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Ground-Water Quality Data in the North San Francisco Bay Hydrologic Provinces, California, 2004: Results from the California Ground-Water Ambient Monitoring and Assessment (GAMA) Program

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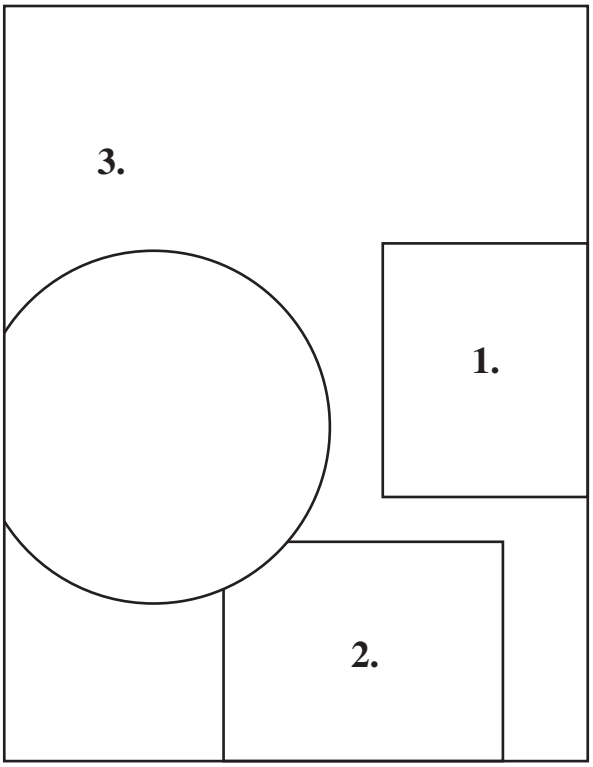

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Ground-Water Quality Data in the North San Francisco Bay Hydrologic Provinces, California, 2004: Results from the California Ground-Water Ambient Monitoring and Assessment (GAMA) Program

By Justin T. Kulongoski, Kenneth Belitz, and Barbara J. Dawson

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Conversion Factors, Abbreviations, and Acronyms

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^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)

Multiply	By	To obtain
	Length	
kilometer (km)	0.6214	mile (mi)
	Area	
square kilometer (km^2)	247.1	acre
square kilometer (km^2)	0.3861	square mile (mi^2)
	Volume	
liter (L)	33.82	ounce, fluid (fl. oz)
liter (L)	0.2642	gallon (gal)
liter (L)	61.02	cubic inch (in^3)
	Pressure	
millimeter (mm) of mercury at 60ºF (in Hg)	0.1333	kilopascal (kPa)
	Radioactivity	
picocurie per liter (pCi/L)	0.037	becquerel per liter (Bq/L)

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

°C=(°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
AF	atomic fluoresence
CAS	Chemical Abstract Service
cm^3 STP	cubic centimeters at standard temperature and pressure (0 degrees Celsius and 1 atmophere of pressure)
DEET	deethyl atrazine
DLR	detection level for the purposes of reporting
DO	dissolved oxygen
DOC	dissolved organic carbon
DS	dissolved solids
GAMA	Ground-Water Ambient Monitoring and Assessment program
GFAA	graphite furnace atomic absorption
HCL	hydrochloric acid
HOT	hydrothermal study
ICRMS	inductively coupled plasma mass spectometer
LRL	laboratory reporting level
LSD	land-surface datum
LT-MDL	long-term method detection level
MCL	maximum contaminant level
MDL	method detection limit
MRL	minimum reporting level
MTBE	methyl tert-butyl ether
MU	method uncertainty
N	normal
NA	not available
NAWQA	National Water Quality Assessment Program
NC	sample not collected
ND	no data

NDMA	N-nitrosodimethylamine
NL	notification level
NRP	National Research Program
NSF	North San Francisco Bay
NSFHOT	North San Francisco Bay Study Unit, hydrothermal study
NSFVOL	North San Francisco Bay Study Unit, Volcanic Highlands study area
NSFVP	North San Francisco Bay Study Unit, Valley and Plains study area
NSFVPFP	North San Francisco Bay Study Unit, Valley and Plains flow-path well
NSFWG	North San Francisco Bay Study Unit, Wilson Grove Formation Highlands study area
NSFWGFP	North San Francisco Bay Study Unit, Wilson Grove Formation Highlands flow-path well
NWIS	National Water Information System
PCE	tetrachloroethylene
QC	quality control
RSD	relative standard deviation
SC	specific conductance
SSMDC	sample specific minimum detectable concentration
SMCL	secondary maximum contaminant level
TCA	1,1,1,-trichloroethane
TCE	trichloroethylene
TCP	trichloropropane
THM	trihalomethane
UCMR	unregulated chemical for which monitoring is required
VP	Valley and Plains study area
VOC	volatile organic compound
VOL	Volcanic Highlands study area
WG	Wilson Grove Formation Highlands study area

Organizations

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

Ground-Water Quality Data in the North San Francisco Bay Hydrologic Provinces, California, 2004: Results from the California Ground-Water Ambient Monitoring and Assessment (GAMA) Program

By Justin T. Kulongoski, Kenneth Belitz, and Barbara J. Dawson

Abstract

Ground-water quality in the ~1,000 square-mile (mi^2) North San Francisco Bay study unit was investigated from August to November, 2004, as part of the California Ground-water Ambient Monitoring and Assessment (GAMA) program. Samples were collected from 89 public-supply wells, 7 hydrothermal wells, and 1 hydrothermal spring in Napa, Sonoma and Marin Counties. Eighty-four of the public-supply wells sampled were selected to provide a spatially distributed, randomized monitoring network for statistical calculations and constituent detection frequency. The study was designed to provide a spatially-unbiased assessment of raw ground-water quality within the study unit, as well as a statistically-consistent basis for comparing the water quality of different study units.

Ground-water samples were analyzed for major and minor ions, trace elements, nutrients, volatile organic compounds, pesticides and pesticide degradates, waste-water indicators, dissolved methane, nitrogen, carbon dioxide and noble gases (in collaboration with Lawrence Livermore National Laboratory). Naturally occurring isotopes (tritium, carbon-14, oxygen-18, deuterium and helium-4) also were measured in the samples to help identify the source and age of the ground water. Results show that no anthropogenic constituents were detected at concentrations higher than those levels set for regulatory purposes, and relatively few naturally-occurring constituents were detected at concentrations greater than regulatory levels.

In this study, 21 of the 88 volatile organic compounds (VOCs) and gasoline additives and (or) oxygenates investigated were detected in ground-water samples, however, detected concentrations were one-half to one-forty-thousandth the maximum contaminant levels (MCL). Thirty-two percent of the randomized wells sampled had at least a single detection of a VOC or gasoline additive and (or) oxygenate. The most frequently detected compounds were chloroform, found in 12 of the 84 randomized wells; carbon disulfide, found in 8 of the 84 randomized wells; and toluene, found in 4 of the 84 randomized wells. Trihalomethanes were the most frequently detected class of VOCs.

