated purge and trap/gas chromatography/mass spectrometry (Rose and Sandstrom, 2003); pesticides by solid-phase extraction and chromatography/mass spectrometry (Furlong and others, 2001; Sandstrom and others, 2001); waste-water indicator compounds by polystyrene-divinylbenzene solid-phase extraction and capillary-column gas chromatography/mass spectrometry (Zaugg and others, 2002); pharmaceutical compounds by solid-phase extraction and high-performance liquid chromatography–electrospray ionization mass spectrometry (Cahill and others, 2004); major ions, trace elements, and nutrients by several methods (Fishman and Friedman, 1989; Fishman, 1993; McLain, 1993; Garbarino, 1999; Garbarino and Damrau, 2001; Patton and Kryskalla, 2003); DOC by UV-promoted persulfate oxidation and infrared spectrometry (Brenton and Arnett, 1993); and radon-222 by liquid scintillation counting (American Society for Testing and Materials, 1992).

The following methods were used for the determination of organic and inorganic and microbial constituents by laboratories other than the NWQL: Perchlorate, NDMA, and 1,4-dioxane analysis by Montgomery Watson and Harza Laboratory using chromatography and mass spectrometry (U.S. Environmental Protection Agency, 1996; Hautman and others, 1999; U.S. Environmental Protection Agency, 1999); stable isotopes of water by the USGS Reston Stable Isotope Laboratory using gaseous hydrogen and carbon dioxide–water equilibration (Epstein and Mayeda, 1953; Coplen and others, 1991); chromium, iron, and arsenic analysis by the USGS NRP laboratory in Boulder, Colorado, using various techniques of UV-VIS spectrophotometry and atomic absorbance spectroscopy (Stookey, 1970; To and others, 1998; Ball and McCleskey, 2003b; McCleskey and others, 2003); F-specific

and somatic coliphage analysis by the USGS Ohio Microbiology Laboratory (U.S. Environmental Protection Agency, 2000a); tritium analysis at the USGS NRP laboratory in Menlo Park, California, using electrolytic enrichment–liquid scintillation method (Thatcher and others, 1977); tritium (helium in-growth method) and noble gases analyzed by LLNL (Eaton and others, 2004); radium-226, radium-228, gross alpha and beta radioactivity analysis by Eberline Analytical Services using several methods (U.S. Environmental Protection Agency, 1980); carbon isotopes analysis by the University of Arizona Accelerated Mass Spectrometry Laboratory (Donahue and others, 1990; Jull and others, 2004); and total and *Escherichia* coliform analyzed by USGS field personnel using the MI method (U.S. Environmental Protection Agency, 2002b).

## Data Reporting

### Laboratory Reporting Conventions

The NWQL uses laboratory reporting levels (LRLs) for reporting non-detections of constituents, but also is able to semi-quantitatively detect compounds below the LRL. The LRL and long-term method detection level (LT-MDL) are calculated on the basis of QC experiments conducted by the NWQL. The LT-MDL mitigates the reporting of false positive readings. The risk of reporting a false positive concentration equal to or greater than the LT-MDL when the constituent is not present is 1 percent or less. The LRL ( $\text{LRL} = 2 \times \text{LT-MDL}$ ) is used to minimize the chance of reporting a false negative reading. The risk of reporting a false negative is 1 percent or less when the actual concentration is equal to or greater than the LRL (Childress and others, 1999).

Some constituent concentrations in this study are reported using method detection limits (MDLs), minimum reporting levels (MRLs), and method uncertainties. The MDL serves the same purpose as the LT-MDL: to reduce the risk of reporting false positives (U.S. Environmental Protection Agency, 2002a). The risk of reporting a false positive concentration equal to or greater than the MDL when the constituent is not present is also 1 percent or less. However, the methods for establishing the LT-MDL are more robust than those used to establish the MDL. Therefore, the LT-MDL may be more representative of true method detection limits. The MRL is the smallest measurable concentration of a constituent that may be reliably reported using a given analytical method (Timme, 1995). The method uncertainty generally indicates the precision of a particular analytical measurement; it gives a range of values wherein the true value will be found.



## Compounds on Multiple Analytical Schedules

Twenty-two constituents targeted in the San Diego GAMA study were determined by more than one analytical schedule (*table 4*). Certain analytical schedules are “preferred” over others because the methodology is more accurate and precise, and generally yields a greater sensitivity for a given constituent. If a constituent appears on multiple analytical schedules, then only the detections determined by the preferred analytical schedule are given in this report.

## Quality Control

During the San Diego GAMA study, quality-control samples were collected at approximately 10 percent of the sampling sites. Quality-control samples are collected to assess the validity of ground-water data that will be used for interpretation, and to describe bias and variability in data associated with sample collection, processing, storage, transportation, and laboratory analysis. Three types of quality-control samples were collected in the field during the San Diego GAMA study: blanks, sequential replicates, and matrix spikes.

## Blanks

Four types of blanks were collected: trip, equipment, field, and source-solution.

Trip blanks are collected to determine if shipping, handling, and intermittent storage of sample containers produces contamination (bias) with respect to VOCs. Equipment blanks are used to determine if the fittings and tubing used to collect ground-water samples are introducing contamination. Field blanks are collected to determine if procedures used during sample collection and laboratory analysis introduce contamination, as well as to determine if the decontamination procedures used to clean sampling equipment are effective. Source solution blanks are collected to verify that the water used for field blanks has no detectable concentrations of VOCs and waste-water indicator compounds. Source solution blanks are only collected for VOCs and waste-water indicator compounds because these chemicals are volatile and ubiquitous, and therefore can contaminate blank water used for quality-control samples.

All blanks were processed using Nitrogen-Purged Universal blank water that is certified for use in the collection of blanks for VOCs, pesticides, waste-water and pharmaceutical compounds, low-level nutrients, dissolved organic carbon, major ions, and trace elements. The trip blank consisted of blank water in a sealed sample vial that was kept with the other sample vials from the start of the field activities through laboratory analysis. The equipment blank was collected at the

USGS San Diego laboratory using the field sampling equipment, and immediately shipped to the NWQL for analysis. Field blanks were collected at the sampling site. Depending on the schedule (expanded, basic-plus, basic) employed at a particular sampling site, blank water was either pumped, using a diaphragm pump equipped with a Teflon diaphragm, or poured through the sampling equipment (fittings and tubing) used to collect ground water. Blank samples were then processed and transported utilizing the same methods used for the collection of ground-water samples. Source-solution blanks also were collected at the sampling site by pouring blank water directly into sample containers that were then stored, shipped, and analyzed in the same manner as the ground-water samples.

Contamination may have been introduced into ground-water samples during collection, processing and transport if the following criteria are met: (1) a constituent is detected in trip, equipment, or field blanks, (2) the constituent is detected in ground-water samples, and (3) the minimum concentration detected in ground-water samples is less than the maximum concentration detected in field blanks. If a constituent was detected in a trip, equipment, or field blank, then the concentration detected in the blank was compared with the concentration detected in the associated source solution blank. If the source solution was identified as the origin of the detection in the blank, then contamination of ground-water samples by the constituent was not of concern.

Field blank detections that could not be attributed to the source solution were compared to detections in associated ground-water samples, and evaluated with respect to criterion 3 above. Associated ground-water samples are defined here as any sample collected on the same day as the field blank. If the field blank was collected at a well that was sampled on an expanded schedule, then the detection in the field blank was compared with detections in the ground-water sample collected immediately before the field blank. A detection of a constituent in the field blank that is also detected in the ground-water sample collected immediately before the field blank indicates possible carry-over contamination. Carry-over contamination occurs when a constituent is introduced into a sample from the sampling equipment, in spite of the cleaning of sample tubing and fittings. If carry-over contamination was identified as the cause of the detection in the field blank, subsequent ground-water samples and field blanks also were evaluated for evidence of carry-over contamination. Carry-over contamination was not considered to be a problem if the constituent in question was not detected in the ground-water samples collected prior and subsequent to the field blank. Wells sampled on basic and basic-plus schedules do not use sample tubing and fittings that have been used previously to collect ground-water samples, and thus field blanks collected at these sites are not evaluated with respect to carry-over contamination.

Ground-water samples that were determined to have a detection of one or more constituents resulting from contamination were censored, and consequently not used in the analysis of ground-water quality. The threshold for censoring data was determined by summing the blank concentration and the LT-MDL, or MDL, for the constituent in question. For example, if toluene was detected in a field blank at a concentration of 0.02 µg/L, and the LT-MDL for toluene is 0.02 µg/L, then the concentration of toluene in the associated ground-water sample would have to be greater than, or equal to, 0.04 µg/L in order to be included in ground-water quality analyses. This method of censoring is based on the assumption that the amount of contamination in the field blank and the associated ground-water sample are comparable. Therefore, detections in ground-water samples that are not censored will have at least a concentration equal to the LT-MDL, or MDL, where the risk of reporting a false positive reading when a constituent concentration is greater than, or equal to, the LT-MDL, or MDL, is 1 percent or less (Childress and others, 1999). If a constituent was detected in multiple blanks (trip, equipment, or field), and the detections could not be attributed to the source solution or to carry-over contamination, then any ground-water sample that had a detection of the constituent in question was censored at the appropriate threshold.

## Replicates

Sequential replicate samples assess variability in the processing and analyses of inorganic and organic constituents. Relative standard deviation (RSD) was used in determining the variability between replicate pairs. The RSD is defined as 100 times the standard deviation divided by the mean concentration for each replicate pair of samples. If one value in a sample pair was reported as a non-detection and the other value was reported as an estimate below the LRL or MRL, the RSD was set to zero because the values are analytically identical. If one value in a sample pair was reported as a non-detection and the other value was greater than the LRL or MRL, then the non-detection value was set equal to one-quarter of the LRL, and the RSD was calculated (Childress and others, 1999). RSD values less than 20 percent are considered acceptable in this study. High RSD values for a constituent likely indicate analytical uncertainty at low concentrations, particularly for concentrations within an order of magnitude of LT-MDL or MDL.

## Matrix Spikes

Matrix spikes are used to evaluate bias and variability of analytical results related to matrix interferences. Matrix spike samples are prepared by adding solutions containing known amounts of organic compounds to replicate ground-water samples. The known compounds added in matrix spikes are the same as those being analyzed in the method. This enables an analysis of matrix interferences on a compound-by-compound basis. Matrix spikes in the San Diego GAMA study were always done by the laboratory performing the analysis. Compounds with low recoveries are of potential concern if environmental concentrations are close to the MCLs; a non-exceedance of an MCL could be falsely indicated. Conversely, compounds with high recoveries are of potential concern if the environmental concentrations exceed MCLs, since a high recovery could falsely indicate an exceedance of MCL. Recoveries between 70 to 130 percent for matrix spikes were considered acceptable in this study.

## Surrogate Compounds

In addition to matrix spikes, surrogate compounds were added to all ground-water and quality-control samples that were analyzed for VOCs, gasoline oxygenates, pesticides, waste-water, and pharmaceutical compounds. Prior to analysis, each sample is spiked with surrogate compounds at the laboratory. Surrogate compounds are not normally found in the environment and are used to identify potential problems associated with laboratory analyses. Potential problems include matrix interferences (such as high levels of dissolved organic carbon) that produce a positive bias, and incomplete laboratory recovery (possibly due to improper maintenance and calibration of analytical equipment) that produces a negative bias. Surrogate compounds are used to identify general problems that may arise during sample analysis that can affect the analysis results for all compounds, whereas matrix spikes are used to indicate problems with specific compound analysis. A 70- to 130-percent recovery of surrogates is generally considered acceptable, except for pharmaceuticals where the acceptable range of recoveries is 75 to 115 percent; values outside these ranges indicate possible problems with the processing and analysis of samples (Connor and others, 1998).

## Results

### Quality-Control Samples

#### Detections in Blanks

A summary of constituent detections in trip, equipment, and field blanks is given in *table 5*. No targeted constituents were detected in the trip blank. Three VOCs (trichloromethane, toluene, and acetone) and NDMA were detected in one of the five field blanks. The field blank detections were not of concern because these constituents were also detected in the associated source-solution blanks. Pesticides, nutrients, and dissolved organic carbon were not detected in any blanks. Silica and calcium were detected in two of two field blanks, and sodium was detected in one of two field blanks. Concentrations detected in the field blanks were at least two orders of magnitude below concentrations detected in ground-water samples; therefore, no data were censored. Copper was the only constituent detected in the equipment blank; it was detected at a concentration of 0.9 µg/L. Copper was also detected in one of two field blanks at a concentration of 1.2 µg/L. Because of these detections, all copper concentrations in ground-water samples that are below 1.4 µg/L are censored. In addition to copper, vanadium and zinc were detected in one of two field blanks at a concentration of 0.8 and 0.3 µg/L, respectively. Because of these field blank detections, three detections of vanadium and one detection of zinc were censored in ground-water samples.

Phenol, a waste-water indicator compound, has been a persistent contaminant found in field blanks collected across the nation (Jim Kingsbury, Hydrologist, U.S. Geological Survey, written commun., 2004). A review of quality-control data collected as part of the NAWQA Source Water Quality Assessment showed that phenol was present in 66 percent of field blanks nationwide. Because of this ongoing problem with phenol contamination, all phenol detections in this study were subjected to censoring. The maximum concentration detected in field blanks for the San Diego GAMA was 0.2 µg/L. Therefore, all phenol detections less than 0.4 µg/L were censored.

#### Variability in Replicate Samples

The majority of replicate pairs collected during the San Diego GAMA study had RSDs of less than 10 percent (*table 6A-E*). Fifteen of nearly 1,500 replicate pairs, representing nine compounds and two measurements of gross radioactivity in water, exceeded the acceptable RSD set for this study of 20 percent. Perchlorate had one replicate pair that slightly exceeded the acceptable limit set for this study with a RSD of 21 percent. Nutrients, DOC, and major ions did not have

any replicate pairs with an RSD greater than 7 percent. Three trace elements had replicate pairs with high RSDs (*table 6D*). Two chromium replicate pairs had RSDs of 47 and 57 percent; hexavalent chromium had two replicate pairs with RSDs of 47 and 85 percent, and vanadium had one replicate pair with a RSD of 31 percent. Constituents in these replicate pairs were detected at concentrations close to, or below, their LT-MDLs or MDLs.

Two measures of gross radioactivity in water, and two radioisotopes, had replicate-pair RSDs that were higher than the acceptable limits set for this study (*table 6E*). Two replicate pairs for 30-day counts of alpha radioactivity had RSDs of 66 and 60 percent, and one replicate pair for a 72-hour count of beta radioactivity had a slightly high RSD of 21 percent. The activities detected in these replicate pairs were at, or below, MDLs except for the replicate pair of 72-hour beta radioactivity that had activities approximately two and four times higher than the MDL. Radium-228 had a replicate pair RSDs of 37 and 26 percent, and one tritium replicate pair had a RSD of 91 percent; detections in these replicates were at activities that were at, or below, MDLs.

#### Matrix Spike Recoveries

A summary of matrix spike recoveries for the San Diego GAMA study is shown in *table 7A-C*. Nineteen VOCs had at least one matrix spike recovery greater than 130 percent (*table 7A*). Four of the 19 VOCs were detected in ground-water samples; chloroform was detected in 18 ground-water samples, and benzene, chloromethane, and 1,2-dichloroethane were each detected in one ground-water sample. All detections in ground-water samples were at concentrations well below MCLs. Styrene was the only VOC that had a matrix spike recovery below 70 percent; it was not detected in any ground-water samples.

Sixteen pesticides had at least one matrix spike recovery greater than 130 percent (*table 7B*). Two of the 16 pesticides were detected in ground-water samples; imazethapyr was detected in one ground-water sample and hydroxyatrazine was detected in two ground-water samples. Neither compound has a drinking-water standard. Sixty-six pesticides had matrix spike recoveries below 70 percent (*table 7B*). Of the 66 pesticides, the following 13 were detected in ground-water samples: 3,4-dichloroaniline, acetochlor, deethylatrazine, deisopropyl atrazine, desulfenyl fipronil, hexazinone, metalaxyl, metolachlor, myclobutanil, prometon, prometryn, simazine, and tebuthiuron. Of the pesticides with a low matrix spike recovery, simazine is the only one that is regulated, with an MCL of 4 µg/L. Concentrations of simazine in ground-water samples did not exceed 0.03 µg/L except in one case where a concentration of 0.2 µg/L was detected.



One waste-water indicator compound, caffeine, had a matrix spike recovery greater than 130 percent (*table 7C*). Caffeine was detected in one ground-water sample, and does not have an MCL. Twelve waste-water indicator compounds had at least one matrix spike recovery below 70 percent. Of the twelve compounds, only D-limonene was detected; it was detected in one ground-water sample at concentrations below the LT-MDL. D-limonene does not have an MCL.

## Surrogate Compound Recoveries

A summary of surrogate compound recoveries for ground-water and quality-control samples is given in *table 8*. Four ground-water samples analyzed for VOCs had recoveries of the surrogate 1,2-dichloroethane-d4 that were higher than the acceptable limit of 130 percent; recoveries ranged from 132 to 142 percent. Two of the four ground-water samples with high surrogate recoveries had VOC detections. The wells SDHDRK-05 and SDALLV-11 had one and six VOC detections, respectively. All detections in these wells were at least an order of magnitude below MCLs, except for a MTBE detection in SDALLV-11 which was detected at 28.3 µg/L; the MCL for MTBE is 13 µg/L.

Analyses for gasoline oxygenates in two field blanks and two source solution blanks had recoveries of the surrogate isobutyl alcohol-d6 that were below the acceptable limit of 70 percent; recoveries ranged from 60 to 64 percent. Each blank had a detection of acetone; however, acetone was not detected in any ground-water samples. VOC analysis for one replicate had a recovery of 144 percent for the surrogate 1,2-dichloroethane-d4. No VOCs were detected in the replicate.

All surrogate recoveries for pesticide and pesticide degradates in ground-water and quality-control samples analyzed by analytical schedule 2003 were within acceptable limits. Twelve surrogate recoveries were outside the acceptable limits for nine ground-water samples analyzed for pesticides and pesticide degradates by analytical schedule 2060. The surrogate caffeine-13C had nine recoveries that ranged from 131 to 141 percent, the surrogate barban had recoveries of 140 and 150 percent, and the surrogate 2,4,5-T had a recovery of 62 percent. A total of five pesticides were detected in two ground-water samples that had high surrogate recoveries. The well SDTEM-01 had one detection, and the well SDTEM-06 had four detections. None of the pesticides detected in either sample has a drinking-water standard.

One field blank sample had a recovery of 145 percent for the surrogate caffeine-13C. No pesticide or pesticide degradates were detected in this sample. One replicate had recoveries of 138 and 152 percent for the surrogates barban and

caffeine-13C, respectively. No pesticides or pesticide degradates were detected in this sample. A matrix spike sample had recoveries of 152 and 135 percent for the surrogates barban and caffeine-13C, respectively. Eighteen compounds in the matrix spike sample had recoveries of greater than 130 percent.

Forty-three ground-water samples analyzed for waste-water indicator compounds had surrogate recoveries outside acceptable limits. Ranges for surrogate recoveries were bisphenol A-d3 from 0 to 150 percent; caffeine-13C from 83 to 152 percent; decafluorobiphenyl from 35 to 86 percent; and fluoranthene-d10 from 66 to 154 percent. Twenty wells had a total of 23 waste-water indicator compound detections; all 20 wells had surrogate recoveries outside the acceptable limits. The majority (70 percent) of surrogate recoveries were below the acceptable limit of 70 percent. None of the waste-water indicator compounds has a drinking-water standard.

Based on surrogate recoveries, results for some waste-water indicator compound analyses of quality-control samples may have been biased due to problems with sample processing and/or analytical methods. One field blank had surrogate recoveries of 150 percent for caffeine-13C and 146 percent for fluoranthene-d10, and one source-solution blank had surrogate recoveries of 146 percent for caffeine-13C and 145 percent for fluoranthene-d10. No waste-water indicator compounds were detected in either blank sample. Three replicates had surrogate recoveries outside the acceptable limits. Bisphenol A-d3 was recovered in two replicates at 44 and 45 percent, and decafluorobiphenyl was recovered in one replicate at 58 percent. Waste-water indicator compounds were not detected in either replicate. One matrix spike had a recovery of bisphenol A-d3 at 134 percent, and a recovery of decafluorobiphenyl at 54 percent. Ten compounds in the matrix spike had recoveries of less than 70 percent. The low surrogate recovery for decafluorobiphenyl indicates that results for this sample may be negatively biased, which may explain the low recoveries observed in the matrix spike.

## Ground-Water Quality

The San Diego GAMA ground-water quality data presented in this report are available in the USGS National Water Information System database (NWIS), except for the following constituents: tritium and noble gases analyzed at LLNL; chromium, arsenic, and iron speciation analyzed at the USGS national research program (NRP) laboratory in Boulder, Colorado; and perchlorate, NDMA, and 1,4-dioxane analyzed at Montgomery Watson and Harza laboratory.

Table 9 shows the general water-quality indicators determined in the field; tables 10-20 show the results of analyses of ground-water samples organized by constituent class and microbial constituents. For simplicity, tables presenting the results of analyses are summarized for the following constituent classes: VOCs, gasoline oxygenates, pesticides and pesticide degradates, and waste-water indicators. In these tables, only constituents that were detected, and wells that had at least a single constituent detection, are shown. Each table shows the number of times a constituent was detected, the frequency at which the constituent was detected, and the number of constituents detected per well. Additionally, VOCs and gasoline oxygenates are combined into one table. Concentrations, or activities, that exceed MCLs are highlighted in the tables by bold font with an asterisk; exceedances of SMCLs are highlighted by bold font; and exceedances of DLRs are highlighted by bold, italicized font.

Detections in the Temecula Valley study area are divided into two categories, detections in non-flow path wells, which are referred to simply as Temecula Valley study area wells, and detections in flow path wells. Flow path wells are not included in comparisons of detections between study areas because the addition of flow-path wells introduces possible spatial bias in the Temecula Valley study area; the bias could arise from sampling additional wells in a relatively small area.

The chemical and microbial data presented in this report are meant to characterize the quality of the untreated ground-water resources in the San Diego GAMA study unit and not the treated drinking water delivered to consumers by water purveyors. The chemical and microbial composition of treated drinking water may differ from untreated ground water in that treated drinking water may be subjected to disinfection, filtration, mixing with other waters, and exposure to the atmosphere prior to being delivered to the consumer.

## VOCs and Gasoline Oxygenates

VOC and gasoline oxygenate samples were collected at all 58 wells sampled in the San Diego GAMA study unit. Twenty-eight wells had at least a single detection of a VOC or gasoline oxygenate (table 10). VOCs and gasoline oxygenates were detected in 11 of 17 wells in the Alluvial Basins study area, 7 of 14 wells in the Temecula Valley study area, 4 of 13 wells in the Hard Rock study area, and 1 of 9 wells in the Warner Valley study area. VOCs and gasoline oxygenates were detected in 5 of 5 Temecula Valley study area flow path wells.

Eighteen of the 88 VOCs and gasoline oxygenates analyzed for were detected in the ground-water samples. Triha-

lomethanes were the most frequently detected class of VOCs; they were detected in 18 of 58 wells. The next most frequently detected class of VOCs were solvents, detected in 12 of 58 wells, followed by VOCs found in gasoline, 9 of 58 wells, and VOCs used in manufacturing (organic synthesis), 3 of 58 wells. Chloroform was the most frequently detected constituent, detected in 18 of 58 wells, followed by bromodichloromethane, 8 of 58 wells, and methyl *tert*-butyl ether (MTBE), 7 of 58 wells. Three VOCs were detected at concentrations greater than the MCL (table 10). Tetrachloroethylene (PCE) and trichloroethylene (TCE) were both detected in SDHDRK-01 at concentrations of 9.75 µg/L and 7.27 µg/L, respectively. The MCL for both of these constituents is 5 µg/L. MTBE was detected in SDALLV-11 at a concentration of 28.3 µg/L; the MCL for MTBE is 13 µg/L.

## Pesticides and Pesticide Degradates

Pesticide and pesticide degrade samples determined by analytical schedule 2003 were collected at all 58 wells sampled for the San Diego GAMA study unit, and pesticides and pesticide degrade samples determined by analytical schedule 2060 were collected at 24 wells. Because pesticide analytical schedule 2060 was not sampled at a uniform rate across the four study areas, constituents detected by this method will not be included when calculating the detection frequency of pesticides and pesticide degradates in the individual study areas. Thirty-three of 58 wells sampled had at least a single detection of a pesticide or pesticide degrade (table 11). Pesticides and pesticide degradates were detected in 9 of 14 wells in the Temecula Valley study area, 10 of 17 wells in the Alluvial Basins study area, 7 of 13 wells in the Hard Rock study area, and 3 of 9 wells in the Warner Valley study area. Pesticides and pesticide degradates were detected in 4 of 5 flow-path wells in the Temecula Valley study area.

Twenty-one of the 122 pesticides and pesticide degradates analyzed for were detected in ground-water samples. Herbicides were the most frequently detected class of pesticides; they were detected in 31 of 58 wells. Pesticide degradates were detected in 19 of 58 wells, and fungicides were detected in 4 of 58 wells. Simazine was the most frequently detected pesticide, detected in 27 of 58 wells. The degradation product deethylatrazine was the second most frequently detected constituent, identified in 14 of 58 wells, and the pesticides prometon and atrazine were detected in 10 and 9 wells, respectively. None of the pesticide concentrations detected exceeded MCLs.

## Waste-Water Indicator Compounds

Waste-water indicator compounds were collected at 50 wells, but three samples were ruined before analysis, and consequently no waste-water analyses are available for SDWARN-08, SDTEM-10, and SDHDRK-11. Eight different waste-water indicator compounds were detected in samples. Twenty of 47 wells sampled had at least a single detection of a waste-water indicator compound (*table 12*). These constituents were detected in 9 of 17 wells in the Alluvial Basins study area, 6 of 12 wells in the Hard Rock study area, 3 of 8 wells in the Warner Valley study area, and 2 of 6 wells in the Temecula Valley study area. Waste-water indicator compounds were detected in 1 of 5 flow-path wells in the Temecula Valley study area. Phenol was the most frequently detected constituent, being identified in 14 of 47 wells. However, given the fact that phenol has been a persistent contaminant found in field blanks, and that 10 of 14 detections in this study were at, or within, 0.1 µg/L of the censoring threshold, phenol data should be used with caution when interpreting ground-water quality in the San Diego GAMA study unit. None of the waste-water indicator compounds detected in this study has a drinking-water standard.

## Perchlorate, NDMA, and 1,4-dioxane

Perchlorate and NDMA were collected at 50 wells, and 1,4-dioxane at 24 wells (*table 13*). Of the 50 wells in which perchlorate was measured, 14 of them had detections. Perchlorate was detected in 4 of 7 wells in the Temecula Valley study area, 2 of 9 wells in the Warner Valley study area, 3 of 17 wells in the Alluvial Basins study area, and 2 of 13 wells in the Hard Rock study area. Perchlorate was also detected in 3 of 4 flow-path wells in the Temecula Valley study area. Perchlorate was detected in SDALLV-05 at a concentration of 4.2 µg/L, which is above the DLR concentration of 4 µg/L. NDMA and 1,4-dioxane were not detected in any samples.

## Nutrients and Dissolved Organic Carbon

Nutrients and DOC samples were collected at 24 wells (*table 14*). Nitrate was detected in 17 of 24 wells, whereas nitrite was detected in only 2 wells. Concentrations of nitrate as N did not exceed the MCL of 10 mg/L; values range from less than 0.1 mg/L to 9.14 mg/L. Nitrite was detected in two wells at estimated concentrations of 0.006 mg/L and 0.028

mg/L. Neither of these concentrations is close to the nitrite MCL of 1 mg/L. Ammonia was detected in 6 of 24 wells at concentrations less than or equal to 0.18 mg/L. Dissolved phosphorus and DOC were both detected in all but two wells.

## Major Ions and Total Dissolved Solids

Major ion and total dissolved solids (TDS) samples were collected at 24 wells (*table 15*). Nine of 24 wells had TDS concentrations that exceeded the recommended SMCL of 500 mg/L, and 3 of 24 wells had TDS concentrations that exceeded the upper limit of the SMCL of 1,000 mg/L. Concentrations of TDS that exceeded SMCLs ranged from 508 to 1,800 mg/L. All six wells in the Alluvial Basins study area, in which TDS was measured, had concentrations above the SMCL; four wells had concentrations greater 500 mg/L, and two wells had concentrations above 1,000 mg/L. Four of seven wells sampled for TDS in the Temecula Valley study area had concentrations greater than 500 mg/L, one of four wells in the Hard Rock study area had a TDS concentration greater than the upper-limit SMCL (1,198 mg/L), and none of the three wells sampled for TDS in the Warner Valley had concentrations greater than 325 mg/L. One of four flow-path wells in the Temecula Valley study area had a TDS concentration greater than 500 mg/L. However, two of the flow path wells had TDS concentrations of 478 and 494 mg/L.

Two wells had exceedances of the chloride SMCL and three wells had exceedances of the sulfate SMCL. SDALLV-06, which had a TDS concentration of 1,800 mg/L, had a chloride concentration of 540 mg/L and sulfate concentration of 421 mg/L. This well exceeded the upper limit chloride SMCL of 500 mg/L and the recommended sulfate SMCL of 250 mg/L. SDALLV-03, which had a TDS concentration of 1,240 mg/L, had a chloride concentration of 472 mg/L, and SDALLV-01 and SDHDRK-05 had sulfate concentrations of 271 and 320 mg/L, respectively.

## Trace Elements

Trace element samples were collected at 24 wells (*table 16*). Of the 25 trace elements measured, 11 have a MCL, six have a SMCL, and three are listed as UCMR constituents, and therefore have a DLR. Beryllium and mercury were the only trace elements not detected in any sample; the LRL for these constituents are 0.01 and 0.06 µg/L, respectively. Arsenic was detected in all 24 wells at concentrations ranging from less than 0.5 µg/L to 7.8 µg/L. These concentrations are below the current arsenic MCL of 50 µg/L, as well as the proposed MCL of 10 µg/L that is scheduled to take effect in 2006. Uranium, barium, and nickel also were detected in all 24 wells sampled. Uranium concentrations range from 0.06 µg/L to 17.8 µg/L. When converted from mass units to activities using the standard conversion factor of 0.67 pCi/µg, all uranium activities are below the DHS MCL of 20 pCi/L (U.S. Environmental Protection Agency, 2004). Barium concentrations range from 2 µg/L to 147 µg/L, and nickel concentrations range from 0.14 µg/L to 3.44 µg/L. Concentrations for these constituents are well below the MCLs for both barium (1,000 µg/L) and nickel (100 µg/L). Selenium has a MCL of 50 µg/L, and was detected in all but one well. Detections of selenium are at concentrations below 3 µg/L, except for the sample collected at SDALLV-01, where the concentration is 30.9 µg/L.

Chromium analysis of samples was done at two different laboratories. Total chromium was analyzed in 24 samples at the NWQL (*table 16*), and in 50 samples at the Boulder NRP laboratory (*table 17*). The NRP laboratory method of chromium analysis is more sensitive than the method used by the NWQL. In addition, the NRP laboratory analyzes for hexavalent chromium, which is classified as an UCMR constituent. Total chromium, as determined at the NRP laboratory, was detected in 44 of 50 wells. Concentrations range from 0.1 µg/L to 5.7 µg/L, with the majority of samples having concentrations less than 2 µg/L. The MCL for total chromium is 50 µg/L. Hexavalent chromium was detected in 36 of 50 wells. Much like total chromium, hexavalent chromium concentrations range from 0.1 µg/L to 5.6 µg/L, with the majority of samples having concentrations less than 2 µg/L. Seven wells with hexavalent chromium detections have concentrations that exceed the DLR of 1 µg/L; four of these wells are in the Temecula Valley study area.

Iron was detected in two wells at concentrations above its SMCL of 300 µg/L (*table 16*). The wells SDALLV-06 and SDALLV-13 had iron concentrations of 2,120 µg/L and 578 µg/L, respectively. Manganese was detected in four wells at concentrations that exceed its SMCL of 50 µg/L. The wells SDALLV-03, SDALLV-06, SDALLV-13, and SDHDRK-06

had manganese concentrations of 169 µg/L, 492 µg/L, 362 µg/L, and 178 µg/L, respectively.

Boron was detected in 23 of the 24 wells sampled. Of those 23 detections, 15 exceed the boron DLR of 100 µg/L. Boron concentrations exceed the DLR most frequently in the Alluvial Basins study area (5 of 6 wells), followed by the Temecula Valley study area (5 of 7 wells), the Warner Valley study area (1 of 3 wells), and the Hard Rock study area (1 of 4 wells). Boron concentrations are also greater than the DLR in three of four Temecula Valley study area flow-path wells. Vanadium was detected in 20 of the 24 wells sampled. Of those 20 detections, 14 have concentrations that exceed the vanadium DLR of 3 µg/L. Vanadium concentrations exceed the DLR most frequently in the Warner Valley study area (3 of 3 wells), followed by the Temecula Valley study area (5 of 7 wells), the Hard Rock study area (2 of 4 wells), and the Alluvial Basins study area (1 of 6 wells). Vanadium concentrations are also greater than the DLR in three of four Temecula Valley study area flow-path wells.

## Isotopes, Radioactivity, and Noble Gases

Isotope activities, stable isotopes, and gross alpha/beta radioactivity were determined in ground-water samples collected for the San Diego GAMA study unit (*tables 18 and 19*). Stable isotopes of water, tritium (using two methods of analysis), and noble gases were collected at all 58 wells, whereas radium-226, radium-228, radon-222, alpha radioactivity (72-hour and 30-day count), beta radioactivity (72-hour and 30-day count), and carbon isotopes were collected at 24 wells. Tritium samples, determined by the helium in-growth method, and noble gas samples were collected at all 58 wells (*table 19*). These samples were analyzed at LLNL, and the results can be used to help determine the chronology and source of ground-water recharge.

Tritium was detected in most samples (*table 19*). The highest activity detected in any sample was 23.7 pCi/L; the MCL for tritium is 20,000 pCi/L. Radium-226 was detected in all samples, but concentrations never exceeded 0.41 pCi/L. Radium-228 was detected in all but four samples. Detections were so low that quantification is not possible except for one sample where it was detected at an activity of 2 pCi/L. No wells exceeded the combined radium-226 and radium-228 MCL of 5 pCi/L. Alpha radioactivity in samples ranged from below quantification limits to 9 pCi/L for both 72-hour and 30-day counts, which does not exceed the alpha radioactivity MCL of 15 pCi/L. Beta radioactivity ranges from below quantification limits to 7 pCi/L for 72-hour counts, and from 2 pCi/L to 11 pCi/L in 30-day counts. The MCL for beta radioactivity is 50 pCi/L.



Radon-222 was detected in every ground-water sample in which it was analyzed, with activities ranging from 180 to 4,820 pCi/L. In 15 of 24 wells, radon-222 activities exceed the proposed MCL of 300 pCi/L (*table 18*), and one sample exceeds the proposed alternate maximum contaminant level (AMCL) of 4,000 pCi/L (U.S. Environmental Protection, Agency, 2000b). Radon-222 exceeded the proposed MCL in three of three wells in the Warner Valley study area, four of four wells in the Hard Rock study area, three of six wells in the Alluvial Basins study area, and two of seven wells in the Temecula Valley study area. In addition, radon-222 was measured at activities greater than 300 pCi/L in three of four Temecula Valley study area flow-path wells.

## Microbial Constituents

Microbial constituents were analyzed for in 24 ground-water samples collected for the San Diego GAMA study (*table 20*). The following microbial constituents were determined: total coliform and *Escherichia* coliform, and the viruses F-specific coliphage and somatic coliphage. Total coliform and *Escherichia* coliform were not detected in any samples. F-specific coliphage was detected in one well, SDALLV-13, and somatic coliphage was detected in two wells, SDTEM-13 and SDWARN-04. Coliphage results are reported as being either present or absent.

## Summary

The GAMA program provides a comprehensive statewide assessment of ground-water quality in areas of California where public-supply wells provide an important source of drinking water. The San Diego GAMA study unit is the first region where an assessment of ground-water quality was implemented under the GAMA program. The San Diego GAMA study unit covers the entire San Diego Drainages hydrogeologic province, and consists of four distinct hydrogeologic study areas: the Temecula Valley study area, the Warner Valley study area, the Alluvial Basins study area, and the Hard Rock study area. A total of 58 ground-water samples were collected from public-supply wells in the San Diego GAMA study unit: 19 wells were sampled in the Temecula Valley study area, 9 wells in the Warner Valley study area, 17 wells in the Alluvial Basins study area, and 13 wells in the Hard Rock study area.

This report presents the results of sample analyses for over 350 chemical and microbial constituents, and water-quality indicators collected from the 58 public supply wells from May to July 2004. The results of sample analyses are presented as detection frequencies for individual constituents, and

classes of constituents, for the entire San Diego GAMA study unit and for the individual study areas. In addition, results of sample analyses are compared to MCLs, SMCLs, and DLRs. The chemical and microbial data presented in this report are meant to characterize the quality of the untreated ground-water resources in this study unit and not the treated drinking water delivered to consumers by water purveyors. The chemical and microbial composition of treated drinking water may differ significantly from untreated ground water in that treated drinking water may be subjected to disinfection, filtration, mixing with other waters, and exposure to the atmosphere prior to being delivered to the consumer.

Eighteen of the 88 VOCs and gasoline oxygenates analyzed were detected in samples. VOCs and gasoline oxygenates were detected in 28 of 58 wells sampled. These constituents were most frequently detected in wells located in the Alluvial Basins study area (11 of 17 wells), and least frequently in the Warner Valley study area (1 of 9 wells). Trihalomethanes were the most frequently detected classes of constituents, being identified in 18 of 58 wells. Chloroform was the most frequently detected constituent (18 of 58 wells). MTBE was also relatively frequently detected; it was identified in 7 of 58 wells. Three constituents had detections that exceeded MCLs (*table 10*). PCE and TCE were detected in SDHDRK-01 at concentrations of 9.75 µg/L and 7.27 µg/L, respectively. The MCL for these constituents is 5 µg/L. MTBE was detected in well SDALLV-11 at a concentration of 28.3 µg/L, which exceeds the MCL of 13 µg/L.

Twenty-one of the 122 pesticides and pesticide degradates analyzed were detected in this study. Pesticides and pesticide degradates were detected in 33 of 58 wells sampled. These constituents were detected most frequently in the Temecula Valley study area (9 of 14 wells), and least frequently in the Warner Valley study area (3 of 9 wells). Herbicides were the class of constituents most frequently detected throughout the study unit (31 of 58 wells), and simazine, a herbicide, was the most frequently detected compound (27 of 58 wells). None of the concentrations of pesticides and pesticide degradates exceeded MCLs.

Eight waste-water indicator compounds were identified in samples. Twenty of 47 wells sampled for waste-water indicator compounds had at least a single detection. These constituents were detected most frequently in the Alluvial Basins study area (9 of 17 wells), and least frequently in the Temecula Valley study area (2 of 6 wells). Phenol was the most frequently detected constituent; it was found in 14 of 47 wells. However, phenol has been a persistent contaminant in field blanks, and therefore phenol results should be used with caution when interpreting water quality in this study. Perchlorate was detected in 14 of 50 wells in the San Diego GAMA study unit. Perchlorate was detected in one well, SDALLV-05, at a concentration (4.2 µg/L) above the DLR.

Nitrate was detected in 17 of the 24 wells that were sampled for nutrients. None of the nitrate concentrations in samples exceeded the MCL of 10 mg/L. Twelve of the 24 wells sampled for major ions had TDS concentrations that exceeded the recommended SMCL of 500 mg/L, with three of these wells also exceeding the upper-limit SMCL of 1,000 mg/L. All six wells in the Alluvial Basins study area, in which TDS was measured, had concentrations greater than the SMCL; four wells had concentrations greater than 500 mg/L, and two wells had concentrations greater than 1,000 mg/L. None of the wells measured for TDS in the Warner Valley study area had concentrations that exceeded SMCLs. Four wells with high TDS also had concentrations of chloride and sulfate that exceeded SMCLs. Well SDALLV-06 had a chloride concentration of 540 mg/L and a sulfate concentration of 421 mg/L, which exceeds the chloride upper limit SMCL of 500 mg/L and the recommended sulfate SMCL of 250 mg/L. Well SDALLV-03 had a chloride concentration of 472 mg/L, and wells SDALLV-01 and SDHDRK-05 had sulfate concentrations of 271 and 320 mg/L, respectively.

Of the 25 trace elements analyzed in this study, only beryllium and mercury were not detected at the LRL of 0.01 and 0.06 µg/L, respectively. Arsenic and uranium were detected in all 24 wells in which they were measured, but at concentrations below their respective MCLs. Additionally, arsenic concentrations did not exceed the 10 µg/L MCL that will replace the current MCL of 50 µg/L in 2006. Forty-four of 50 wells that were analyzed for chromium had detectable concentrations; all total chromium concentrations were below its MCL of 50 µg/L. Thirty-six of 50 wells had detectable amounts of hexavalent chromium; seven of these wells had concentrations that exceeded the hexavalent chromium DLR of 1 µg/L.

Iron concentrations exceeded the SMCL of 300 µg/L in two wells; SDALLV-06 and SDALLV-13 had iron concentrations of 2,120 µg/L and 578 µg/L, respectively. Manganese was detected in four wells at concentrations that exceeded the SMCL of 50 µg/L; wells SDALLV-03, SDALLV-06, SDALLV-13, and SDHDRK-06 had manganese concentrations of 169 µg/L, 492 µg/L, 362 µg/L, and 178 µg/L, respectively. Boron was detected in 23 of 24 wells; 14 of those detections exceeded the boron DLR of 100 µg/L; the DLR was most frequently exceeded in the Alluvial Basins study area, and least frequently detected in the Hard Rock study area. Vanadium was detected in 20 of 24 wells; 11 of those detections had concentrations that exceeded the vanadium DLR of 3 µg/L; the DLR was most frequently exceeded in the Warner Valley study area, and least frequently exceeded in the Alluvial Basins study area.

Tritium was detected in the majority of samples; activities were well below the MCL of 20,000 pCi/L. Radium-226 and radium-228 was detected together in all but four samples; however, activities detected in samples were low. Activities of radium-228 were below quantification limits in all but one sample. No wells exceeded the combined radium-226 and radium-228 MCL of 5 pCi/L. Alpha and beta radioactiv-

ity were detected in all but two samples; activities did not exceed the respective MCLs of 15 and 50 pCi/L. Radon-222 was detected in every ground-water sample in which it was analyzed. Radon-222 activities in 62 percent of the samples exceeded the proposed MCL of 300 pCi/L, and one sample exceeded the proposed alternate maximum contaminant level (AMCL) of 4,000 pCi/L (*table 18*). Radon-222 activities exceeded the proposed MCL in all Warner Valley and Alluvial Basins study area wells in which it was measured.

Total coliform and *Escherichia* coliform were not detected in any of the 24 samples analyzed for microbial constituents. F-specific coliphage was detected in one well, SDALLV-13, and somatic coliphage was detected in two wells, SDTEM-13 and SDWARN-04. Coliphage results are reported as the organism either being present or absent.

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## Tables

**Table 1.** Classes of chemical and microbial constituents and water-quality indicators collected for the expanded, basic-plus, and basic sampling schedules in the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[SC, specific conductance; DO, dissolved oxygen; NDMA, N-nitrosodimethylamine]

Expanded schedule	Basic-plus schedule	Basic schedule
Water-quality indicators (pH, SC, DO, temperature, alkalinity)	Water-quality indicators (SC and temperature)	Water-quality indicators (SC and temperature)
Volatile organic compounds	Volatile organic compounds	Volatile organic compounds
Gasoline oxygenates	Gasoline oxygenates	Gasoline oxygenates
Pesticides	Pesticides	Pesticides
Polar pesticides and degradates	Waste-water indicator compounds	Stable isotopes of water
Waste-water indicator compounds	Pharmaceuticals	Tritium <sup>1</sup>
Pharmaceuticals	Emerging contaminants (perchlorate and NDMA)	Tritium and noble gases <sup>2</sup>
Emerging contaminants (perchlorate, 1,4-dioxane, and NDMA)	Chromium speciation	
Nutrients and dissolved organic carbon	Stable isotopes of water	
Major ions and trace elements	Tritium <sup>1</sup>	
Chromium speciation	Tritium and noble gases <sup>2</sup>	
Arsenic and iron speciation		
Stable isotopes of water		
Carbon isotopes		
Radium isotopes		
Gross alpha/beta radiation		
Radon-222		
Tritium <sup>1</sup>		
Tritium and noble gases <sup>2</sup>		
Microbial constituents		

<sup>1</sup>Analyzed at the U.S. Geological Survey stable isotope and tritium lab, Menlo Park, California.<sup>2</sup>Analyzed at Lawrence Livermore National Laboratory, Livermore, California.

**Table 2A.** Volatile organic compounds, primary use or source, Chemical Abstract Service (CAS) number, and laboratory reporting level (LRL) for the U.S. Geological Survey's National Water Quality Laboratory analytical schedule 2020.

[µg/L, micrograms per liter]

Compound	Primary use/source	CAS number	LRL (µg/L)
1,1,1,2-Tetrachloroethane	Solvent	630-20-6	0.03
1,1,1-Trichloroethane (TCA)	Solvent	71-55-6	0.032
1,1,2,2-Tetrachloroethane	Solvent	79-34-5	0.16
1,1,2-Trichloroethane	Solvent	79-00-5	0.064
1,1,2-Trichlorotrifluoroethane (CFC-113)	Refrigerant	76-13-1	0.038
1,1-Dichloroethane	Solvent	75-34-3	0.035
1,1-Dichloroethylene	Organic synthesis	75-35-4	0.024
1,1-Dichloropropene	Organic synthesis	563-58-6	0.026
1,2,3,4-Tetramethylbenzene	Hydrocarbon	488-23-3	0.14
1,2,3,5-Tetramethylbenzene (isodurene)	Hydrocarbon	527-53-7	0.14
1,2,3-Trichlorobenzene	Organic synthesis	87-61-6	0.27
1,2,3-Trichloropropane	Solvent	96-18-4	0.18
1,2,3-Trimethylbenzene	Gasoline	526-73-8	0.06
1,2,4-Trichlorobenzene	Solvent	120-82-1	0.12
1,2,4-Trimethylbenzene	Organic synthesis	95-63-6	0.056
1,2-Dibromo-3-chloropropane	Fumigant	96-12-8	0.51
1,2-Dibromoethane	Solvent	106-93-4	0.036
1,2-Dichlorobenzene	Solvent	95-50-1	0.048
1,2-Dichloroethane	Solvent	107-06-2	0.13
1,2-Dichloropropane	Solvent	78-87-5	0.029
1,3,5-Trimethylbenzene	Gasoline	108-67-8	0.044
1,3-Dichlorobenzene	Solvent	541-73-1	0.03
1,3-Dichloropropane	Organic synthesis	142-28-9	0.06
1,4-Dichlorobenzene	Fumigant	106-46-7	0.034
2,2-Dichloropropane	Organic synthesis	594-20-7	0.05
2-Butanone	Solvent	78-93-3	4
2-Chlorotoluene	Solvent	95-49-8	0.04
2-Hexanone	Solvent	591-78-6	0.7
3-Chloropropene	Organic synthesis	107-05-1	0.5
4-Chlorotoluene	Solvent	106-43-4	0.05
4-Isopropyl-1-methylbenzene	Organic synthesis	99-87-6	0.08
4-Methyl-2-pentanone	Solvent	108-10-1	0.37
Acetone	Solvent	67-64-1	6
Acrylonitrile	Organic synthesis	107-13-1	0.8
Benzene	Gasoline	71-43-2	0.021
Bromobenzene	Solvent	108-86-1	0.028
Bromochloromethane	Organic synthesis	74-97-5	0.12

**Table 2A.** Volatile organic compounds, primary use or source, Chemical Abstract Service (CAS) number, and laboratory reporting level (LRL) for the U.S. Geological Survey's National Water Quality Laboratory analytical schedule 2020—Continued.

[µg/L, micrograms per liter]

Compound	Primary use/source	CAS number	LRL (µg/L)
Bromodichloromethane	Disinfection by-product	75-27-4	0.028
Bromoethene	Fire retardant	593-60-2	0.1
Bromoform (tribromomethane)	Disinfection by-product	75-25-2	0.1
Bromomethane	Fumigant	74-83-9	0.26
Butylbenzene	Organic synthesis	104-51-8	0.12
Carbon disulfide	Organic synthesis	75-15-0	0.038
Chlorobenzene	Solvent	108-90-7	0.028
Chloroethane	Solvent	75-00-3	0.12
Chloroform (trichloromethane)	Disinfection by-product	67-66-3	0.024
Chloromethane	Refrigerant	74-87-3	0.17
<i>cis</i> -1,2-Dichloroethylene	Solvent	156-59-2	0.024
<i>cis</i> -1,3-Dichloropropene	Fumigant	10061-01-5	0.05
Dibromochloromethane	Disinfection by-product	124-48-1	0.1
Dibromomethane	Solvent	74-95-3	0.05
Dichlorodifluoromethane (CFC-12)	Refrigerant	75-71-8	0.18
Dichloromethane (methylene chloride)	Solvent	75-09-2	0.06
Diethyl ether	Solvent	60-29-7	0.08
Diisopropyl ether	Gasoline	108-20-3	0.1
Ethyl methacrylate	Organic synthesis	97-63-2	0.18
Ethyl <i>tert</i> -butyl ether (ETBE)	Gasoline	637-92-3	0.05
Ethylbenzene	Gasoline	100-41-4	0.03
Hexachlorobutadiene	Organic synthesis	87-68-3	0.14
Hexachloroethane	Solvent	67-72-1	0.14
Isopropylbenzene	Organic synthesis	98-82-8	0.038
<i>m</i> - and <i>p</i> -Xylene	Gasoline	108-38-3/106-42-3	0.06
Methyl acrylate	Organic synthesis	96-33-3	2
Methyl acrylonitrile	Organic synthesis	126-98-7	0.76
Methyl iodide	Organic synthesis	74-88-4	0.35
Methyl methacrylate	Organic synthesis	80-62-6	0.35
Methyl <i>tert</i> -butyl ether	Gasoline	1634-04-4	0.17
Naphthalene	Organic synthesis	91-20-3	0.52
<i>n</i> -Propylbenzene	Solvent	103-65-1	0.042
<i>o</i> -Ethyl toluene	Hydrocarbon	611-14-3	0.06
<i>o</i> -Xylene	Gasoline	95-47-6	0.038
<i>sec</i> -Butylbenzene	Organic synthesis	135-98-8	0.06
Styrene	Organic synthesis	100-42-5	0.042
<i>tert</i> -Amyl methyl ether	Gasoline	994-05-8	0.08
<i>tert</i> -Butylbenzene	Organic synthesis	98-06-6	0.06
Tetrachloroethylene (PCE)	Solvent	127-18-4	0.06



**Table 2A.** Volatile organic compounds, primary use or source, Chemical Abstract Service (CAS) number, and laboratory reporting level (LRL) for the U.S. Geological Survey's National Water Quality Laboratory analytical schedule 2020—Continued.

[µg/L, micrograms per liter]

Compound	Primary use/source	CAS number	LRL (µg/L)
Tetrachloromethane (carbon tetrachloride)	Solvent	56-23-5	0.06
Tetrahydrofuran	Solvent	109-99-9	1
Toluene	Gasoline	108-88-3	0.02
<i>trans</i> -1,2-Dichloroethylene	Solvent	156-60-5	0.032
<i>trans</i> -1,3-Dichloropropene	Fumigant	10061-02-6	0.09
<i>trans</i> -1,4-Dichloro-2-butene	Organic synthesis	110-57-6	0.7
Trichloroethylene (TCE)	Solvent	79-01-6	0.038
Trichlorofluoromethane (CFC-11)	Refrigerant	75-69-4	0.16
Vinyl chloride	Organic synthesis	75-01-4	0.06

**Table 2B.** Gasoline oxygenates and gasoline oxygenate degradates, primary use or source, Chemical Abstract Service (CAS) number, and laboratory reporting level (LRL) for the U.S. Geological Survey's National Water Quality Laboratory analytical schedule 4024.

[µg/L, micrograms per liter]

Compound	Primary use/source	CAS number	LRL (µg/L)
Acetone	Degradate	67-64-1	1.2
Diisopropyl ether	Gasoline oxygenate	108-20-3	0.08
Ethyl tert-butyl ether	Gasoline oxygenate	637-92-3	0.1
Methyl acetate	Degradate	79-20-9	0.4
<i>tert</i> -Amyl alcohol	Degradate	75-85-4	0.43
<i>tert</i> -Butyl alcohol	Degradate	75-65-0	1
<i>tert</i> -Butyl methyl ether	Gasoline oxygenate	1634-04-4	0.08
<i>tert</i> -Pentyl methyl ether	Gasoline oxygenate	994-05-8	0.07

**Table 2C.** Pesticides and pesticide degradates, primary use or source, Chemical Abstract Service (CAS) number, and laboratory reporting level (LRL) for the U.S. Geological Survey's National Water Quality Laboratory analytical schedule 2003.

[NA, not available; µg/L, micrograms per liter]

Compound	Primary use/source	CAS number	LRL (µg/L)
1-Naphthol	Degradate	90-15-3	0.088
2,6-Diethylaniline	Degradate	579-66-8	0.006
2-Chloro-2,6-diethylacetanilide	Degradate	6967-29-9	0.005
2-Ethyl-6-methylaniline	Degradate	24549-06-2	0.004
3,4-Dichloroaniline	Degradate	95-76-1	0.004
4-Chloro-2-methylphenol	Degradate	1570-64-5	0.005
Acetochlor	Herbicide	34256-82-1	0.006
Alachlor	Herbicide	15972-60-8	0.005
Atrazine	Herbicide	1912-24-9	0.007
Azinphos-methyl oxygen analog	Degradate	90-15-4	0.016
Azinphos-methyl	Degradate	90-15-4	0.05
Benfluralin	Degradate	579-66-9	0.01
Carbaryl	Insecticide	63-25-2	0.041
Chlorpyrifos	Insecticide	2921-88-2	0.005
Chlorpyrifos, oxygen analog	Degradate	5598-15-2	0.056
cis-Permethrin	Insecticide	54774-45-7	0.006
Cyfluthrin	Insecticide	68359-37-5	0.008
Cypermethrin	Insecticide	52315-07-8	0.008
Dacthal	Herbicide	1861-32-1	0.003
Deethylatrazine	Degradate	6190-65-4	0.006
Desulfinylfipronil	Degradate	NA	0.012
Desulfinylfipronil amide	Degradate	NA	0.029
Diazinon	Insecticide	333-41-5	0.005
Diazinon, oxygen analog	Insecticide	962-58-3	0.01
Dichlorvos	Fumigant	62-73-7	0.011
Dicrotophos	Insecticide	141-66-2	0.084
Dieldrin	Insecticide	60-57-1	0.009
Dimethoate	Insecticide	60-51-5	0.006
Ethion	Insecticide	563-12-2	0.004
Ethion monoxon	Degradate	17356-42-2	0.033
Fenamiphos	Insecticide	22224-92-6	0.029
Fenamiphos sulfone	Degradate	31972-44-8	0.007
Fenamiphos sulfoxide	Degradate	31972-43-7	0.031
Fipronil	Insecticide	120068-37-3	0.016
Fipronil sulfide	Degradate	120067-83-6	0.013
Fipronil sulfone	Degradate	120068-36-2	0.024
Fonofos	Insecticide	944-22-9	0.003
Fonofos, oxygen analog	Degradate	944-21-8	0.002
Hexazinone	Herbicide	51235-04-2	0.012

**Table 2C.** Pesticides and pesticide degradates, primary use or source, Chemical Abstract Service (CAS) number, and laboratory reporting limits (LRLs) for the U.S. Geological Survey's National Water Quality Laboratory analytical schedule 2003—Continued.

[NA, not available; µg/L, micrograms per liter]

Compound	Primary use/source	CAS number	LRL (µg/L)
Iprodione	Fungicide	36734-19-7	1.422
Isofenphos	Insecticide	25311-71-1	0.003
Malaoxon	Degradate	1634-78-2	0.008
Malathion	Insecticide	121-75-5	0.027
Metalaxyl	Fungicide	57837-19-1	0.005
Methidathion	Insecticide	950-37-8	0.005
Metolachlor	Herbicide	51218-45-2	0.013
Metribuzin	Herbicide	21087-64-9	0.006
Myclobutanil	Fungicide	88671-89-0	0.008
Paraoxon-methyl	Degradate	950-35-6	0.029
Parathion-methyl	Insecticide	298-00-0	0.015
Pendimethalin	Herbicide	40487-42-1	0.022
Phorate	Insecticide	298-02-2	0.011
Phorate oxygen analog	Degradate	2600-69-3	0.097
Phosmet	Insecticide	732-11-6	0.007
Phosmet oxon	Degradate	3735-33-9	0.055
Prometon	Herbicide	1610-18-0	0.005
Prometryn	Herbicide	7287-19-6	0.005
Propyzamide	Herbicide	23950-58-5	0.004
Simazine	Herbicide	122-34-9	0.005
Tebuthiuron	Herbicide	34014-18-1	0.016
Terbufos	Insecticide	13071-79-9	0.017
Terbufos oxygen analog sulfone	Degradate	56070-15-6	0.067
Terbuthylazine	Herbicide	5915-41-3	0.010
Trifluralin	Herbicide	1582-09-8	0.009

**Table 2D.** Pesticides, pesticide degradates, and caffeine, primary use or source, Chemical Abstract Service (CAS) number, and laboratory reporting level (LRL) for the U.S. Geological Survey's National Water Quality Laboratory analytical schedule 2060.

[µg/L, micrograms per liter]

Compound	Primary use/source	CAS number	LRL (µg/L)
2,4-D	Herbicide	94-75-7	0.021
2,4-D methyl ester	Herbicide	1928-38-7	0.008
2,4-DB	Herbicide	94-82-6	0.016
3(4-Chlorophenyl)-1-methyl urea	Degradate	5352-88-5	0.024
3-Hydroxycarbofuran	Degradate	16655-82-6	0.005
3-Ketocarbofuran	Degradate	16709-30-1	0.014
Acifluorfen	Herbicide	50594-66-6	0.006
Aldicarb	Insecticide	116-06-3	0.04
Aldicarb sulfone	Degradate	1646-88-4	0.02
Aldicarb sulfoxide	Degradate	1646-87-3	0.008
Atrazine	Herbicide	1912-24-9	0.009
Bendiocarb	Insecticide	22781-23-3	0.025
Benomyl	Fungicide	17804-35-2	0.003
Bensulfuron-methyl	Herbicide	83055-99-6	0.015
Bentazon	Herbicide	25057-89-0	0.011
Bromacil	Herbicide	314-40-9	0.033
Bromoxynil	Herbicide	1689-84-5	0.017
Caffeine	Beverages	58-08-2	0.009
Carbaryl	Insecticide	63-25-2	0.028
Carbofuran	Herbicide	1563-66-2	0.005
Chloramben, methyl ester	Herbicide	7286-84-2	0.018
Chlorimuron-ethyl	Herbicide	90982-32-4	0.009
Chlorothalonil	Herbicide	1897-45-6	0.035
Clopyralid	Herbicide	1702-17-6	0.013
Cycloate	Herbicide	1134-23-2	0.013
Dacthal monoacid	Degradate	887-54-7	0.011
Deethylatrazine	Degradate	6190-65-4	0.028
Deethyldeisopropylatrazine	Degradate	3397-62-4	0.04
Deisopropylatrazine	Degradate	1007-28-9	0.01
Dicamba	Herbicide	1918-00-9	0.012
Dichlorprop	Herbicide	120-36-5	0.013
Dinoseb	Herbicide	88-85-7	0.012
Diphenamid	Herbicide	957-51-7	0.026
Diuron	Herbicide	330-54-1	0.015
Fenuron	Herbicide	101-42-8	0.031
Flumetsulam	Herbicide	98967-40-9	0.011
Fluometuron	Herbicide	2164-17-2	0.031
Hydroxyatrazine	Degradate	2163-68-0	0.008
Imazaquin	Herbicide	81335-37-7	0.016



**Table 2D.** Pesticides, pesticide degradates, and caffeine, primary use or source, Chemical Abstract Service (CAS) number, and laboratory reporting level (LRL) for the U.S. Geological Survey's National Water Quality Laboratory analytical schedule 2060—Continued.

[µg/L, micrograms per liter]

Compound	Primary use/source	CAS number	LRL (µg/L)
Imazethapyr	Herbicide	81335-77-5	0.017
Imidacloprid	Insecticide	138261-41-3	0.006
Linuron	Herbicide	330-55-2	0.014
MCPA	Herbicide	94-74-6	0.016
MCPB	Herbicide	94-81-5	0.015
Metalaxyl	Fungicide	57837-19-1	0.02
Methiocarb	Insecticide	2032-65-7	0.008
Methomyl	Insecticide	16752-77-5	0.004
Metsulfuron methyl	Herbicide	74223-64-6	0.025
Neburon	Herbicide	555-37-3	0.012
Nicosulfuron	Herbicide	111991-09-4	0.013
Norflurazon	Herbicide	27314-13-2	0.016
Oryzalin	Herbicide	19044-88-3	0.017
Oxamyl	Insecticide	23135-22-0	0.012
Picloram	Herbicide	6607	0.019
Propham	Herbicide	122-42-9	0.009
Propiconazole	Fungicide	60207-90-1	0.021
Propoxur	Insecticide	114-26-1	0.008
Siduron	Herbicide	1982-49-6	0.016
Sulfometuron-methyl	Herbicide	74222-97-2	0.008
Tebuthiuron	Herbicide	34014-18-1	0.006
Terbacil	Herbicide	5902-51-2	0.009
Tribenuron-methyl	Herbicide	101200-48-0	0.008
Triclopyr	Herbicide	55335-06-3	0.022

**Table 2E.** Waste-water indicator compounds, primary use or source, Chemical Abstract Service (CAS) number, and laboratory reporting level (LRL) for the U.S. Geological Survey's National Water Quality Laboratory analytical schedule 1433.

[µg/L, micrograms per liter]

Compound	Primary use/source	CAS number	LRL (µg/L)
1,4-Dichlorobenzene	Moth repellant, fumigant, deodorant	106-46-7	0.5
1-Methylnaphthalene	Gasoline, diesel fuel, or crude oil	90-12-0	0.5
2,6-Dimethylnaphthalene	Diesel/kerosene (trace in gasoline)	581-42-0	0.5
2-Methylnaphthalene	Gasoline, diesel fuel, or crude oil	91-57-6	0.5
3- <i>beta</i> -Coprostanol	Carnivore fecal indicator	360-68-9	2
3-Methyl-1(H)-indole (Skatole)	Fragrance, stench in feces and coal tar	83-34-1	1
3- <i>tert</i> -Butyl-4-hydroxy anisole (BHA)	Antioxidant, general preservative	25013-16-5	5
4-Cumylphenol	Nonionic detergent metabolite	599-64-4	1
4- <i>n</i> -Octylphenol	Nonionic detergent metabolite	1806-26-4	1
4- <i>tert</i> -Octylphenol	Nonionic detergent metabolite	140-66-9	1
5-Methyl-1H-benzotriazole	Antioxidant in antifreeze and deicers	136-85-6	2
Acetophenone	Fragrance in detergent and tobacco, flavor in beverages	98-86-2	0.5
Acetyl hexamethyl tetrahydronaphthalene (AHTN)	Musk fragrance	21145-77-7	0.5
Anthracene	Wood preservative, tar, diesel, crude oil, combustion product	120-12-7	0.5
Anthraquinone	Manuf dye/textiles, seed treatment, bird repellant	84-65-1	0.5
Benzo[a]pyrene	Cancer research, combustion product	50-32-8	0.5
Benzophenone	Fixative for perfumes and soaps	119-61-9	0.5
<i>beta</i> -Sitosterol	Plant sterol	83-46-5	2
<i>beta</i> -Stigmastanol	Plant sterol	19466-47-8	2
Bisphenol A	Manuf polycarbonate resins, antioxidant, flame retardant	80-05-7	1
Bromacil	Herbicide, >80 percent noncrop usage on grass/brush	314-40-9	0.5
Bromoform	Byproduct waste water treatment, military/explosives	75-25-2	0.5
Caffeine	Beverages	58-08-2	0.5
Camphor	Flavor, odorant, ointments	76-22-2	0.5
Carbaryl	Insecticide, crop and garden uses	63-25-2	1
Carbazole	Insecticide, manuf. dyes, explosives, and lubricants	86-74-8	0.5
Chlorpyrifos	Insecticide, domestic pest and termite control	2921-88-2	0.5
Cholesterol	Fecal indicator, plant sterol	57-88-5	2
Cotinine	Primary nicotine metabolite	486-56-6	1
Diazinon	Insecticide, >40 percent nonagricultural usage, ants, flies	333-41-5	0.5
Dichlorvos	Insecticide degradate of naled or trichlofon	62-73-7	1
<i>d</i> -Limonene	Fungicide, antimicrobial, antiviral, fragrance in aerosols	5989-27-5	0.5
Fluoranthene	Component of coal tar and asphalt	206-44-0	0.5

**Table 2E.** Waste-water indicator compounds, primary use or source, Chemical Abstract Service (CAS) number, and laboratory reporting level (LRL) for the U.S. Geological Survey's National Water Quality Laboratory analytical schedule 1433—Continued.

[µg/L, micrograms per liter]

Compound	Primary use/source	CAS number	LRL (µg/L)
Hexahydrohexamethylcyclopentabenzopyran (HHCB)	Musk fragrance	1222-05-5	0.5
Indole	Pesticide ingredient, fragrance in coffee	120-72-9	0.5
Isoborneol	Fragrance in perfumery, in disinfectants	124-76-5	0.5
Isophorone	Solvent for lacquer, plastic, oil, silicon, resin	78-59-1	0.5
Isopropylbenzene	Manuf phenol/acetone, fuels and paint thinner	98-82-8	0.5
Isoquinoline	Flavors and fragrances	119-65-3	0.5
Menthol	Cigarettes, cough drops, liniment, mouthwash	89-78-1	0.5
Metalaxyl	Herbicide, fungicide, mildew, blight, pathogens, golf/turf	57837-19-1	0.5
Methyl salicylate	Liniment, food, beverage, UV-absorbing lotion	119-36-8	0.5
Metolachlor	Herbicide, indicator of agricultural drainage	51218-45-2	0.5
N,N-diethyl-meta-toluamide (DEET)	Insecticide, urban uses, mosquito repellent	134-62-3	0.5
Naphthalene	Fumigant, moth repellent, major component of gasoline	91-20-3	0.5
Nonylphenol, diethoxy- (total)	Nonionic detergent metabolite	26027-38-2	5
Octylphenol, diethoxy- (OPEO2)	Nonionic detergent metabolite	26636-32-8	1
Octylphenol, monoethoxy- (OPEO1)	Nonionic detergent metabolite	26636-32-8	1
<i>para</i> -Nonylphenol (total)	Nonionic detergent metabolite	84852-15-3	5
<i>p</i> -Cresol	Wood preservative	106-44-5	1
Pentachlorophenol	Herbicide, fumigant, wood preservative, termite control	87-86-5	2
Phenanthrene	Manuf. explosives, tar, diesel, crude oil, combustion product	85-01-8	0.5
Phenol	Disinfectant, product manufacturing, leachate	108-95-2	0.5
Prometon	Herbicide (non-crop only) applied prior to black-top	1610-18-0	0.5
Pyrene	Component of coal tar and asphalt	129-00-0	0.5
Tetrachloroethylene	Solvent, degreaser, veterinary anthelmintic	127-18-4	0.5
Tri(2-butoxyethyl)phosphate	Flame retardant	78-51-3	0.5
Tri(2-chloroethyl)phosphate	Plasticizer, flame retardant	115-96-8	0.5
Tributyl phosphate	Antifoaming agent, flame retardant	126-73-8	0.5
Triclosan	Disinfectant, antimicrobial	3380-34-5	1
Triethyl citrate (ethyl citrate)	Cosmetics, pharmaceuticals	77-93-0	0.5
Triphenyl phosphate	Plasticizer, resin, wax, finish, roofing paper, flame retardant	115-86-6	0.5
Tris(dichlorisopropyl)phosphate	Flame retardant	13674-87-8	0.5

**Table 2F.** Pharmaceutical compounds, primary use or source, Chemical Abstract Service (CAS) number, and method detection limit (MDL) for the U.S. Geological Survey's National Water Quality Laboratory custom laboratory code 9003.

[CNS, central nervous system; NA, not available; µg/L, micrograms per liter]

Compound	Primary use/source	CAS number	MDL (µg/L)
1,7-dimethylxanthine	CNS stimulant	611-59-6	0.019
Acetaminophen	Analgesic	103-90-2	0.008
Azithromycin	Antibacterial	83905-01-5	NA
Caffeine	Beverages	58-08-2	0.014
Carbamazepine	Anticonvulsant	298-46-4	NA
Cimetidine <sup>1</sup>	Antihistamine	51481-61-9	0.006
Codeine	Analgesic	76-57-3	NA
Cotinine	CNS stimulant	486-56-6	0.023
Dehydronifedipine	Antianginal (metabolite)	67035-22-7	0.009
Diltiazem <sup>1</sup>	Antiangina, antihypertensive	42399-41-7	0.012
Diphenhydramine <sup>1</sup>	Antihistamine	58-73-1	NA
Erythromycin	Antibacterial	114-07-8	NA
Fluoxetine <sup>1</sup>	Antidepressant	54910-89-3	0.018
Furosemide	Diuretic	54-31-9	NA
Gemfibrozil <sup>1</sup>	Antihyperlipidemic	25812-30-0	0.015
Ibuprofen <sup>1</sup>	Analgesic	15687-27-1	0.018
Metformin	Antihyperglycemic	657-24-9	0.003
Miconazole	Antifungal	22916-47-8	NA
Ranitidine <sup>1</sup>	Antihistamine	66357-35-5	0.01
Salbutamol (Albuterol)	Antiasthmatic	18559-94-9	0.03
Sulfamethoxazole <sup>1</sup>	Antibacterial	723-46-6	0.023
Thiabendazole	Antiparasitic	148-79-8	NA
Trimethoprim	Antibacterial	738-70-5	0.014
Warfarin	Anticoagulant	81-81-2	0.006

<sup>1</sup>Concentrations of these compounds are reported as estimates only.



**Table 2G.** The emerging contaminant compounds perchlorate, 1,4-dioxane, and N-nitrosodimethylamine (NDMA), Chemical Abstract Service (CAS) number, and minimum reporting level (MRL) for Montgomery Watson Harza Laboratory.

[ug/L, micrograms per liter]

Compound	Primary use/source	CAS number	MRL (µg/L)
Perchlorate	Rocket fuel, fireworks, flares	14797-73-0	0.25, 0.5, 1.0, 2.0
1,4-dioxane	Solvent stabilizer, solvent	123-91-1	2
N-Nitrosodimethylamine	Rocket fuel manuf., plasticizer	62-75-9	0.002

**Table 2H.** Nutrients and dissolved organic carbon, Chemical Abstract Service (CAS) number, and laboratory reporting level (LRL) for the U.S. Geological Survey's National Water Quality Laboratory analytical schedule 2755 and laboratory code 2613.

[NA, not available; µg/L, micrograms per liter]

Compound	CAS number	LRL (µg/L)
Ammonia	7664-41-7	0.04
Nitrite	14797-65-0	0.008
Nitrate plus nitrite	NA	0.06
Total nitrogen (ammonia, nitrite, nitrate, organic nitrogen)	17778-88-0	0.03
Phosphorus, phosphate, ortho	14265-44-2	0.006
Dissolved organic carbon	NA	0.3

**Table 21.** Major ions and trace elements, Chemical Abstract Service (CAS) number, and laboratory reporting level (LRL) for the U.S. Geological Survey's National Water Quality Laboratory analytical schedule 1948.

[NA, not available; µg/L, micrograms per liter; mg/L, milligrams per liter]

Compound	CAS number	LRL
Major Ions, mg/L		
Bromide	24959-67-9	0.02
Calcium	7440-70-2	0.02
Chloride	16887-00-6	0.2
Fluoride	16984-48-8	0.1
Magnesium	7439-95-4	0.008
Potassium	2023695	0.16
Silica	7631-86-9	0.04
Sodium	7440-23-5	0.2
Sulfate	14808-79-8	0.18
Residue on evaporation	NA	10
Trace Elements, µg/L		
Aluminum	7429-90-5	1.6
Antimony	7440-36-0	0.2
Arsenic	7440-38-2	0.2
Barium	7440-39-3	0.2
Beryllium	7440-41-7	0.06
Boron	7440-42-8	8
Cadmium	7440-43-9	0.04
Chromium	7440-47-3	0.8
Cobalt	7440-48-4	0.014
Copper	7440-50-8	0.4
Iron	7439-89-6	6
Lead	7439-92-1	0.08
Lithium	7439-93-2	0.6
Manganese	7439-96-5	0.2
Mercury	7439-97-6	0.01
Molybdenum	7439-98-7	0.4
Nickel	7440-02-0	0.06
Selenium	7782-49-2	0.4
Silver	7440-22-4	0.2
Strontium	7440-24-6	0.4
Thallium	7440-28-0	0.04
Tungsten	7440-33-7	0.5
Uranium	7440-61-1	0.04
Vanadium	7440-62-2	0.14
Zinc	7440-66-6	0.6

**Table 2J.** Iron, arsenic, and chromium speciation, Chemical Abstract Service (CAS) number, and method detection limit (MDL) for the U.S. Geological Survey's National Research Program Laboratory, Boulder, Colorado.

[µg/L, micrograms per liter; oxidation states in parentheses]

Constituent	CAS number	MDL (µg/L)
Iron	7439-89-6	1
Iron (II)	7439-89-6	1
Arsenic	7440-38-2	0.5
Arsenic (III)	1327-53-3	1
Chromium	7440-47-3	0.1
Hexvalent chromium	11104-59-9	0.1

**Table 2K.** Isotopic and radioactive constituents, Chemical Abstract Service (CAS) number, reporting level type, reporting level/uncertainty, and reporting units for the U.S. Geological Survey's National Water Quality Laboratory, Stable Isotope and Tritium Laboratory, Menlo Park, California<sup>a</sup>, Stable Isotope Laboratory, Reston, Virginia<sup>b</sup>, and the contract laboratories Eberline Analytical Services<sup>c</sup> and University of Arizona, Accelerator Mass Spectrometry Laboratory<sup>d</sup>.

[NA, not applicable; SSMDC, sample specific minimum detectable concentration; MU, method uncertainty; pCi/L, pico curies per liter]

Constituent	CAS number	Reporting level type	Reporting level/uncertainty	Reporting units
Radon-222	14859-67-7	SSMDC	26	pCi/L
Tritium <sup>a</sup>	10028-17-8	SSMDC	1	pCi/L
Deuterium/protium <sup>b</sup>	7782-39-0/1333-74-0	MU	2	per mil
Oxygen-18/oxygen-16 <sup>b</sup>	NA/7782-44-7	MU	0.2	per mil
Gross-alpha radioactivity, 72-hr count <sup>c</sup>	12587-46-1	SSMDC	3	pCi/L
Gross-alpha radioactivity, 30-day count <sup>c</sup>	12587-46-1	SSMDC	3	pCi/L
Gross-beta radioactivity, 72-hr count <sup>c</sup>	12587-47-2	SSMDC	4	pCi/L
Gross-beta radioactivity, 30-day count <sup>c</sup>	12587-47-2	SSMDC	4	pCi/L
Radium-226 <sup>c</sup>	13982-63-3	SSMDC	0.04	pCi/L
Radium-228 <sup>c</sup>	15262-20-1	SSMDC	1	pCi/L
Carbon-13/Carbon-12 <sup>d</sup>	NA/7440-44-0	NA	NA	NA
Carbon-14 <sup>d</sup>	14762-75-5	NA	NA	NA

**Table 2L.** Tritium and noble gases, Chemical Abstract Service (CAS) number, method uncertainty (MU), and reporting units for Lawrence Livermore National Laboratory.[NA, not available; ND, no data; pCi/L, picocuries per liter; cm<sup>3</sup>STP/g, cubic centimeter of gas at standard temperature and pressure per gram of water]

Compound	CAS number	MU (percent)	Unit
Tritium	10028-17-8	NA	pCi/L
Helium-3/Helium-4	ND/7440-59-7	0.75	NA
Helium-4	7440-59-7	2	cm <sup>3</sup> STP/g
Argon	7440-37-1	2	cm <sup>3</sup> STP/g
Krypton	7439-90-9	2	cm <sup>3</sup> STP/g
Neon	7440-01-09	2	cm <sup>3</sup> STP/g
Xenon	7440-63-3	2	cm <sup>3</sup> STP/g

**Table 2M.** Microbial constituents, primary use and source, and method detection limit (MDL) for the U.S. Geological Survey's Ohio Microbiology Laboratory parameter codes 90901, 90900, 99335, and 99332.

[NA, not available; ml, milliliters]

Microbial constituent	Primary use/source	MDL
Total coliforms	Water quality indicator/Soil, water and intestinal tracts of animals	1 colony/100ml
<i>Escherichia</i> coliform	Sewage and animal waste indicator/ Intestinal tracts of humans and animals	1 colony/100ml
F-specific coliphage	Viral indicator/Intestinal tracts of warm-blooded animals	NA
Somatic coliphage	Viral indicator/Fecal contaminated waters	NA

**Table 3.** Identification, sampling, and construction information for sampled wells in the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study unit, California, May to July 2004.

[ft, foot; LSD, land surface datum; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV, alluvial study area; SDHDRK, hard rock study area; NA, not available]

GAMA identification No.	Sampling information				Construction information		
	Date	Time	Sampling schedule	Year of construction	Well depth, (ft below LSD)	Top perforation, (ft below LSD)	Bottom perforation, (ft below LSD)
SDTEM-01	05/18/04	1130	Expanded	1965	1,000	150	1,000
SDTEM-02	05/24/04	1010	Basic	NA	NA	320	1,110
SDTEM-03	05/24/04	1200	Basic	NA	NA	466	909
SDTEM-04	05/24/04	1400	Basic	NA	NA	109	245
SDTEM-05	05/25/04	1200	Expanded	1967	960	200	900
SDTEM-06	05/26/04	1130	Expanded	NA	NA	170	470
SDTEM-07	05/27/04	1040	Basic	1962	307	60	307
SDTEM-08	05/27/04	1150	Basic	1965	NA	114	426
SDTEM-09	05/27/04	1350	Basic	NA	NA	450	950
SDTEM-10	05/27/04	1440	Expanded	NA	NA	50	210
SDTEM-11	06/16/04	1500	Basic	NA	1,000	340	980
SDTEM-12	06/21/04	1130	Expanded	NA	NA	96	542
SDTEM-13	06/22/04	1130	Expanded	NA	860	235	860
SDTEM-14	06/23/04	1200	Expanded	NA	NA	270	1,000
SDTEMFP-01	05/19/04	1200	Expanded	1951	NA	234	1,223
SDTEMFP-02	05/20/04	1330	Expanded	NA	NA	378	838
SDTEMFP-03	06/14/04	1120	Expanded	NA	NA	313	853
SDTEMFP-04	06/15/04	1220	Expanded	NA	480	75	465
SDTEMFP-05	06/16/04	1020	Basic	NA	280	80	270
SDWARN-01	06/17/04	1030	Basic plus	1957	473	113	473
SDWARN-02	06/17/04	1130	Basic plus	1976	NA	100	575
SDWARN-03	06/17/04	1400	Basic plus	1951	550	118	550
SDWARN-04	06/24/04	0900	Expanded	1957	438	170	438
SDWARN-05	06/28/04	1000	Expanded	1957	743	130	743
SDWARN-06	06/29/04	1000	Expanded	1957	730	190	730
SDWARN-07	07/13/04	0920	Basic plus	1984	295	70	165
SDWARN-08	07/13/04	1110	Basic plus	1987	700	280	600
SDWARN-09	07/13/04	1320	Basic plus	1996	642	60	642
SDALLV-01	06/30/04	1130	Expanded	1999	200	100	180
SDALLV-02	07/01/04	1210	Expanded	1957	130	94	117
SDALLV-03	07/12/04	1150	Expanded	1998	606	222	566
SDALLV-04	07/12/04	1330	Basic plus	2003	180	80	180
SDALLV-05	07/12/04	1630	Basic plus	1961	582	234	513
SDALLV-06	07/13/04	1100	Expanded	1995	200	100	142
SDALLV-07	07/14/04	0900	Basic plus	1952	199	39	NA
SDALLV-08	07/14/04	1100	Basic plus	NA	87	50	78



**Table 3.** Identification, sampling, and construction information for sampled wells in the San Diego Ground -Water Ambient Monitoring and Assessment (GAMA) study unit, California, May to July 2004—Continued.

[ft, foot; LSD, land surface datum; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV, alluvial study area; SDHDRK, hard rock study area; NA, not available]

GAMA identification No.	Sampling information				Construction information		
	Date	Time	Sampling schedule	Year of construction	Well depth, (ft below LSD)	Top perforation, (ft below LSD)	Bottom perforation, (ft below LSD)
SDALLV-09	07/14/04	1110	Expanded	1983	810	690	800
SDALLV-10	07/14/04	1340	Basic plus	1995	135	65	130
SDALLV-11	07/15/04	0910	Basic plus	1992	405	50	148
SDALLV-12	07/15/04	1030	Basic plus	1996	230	60	220
SDALLV-13	07/15/04	1040	Expanded	2001	NA	96	176
SDALLV-14	07/15/04	1310	Basic plus	1978	80	40	80
SDALLV-15	07/27/04	1250	Basic plus	1995	107	54	107
SDALLV-16	07/28/04	0900	Basic plus	1956	120	48	NA
SDALLV-17	07/29/04	1000	Basic plus	1966	NA	NA	NA
SDHDRK-01	07/12/04	1030	Basic plus	1997	906	110	906
SDHDRK-02	07/13/04	1510	Basic plus	1987	92	52	92
SDHDRK-03	07/15/04	1530	Basic plus	NA	510	80	510
SDHDRK-04	07/19/04	1410	Expanded	1964	315	NA	NA
SDHDRK-05	07/20/04	1100	Expanded	1987	450	50	450
SDHDRK-06	07/21/04	1130	Expanded	1991	1,000	52	1,000
SDHDRK-07	07/22/04	1130	Expanded	1994	400	97	400
SDHDRK-08	07/27/04	1000	Basic plus	1997	500	60	500
SDHDRK-09	07/27/04	1510	Basic plus	1975	400	75	400
SDHDRK-10	07/28/04	1140	Basic plus	NA	NA	NA	NA
SDHDRK-11	07/28/04	1550	Basic plus	1972	455	20	455
SDHDRK-12	07/29/04	1300	Basic plus	1990	186	60	186
SDHDRK-13	07/29/04	1500	Basic plus	NA	46	41	NA

**Table 4.** Compounds analyzed for in ground-water samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004, that appear on multiple analytical schedules, primary compound classification, analytical schedules compound appears on, and preferred analytical schedule.

[VOC, volatile organic compound]

Compound	Primary classification	Analytical schedules	Preferred <sup>1</sup> analytical schedule
Acetone	VOC	2020, 4204	2020
Diisopropyl ether	VOC	2020, 4204	2020
Methyl <i>tert</i> -butyl ether	VOC	2020, 4204	2020
Methyl <i>tert</i> -pentyl ether	VOC	2020, 4204	2020
<i>tert</i> -Butyl ethyl ether	VOC	2020, 4204	2020
1,4-Dichlorobenzene	VOC	1433, 2020	2020
Isopropylbenzene	VOC	1433, 2020	2020
Naphthalene	VOC	1433, 2020	2020
Tetrachloroethene	VOC	1433, 2020	2020
Tribromomethane	VOC	1433, 2020	2020
Caffeine	Waste-water indicator	1433, 2060, 9003	2060
Cotinine	Waste-water indicator	1433, 9003	1433
Atrazine	Pesticide	2003, 2060	2003
Bromacil	Pesticide	1433, 2060	2060
Carbaryl	Pesticide	1433, 2003, 2060	2003
Chlorpyrifos	Pesticide	1433, 2003	2003
Deethyl atrazine	Pesticide degradate	2003, 2060	2003
Diazinon	Pesticide	1433, 2003	2003
Dichlorvos	Pesticide	1433, 2003	2003
Metalaxyl	Pesticide	1433, 2003, 2060	2060
Metolachlor	Pesticide	1433, 2003	2003
Prometon	Pesticide	1433, 2003	2003

<sup>1</sup>Preferred analytical schedules are the most accurate and precise methods of analysis for the compound shown.

**Table 5.** Quality-control summary for volatile organic compounds and gasoline oxygenates, waste-water indicator compounds, emerging contaminant compounds, pesticide compounds, nutrients and dissolved organic carbon, major ions, and trace elements detected in trip blanks, equipment blanks, field blanks and ground-water samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[µg/L, micrograms per liter; E, estimated value; NA, not available; NC, sample not collected; —, not detected; NDMA, N-nitrosodimethylamine]

Compounds	Number of trip blank detections/analyses	Maximum concentration detected in trip blank samples, µg/L	Number of equipment blank detections/analyses	Maximum concentration detected in equipment blank samples, µg/L	Number of field blank detections/analyses	Maximum concentration detected in field blank samples, µg/L	Minimum concentration detected in ground-water samples, µg/L	Number of ground-water samples censored
Volatile Organic Compounds and Gasoline Oxygenates								
Trichloromethane	0/1	—	0/1	—	1/5 <sup>1</sup>	0.13	—	0
Toluene	0/1	—	0/1	—	1/5 <sup>1</sup>	E0.02	—	0
Acetone	0/1	—	0/1	—	1/5 <sup>1</sup>	E3	—	0
Waste-Water Indicator Compounds								
Phenol	NC	NC	NC	NC	2/4 <sup>2</sup>	E0.2	E0.1	18 <sup>3</sup>
Emerging Contaminant Compounds								
NDMA	NC	NC	NC	NC	1/5 <sup>1</sup>	0.005	—	0
Pesticide Compounds								
None detected	NC	NC	NC	NC	0/5	NA	NA	NA
Nutrients and Dissolved Organic Carbon								
None detected	NC	NC	0/1 <sup>4</sup>	NC	0/2	NA	NA	NA
Major Ions								
Sodium	NC	NC	NC	NC		0.1 <sup>5</sup>	14.5 <sup>5</sup>	0
Silica	NC	NC	NC	NC	2/2	0.06 <sup>5</sup>	13.1 <sup>5</sup>	0
Calcium	NC	NC	NC	NC	2/2	0.02 <sup>5</sup>	4.17 <sup>5</sup>	0
Trace Elements								
Copper	NC	NC	1/2	0.9	1/2	1.2	E0.2	15
Vanadium	NC	NC	0/2	—	1/2	0.8	0.2	3
Zinc	NC	NC	0/2	—	1/2	0.3	E0.3	1

<sup>1</sup>Compounds also detected in associated source solution blanks.<sup>2</sup>Waste-water indicator compound detected in one of two associated source solution blanks.<sup>3</sup>Because of ongoing problems with the analytical procedures used to determine phenol, all ground-water samples with concentrations less than 0.4 µg/L are censored.<sup>4</sup>Dissolved organic carbon not determined.<sup>5</sup>Concentration in milligrams per liter.

**Table 6A.** Quality-control summary of replicate volatile organic compounds and gasoline oxygenates, pesticides and pesticide degradates, and emerging contaminant samples with relative standard deviations greater than zero, collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[NA, not available; no replicate pairs of waste-water compounds, or coliphage, had a relative standard deviation greater than zero]

Compound <sup>1</sup>	Number of relative standard deviations greater than zero/replicate pairs	Maximum relative standard deviation (percent)	Median of relative standard deviations greater than zero (percent)
Volatile Organic Compounds and Gasoline Oxygenates			
Dichloromethane	1/5	4	NA
Chloroform	2/5	4	3
Tetrachloroethene	1/5	2	NA
Bromodichloromethane	1/5	1	NA
Pesticides and Pesticide Degradates			
3,4-Dichloroaniline	1/5	7	NA
Hexazinone	1/5	6	NA
Simazine	1/5	5	NA
Atrazine	1/5	5	NA
Terbutylazine	1/5	2	NA
Prometryn	1/5	2	NA
Deethylatrazine	1/5	1	NA
Prometon	1/5	1	NA
Emerging Contaminants			
Perchlorate	2/5	21	13

<sup>1</sup>Due to the large number of compounds, only compounds with relative standard deviations above zero are shown.

**Table 6B.** Quality-control summary of replicate nutrient and dissolved organic carbon samples collected for the San Diego Ground Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[NA, not available]

<b>Compound</b>	<b>Number of relative standard deviations greater than zero/replicate pairs</b>	<b>Maximum relative standard deviation (percent)</b>	<b>Median of relative standard deviations greater than zero (percent)</b>
Dissolved organic carbon	2/2	7	9.3
Phosphorus	1/2	1	NA
Total nitrogen	1/2	1	NA
Nitrate plus nitrite	0/2	0	NA
Ammonia	0/2	0	NA
Nitrite	0/2	0	NA

**Table 6C.** Quality-control summary of replicate major ion samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[NA, not available]

<b>Constituent</b>	<b>Number of relative standard deviations greater than zero/replicate pairs</b>	<b>Maximum relative standard deviation (percent)</b>	<b>Median of relative standard deviations greater than zero (percent)</b>
Bromide	2/2	7	4
Potassium	2/2	3	2
Sulfate	2/2	3	2
Magnesium	2/2	2	2
Sodium	2/2	2	1
Chloride	2/2	2	2
Fluorine	1/2	1	NA
Residue on evaporation	2/2	1	1
Calcium	1/2	1	NA
Silica	2/2	1	1



**Table 6D.** Quality-control summary of replicate trace-element samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[NA, not available]

Constituent	Number of relative standard deviations greater than zero/replicate pairs	Maximum relative standard deviation (percent)	Median of relative standard deviations greater than zero (percent)
Chromium (VI) <sup>1</sup>	2/5	85	66
Chromium <sup>1</sup>	3/5	57	47
Vanadium	2/2	31	16
Nickel	2/2	20	16
Arsenic	2/2	14	10
Cadmium	1/2	10	NA
Selenium	2/2	8	7
Lead	2/2	8	5
Copper	2/2	7	6
Cobalt	2/2	6	4
Boron	2/2	5	3
Chromium	1/2	3	NA
Barium	2/2	2	1
Uranium	2/2	2	1
Zinc	2/2	2	1
Manganese	2/2	2	1
Strontium	2/2	2	1
Molybdenum	2/2	1	1
Lithium	1/2	1	NA
Iron	0/2	0	NA
Tungsten	0/2	0	NA
Aluminum	0/2	0	NA
Antimony	0/2	0	NA
Beryllium	0/2	0	NA
Iron <sup>1</sup>	0/2	0	NA
Iron (II) <sup>1</sup>	0/2	0	NA
Arsenic <sup>1</sup>	0/2	0	NA
Arsenic (III) <sup>1</sup>	0/2	0	NA
Mercury	0/2	0	NA
Silver	0/2	0	NA
Thallium	0/2	0	NA

<sup>1</sup>Samples analyzed at U.S. Geological Survey national research program laboratory, Boulder, Colorado.

**Table 6E.** Quality-control summary of replicate isotope and radioactivity samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[NA, not available]

<b>Isotopes and radioactive constituents</b>	<b>Number of relative standard deviations greater than zero/replicate pairs</b>	<b>Maximum relative standard deviation (percent)</b>	<b>Median of relative standard deviations greater than zero (percent)</b>
Alpha radioactivity, 30 day count	2/2	66	63
Alpha radioactivity, 72 hour count	1/2	6	NA
Beta radioactivity, 30 day count	2/2	17	17
Beta radioactivity, 72 hour count	2/2	21	19
Carbon-13/Carbon-12	1/1	19	NA
Carbon-14 fraction modern	1/1	1	NA
Deuterium/Protium	1/5	1	NA
Oxygen-18/Oxygen-16	1/5	1	NA
Radium-226	2/2	6	4
Radium-228	2/2	37	32
Radon-222	1/2	11	NA
Tritium <sup>1</sup>	4/4	91	7
Tritium <sup>2</sup>	5/5	18	9

<sup>1</sup>Analysis done at Lawrence Livermore National Laboratory.<sup>2</sup>Analysis done at U.S. Geological Survey, Menlo Park, California.

**Table 7A.** Quality-control summary of volatile organic compound, gasoline oxygenate, NDMA, and 1,4-dioxane matrix spike recoveries for samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

Compound	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)
Acetone <sup>1</sup>	4	128	171	140
Chloromethane	4	88	153	132
<i>trans</i> -1,4-Dichloro-2-butene	4	111	135	132
2-Butanone	4	112	144	130
Vinyl chloride	4	105	150	126
Bromomethane	4	70	156	126
1,1-Dichloroethane	4	115	137	125
1,2-Dichloroethane	4	114	135	123
Chloroethane	4	112	137	123
Acrylonitrile	4	113	137	122
Ethyl <i>tert</i> -butyl ether (ETBE) <sup>1</sup>	4	113	135	119
Tetrahydrofuran	4	112	137	119
Bromodichloromethane	4	110	130	119
1,1,1-Trichloroethane (TCA)	4	107	127	118
Methyl acrylate	4	116	143	118
Trichlorofluoromethane (CFC-11)	4	115	138	118
3-Chloropropene	4	111	133	117
Diethyl ether	4	114	140	116
1,1-Dichloropropene	4	107	122	116
Benzene	4	110	127	116
2-Hexanone	4	98	120	116
Bromoethene	4	106	138	115
Chloroform (trichloromethane)	4	113	131	115
Methyl acrylonitrile	4	106	128	115
Methyl <i>tert</i> -Butyl methyl ether <sup>1</sup>	4	109	130	114
<i>cis</i> -1,2-Dichloroethylene	4	109	130	113
Diisopropyl ether <sup>1</sup>	4	111	130	113
Tetrachloromethane (carbon tetrachloride)	4	102	127	113
2,2-Dichloropropane	4	97	115	112
Dibromomethane	4	102	125	112
1,2,3,5-Tetramethylbenzene (isodurene)	4	99	116	112
1,2,3-Trichloropropane	4	97	114	112
1,3-Dichloropropane	4	102	118	111
Dichloromethane (methylene chloride)	4	107	131	111
4-Methyl-2-pentanone	4	99	118	111
1,1,2-Trichlorotrifluoroethane (CFC-113)	4	103	121	111
1,1-Dichloroethylene	4	105	126	111
<i>tert</i> -Amyl methyl ether <sup>1</sup>	4	104	122	111
<i>tert</i> -Amyl alcohol	4	91	129	110
1,1,2,2-Tetrachloroethane	4	102	121	109

**Table 7A.** Quality-control summary of volatile organic compound, gasoline oxygenate, NDMA, and 1,4-dioxane matrix spike recoveries for samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

Compound	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)
1,2-Dibromoethane	4	95	114	109
<i>tert</i> -Butyl alcohol	4	87	126	109
Ethyl methacrylate	4	98	117	109
<i>trans</i> -1,2-Dichloroethylene	4	106	125	109
<i>tert</i> -Butylbenzene	4	97	115	108
1,1,2-Trichloroethane	4	100	125	108
Bromochloromethane	4	101	121	108
Dibromochloromethane	4	97	115	107
1,2,4-Trimethylbenzene	4	96	110	106
1,2-Dichloropropane	4	99	119	106
Trichloroethylene (TCE)	4	100	115	106
<i>o</i> -Xylene	4	94	108	106
1,1,1,2-Tetrachloroethane	4	93	112	105
1,2-Dibromo-3-chloropropane	4	103	123	105
1,2,3-Trimethylbenzene	4	93	110	105
Methyl acetate	4	101	115	104
NDMA	3	94	113	104
1,2-Dichlorobenzene	4	97	115	104
Toluene	4	100	110	103
Ethylbenzene	4	93	109	103
Chlorobenzene	4	91	106	103
Isopropylbenzene	4	91	107	103
Bromoform (tribromomethane)	4	93	110	102
<i>m</i> - and <i>p</i> -Xylene	4	92	106	102
1,3,5-Trimethylbenzene	4	92	104	101
<i>sec</i> -Butylbenzene	4	92	105	101
<i>trans</i> -1,3-Dichloropropene	4	96	112	101
Methyl methacrylate	4	92	110	101
2-Chlorotoluene	4	88	101	100
1,2,3-Trichlorobenzene	4	96	115	100
Bromobenzene	4	90	105	100
1,3-Dichlorobenzene	4	93	108	100
1,2,3,4-Tetramethylbenzene	4	90	104	99
<i>o</i> -Ethyl toluene	4	91	102	99
Naphthalene	4	89	107	98
Hexachloroethane	4	90	105	98
Tetrachloroethylene (PCE)	4	93	106	98
4-Isopropyl-1-methylbenzene	4	88	101	97
<i>n</i> -Propylbenzene	4	87	100	96
4-Chlorotoluene	4	91	103	95

**Table 7A.** Quality-control summary of volatile organic compound, gasoline oxygenate, NDMA, and 1,4-dioxane matrix spike recoveries for samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

Compound	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)
1,2,4-Trichlorobenzene	4	89	110	95
Hexachlorobutadiene	4	84	101	94
<i>cis</i> -1,3-Dichloropropene	4	90	104	94
1,4-Dichlorobenzene	4	91	107	93
Carbon disulfide	4	86	110	91
Methyl iodide	4	72	94	90
1,4-dioxane	2	78	99	88
Dichlorodifluoromethane (CFC-12)	4	73	111	87
Butylbenzene	4	80	93	86
Styrene	4	4	101	53

<sup>1</sup>Compounds on schedules 2020 and 4024; only 2020 values are reported because it is the preferred analytical schedule.



**Table 7B.** Quality-control summary of matrix pesticide spike recoveries for samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[—, not detected]

<b>Compound</b>	<b>Number of spike samples</b>	<b>Minimum recovery (percent)</b>	<b>Maximum recovery (percent)</b>	<b>Median recovery (percent)</b>
Imazaquin	2	144	271	208
Flumetsulam	2	136	241	189
Imazethapyr	2	175	185	180
Imidacloprid	2	152	194	173
Hydroxyatrazine	2	147	146	147
2,4-D	2	135	146	141
Sulfometuron	2	139	142	140
Bensulfuron	2	113	159	136
Norflurazon	2	110	146	128
Siduron	2	111	137	124
Diphenamid	2	104	145	124
Propiconazole	2	101	139	120
Propham	2	107	133	120
Fluometuron	2	107	129	118
Linuron	2	108	128	118
Methiocarb	2	107	129	118
Diuron	2	109	126	117
Deethylde-isopropyl-atrazine	2	111	123	117
Chloramben methyl ester	2	92	140	116
Neburon	2	105	127	116
Terbacil	2	99	127	113
Acifluorfen	2	106	119	113
Dacthal monoacid	2	106	111	109
Picloram	2	95	122	109
Propoxur	2	97	120	108
Oryzalin	2	94	120	107
3-Hydroxy carbofuran	2	95	118	107
Fenuron	2	95	118	106
Dinoseb	2	86	126	106
Clopyralid	2	83	129	106
N-(4-Chlorophenyl)-N'-methylurea	2	87	123	105
Dicamba	2	91	119	105
Terbuthylazine	4	72	120	104
Chlorimuron	2	108	99	104
Carbofuran	2	99	107	103
Bromacil	2	91	114	103
Methomyl	2	93	112	103
2,4-D methyl ester	2	90	113	102

**Table 7B.** Quality-control summary of matrix pesticide spike recoveries for samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

[—, not detected]

Compound	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)
Dacthal	4	76	120	102
Nicosulfuron	2	70	132	101
Atrazine <sup>1</sup>	4	70	120	101
Metalaxyl <sup>1</sup>	4	62	109	100
Bromoxynil	2	67	134	100
Triclopyr	2	93	104	99
Metolachlor	4	65	125	98
Dichlorprop	2	99	97	98
Prometryn	4	56	108	98
2-Chloro-2',6'-diethylacetanilide	4	64	115	97
Bentazon	2	89	103	96
Simazine	4	60	106	96
Alachlor	4	59	111	95
MCPA	2	93	97	95
Desulfinyl fipronil	4	67	107	95
Oxamyl	2	79	110	95
Carbaryl <sup>1</sup>	4	70	107	95
Prometon	4	56	108	94
Diazinon	4	62	102	94
Tebuthiuron <sup>1</sup>	4	63	111	94
Chlorpyrifos	4	56	101	93
Isofenphos	4	57	109	93
Bendiocarb	2	72	113	92
Acetochlor	4	56	113	92
Cycloate	2	69	111	90
Malaoxon	4	59	97	89
Fonofos	4	54	101	89
Pronamide	4	58	102	89
Malathion	4	57	126	88
Terbufos oxygen analog sulfone	4	62	105	88
Fenamiphos sulfone	4	48	97	87
Ethion monoxon	4	59	104	87
Diazinon oxygen analog	4	56	107	87
Dieldrin,	4	79	102	87
Myclobutanil	4	67	110	86
Terbufos	4	47	91	85
Hexazinone	4	61	100	82
MCPB	2	85	78	82

**Table 7B.** Quality-control summary of matrix pesticide spike recoveries for samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

[—, not detected]

Compound	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)
Fipronil sulfide	4	66	97	81
2,4-DB	2	85	76	80
2,6-Diethylaniline	4	58	91	80
Azinphos-methyl oxygen analog	4	39	97	80
Methidathion	4	60	91	80
Azinphos-methyl	4	67	96	80
Desulfinylfipronil amide	4	75	97	80
Methyl parathion	4	65	81	79
Fipronil, water	4	60	90	78
Pendimethalin	4	70	93	78
Benomyl	2	68	87	78
Phorate oxygen analog	4	72	95	77
2-Ethyl-6-methylaniline	4	28	88	76
Fonofos oxygen analog	4	49	94	76
Phorate	4	43	85	76
Trifluralin	4	63	97	75
Ethion	4	60	91	73
3-Ketocarbofuran	2	52	91	71
Benfluralin	4	51	91	70
Fenamiphos	4	56	79	66
Metribuzin	4	50	81	66
Fipronil sulfone	4	53	90	65
Methyl paraoxon	4	55	78	64
Iprodione	4	27	70	62
Aldicarb sulfone	2	43	73	58
cis-Permethrin	4	46	75	55
Aldicarb sulfoxide	2	57	54	55
Chlorpyrifos oxygen analog	4	25	76	53
Dichlorvos	4	31	74	52
Deisopropyl atrazine	2	59	42	51
4-Chloro-2-methylphenol	4	38	60	50
Fenamiphos sulfoxide	4	21	90	50
Cyfluthrin	4	45	76	49
Cypermethrin	4	43	72	48
3,4-Dichloroaniline	4	19	80	44
Deethyl atrazine <sup>1</sup>	4	31	49	42
Dicrotophos	4	15	44	30
Chlorothalonil	2	46	13	29

**Table 7B.** Quality-control summary of matrix pesticide spike recoveries for samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

[—, not detected]

Compound	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)
Dimethoate	4	17	30	24
Aldicarb	2	31	15	23
Phosmet oxygen analog	4	—	32	20
Phosmet	4	7	29	19
Metsulfuron	2	25	9	17
1-Naphthol	4	10	14	12

<sup>1</sup>Compounds on schedule 2003 and 2060; only 2003 values are reported because it is the preferred analytical schedule.

**Table 7C.** Quality-control summary of matrix waste-water compound spike recoveries for samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

Compound	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)
Caffeine <sup>1</sup>	1	142	142	na
Tris(2-butoxyethyl) phosphate	2	118	127	123
Tris(dichloroisopropyl) phosphate	2	105	109	107
Carbazole	2	100	109	105
Anthracene, water	2	100	105	102
Triphenyl phosphate	2	100	100	100
Tris(2-chloroethyl) phosphate	2	100	100	100
Phenol	2	95	100	98
Triethyl citrate	2	95	100	98
Fluoranthene	2	91	100	95
Triclosan	2	91	91	91
Phenanthrene	2	86	95	91
Acetophenone	2	86	91	89
3-Methyl-1H-indole	2	86	89	88
<i>p</i> -Cresol	2	85	91	88
Benzophenone	2	85	86	86
4-Nonylphenol	2	85	92	89
4-Cumylphenol, water	2	84	105	94
DEET	2	84	91	87
5-Methyl-1H-benzotriazole	2	82	110	96
Hexahydrohexamethyl cyclopentabenzopyran	2	82	95	89
Tributyl phosphate	2	82	87	85
Isophorone	2	82	86	84
Acetyl hexamethyl tetrahydro naphthalene	2	82	85	83
Isoquinoline	2	82	85	83
Isoborneol, water	2	81	86	84
Camphor	2	80	91	85
Methyl salicylate	2	80	86	83
4-Octylphenol	2	79	95	87
4-tert-Octylphenol	2	78	86	82
Indole	2	77	82	80
Bisphenol A	2	77	79	78
Menthol	2	76	82	79
Pyrene	2	75	86	81
1-Methylnaphthalene	2	73	86	80
2,6-Dimethylnaphthalene	2	73	86	80
2-Methylnaphthalene	2	72	86	79
Cholesterol	2	67	68	67
Benzo[a]pyrene	2	66	91	79



**Table 7C.** Quality-control summary of matrix waste-water compound spike recoveries for samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July, 2004—Continued.

Compound	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)
3- <i>tert</i> -Butyl-4-hydroxyanisole	2	66	68	67
3- <i>beta</i> -Coprostanol	2	64	75	69
Diethoxynonylphenol	2	61	97	79
Diethoxyoctylphenol	2	60	80	70
9,10-Anthraquinone	2	55	78	66
Pentachlorophenol	2	50	74	62
Ethoxyoctylphenol	2	45	80	62
D-Limonene	2	35	86	61
<i>beta</i> -Stigmastanol	2	34	52	43
<i>beta</i> -Sitosterol	2	30	55	42

<sup>1</sup>Analyzed on pesticide schedule 2060.**Table 8.** Summary of surrogate compound recoveries for ground-water and quality-control analyses of volatile organic compounds, gasoline oxygenates, pesticides and pesticide degradates, and waste-water indicator compound samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

Surrogate	Analytical schedule	Compound class	Number of analyses	Number of surrogate recoveries below 70 percent	Number of surrogate recoveries between 70 and 130 percent	Number of surrogate recoveries above 130 percent
1,2-Dichloroethane-d4	2020	Volatile organic compounds	77	0	72	5
1-Bromo-4-fluorobenzene	2020	Volatile organic compounds	77	0	77	0
Toluene-d8	2020	Volatile organic compounds	77	0	77	0
1,2-Dichloroethane-d4	4024	Gasoline oxygenates	77	0	77	0
1-Bromo-4-fluorobenzene	4024	Gasoline oxygenates	77	0	77	0
Toluene-d8	4024	Gasoline oxygenates	77	0	77	0
Isobutyl alcohol-d6	4024	Gasoline oxygenates	77	7	70	0
alpha-HCH-d6	2003	Pesticides and degradates	72	0	72	0
Diazinon-d10	2003	Pesticides and degradates	72	0	72	0
2,4,5-T	2060	Pesticides and degradates	30	1	29	0
Barban	2060	Pesticides and degradates	30	0	26	4
Caffeine- <sup>13</sup> C	2060	Pesticides and degradates	30	0	18	12
Bisphenol A-d3	1433	Waste-water indicators	61	24	31	6
Caffeine- <sup>13</sup> C	1433	Waste-water indicators	61	0	49	12
Decafluorobiphenyl	1433	Waste-water indicators	61	33	28	0
Fluoranthene-d10	1433	Waste-water indicators	25	1	37	11

**Table 9.** General water-quality parameters determined in the field for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[The five-digit number below the constituent name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property; NTU, nephelometric turbidity unit; SDTEM, Temecula Valley study area; SDTEMF, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV alluvial study area; SDHDRK, hard rock study area;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter; C, Celsius;  $\text{mg}/\text{L}$ , milligrams per liter; mm, millimeter; NC, sample not collected; —, not detected]

GAMA identification No.	Turbidity, NTU (61028)	Barometric Pressure, mm of mercury (00025)	Dissolved oxygen, $\text{mg}/\text{L}$ (00300)	pH, standard units, field (00400)	Specific conductance, $\mu\text{S}/\text{cm}@25\text{C}$ , field (00095)	Total hardness, $\text{mg}/\text{L}$ as $\text{CaCO}_3$ (00900)	Alkalinity, dissolved, as $\text{CaCO}_3$ $\text{mg}/\text{L}$ (29802)	Bicarbonate, dissolved, as $\text{HCO}_3$ $\text{mg}/\text{L}$ (63786)	Carbonate, dissolved, as $\text{CO}_3$ $\text{mg}/\text{L}$ as $\text{CO}_3$ $\text{mg}/\text{L}$ (63788)
SDTEM-01	0.2	NC	4.8	8.5	439	49	69.2	84	—
SDTEM-02	NC	NC	NC	NC	1,020	NC	NC	NC	NC
SDTEM-03	NC	NC	NC	NC	392	NC	NC	NC	NC
SDTEM-04	NC	NC	NC	NC	1,020	NC	NC	NC	NC
SDTEM-05	1.2	NC	5.0	7.3	648	173	160	194	1
SDTEM-06	0.3	735	4.4	7.2	807	316	194	239	—
SDTEM-07	NC	NC	NC	NC	1,260	NC	NC	NC	NC
SDTEM-08	NC	NC	NC	NC	920	NC	NC	NC	NC
SDTEM-09	NC	NC	NC	NC	510	NC	NC	NC	NC
SDTEM-10	NC	727	3.5	7.5	858	261	141	172	—
SDTEM-11	NC	NC	NC	NC	431	NC	NC	NC	NC
SDTEM-12	—	722	4.2	7.4	870	208	165	201	1
SDTEM-13	—	730	0.9	8.3	975	78	68	81	1
SDTEM-14	—	733	0.2	8.3	737	96	154	185	2
SDTEMF-01	0.3	735	4.6	8.1	704	77	116	142	2
SDTEMF-02	0.3	NC	2.1	7.9	818	102	144	172	2
SDTEMF-03	0.3	730	2.3	8.9	807	11	150	166	9
SDTEMF-04	0.3	NC	4.5	7.5	845	243	113	132	—
SDTEMF-05	NC	NC	NC	NC	1,380	NC	NC	NC	NC
SDWARN-01	NC	NC	NC	NC	773	NC	NC	NC	NC
SDWARN-02	NC	NC	NC	NC	535	NC	NC	NC	NC
SDWARN-03	NC	NC	NC	NC	565	NC	NC	NC	NC

**Table 9.** General water-quality parameters determined in the field for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July, 2004—Continued.

[The five-digit number below the constituent name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property; NTU, nephelometric turbidity unit; SDTEM, Temecula Valley study area; SDTEMP, Temecula Valley study area flow path well; SDWARN, Warner Valley study area; SDALLY alluvial study area; SDHDRK, hard rock study area;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter; C, Celsius;  $\text{mg}/\text{L}$ , milligrams per liter; mm, millimeter; NC, sample not collected; —, not detected]

GAMA identification No.	Turbidity, NTU (61028)	Barometric Pressure, mm of mercury (00025)	Dissolved oxygen, $\text{mg}/\text{L}$ (00300)	pH, standard units, field (00400)	Specific conductance, $\mu\text{S}/\text{cm}@25\text{C}$ , field (00095)	Total hardness, $\text{mg}/\text{L}$ as $\text{CaCO}_3$ (00900)	Alkalinity, dissolved, as $\text{CaCO}_3$ , $\text{mg}/\text{L}$ (29802)	Bicarbonate, dissolved, as $\text{HCO}_3$ , $\text{mg}/\text{L}$ (63786)	Carbonate, dissolved, as $\text{CO}_3$ , $\text{mg}/\text{L}$ (63788)
SDWARN-04	—	690	1.1	8.9	496	65	123	139	5
SDWARN-05	—	NC	2.2	7.6	502	111	140	170	1
SDWARN-06	0.1	686	4.9	7.7	441	86	115	141	1
SDWARN-07	NC	NC	NC	NC	555	NC	NC	NC	NC
SDWARN-08	NC	NC	NC	NC	371	NC	NC	NC	NC
SDWARN-09	NC	NC	NC	NC	382	NC	NC	NC	NC
SDALLY-01	0.3	744	5.5	6.9	1,190	466	133	162	—
SDALLY-02	0.3	758	3.4	6.8	1,370	552	300	365	—
SDALLY-03	0.1	758	0.1	7.5	2,130	418	221	267	1
SDALLY-04	NC	NC	NC	NC	911	NC	NC	NC	NC
SDALLY-05	NC	NC	NC	NC	978	NC	NC	NC	NC
SDALLY-06	.1	758	0.1	7.0	2,787	922	262	319	—
SDALLY-07	NC	NC	NC	NC	806	NC	NC	NC	NC
SDALLY-08	NC	NC	NC	NC	1,060	NC	NC	NC	NC
SDALLY-09	.2	759	0.1	7.6	1,240	201	197	239	1
SDALLY-10	NC	NC	NC	NC	2,530	NC	NC	NC	NC
SDALLY-11	NC	NC	NC	NC	2,070	NC	NC	NC	NC
SDALLY-12	NC	NC	NC	NC	1,310	NC	NC	NC	NC
SDALLY-13	.1	762	0.1	7.2	1,300	364	210	255	—
SDALLY-14	NC	NC	NC	NC	1,290	NC	NC	NC	NC
SDALLY-15	NC	NC	NC	NC	805	NC	NC	NC	NC
SDALLY-16	NC	NC	NC	NC	1,320	NC	NC	NC	NC
SDALLY-17	NC	NC	NC	NC	836	NC	NC	NC	NC
SDHDRK-01	NC	NC	NC	NC	2,280	NC	NC	NC	NC

**Table 9.** General water-quality parameters determined in the field for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

[The five-digit number below the constituent name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property; NTU, nephelometric turbidity unit; SDTEM, Temecula Valley study area; SDTEMP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV alluvial study area; SDHDRK, hard rock study area;  $\mu\text{S}/\text{cm}$ , microsiemens per centimeter; C, Celsius;  $\text{mg}/\text{L}$ , milligrams per liter; mm, millimeter; NC, sample not collected; —, not detected]

GAMA identification No.	Turbidity, NTU (61028)	Barometric Pressure, mm of mercury (00025)	Dissolved oxygen, $\text{mg}/\text{L}$ (00300)	pH, standard units, field (00400)	Specific conductance, $\mu\text{S}/\text{cm}@25\text{C}$ , field (00095)	Total hardness, $\text{mg}/\text{L}$ as $\text{CaCO}_3$ (00900)	Alkalinity, dissolved, as $\text{CaCO}_3$ , $\text{mg}/\text{L}$ (29802)	Bicarbonate, dissolved, as $\text{HCO}_3$ , $\text{mg}/\text{L}$ (63786)	Carbonate, dissolved, as $\text{CO}_3$ , $\text{mg}/\text{L}$ (63788)
SDHDRK-02	NC	NC	NC	NC	712	NC	NC	NC	NC
SDHDRK-03	NC	NC	NC	NC	1,290	NC	NC	NC	NC
SDHDRK-04	2	645	1.2	7.0	214	71	88.0	107	—
SDHDRK-05	0.1	751	1.8	7.0	1,810	570	266	320	—
SDHDRK-06	0.1	750	0.2	7.3	485	165	144	175	—
SDHDRK-07	0.5	662.5	0.3	7.6	238	74	92.0	112	—
SDHDRK-08	NC	NC	NC	NC	1,240	NC	NC	NC	NC
SDHDRK-09	NC	NC	NC	NC	568	NC	NC	NC	NC
SDHDRK-10	NC	NC	NC	NC	587	NC	NC	NC	NC
SDHDRK-11	NC	NC	NC	NC	919	NC	NC	NC	NC
SDHDRK-12	NC	NC	NC	NC	209	NC	NC	NC	NC
SDHDRK-13	NC	NC	NC	NC	844	NC	NC	NC	NC

**Table 10.** Analysis for volatile organic compounds (VOCs) and gasoline oxygenates in ground-water samples collected in the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[Bold, asterisked numbers indicate VOCs detected at concentrations above the maximum contaminant level (MCL); percentage values are detection frequencies; the five-digit number below the compound name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property; LRL, laboratory reporting level; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLY alluvial study area; SDHDRK, hard rock study area; µg/L, microgram per liter; E, estimated value; NQ, compound identified but not quantified; —, not detected]

GAMA identification No.	Trihalomethane					Solvent				
	Chloroform (trichloro- methane) (µg/L) (32106)	Bromo- dichloro- methane (µg/L) (32101)	Dibromo- chloro- methane (µg/L) (32105)	Bromoform (tribromo- methane) (µg/L) (32104)	Tetrachloro- ethylene (PCE) (µg/L) (34475)	<i>cis</i> -1,2- Dichloro- ethylene (µg/L) (77093)	Trichloro- ethylene (TCE) (µg/L) (39180)	1,1,1-Tri- chloro- ethane (TCA) (µg/L) (34506)	Dichloro- methane (methylene chloride) (µg/L) (34423)	1,2-Di- chloro- ethane (µg/L) (32103)
(LRL)	0.02	0.03	0.1	0.1	0.06	0.02	0.04	0.03	0.1	0.1
SDTEM-01	E0.01	—	—	—	—	—	—	—	—	—
SDTEM-02	—	—	—	—	—	—	—	—	—	—
SDTEM-03	E0.02	—	—	—	—	—	—	—	—	—
SDTEM-05	E0.03	—	—	—	E0.02	—	—	—	—	—
SDTEM-07	0.13	E0.02	—	—	E0.02	—	—	—	—	—
SDTEM-10	0.49	0.11	—	—	—	—	—	—	NQ	—
SDTEM-14	—	—	—	—	—	—	0.14	—	—	—
SDTEMFP-01	—	—	—	—	E0.01	—	—	—	—	—
SDTEMFP-02	0.11	E0.09	—	—	—	—	—	—	—	—
SDTEMFP-03	E0.02	—	—	—	—	—	—	—	—	—
SDTEMFP-04	0.48	0.13	—	—	—	—	—	—	—	—
SDTEMFP-05	—	—	—	—	—	—	—	—	—	—
SDWARN-09	—	—	—	—	—	—	—	—	—	—
SDALLY-02	E0.06	E0.06	—	—	—	—	—	E0.02	—	—
SDALLY-04	—	—	—	—	—	—	—	E0.02	—	—
SDALLY-05	0.39	0.11	—	—	—	—	—	—	—	—
SDALLY-06	—	—	—	—	—	E0.03	—	—	—	—
SDALLY-07	E0.02	—	—	—	—	—	—	—	—	—
SDALLY-09	E0.05	—	—	—	—	—	—	—	—	—
SDALLY-11	0.20	—	—	—	0.37	—	E0.03	—	—	—



**Table 10.** Analysis for volatile organic compounds (VOCs) and gasoline oxygenates in ground-water samples collected in the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

[Bold, astericked numbers indicate VOCs detected at concentrations above the maximum contaminant level (MCL); percentage values are detection frequencies; the five-digit number below the compound name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property; LRL, laboratory reporting level; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV alluvial study area; SDHDRK, hard rock study area; µg/L, microgram per liter; E, estimated value; NQ, compound identified but not quantified; —, not detected]

GAMA identification No.	Solvent		Gasoline				Organic synthesis		Detections per well
	Tetrachloro- methane (carbon tetra- chloride) (µg/L) (32102)	1,2-Dichloro- propane (µg/L) (34541)	Methyl tert- butyl ether (MTBE) (µg/L) (78032)	Toluene (µg/L) (34010)	Diisopropyl ether (µg/L) (81577)	Benzene (µg/L) (34030)	1,1-Dichloro- ethylene (DCE) (µg/L) (34501)	Carbon disulfide (µg/L) (77041)	
(LRL)	0.06	0.03	0.2	0.05	0.1	0.02	0.02	0.04	
SDTEM-01	—	—	—	—	—	—	—	—	1
SDTEM-02	—	—	0.2	—	—	E0.02	—	—	2
SDTEM-03	—	—	—	—	—	—	—	—	1
SDTEM-05	—	—	—	E0.01	—	—	—	—	3
SDTEM-07	—	—	E0.1	—	—	—	—	—	4
SDTEM-10	—	—	—	—	—	—	—	—	3
SDTEM-14	—	—	—	—	—	—	—	—	1
SDTEMFP-01	—	—	—	0.01	—	—	—	—	2
SDTEMFP-02	—	—	—	0.01	—	—	—	—	3
SDTEMFP-03	—	—	—	—	—	—	—	—	1
SDTEMFP-04	—	—	—	—	—	—	—	—	2
SDTEMFP-05	—	—	NQ	—	—	—	—	—	1
SDWARN-09	—	—	0.8	—	—	—	—	—	1
SDALLV-02	—	—	—	E0.01	—	—	—	—	4
SDALLV-04	—	—	—	—	—	—	—	—	1
SDALLV-05	—	—	—	—	—	—	—	—	2
SDALLV-06	—	1.19	—	—	—	—	—	—	2
SDALLV-07	—	—	—	—	—	—	—	—	1
SDALLV-09	—	—	—	—	—	—	—	—	1
SDALLV-11	E0.02	—	28.3*	—	—	—	E0.03	—	6

**Table 10.** Analysis for volatile organic compounds (VOCs) and gasoline oxygenates in ground-water samples collected in the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

[Bold, astericked numbers indicate VOCs detected at concentrations above the maximum contaminant level (MCL); percentage values are detection frequencies; the five-digit number below the compound name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property; LRL, laboratory reporting level; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLY alluvial study area; SDHDRK, hard rock study area; µg/L, microgram per liter; E, estimated value; NQ, compound identified but not quantified; —, not detected]

GAMA identification No.	Trihalomethane				Solvent					
	Chloroform (trichloro- methane) (µg/L) (32106)	Bromo- dichloro- methane (µg/L) (32101)	Dibromo- chloro- methane (µg/L) (32105)	Bromoform (tribromo- methane) (µg/L) (32104)	Tetrachloro- ethylene (PCE) (µg/L) (34475)	<i>cis</i> -1,2- Dichloro- ethylene (µg/L) (77093)	Trichloro- ethylene (TCE) (µg/L) (39180)	1,1,1-Tri- chloro- ethane (TCA) (µg/L) (34506)	Dichloro- methane (methylene chloride) (µg/L) (34423)	1,2-Di- chloro- ethane (µg/L) (32103)
(LRL)	0.02	0.03	0.1	0.1	0.06	0.02	0.04	0.03	0.1	0.1
SDALLY-12	—	—	—	—	—	—	—	—	—	—
SDALLY-13	—	—	—	—	—	0.11	—	—	—	—
SDALLY-16	E0.03	E0.05	0.1	—	—	—	—	—	—	—
SDALLY-17	—	—	—	—	—	—	—	—	—	—
SDHDRK-01	0.27	—	—	—	<b>9.75*</b>	1.08	<b>7.27*</b>	—	—	0.3
SDHDRK-03	E0.05	—	—	—	—	—	—	—	—	—
SDHDRK-05	E0.01	—	—	—	—	—	—	—	—	—
SDHDRK-13	0.69	3	9.3	7.9	—	—	—	—	—	—
Wells with VOC detections	18	8	2	1	5	3	3	2	1	1
Detection frequency (percent)	31	14	3	2	9	5	5	3	2	2

**Table 10.** Analysis for volatile organic compounds (VOCs) and gasoline oxygenates in ground-water samples collected in the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July, 2004—Continued.

[Bold, astericked numbers indicate VOCs detected at concentrations above the maximum contaminant level (MCL); percentage values are detection frequencies; the five-digit number below the compound name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property; LRL, laboratory reporting level; SDTEM, Temecula Valley study area; SDTEMF, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLY alluvial study area; SDHDRK, hard rock study area; µg/L, microgram per liter; E, estimated value; NQ, compound identified but not quantified; —, not detected]

GAMA identification No.	Solvent		Gasoline				Organic synthesis		Detections per well
	Tetrachloro- methane (carbon tetra- chloride) (µg/L) (32102)	1,2-Dichloro- propane (µg/L) (34541)	Methyl tert- butyl ether (MTBE) (µg/L) (78032)	Toluene (µg/L) (34010)	Diisopropyl ether (µg/L) (81577)	Benzene (µg/L) (34030)	1,1-Di-chloro- ethylene (DCE) (µg/L) (34501)	Carbon disulfide (µg/L) (77041)	
(LRL)	0.06	0.03	0.2	0.05	0.1	0.02	0.02	0.04	
SDALLV-12	—	—	E0.1	—	—	—	—	—	1
SDALLV-13	—	—	—	—	—	—	—	—	1
SDALLV-16	—	—	—	—	—	—	—	—	3
SDALLV-17	—	—	—	—	—	—	—	0.26	1
SDHDRK-01	—	—	0.8	—	0.1	—	E0.08	—	8
SDHDRK-03	—	—	—	—	—	—	—	—	1
SDHDRK-05	—	—	—	—	—	—	—	—	1
SDHDRK-13	—	—	—	—	—	—	—	—	4
Wells with VOC detections	1	1	7	4	1	1	2	1	
Detection frequency (percent)	2	2	12	7	2	2	3	2	

**Table 11.** Analysis for pesticides in ground-water samples collected for the San Diego Ground-Water Monitoring and Assessment (GAMA) study, California, May to July 2004.

[Percentage values are detection frequencies; the five-digit number below the compound name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property; LRL, laboratory reporting level; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLY alluvial study area; DHDRK, hard rock study area; µg/L, microgram per liter; E, estimated value; NQ, compound identified but not quantified; —, not detected]

GAMA identification No.	Herbicide											
	Simazine (µg/L) (04035)	Prometon (µg/L) (04037)	Atrazine (µg/L) (39632)	Tebuthi- uron (µg/L) (82670)	Metolachlor (µg/L) (39415)	Bentazon <sup>1</sup> (µg/L) (38711)	Bromacil <sup>1</sup> (µg/L) (04029)	Diuron <sup>1</sup> (µg/L) (49300)	Imaze- thapyr <sup>1</sup> (µg/L) (50407)	Aceto- chlor (µg/L) (49260)	Hexazi- none (µg/L) (04025)	Prometryn (µg/L) (04036)
(LRL)	0.005	0.01	0.007	0.02	0.013	0.01	0.03	0.01	0.02	0.006	0.013	0.005
SDTEM-01	0.005	—	—	—	—	—	—	—	—	—	—	—
SDTEM-02	0.015	0.01	E0.005	—	—	—	—	—	—	—	—	—
SDTEM-03	0.006	—	—	—	—	—	—	—	—	—	—	—
SDTEM-05	—	—	E0.003	—	E0.002	—	—	—	—	E0.002	—	—
SDTEM-06	0.006	—	0.025	—	—	—	E0.02	—	—	—	—	—
SDTEM-07	0.011	0.01	0.008	—	—	—	—	—	—	—	—	—
SDTEM-10	0.017	0.01	0.007	—	—	—	—	—	—	—	E0.01	0.008
SDTEM-12	0.012	—	—	—	—	—	—	—	—	—	—	—
SDTEM-13	0.010	—	E0.006	—	—	—	—	—	—	—	—	—
SDTEMFP-01	0.006	—	—	—	—	—	—	—	—	—	—	—
SDTEMFP-02	0.006	—	—	—	—	—	—	—	—	—	—	—
SDTEMFP-04	0.007	—	—	—	—	—	—	—	—	—	—	—
SDTEMFP-05	0.009	0.01	—	—	—	—	—	—	—	—	—	—
SDWARN-03	0.007	—	—	—	—	—	—	—	—	—	—	—
SDWARN-04	—	—	—	—	—	—	—	—	—	—	—	—
SDWARN-07	0.007	—	—	—	—	—	—	—	—	—	—	—
SDALLY-01	0.018	—	—	—	E0.01	—	—	—	—	—	—	—
SDALLY-02	0.012	—	—	—	—	—	—	—	—	—	—	—
SDALLY-06	—	—	—	—	—	E0.01	—	—	E0.07	—	—	—

Percentage values are detection frequencies; the five-digit number below the compound name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property; LRL, laboratory reporting level; SDTEM, Temecula Valley study area; SDTEMPF, Temecula Valley study area flow-path well; SDWV, Warner Valley study area; SDALLV alluvial study area; DHDPRK, hard rock study area;  $\mu\text{g/L}$ , microgram per liter; E, estimated value; NQ, compound identified but not quantified; —, not detected

[illegible]





**Table 11.** Analysis for pesticides in ground-water samples collected for the San Diego Ground-Water Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

[Percentage values are detection frequencies; the five-digit number below the compound name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property; LRL, laboratory reporting level; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLY alluvial study area; DHDRK, hard rock study area; µg/L, microgram per liter; E, estimated value; NQ, compound identified but not quantified; —, not detected]

GAMA identification No.	Herbicide	Pesticide degradates						Fungicide			Detections per well
	Terbuthylazine (µg/L) (04022)	Deethyl- atrazine (µg/L) (04040)	3,4-Dichloro- aniline (µg/L) (61625)	Deethylde- isopropyl- atrazine (µg/L) (04039)	Deisopropyl atrazine (µg/L) (04038)	Hydroxy- atrazine (µg/L) (50355)	Metalaxyl (µg/L) (61596)	Myclo- butanil (µg/L) (61599)	Desulfinyl fipronil (µg/L) (62170)		
(LRL)	0.01	0.006	0.004	0.04	0.01	0.008	0.005	0.008	0.012		
SDALLV-07	—	E0.006	—	—	—	—	—	—	—	2	
SDALLV-08	—	—	—	—	—	—	—	—	—	1	
SDALLV-10	—	—	—	—	—	—	0.009	E0.006	—	5	
SDALLV-11	—	E0.006	—	—	—	—	—	0.013	—	6	
SDALLV-12	—	0.006	—	—	—	—	—	—	—	5	
SDALLV-13	—	—	0.013	—	—	E0.024	—	—	—	3	
SDALLV-16	—	—	—	—	—	—	—	—	—	2	
SDHDRK-01	—	E0.013	—	—	—	—	—	—	—	5	
SDHDRK-02	—	E0.006	—	—	—	—	—	—	—	1	
SDHDRK-03	—	—	—	—	—	—	—	—	—	2	
SDHDRK-05	—	—	—	—	—	—	—	—	—	1	
SDHDRK-08	—	E0.006	—	—	—	—	—	—	—	2	
SDHDRK-09	—	E0.006	—	—	—	—	—	—	—	2	
SDHDRK-13	—	—	—	—	—	—	—	—	—	1	
Detections per compound	1	14	4	2	2	2	3	3	1		
Detection frequency (percent)	2	24	7	8	8	8	5	5	2		

**Table 12.** Analysis for waste-water indicator compounds in ground-water samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[Concentrations preceded by a “V” indicate detections attributed to contamination, and are not included in ground-water quality analysis; percentage values are detection frequencies; the five-digit number below the compound name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property; LRL, laboratory reporting level; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV alluvial study area; SDHDRK, hard rock study area; µg/L, microgram per liter; E, estimated value; NQ, compound identified but not quantified; —, not detected]

GAMA identification No.	Phenol (µg/L) (34466)	Methyl salicylate (µg/L) (62081)	DEET (µg/L) (62082)	Caffeine <sup>1</sup> (µg/L) (50305)	4-tert- octyl phenol (µg/L) (62062)	Triphenyl phosphate (µg/L) (62092)	Tris (2-butox- yethyl) phosphate (µg/L) (62093)	D-Limo- nene (µg/L) (62073)	Detect- ions per well
(LRL)	0.5	0.5	0.5	0.009	1	0.5	0.5	0.5	
SDTEM-12	V0.2	—	—	—	—	NQ	—	—	1
SDTEM-13	V0.1	—	—	—	—	—	—	—	0
SDTEM-14	0.4	—	—	—	—	—	—	NQ	2
SDTEMFP-03	V0.3	—	—	—	—	—	—	—	0
SDTEMFP-04	V0.3	—	E0.1	0.0361	—	—	—	—	2
SDWARN-03	V0.1	—	—	—	—	—	—	—	0
SDWARN-04	0.4	—	—	—	—	—	—	—	1
SDWARN-05	0.5	E0.1	—	—	—	—	—	—	2
SDWARN-07	0.5	—	—	—	—	—	—	—	1
SDWARN-09	V0.2	—	—	—	—	—	—	—	0
SDALLV-02	V0.2	—	—	—	—	—	—	—	0
SDALLV-03	1.7	—	—	—	—	—	—	—	1
SDALLV-04	0.8	—	—	—	—	—	—	—	1
SDALLV-06	V0.2	—	—	—	NQ	—	—	—	1
SDALLV-07	V0.3	—	—	—	—	—	—	—	0
SDALLV-08	V0.3	—	—	—	—	—	—	—	0
SDALLV-09	0.5	—	—	—	—	—	—	—	1
SDALLV-10	V0.3	—	—	—	—	—	—	—	0
SDALLV-11	0.5	—	—	—	—	—	—	—	1
SDALLV-12	E0.4	—	—	—	—	—	—	—	1
SDALLV-13	E0.4	—	—	—	—	—	—	—	1
SDALLV-14	V0.3	—	—	—	—	—	—	—	0
SDALLV-15	V0.2	—	—	—	—	—	—	—	0
SDALLV-16	0.6	—	—	—	—	—	—	—	1
SDALLV-17	—	—	—	—	—	—	7	—	1
SDHDRK-01	V0.2	—	—	—	—	—	—	—	0
SDHDRK-02	0.5	—	—	—	—	—	—	—	1
SDHDRK-03	2.2	—	—	—	—	—	—	—	1
SDHDRK-04	V0.3	—	—	—	—	—	—	—	0
SDHDRK-07	V0.2	—	—	—	—	—	—	—	0
SDHDRK-08	V0.3	—	—	—	—	—	—	—	0
SDHDRK-09	V0.2	NQ	—	—	—	—	—	—	1
SDHDRK-10	0.5	—	—	—	—	—	—	—	1
SDHDRK-13	—	—	NQ	—	—	—	—	—	1
Detections per compound	14	2	2	1	1	1	1	1	
Detection frequency (percent)	30	4	4	2	2	2	2	2	

<sup>1</sup>Caffeine concentration determined by the preferred analysis method, pesticide analytical schedule 2060.

**Table 13.** Analysis for emerging contaminant compounds perchlorate, 1,4-dioxane, and N-nitrosodimethylamine (NDMA) in ground-water samples collected in the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[Bold, italicized numbers indicate perchlorate detections at concentrations above the detection level for the purposes of reporting (DLR); percentage values are detection frequencies; MRL, minimum reporting level; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV alluvial study area; SDHDRK, hard rock study area; µg/L, microgram per liter; NC, sample not collected; <, less than; —, not detected]

<b>GAMA identification No.</b>	<b>Perchlorate<sup>1</sup> (µg/L)</b>	<b>1,4-dioxane (µg/L)</b>	<b>N-nitrosodimethylamine, (NDMA) (µg/L)</b>	<b>Detections per well</b>
<b>(MRL)</b>	<b>0.25, 0.5, 1, 2</b>	<b>2</b>	<b>0.002</b>	
SDTEM-01	1.3	—	—	1
SDTEM-05	0.96	—	—	1
SDTEM-06	<0.25	—	—	0
SDTEM-10	0.74	—	—	1
SDTEM-12	0.93	—	—	1
SDTEM-13	<0.25	—	—	0
SDTEM-14	<0.25	—	—	0
SDTEMFP-01	1.4	—	—	1
SDTEMFP-02	<0.25	—	—	0
SDTEMFP-03	0.49	—	—	1
SDTEMFP-04	2.2	—	—	1
SDWARN-01	<0.25	NC	—	0
SDWARN-02	<0.25	NC	—	0
SDWARN-03	<0.25	NC	—	0
SDWARN-04	<0.25	—	—	0
SDWARN-05	0.33	—	—	1
SDWARN-06	0.58	—	—	1
SDWARN-07	<1	NC	—	0
SDWARN-08	<1	NC	—	0
SDWARN-09	<1	NC	—	0
SDALLV-01	0.99	—	—	1
SDALLV-02	<0.5	—	—	0
SDALLV-03	<1	—	—	0
SDALLV-04	<1	NC	—	0
SDALLV-05	4.2	NC	—	1
SDALLV-06	<1	—	—	0
SDALLV-07	<1	NC	—	0
SDALLV-08	<1	NC	—	0
SDALLV-09	<0.25	—	—	0
SDALLV-10	<2	NC	—	0
SDALLV-11	2.5	NC	—	1
SDALLV-12	<1	NC	—	0

**Table 13.** Analysis for emerging contaminant compounds perchlorate, 1,4-dioxane, and N-nitrosodimethylamine (NDMA) of the ground-water samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

[Bold, italicized numbers indicate perchlorate detections at concentrations above the detection level for the purposes of reporting (DLR); percentage values are detection frequencies; MRL, minimum reporting level; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV alluvial study area; SDHDRK, hard rock study area; µg/L, microgram per liter; NC, sample not collected; <, less than; —, not detected]

<b>GAMA identification No.</b>	<b>Perchlorate<sup>1</sup> (µg/L)</b>	<b>1,4-dioxane (µg/L)</b>	<b>N-nitrosodimethylamine, (NDMA) (µg/L)</b>	<b>Detections per well</b>
<b>(MRL)</b>	<b>0.25, 0.5, 1, 2</b>	<b>2</b>	<b>0.002</b>	
SDALLV-13	<1	—	—	0
SDALLV-14	<1	NC	—	0
SDALLV-15	<0.5	NC	—	0
SDALLV-16	<0.5	NC	—	0
SDALLV-17	<0.5	NC	—	0
SDHDRK-01	1.2	NC	—	1
SDHDRK-02	1.7	NC	—	1
SDHDRK-03	<1	NC	—	0
SDHDRK-04	<1	—	—	0
SDHDRK-05	<1	—	—	0
SDHDRK-06	<0.5	—	—	0
SDHDRK-07	<0.5	—	—	0
SDHDRK-08	<0.5	NC	—	0
SDHDRK-09	<0.5	NC	—	0
SDHDRK-10	<0.5	NC	—	0
SDHDRK-11	<0.5	NC	—	0
SDHDRK-12	<0.5	NC	—	0
SDHDRK-13	<0.5	NC	—	0
Detections per compound	14	0	0	
Detection frequency (percent)	28	0	0	

<sup>1</sup>Four different MRLs were used for perchlorate analysis; therefore, non-detects were reported as less than the MRL.

**Table 14.** Analysis for nutrients and dissolved organic carbon in ground-water samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[The five-digit number below the constituent name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property; LRL, laboratory reporting level; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV alluvial study area; SDHDRK, hard rock study area; mg/L, milligram per liter; E, estimated value; —, not detected]

<b>GAMA identification No.</b>	<b>Ammonia, dissolved (mg/L as N) (00608)</b>	<b>Nitrate plus nitrite, dissolved (mg/L as N) (00631)</b>	<b>Nitrite, dissolved (mg/L as N) (00613)</b>	<b>Phosphorus, dissolved (mg/L as P) (00671)</b>	<b>Total nitrogen (nitrate + nitrite + ammonia + organic-N), dissolved (62854)</b>	<b>Dissolved organic carbon (mg/L) (00681)</b>
<b>(LRL)</b>	<b>0.04</b>	<b>0.06</b>	<b>0.008</b>	<b>0.006</b>	<b>0.03</b>	<b>0.3</b>
SDTEM-01 <sup>1</sup>	—	4.3	—	0.013	4.22	E0.2
SDTEM-05 <sup>1</sup>	—	5.8	—	0.052	5.35	1.3
SDTEM-06 <sup>1</sup>	—	3.14	E0.006	0.08	3.11	0.5
SDTEM-10	—	0.41	—	0.037	0.47	0.9
SDTEM-12	—	5.47	—	0.019	5.47	0.6
SDTEM-13	—	1.34	—	—	1.39	E0.3
SDTEM-14	0.11	—	—	0.033	0.15	0.5
SDTEMFP-01 <sup>1</sup>	—	3.84	0.028	0.015	3.67	E0.3
SDTEMFP-02	—	0.52	—	0.01	0.54	0.6
SDTEMFP-03	—	1.28	—	0.013	1.31	0.4
SDTEMFP-04	—	0.5	—	0.073	0.53	0.7
SDWARN-04	—	0.68	—	0.048	0.68	E0.3
SDWARN-05	—	0.92	—	0.012	0.93	—
SDWARN-06	—	1.57	—	0.049	1.66	—
SDALLV-01 <sup>1</sup>	—	9.14	—	0.021	8.96	0.8
SDALLV-02	—	1.76	—	0.016	1.88	0.8
SDALLV-03	0.06	—	—	0.022	0.04	0.9
SDALLV-06	0.18	—	—	0.062	0.3	2.1
SDALLV-09	E0.04	E0.04	—	0.008	0.1	0.4
SDALLV-13	0.18	—	—	0.092	0.27	2.1
SDHDRK-04	—	—	—	E0.003	—	3.4
SDHDRK-05	—	0.79	—	0.026	0.85	2.1
SDHDRK-06	—	—	—	—	—	0.4
SDHDRK-07	E0.03	—	—	0.031	0.05	E0.3

<sup>1</sup>Total nitrogen in these samples is less than the sum of the filtered nitrogen analytes, but falls within the U.S. Geological Survey National Water Quality Laboratory acceptance criterion of a 10 percent relative percent difference.

**Table 15.** Analysis for major ions and total dissolved solids in ground-water samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[Bold numbers indicate major ion and total dissolved solid concentrations above the recommended secondary maximum contaminant level (SMCL); the five-digit number below the compound name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property; LRL, laboratory reporting level; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLY alluvial study area; SDHDRK, hard rock study area; mg/L, milligram per liter; —, not detected]

GAMA identification No.	Total dis- solved solids (residue on evaporation) (mg/L) (70300)										
		10	0.01	0.008	0.16	0.1	0.02	0.2	0.04	0.2	0.2
(LRL)											
SDTEM-01	259	17.1	1.52	1.6	71.3	0.2	62.7	0.3	20.9	13.4	
SDTEM-05	402	42.3	16.3	1.82	67.6	0.26	71.7	0.6	46.6	28.8	
SDTEM-06	<b>520</b>	93.5	19.8	1.3	57.1	00.26	57.8	0.3	32.7	115	
SDTEM-10	<b>540</b>	65	23.7	4.29	76.6	0.14	79.9	0.3	13.1	173	
SDTEM-12	<b>508</b>	57	15.81	2.2	99.9	0.44	136	0.7	31.9	32.1	
SDTEM-13	<b>510</b>	26.8	2.46	1.97	156	0.27	208	0.9	16.3	42.2	
SDTEM-14	407	33.7	2.81	1.31	119	0.31	96.1	0.3	14.3	56.6	
SDTEMFP-01	423	25.6	3	1.77	116	0.32	86.8	0.8	18.2	61.1	
SDTEMFP-02	494	25.6	9.08	2.33	127	0.37	98.8	1	22.2	96.6	
SDTEMFP-03	478	4.17	0.195	0.9	172	0.34	84.8	0.6	14.3	87.1	
SDTEMFP-04	<b>532</b>	61.9	21.4	5.32	81.7	0.15	80.5	0.5	20.1	165	
SDWARN-04	325	21	3.02	0.45	83.1	0.17	41.1	1.4	25.3	58.5	
SDWARN-05	274	37.5	4.2	1.68	63	0.16	34.8	—	23.9	43.8	
SDWARN-06	282	26.9	4.5	1.64	59.5	0.17	42.6	0.2	25.9	32.8	
SDALLY-01	<b>822</b>	123	38.4	5.38	68	0.17	113	—	38.9	<b>271</b>	
SDALLY-02	<b>766</b>	165	33.7	2.51	87.5	0.35	123	0.2	26.1	233	
SDALLY-03	<b>1,240</b>	95.3	43.6	4.78	295	1.44	<b>472</b>	0.2	19.4	157	
SDALLY-06	<b>1,800</b>	234	81.6	9.1	248	1.74	<b>540</b>	0.3	28	<b>421</b>	
SDALLY-09	<b>685</b>	43	22.5	3.55	174	0.77	228	0.4	22.8	61.7	
SDALLY-13	<b>812</b>	93	31.9	2.99	126	0.35	179	0.5	25.6	188	



**Table 15.** Analysis for major ions and total dissolved solids in ground-water samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

[Bold numbers indicate major ion and total dissolved solid concentrations above the recommended secondary maximum contaminant level (SMCL); the five-digit number below the compound name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property; LRL, laboratory reporting level; SDTEM, Temecula Valley study area; SDTEMF, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLY alluvial study area; SDHDRK, hard rock study area; mg/L, milligram per liter; —, not detected]

<b>GAMA identification No.</b>	<b>Total dis- solved solids (residue on evaporation) (mg/L) (70300)</b>	<b>Calcium dissolved (mg/L) (00915)</b>	<b>Magnesium, dissolved (mg/L ) (00925)</b>	<b>Potassium dissolved (mg/L) (00935)</b>	<b>Sodium dissolved (mg/L) (00930)</b>	<b>Bromide, dissolved (mg/L) (71870)</b>	<b>Chloride dissolved (mg/L) (00940)</b>	<b>Fluoride, dissolved (mg/L) (00950)</b>	<b>Silica, dissolved (mg/L) (00955)</b>	<b>Sulfate, dissolved (mg/L) (00945)</b>
<b>(LRL)</b>	<b>10</b>	<b>0.01</b>	<b>0.008</b>	<b>0.16</b>	<b>0.1</b>	<b>0.02</b>	<b>0.2</b>	<b>0.2</b>	<b>0.04</b>	<b>0.2</b>
SDHDRK-04	148	16.2	7.36	3.04	14.5	0.03	6.32	—	37.6	9.4
SDHDRK-05	<b>1,198</b>	118	66.6	5.2	164	0.53	247	0.4	47.2	<b>320</b>
SDHDRK-06	311	51.6	8.86	3.03	37.7	0.14	40.7	0.9	35.9	35.7
SDHDRK-07	155	19.8	5.95	2.86	18.5	0.04	9.71	0.3	29.8	12

**Table 16.** Analysis for trace elements in ground-water samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[Beryllium and mercury were not detected in any samples; concentrations preceded by a “V” indicate detections attributed to contamination, and are not counted in ground-water quality analysis; numbers in bold indicate concentrations that exceed secondary maximum contaminant levels (SMCL); bold italics indicate concentrations that exceed detection levels for the purposes of reporting (DLR); the five-digit number below the compound name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property; LRL, laboratory reporting level; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV alluvial study area; SDHDRK, hard rock study area; µg/L, microgram per liter; E, estimated value; —, not detected]

<b>GAMA identification No.</b>	<b>Aluminum dissolved (µg/L) (01106)</b>	<b>Antimony, dissolved (µg/L) (01095)</b>	<b>Arsenic, dissolved (µg/L) (01000)</b>	<b>Barium, dissolved (µg/L) (01005)</b>	<b>Boron, dissolved (µg/L) (01020)</b>	<b>Cadmium, dissolved (µg/L) (01025)</b>	<b>Chromium, dissolved (µg/L) (01030)</b>	<b>Cobalt, dissolved (µg/L) (01035)</b>	<b>Copper, dissolved (µg/L) (01040)</b>
<b>(LRL)</b>	<b>2</b>	<b>0.2</b>	<b>0.2</b>	<b>0.2</b>	<b>8</b>	<b>0.04</b>	<b>0.8</b>	<b>0.014</b>	<b>0.4</b>
SDTEM-01	2	—	3.4	59	<b>122</b>	—	3	0.038	V0.8
SDTEM-05	—	—	1.3	79	41	E0.03	6	0.112	V0.8
SDTEM-06	—	—	.9	93	68	—	4.4	0.293	1.7
SDTEM-10	—	E0.11	.5	35	<b>159</b>	E0.02	—	0.2	4.9
SDTEM-12	2	—	3.1	147	<b>218</b>	—	E0.8	0.175	2.4
SDTEM-13	3	—	2.7	134	<b>1054</b>	—	1.1	0.073	V0.5
SDTEM-14	4	—	1.9	125	<b>143</b>	—	—	0.127	V0.5
SDTEMFP-01	5	—	7.8	63	<b>299</b>	—	1.6	0.069	V0.9
SDTEMFP-02	4	—	3.1	53	<b>726</b>	0.05	E0.6	0.066	V1.1
SDTEMFP-03	3	—	.9	3	—	—	1	0.027	V0.4
SDTEMFP-04	—	—	.9	34	<b>105</b>	E0.03	—	0.151	2.4
SDWARN-04	19	—	7.4	45	<b>361</b>	—	E0.4	0.06	V0.5
SDWARN-05	E1	—	1.8	48	42	—	—	0.104	V0.8
SDWARN-06	2	—	2.3	46	36	—	1.4	0.085	V0.6
SDALLV-01	—	—	1.6	87	51	0.05	—	0.382	6.9
SDALLV-02	3	E0.11	0.9	79	<b>107</b>	0.14	—	0.546	5.8
SDALLV-03	E1	—	2	52	<b>228</b>	E0.02	—	0.317	1.3
SDALLV-06	—	—	.9	144	<b>161</b>	—	—	0.68	2.1
SDALLV-09	E1	—	.5	21	<b>214</b>	—	—	0.134	V0.5
SDALLV-13	—	—	1.7	118	<b>171</b>	—	—	0.358	V1.2
SDHDRK-04	—	—	E0.1	2	E6	—	—	0.059	V0.2
SDHDRK-05	—	0.69	5.7	17	<b>158</b>	0.07	—	0.976	13.2
SDHDRK-06	—	—	.3	8	65	—	—	0.198	V0.4
SDHDRK-07	—	—	.4	139	24	—	—	0.071	V0.8

**Table 16.** Analysis for trace elements in ground-water samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

[Beryllium and mercury were not detected in any samples; concentrations preceded by a “V” indicate detections attributed to contamination, and are not counted in ground-water quality analysis; numbers in bold indicate concentrations that exceed secondary maximum contaminant levels (SMCL); bold italics indicate concentrations that exceed detection levels for the purposes of reporting (DLR); the five-digit number below the compound name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property; LRL, laboratory reporting level; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV alluvial study area; SDHDRK, hard rock study area; µg/L, microgram per liter; E, estimated value; —, not detected]

GAMA identification No.	Iron, dissolved (µg/L) (01046)	Lead, dissolved (µg/L) (01049)	Lithium, dissolved (µg/L) (01130)	Manganese, dissolved (µg/L) (01056)	Molybde- num, dis- solved (µg/L) (01060)	Nickel, dissolved (µg/L) (01065)	Selenium, dissolved (µg/L) (01145)	Silver, dissolved (µg/L) (01075)
(LRL)	6	0.08	0.6	0.2	0.4	0.06	0.4	0.2
SDTEM-01	—	0.16	2.2	—	1.9	0.17	0.5	—
SDTEM-05	—	0.09	14.8	0.2	6.2	0.39	2.1	—
SDTEM-06	—	0.28	4.9	—	1.6	1.56	2.1	—
SDTEM-10	—	0.94	17.4	0.3	4.1	1.33	1.3	—
SDTEM-12	E5	0.21	1.3	E0.1	3.8	0.75	0.7	—
SDTEM-13	E4	E0.07	5.2	E0.1	4	0.25	1.2	—
SDTEM-14	11	0.35	3.9	8.9	10	0.33	.5	—
SDTEMFP-01	E6	0.11	4.2	—	2	0.55	1.8	—
SDTEMFP-02	—	0.15	4.1	E0.2	4.6	0.53	1	—
SDTEMFP-03	E4	—	0.6	0.7	1.6	0.14	E0.3	—
SDTEMFP-04	—	0.12	3.5	—	8	0.4	1.1	—
SDWARN-04	—	0.4	3.4	—	7.6	0.29	0.5	—
SDWARN-05	E4	0.09	18	0.3	0.5	0.92	0.7	—
SDWARN-06	—	—	15.4	E0.1	1.2	0.29	0.5	—
SDALLV-01	E4	0.29	3.8	0.3	2.5	1.84	30.9	—
SDALLV-02	—	2.7	14.9	E0.1	6.4	2.76	2.1	—
SDALLV-03	37	0.76	18.9	<b>169</b>	11.8	1.19	1.7	—
SDALLV-06	<b>2120</b>	—	3.9	<b>492</b>	10.6	3.44	E0.4	—
SDALLV-09	61	0.4	17.6	14.2	7.2	0.7	1.1	E0.1
SDALLV-13	<b>578</b>	0.08	3.8	<b>362</b>	9.5	2.19	E0.3	—
SDHDRK-04	266	E0.07	11.5	27.8	6.1	0.22	0.4	—
SDHDRK-05	—	0.29	32.1	.6	20.8	3.24	2.7	—
SDHDRK-06	183	0.21	24.6	<b>178</b>	5.3	1.74	0.4	—
SDHDRK-07	—	0.18	10.6	20.5	5.4	0.33	—	—

**Table 16.** Analysis for trace elements in ground-water samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

[Beryllium and mercury were not detected in any samples; concentrations preceded by a “V” indicate detections attributed to contamination, and are not counted in ground-water quality analysis; numbers in bold indicate concentrations that exceed secondary maximum contaminant levels (SMCL); bold italics indicate concentrations that exceed detection levels for the purposes of reporting (DLR); the five-digit number below the compound name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property; LRL, laboratory reporting level; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV alluvial study area; SDHDRK, hard rock study area; µg/L, microgram per liter; E, estimated value; —, not detected]

<b>GAMA identification No.</b>	<b>Strontium, dissolved (µg/L) (01080)</b>	<b>Thallium, dissolved (µg/L) (01057)</b>	<b>Tungsten, dissolved (µg/L) (01155)</b>	<b>Vanadium, dissolved (µg/L) (01085)</b>	<b>Zinc, dissolved (µg/L) (01090)</b>	<b>Uranium, dissolved (µg/L) (22703)</b>
<b>(LRL)</b>	<b>0.4</b>	<b>0.04</b>	<b>0.5</b>	<b>0.7</b>	<b>0.6</b>	<b>0.04</b>
SDTEM-01	127	—	2.7	<b>47.6</b>	V0.3	0.71
SDTEM-05	184	—	—	<b>29.9</b>	11.1	1.66
SDTEM-06	396	—	—	<b>16.4</b>	1.1	8.75
SDTEM-10	706	—	—	3	2.9	2.67
SDTEM-12	443	—	1.2	<b>30.8</b>	2.1	3.62
SDTEM-13	325	—	10	<b>35.3</b>	E0.4	0.83
SDTEM-14	355	—	2.6	1	0.6	0.82
SDTEMFP-01	277	—	13.7	<b>69</b>	E0.6	2.55
SDTEMFP-02	396	—	21	<b>43.4</b>	0.7	3.56
SDTEMFP-03	38.8	—	7.7	V0.3	1.1	0.24
SDTEMFP-04	343	—	—	<b>5.8</b>	2.2	1.09
SDWARN-04	121	—	18.0	<b>11.2</b>	1.8	7.94
SDWARN-05	364	—	1.5	<b>11.1</b>	1.4	5.89
SDWARN-06	223	—	1.9	<b>25.9</b>	1.1	2.35
SDALLV-01	409	—	—	<b>17</b>	17.8	0.86
SDALLV-02	839	—	—	1.8	2.1	7.91
SDALLV-03	740	—	—	—	29.7	2.9
SDALLV-06	1130	—	—	2.1	E1.1	5.2
SDALLV-09	588	—	—	V0.8	0.7	0.46
SDALLV-13	558	—	0.7	1.1	1	0.95
SDHDRK-04	67.2	—	—	1	77.5	0.06
SDHDRK-05	438	E0.04	1.2	<b>25.8</b>	4.7	17.8
SDHDRK-06	109	—	2.9	V0.2	15.7	4.89
SDHDRK-07	110	—	0.8	<b>3.8</b>	11.4	0.26

**Table 17.** Analysis for chromium, arsenic, and iron speciation by the U.S. Geological Survey National Research Program in ground-water samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[Concentrations preceded by a “V” indicate detections attributed to contamination, and are not included in ground-water quality analysis; numbers in bold indicate concentrations that exceed secondary maximum contaminant levels (SMCL); bold italics indicate concentrations that exceed detection levels for the purposes of reporting (DLR). MDL, method detection limit; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV alluvial study area; SDHDRK, hard rock study area; µg/L, microgram per liter; NC, sample not collected or ruined before analysis; —, not detected]

GAMA identification No.	Chromium, dissolved (µg/L)	Chromium (VI), (hexavalent) dissolved (µg/L)	Arsenic, dissolved (µg/L)	Arsenic (III), dissolved (µg/L)	Iron, dissolved (µg/L)	Iron (II), dissolved (µg/L)
(MDL)	0.1	0.1	0.5	1	1	1
SDTEM-01	3.5	<b>2.7</b>	3.3	—	—	—
SDTEM-05	5.7	<b>5.6</b>	0.8	—	—	—
SDTEM-06	4.5	<b>4.7</b>	—	—	3	3
SDTEM-10	—	—	NC	NC	NC	NC
SDTEM-12	0.9	0.8	2.8	—	5	4
SDTEM-13	1.1	<b>1.1</b>	2.2	—	3	2
SDTEM-14	0.7	—	1.6	—	8	3
SDTEMFP-01	2.5	<b>2.6</b>	7.4	—	—	—
SDTEMFP-02	1.2	—	2.8	—	5	3
SDTEMFP-03	0.9	0.6	3.3	—	2	—
SDTEMFP-04	0.6	0.2	—	—	—	—
SDWARN-01	1.7	<b>1.1</b>	NC	NC	NC	NC
SDWARN-02	0.5	0.6	NC	NC	NC	NC
SDWARN-03	0.7	0.3	NC	NC	NC	NC
SDWARN-04	—	0.6	7.5	—	2	—
SDWARN-05	0.4	0.4	1.5	—	3	2
SDWARN-06	1.1	0.6	1.8	—	3	2
SDWARN-07	0.4	—	NC	NC	NC	NC
SDWARN-08	0.7	0.7	NC	NC	NC	NC
SDWARN-09	0.1	0.1	NC	NC	NC	NC
SDALLV-01	2.1	0.3	—	—	2	2
SDALLV-02	0.4	0.3	—	—	2	2
SDALLV-03	0.2	—	1.6	1.6	33	29
SDALLV-04	1.1	0.4	NC	NC	NC	NC
SDALLV-05	2.0	<b>1.6</b>	NC	NC	NC	NC
SDALLV-06	1.3	0.5	NC	NC	<b>1,917</b>	1,913
SDALLV-07	0.5	0.2	NC	NC	NC	NC
SDALLV-08	0.2	0.2	NC	NC	NC	NC
SDALLV-09	—	—	—	—	50	12
SDALLV-10	—	V2.6	NC	NC	NC	NC
SDALLV-11	—	0.3	NC	NC	NC	NC
SDALLV-12	0.3	—	NC	NC	NC	NC
SDALLV-13	0.3	0.9	1.4	1.4	<b>521</b>	504
SDALLV-14	0.2	0.1	NC	NC	NC	NC
SDALLV-15	0.7	—	NC	NC	NC	NC

**Table 17.** Analysis for chromium, arsenic, and iron speciation by the U.S. Geological Survey National Research Program in ground-water samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

[Concentrations preceded by a “V” indicate detections attributed to contamination, and are not included in ground-water quality analysis; numbers in bold indicate concentrations that exceed secondary maximum contaminant levels (SMCL); bold italics indicate concentrations that exceed detection levels for the purposes of reporting (DLR). MDL, method detection limit; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV alluvial study area; SDHDRK, hard rock study area; µg/L, microgram per liter; NC, sample not collected or ruined before analysis; —, not detected]

GAMA identification No.	Chromium, dissolved (µg/L)	Chromium (VI), (hexavalent) dissolved (µg/L)	Arsenic, dissolved (µg/L)	Arsenic (III), dissolved (µg/L)	Iron, dissolved (µg/L)	Iron (II), dissolved (µg/L)
SDALLV-16	0.3	0.5	NC	NC	NC	NC
SDALLV-17	0.2	—	NC	NC	NC	NC
SDHDRK-01	0.6	0.3	NC	NC	NC	NC
SDHDRK-02	1.2	0.8	NC	NC	NC	NC
SDHDRK-03	—	—	NC	NC	NC	NC
SDHDRK-04	0.5	0.3	—	—	235	225
SDHDRK-05	1.2	0.2	4.9	—	—	—
SDHDRK-06	0.6	0.4	—	—	166	161
SDHDRK-07	0.9	0.3	—	—	1	—
SDHDRK-08	0.2	0.4	NC	NC	NC	NC
SDHDRK-09	0.3	—	NC	NC	NC	NC
SDHDRK-10	0.3	0.3	NC	NC	NC	NC
SDHDRK-11	0.3	0.5	NC	NC	NC	NC
SDHDRK-12	0.1	—	NC	NC	NC	NC
SDHDRK-13	0.1	—	NC	NC	NC	NC



**Table 18.** Analysis for isotopes and radioactivity in ground-water samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[The five-digit number below the constituent name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property. SDTEM, Temecula Valley study area; SDTEMP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV alluvial study area; SDHDRK, hard rock study area; pCi/L, picocuries per liter; NA, not applicable; NC, sample not collected or ruined before analysis; NQ, detected but not quantified; —, not detected]

GAMA identification No.	Deu- terium/ protium ratio, per mil (82082)	Oxygen- 18/ oxygen-16 ratio (per mil) (82085)	Radium- 226 (pCi/L) (09511)	Radium- 228 (pCi/L) (81366)	Radon- 222 (pCi/L) (82303)	Radon-222 2-sigma combined uncer- tainty (pCi/L) (76002)	Tritium (pCi/L) (07000)	Tritium 2- sigma combined uncer- tainty (pCi/L) (75985)	Alpha radio- activity, 72-hour count (pCi/L) (62636)	Alpha radio- activity, 30-day count (pCi/L) (62369)	Beta radio- activity, 72-hour count (pCi/L) (62642)	Beta radio- activity, 30-day count (pCi/L) (62645)	Carbon-13/ carbon-12 (ratio per mil) (NA) (NA)	Carbon- 14 (percent modern) (NA) (NA)
SDTEM-01	-48	-7.05	0.05	NQ	250	22	NQ	1	1	NQ	2	2	-16.4*	0.51
SDTEM-02	-45	-6.76	NC	NC	NC	NC	4	0.6	NC	NC	NC	NC	NC	NC
SDTEM-03	-50.3	-7.44	NC	NC	NC	NC	NQ	1	NC	NC	NC	NC	NC	NC
SDTEM-04	-46	-5.9	NC	NC	NC	NC	11	1	NC	NC	NC	NC	NC	NC
SDTEM-05	-45.5	-6.81	0.03	—	250	22	1	1	2	1	2	2	-20.1*	0.84
SDTEM-06	-42.5	-6.62	0.03	NQ	350	23	5	1	6	6	2	4	-17.7*	0.96
SDTEM-07	-45.9	-6.42	NC	NC	NC	NC	10	1	NC	NC	NC	NC	NC	NC
SDTEM-08	-44.9	-6.73	NC	NC	NC	NC	3	0.6	NC	NC	NC	NC	NC	NC
SDTEM-09	-54.3	-8.13	NC	NC	NC	NC	—	0.6	NC	NC	NC	NC	NC	NC
SDTEM-10	-80.7	-10.02	0.07	NQ	270	22	20	1.3	2	1	4	6	-10.5*	0.91
SDTEM-11	-49	-7.15	NC	NC	NC	NC	—	1	NC	NC	NC	NC	NC	NC
SDTEM-12	-50.7	-7.31	0.08	—	350	22	3	0.6	3	NQ	3	4	-16.4*	0.98
SDTEM-13	-49.2	-7.11	0.06	NQ	230	22	NQ	0.6	2	NQ	2	3	-16.8*	0.58
SDTEM-14	-44.9	-6.9	0.05	2	280	22	2	0.6	2	NQ	1	2	-17.3*	0.60
SDTEMP-01	-48.1	-7.02	0.05	NQ	410	25	2	1	3	1	2	2	-16.5*	0.74
SDTEMP-02	-46	-6.4	0.02	NQ	310	23	4	0.6	4	3	2	3	-14.1*	0.70
SDTEMP-03	-46.6	-6.63	0.15	NQ	420	24	2	1	1	NQ	NQ	2	-14.2*	0.75
SDTEMP-04	-84.8	-10.5	0.05	NQ	210	28	22	1.3	NQ	NQ	5	6	-11.0*	0.92
SDTEMP-05	-46.6	-6.4	NC	NC	NC	NC	9	1	NC	NC	NC	NC	NC	NC
SDWARN-01	-51.4	-7.57	NC	NC	NC	NC	NQ	1	NC	NC	NC	NC	NC	NC
SDWARN-02	-55.5	-8.35	NC	NC	NC	NC	6	1	NC	NC	NC	NC	NC	NC

**Table 18.** Analysis for isotopes and radioactivity in ground-water samples collected in the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

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GAMA identification No.	Deu- terium/ protium ratio, per mil (82082)	Oxygen- 18/ oxygen-16 ratio (per mil) (82085)	Radium- 226 (pCi/L) (09511)	Radium- 228 (pCi/L) (81366)	Radon- 222 (pCi/L) (82303)	Radon-222 2-sigma combined uncer- tainty (pCi/L) (76002)	Tritium (pCi/L) (07000)	Tritium 2- sigma combined uncer- tainty (pCi/L) (75985)	Alpha radio- activity, 72-hour count (pCi/L) (62636)	Alpha radio- activity, 30-day count (pCi/L) (62369)	Beta radio- activity, 72-hour count (pCi/L) (62642)	Beta radio- activity, 30-day count (pCi/L) (62645)	Carbon-13/ carbon-12 (ratio per mil) (NA) (NA)	Carbon-14 (percent modern) (NA) (NA)
SDWARN-03	-50.8	-7.36	NC	NC	NC	NC	5	0.6	NC	NC	NC	NC	NC	NC
SDWARN-04	-56.4	-8.4	0.08	NQ	1,120	34	NQ	0.6	3	2	—	3	-16.4*	0.78
SDWARN-05	-55.7	-8.4	0.04	NQ	910	31	NQ	0.6	4	2	2	4	-15.4*	0.85
SDWARN-06	-57	-8.31	0.09	NQ	780	30	NQ	0.6	2	NQ	2	2	-25.8*	0.81
SDWARN-07	-56.3	-8.53	NC	NC	NC	NC	4	0.6	NC	NC	NC	NC	NC	NC
SDWARN-08	-59.7	-9.04	NC	NC	NC	NC	1	0.6	NC	NC	NC	NC	NC	NC
SDWARN-09	-66.6	-9.78	NC	NC	NC	NC	NQ	0.6	NC	NC	NC	NC	NC	NC
SDALLV-01	-47.3	-6.77	0.09	—	530	26	10	0.3	2	—	4	7	-16.8	0.99
SDALLV-02	-43.4	-6.26	0.16	NQ	1,190	34	11	1	4	4	2	6	-17.64	0.99
SDALLV-03	-38.8	-5.98	0.1	NQ	240	21	—	0.6	5	2	6	4	-13.88	0.59
SDALLV-04	-37.2	-5.77	NC	NC	NC	NC	5	0.6	NC	NC	NC	NC	NC	NC
SDALLV-05	-45.7	-7.19	NC	NC	NC	NC	13	0.6	NC	NC	NC	NC	NC	NC
SDALLV-06	-41.5	-5.94	0.2	NQ	180	21	19	1.3	9	2	7	11	-15.73	1.01
SDALLV-07	-37.1	-5.77	NC	NC	NC	NC	14	1	NC	NC	NC	NC	NC	NC
SDALLV-08	-42.8	-6.26	NC	NC	NC	NC	12	1	NC	NC	NC	NC	NC	NC
SDALLV-09	-36.7	-5.56	0.14	NQ	420	25	—	0.6	3	NQ	3	6	-13.69	0.22
SDALLV-10	-49	-6.52	NC	NC	NC	NC	19	1.3	NC	NC	NC	NC	NC	NC
SDALLV-11	-46.9	-6.54	NC	NC	NC	NC	22	1.3	NC	NC	NC	NC	NC	NC
SDALLV-12	-30.6	-4.1	NC	NC	NC	NC	8	0.6	NC	NC	NC	NC	NC	NC
SDALLV-13	-39.2	-5.43	0.13	NQ	180	20	11	1	2	NQ	1	3	-17.74	0.95
SDALLV-14	-42	-6.29	NC	NC	NC	NC	6	0.6	NC	NC	NC	NC	NC	NC
SDALLV-15	-46.6	-7.22	NC	NC	NC	NC	7	1	NC	NC	NC	NC	NC	NC

**Table 18.** Analysis for isotopes and radioactivity in ground-water samples collected in the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

[The five-digit number below the constituent name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property. SDTEM, Temecula Valley study area; SDTEMP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV alluvial study area; SDHDRK, hard rock study area; pCi/L, picocuries per liter; NA, not applicable; NC, sample not collected or ruined before analysis; NQ, detected but not quantified; —, not detected]

GAMA identification No.	Deu- terium/ protium ratio, per mil (82082)	Oxygen- 18/ oxygen-16 ratio (per mil) (82085)	Radium- 226 (pCi/L) (09511)	Radium- 228 (pCi/L) (81366)	Radium- 222 (pCi/L) (82303)	Radon-222 combined uncer- tainty (pCi/L) (76002)	Tritium (pCi/L) (07000)	Tritium 2- sigma combined uncer- tainty (pCi/L) (75985)	Alpha radio- activity, 72-hour count (pCi/L) (62636)	Alpha radio- activity, 30-day count (pCi/L) (62369)	Beta radio- activity, 72-hour count (pCi/L) (62642)	Beta radio- activity, 30-day count (pCi/L) (62645)	Carbon-13/ carbon-12 (ratio per mil) (NA)	Carbon- 14 (percent modern) (NA)
SDALLV-16	-52.9	-6.9	NC	NC	NC	NC	16	1.3	NC	NC	NC	NC	NC	NC
SDALLV-17	-56.6	-7.76	NC	NC	NC	NC	7	1	NC	NC	NC	NC	NC	NC
SDHDRK-01	-39.5	-5.7	NC	NC	NC	NC	8	1	NC	NC	NC	NC	NC	NC
SDHDRK-02	-48.7	-7.12	NC	NC	NC	NC	2	0.6	NC	NC	NC	NC	NC	NC
SDHDRK-03	-47.4	-6.81	NC	NC	NC	NC	8	1	NC	NC	NC	NC	NC	NC
SDHDRK-04	-51.9	-8.39	0.04	NQ	1,550	39	6	0.6	NQ	1	3	3	-19.9*	0.97
SDHDRK-05	-48	-6.56	0.13	NQ	1,420	37	11	1	8	9	6	10	-15.75	1.02
SDHDRK-06	-54.2	-8.25	0.41	NQ	4,820	65	1	0.6	8	6	4	7	-17.73	0.76
SDHDRK-07	-49.1	-7.86	0.05	—	550	26	1.2	0.6	NQ	NQ	3	2	-22.66	0.64
SDHDRK-08	-49.3	-7.48	NC	NC	NC	NC	5	0.6	NC	NC	NC	NC	NC	NC
SDHDRK-09	-43.3	-6.93	NC	NC	NC	NC	7	1	NC	NC	NC	NC	NC	NC
SDHDRK-10	-45.7	-7.1	NC	NC	NC	NC	9	1	NC	NC	NC	NC	NC	NC
SDHDRK-11	-34.3	-5.05	NC	NC	NC	NC	3	0.6	NC	NC	NC	NC	NC	NC
SDHDRK-12	-53.2	-8.18	NC	NC	NC	NC	2	0.6	NC	NC	NC	NC	NC	NC
SDHDRK-13	-36.8	-5.29	NC	NC	NC	NC	9	1	NC	NC	NC	NC	NC	NC

\*Carbon-13/carbon-12 ratio not used to correct carbon-14 percent modern value for that sample.

**Table 19.** Analysis for tritium and noble gases done at Lawrence Livermore National Laboratory in samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[Duplicate noble gas analyses are shown for each sample; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLY alluvial study area; SDHDRK, hard rock study area. NA, not available; NC, sample not collected or ruined before analysis; —, not detected]

GAMA identification No.	Collection date	Tritium (pCi/L)	Tritium 2- sigma, combined uncertainty (pCi/L)	Dissolved gas analysis date	Helium-3/ Helium-4 (atom ratio)	Helium-4 (cm <sup>3</sup> STP/g)	Neon (cm <sup>3</sup> STP/g)	Argon (cm <sup>3</sup> STP/g)	Krypton (cm <sup>3</sup> STP/g)	Xenon (cm <sup>3</sup> STP/g)
					$\times 10^{-6}$	$\times 10^{-7}$	$\times 10^{-7}$	$\times 10^{-4}$	$\times 10^{-8}$	$\times 10^{-8}$
SDTEM-01	05/18/04	0.29	0.66	09/19/04	3.008	12.106	2.356	3.500	7.254	0.971
				09/23/04	3.046	12.383	2.365	3.464	7.389	0.985
SDTEM-02	05/24/04	NC	NC	09/20/04	3.027	20.008	3.671	4.612	9.093	1.196
				09/24/04	3.027	20.612	3.816	4.584	9.322	1.212
SDTEM-03	05/24/04	1.13	0.15	09/19/04	2.391	6.840	2.470	3.657	8.007	1.041
				09/23/04	2.372	6.922	2.578	3.646	7.999	1.040
SDTEM-04	05/24/04	10.47	0.45	09/20/04	1.546	1.168	3.771	4.626	9.153	1.133
				09/23/04	1.535	1.190	3.815	4.650	9.054	1.147
SDTEM-05	05/25/04	—	0.48	09/20/04	0.646	1.770	2.835	3.959	8.026	1.013
				09/24/04	0.642	1.786	2.746	3.930	8.178	1.040
SDTEM-06	05/26/04	4.78	0.28	09/20/04	1.315	0.823	2.549	3.792	8.126	1.088
				09/24/04	1.313	0.823	2.613	3.786	8.040	1.090
SDTEM-07	05/27/04	9.92	0.44	09/21/04	1.458	0.739	3.024	4.000	8.657	1.114
				09/24/04	1.463	0.742	3.025	3.980	8.358	1.114
SDTEM-08	05/27/04	2.90	0.22	09/21/04	3.644	5.370	2.544	3.600	7.889	0.981
				10/13/04	3.625	5.624	2.610	3.610	7.713	1.003
SDTEM-09	05/27/04	0.10	0.12	09/20/04	2.082	86.537	2.944	4.176	9.163	1.204
				10/12/04	2.044	87.160	2.911	4.203	9.223	1.194
SDTEM-10	05/27/04	20.21	0.88	09/20/04	1.369	1.017	4.053	4.303	8.430	1.106
				10/13/04	1.382	1.028	4.148	4.348	9.001	1.122

**Table 19.** Analysis for tritium and noble gases done at Lawrence Livermore National Laboratory in samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

[Duplicate noble gas analyses are shown for each sample; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV alluvial study area; SDHDRK, hard rock study area. NA, not available; NC, sample not collected or ruined before analysis; —, not detected]

GAMA identification No.	Collection date	Tritium (pCi/L)	Tritium 2- sigma, combined uncertainty (pCi/L)	Dissolved gas analysis date	Helium-3/ Helium-4 (atom ratio)	Helium-4 (cm <sup>3</sup> STP/g)	Neon (cm <sup>3</sup> STP/g)	Argon (cm <sup>3</sup> STP/g)	Krypton (cm <sup>3</sup> STP/g)	Xenon (cm <sup>3</sup> STP/g)
					$\times 10^{-6}$	$\times 10^{-7}$	$\times 10^{-7}$	$\times 10^{-4}$	$\times 10^{-8}$	$\times 10^{-8}$
SDTEM-11	06/16/04	0.13	0.12	09/22/04	1.917	3.526	2.476	3.557	7.614	1.054
				09/27/04	1.947	3.526	2.434	3.486	7.479	1.012
SDTEM-12	06/21/04	2.89	0.23	09/22/04	2.526	10.359	2.531	3.654	7.988	1.021
				09/28/04	2.526	10.764	2.555	3.621	7.751	1.038
SDTEM-13	06/22/04	0.90	0.16	09/23/04	3.490	87.371	2.287	3.436	7.539	1.003
				09/28/04	3.451	88.055	2.266	3.401	7.434	0.978
SDTEM-14	06/23/04	1.98	0.20	09/23/04	3.972	17.712	2.474	3.645	7.757	1.058
				09/28/04	3.972	17.996	2.455	3.620	7.749	1.067
SDTEMFP-01	05/19/04	0.89	0.14	09/19/04	2.179	9.281	2.512	3.571	7.737	1.001
				09/23/04	2.198	9.732	2.505	3.532	7.442	1.022
SDTEMFP-02	05/20/04	3.82	0.23	09/19/04	2.082	20.665	3.837	4.780	9.571	1.237
				09/23/04	2.102	21.145	3.727	4.738	9.978	1.241
SDTEMFP-03	06/14/04	2.83	0.19	09/21/04	1.807	11.772	4.259	4.996	10.238	1.229
				09/27/04	1.812	11.841	4.077	4.976	10.073	1.262
SDTEMFP-04	06/15/04	23.52	0.98	09/21/04	1.381	0.681	2.760	3.856	8.367	1.153
				09/27/04	1.382	0.682	2.770	3.827	8.275	1.142
SDTEMFP-05	06/16/04	9.49	0.46	09/21/04	1.510	0.935	3.281	4.234	8.837	1.131
				09/27/04	1.537	0.854	2.997	4.099	8.897	1.175
SDWARN-01	06/17/04	—	0.21	09/22/04	0.316	3.338	2.748	3.962	8.594	1.122
				09/28/04	0.659	14.593	24.044	9.834	22.663	2.134
SDWARN-02	06/17/04	5.69	0.31	09/22/04	1.284	1.511	5.825	6.313	11.459	1.398
				09/28/04	1.284	1.845	7.020	6.986	12.630	1.440

**Table 19.** Analysis for tritium and noble gases done at Lawrence Livermore National Laboratory in samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

[Duplicate noble gas analyses are shown for each sample; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV alluvial study area; SDHDRK, hard rock study area. NA, not available; NC, sample not collected or ruined before analysis; —, not detected]

GAMA identification No.	Collection date	Tritium (pCi/L)	Tritium 2- sigma, combined uncertainty (pCi/L)	Dissolved gas analysis date	Helium-3/ Helium-4 (atom ratio)	Helium-4 (cm <sup>3</sup> STP/g)	Neon (cm <sup>3</sup> STP/g)	Argon (cm <sup>3</sup> STP/g)	Krypton (cm <sup>3</sup> STP/g)	Xenon (cm <sup>3</sup> STP/g)
					$\times 10^6$	$\times 10^{-7}$	$\times 10^{-7}$	$\times 10^{-4}$	$\times 10^{-8}$	$\times 10^{-8}$
SDWARN-03	06/17/04	7.03	0.36	09/22/04	1.425	1.047	4.179	4.503	9.014	1.185
				09/28/04	1.429	1.076	4.229	4.603	9.332	1.181
SDWARN-04	06/24/04	0.06	0.33	09/23/04	0.115	21.553	4.606	5.374	10.413	1.294
				09/28/04	0.118	21.800	4.488	5.396	10.676	1.221
SDWARN-05	06/28/04	0.18	0.14	09/28/04	1.039	1.734	4.955	5.064	10.211	1.284
				10/05/04	1.035	1.085	3.206	4.410	9.118	1.199
SDWARN-06	06/29/04	0.18	0.15	09/28/04	1.140	1.266	4.304	5.056	10.274	1.229
				10/05/04	1.143	1.266	4.439	5.093	10.034	1.210
SDWARN-07	07/13/04	4.91	0.32	NA	NC	NC	NC	NC	NC	NC
				NA	NC	NC	NC	NC	NC	NC
SDWARN-08	07/13/04	0.67	0.15	09/29/04	0.125	24.350	2.410	3.511	8.043	1.113
				10/06/04	0.189	52.606	2.481	3.706	8.051	1.137
SDWARN-09	07/13/04	0.13	0.17	09/29/04	0.061	53.498	2.792	3.929	8.628	1.169
				10/07/04	0.061	53.891	2.782	3.972	8.555	1.134
SDALLV-01	06/30/04	12.17	0.73	09/29/04	1.313	0.647	2.465	3.550	7.872	1.067
				10/05/04	1.315	0.639	2.410	3.568	8.059	1.069
SDALLV-02	07/01/04	13.03	0.58	09/29/04	1.251	0.565	2.276	3.550	7.961	1.027
				10/05/04	1.282	0.563	2.278	3.532	7.940	1.090
SDALLV-03	07/12/04	—	0.21	09/29/04	0.212	6.379	2.494	3.790	8.108	1.097
				10/06/04	0.206	6.252	2.539	3.779	8.146	1.068
SDALLV-04	07/12/04	7.28	0.36	09/29/04	1.363	0.898	3.179	4.174	8.559	1.076
				10/06/04	1.350	0.895	3.236	4.166	8.783	1.064



**Table 19.** Analysis for tritium and noble gases done at Lawrence Livermore National Laboratory in samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

[Duplicate noble gas analyses are shown for each sample; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLY alluvial study area; SDHDRK, hard rock study area. NA, not available; NC, sample not collected or ruined before analysis; —, not detected]

GAMA identification No.	Collection date	Tritium (pCi/L)	Tritium 2- sigma, combined uncertainty (pCi/L)	Dissolved gas analysis date	Helium-3/ Helium-4 (atom ratio)	Helium-4 (cm <sup>3</sup> STP/g)	Neon (cm <sup>3</sup> STP/g)	Argon (cm <sup>3</sup> STP/g)	Krypton (cm <sup>3</sup> STP/g)	Xenon (cm <sup>3</sup> STP/g)
					x 10 <sup>-6</sup>	x 10 <sup>-7</sup>	x 10 <sup>-7</sup>	x 10 <sup>-4</sup>	x 10 <sup>-8</sup>	x 10 <sup>-8</sup>
SDALLY-05	07/12/04	13.20	0.59	NA	NC	NC	NC	NC	NC	NC
SDALLY-06	07/13/04	19.83	0.82	NA	NC	NC	NC	NC	NC	NC
SDALLY-07	07/14/04	13.74	0.58	09/29/04	1.186	3.070	5.448	5.304	10.251	1.201
				10/06/04	1.172	1.720	3.517	4.417	8.967	1.109
				09/30/04	1.369	0.722	2.658	3.711	8.198	1.113
				10/07/04	1.359	0.722	2.699	3.795	8.238	1.045
SDALLY-08	07/14/04	12.12	0.53	09/30/04	0.883	1.530	3.570	4.352	8.464	1.076
				10/07/04	0.883	1.457	3.345	4.270	8.369	1.014
SDALLY-09	07/14/04	0.03	0.11	09/30/04	0.299	2.888	2.133	3.204	7.195	0.931
				10/07/04	0.301	3.007	2.209	3.238	7.209	0.947
SDALLY-10	07/14/04	18.55	0.71	09/30/04	1.165	0.738	2.421	3.724	8.238	1.123
				10/07/04	1.155	0.740	2.378	3.732	8.456	1.128
SDALLY-11	07/15/04	23.70	0.98	09/30/04	0.856	1.306	2.372	3.518	7.821	1.019
SDALLY-12	07/15/04	8.44	0.37	10/07/04	0.854	1.298	2.354	3.500	7.691	1.026
				09/30/04	0.374	3.681	2.410	3.468	7.517	1.015
SDALLY-13	07/15/04	11.25	0.78	10/07/04	0.366	3.797	2.467	3.482	7.578	0.990
				09/30/04	0.893	1.492	2.621	3.791	8.414	1.109
				10/07/04	0.897	1.492	2.713	3.815	8.071	1.083
SDALLY-14	07/15/04	6.89	0.33	09/30/04	1.116	0.822	2.381	3.750	8.264	1.113
				10/08/04	1.107	0.819	2.397	3.771	8.475	1.075
SDALLY-15	07/27/04	6.09	0.30	10/04/04	0.442	1.762	2.150	3.353	7.366	0.977
				10/11/04	0.441	1.775	2.149	3.350	7.540	0.985

**Table 19.** Analysis for tritium and noble gases done at Lawrence Livermore National Laboratory in samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

[Duplicate noble gas analyses are shown for each sample; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLY alluvial study area; SDHDRK, hard rock study area. NA, not available; NC, sample not collected or ruined before analysis; —, not detected]

GAMA identification No.	Collection date	Tritium (pCi/L)	Tritium 2- sigma, combined uncertainty (pCi/L)	Dissolved gas analysis date	Helium-3/ Helium-4 (atom ratio)	Helium-4 (cm <sup>3</sup> STP/g)	Neon (cm <sup>3</sup> STP/g)	Argon (cm <sup>3</sup> STP/g)	Krypton (cm <sup>3</sup> STP/g)	Xenon (cm <sup>3</sup> STP/g)
					x 10 <sup>-6</sup>	x 10 <sup>-7</sup>	x 10 <sup>-7</sup>	x 10 <sup>-4</sup>	x 10 <sup>-8</sup>	x 10 <sup>-8</sup>
SDALLY-16	07/28/04	15.43	0.65	10/04/04	1.371	0.590	2.460	3.457	7.539	0.968
				10/11/04	1.382	0.595	2.455	3.479	7.614	0.979
SDALLY-17	07/29/04	5.87	0.28	10/05/04	0.195	75.546	2.329	3.585	7.825	1.017
				10/12/04	0.186	123.926	2.353	3.567	7.772	0.989
SDHDRK-01	07/12/04	3.88	0.29	09/29/04	0.251	4.905	2.570	3.536	7.572	0.976
				10/05/04	0.241	4.934	2.589	3.532	7.457	0.976
SDHDRK-02	07/13/04	1.02	0.20	09/29/04	1.473	0.608	2.528	3.807	8.341	1.117
				10/07/04	1.483	0.609	2.563	3.868	8.227	1.093
SDHDRK-03	07/15/04	9.58	0.45	09/30/04	0.536	1.938	2.815	3.802	7.953	1.021
				10/08/04	0.534	1.899	2.789	3.760	8.136	0.986
SDHDRK-04	07/19/04	5.52	0.52	10/01/04	1.531	0.681	2.636	4.053	8.967	1.216
				10/08/04	1.548	0.670	2.581	4.055	9.105	1.139
SDHDRK-05	07/20/04	11.17	0.48	10/01/04	0.474	1.928	2.737	3.775	8.031	1.056
				10/08/04	0.526	2.058	3.214	4.001	8.208	1.031
SDHDRK-06	07/21/04	1.30	0.15	10/01/04	0.307	23.379	3.054	4.204	8.999	1.158
				10/10/04	0.312	22.757	3.129	4.199	9.078	1.162
SDHDRK-07	07/22/04	1.20	0.15	10/03/04	0.781	0.932	2.250	3.614	8.095	1.049
				10/11/04	0.792	0.943	2.246	3.632	8.227	1.070
SDHDRK-08	07/27/04	6.13	0.34	10/03/04	0.237	13.125	3.348	4.041	8.608	1.098
				10/11/04	0.488	2.277	2.507	3.479	7.812	1.062
SDHDRK-09	07/27/04	6.16	0.31	10/03/04	0.989	0.682	1.973	3.307	7.571	1.022
SDHDRK-10	07/28/04	8.98	0.40	10/04/04	1.076	0.817	2.863	3.746	8.212	1.070

**Table 19.** Analysis for tritium and noble gases done at Lawrence Livermore National Laboratory in samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004—Continued.

[Duplicate noble gas analyses are shown for each sample; SDTEM, Temecula Valley study area; SDTEMP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV alluvial study area; SDHDRK, hard rock study area. NA, not available; NC, sample not collected or ruined before analysis; —, not detected]

GAMA identification No.	Collection date	Tritium (pCi/L)	Tritium 2- sigma, combined uncertainty (pCi/L)	Dissolved gas analysis date	Helium-3/ Helium-4 (atom ratio)	Helium-4 (cm <sup>3</sup> STP/g)	Neon (cm <sup>3</sup> STP/g)	Argon (cm <sup>3</sup> STP/g)	Krypton (cm <sup>3</sup> STP/g)	Xenon (cm <sup>3</sup> STP/g)
					$\times 10^{-6}$	$\times 10^{-7}$	$\times 10^{-7}$	$\times 10^{-4}$	$\times 10^{-3}$	$\times 10^{-8}$
SDHDRK-11	07/28/04	3.64	0.22	10/11/04	1.072	0.809	2.650	3.757	8.311	1.064
				10/04/04	0.233	4.819	2.873	3.696	7.803	0.988
				10/11/04	0.229	4.823	2.910	3.689	7.683	1.023
SDHDRK-12	07/29/04	1.62	0.13	10/05/04	1.253	0.907	3.441	4.614	9.897	1.200
				10/12/04	1.251	0.915	3.447	4.615	9.747	1.184
SDHDRK-13	07/29/04	8.62	0.43	10/05/04	1.014	0.693	2.206	3.350	7.691	1.016
				10/11/04	1.016	0.643	2.102	3.300	7.706	1.011

**Table 20.** Microbial analysis of ground-water samples collected for the San Diego Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, May to July 2004.

[The five-digit number below the microbe name, the data parameter code, is used in the U.S. Geological Survey computerized data system, National Water Information System (NWIS), to uniquely identify a specific constituent or property; LRL, laboratory reporting level; SDTEM, Temecula Valley study area; SDTEMFP, Temecula Valley study area flow-path well; SDWARN, Warner Valley study area; SDALLV alluvial study area; SDHDRK, hard rock study area; mL, milliliter; NQ, microbial constituent identified but not quantified; —, not detected]

<b>GAMA identification No.</b>	<b>Coliphage, F-specific (99335)</b>	<b>Coliphage, somatic (99332)</b>	<b>E. coli, colonies/100mL (90901)</b>	<b>Total coliforms, colonies/100mL (90900)</b>
SDTEM-01	—	—	—	—
SDTEM-05	—	—	—	—
SDTEM-06	—	—	—	—
SDTEM-10	—	—	—	—
SDTEM-12	—	—	—	—
SDTEM-13	—	NQ	—	—
SDTEM-14	—	—	—	—
SDTEMFP-01	—	—	—	—
SDTEMFP-02	—	—	—	—
SDTEMFP-03	—	—	—	—
SDTEMFP-04	—	—	—	—
SDWARN-04	—	NQ	—	—
SDWARN-05	—	—	—	—
SDWARN-06	—	—	—	—
SDALLV-01	—	—	—	—
SDALLV-02	—	—	—	—
SDALLV-03	—	—	—	—
SDALLV-06	—	—	—	—
SDALLV-09	—	—	—	—
SDALLV-13	NQ	—	—	—
SDHDRK-04	—	—	—	—
SDHDRK-05	—	—	—	—
SDHDRK-06	—	—	—	—
SDHDRK-07	—	—	—	—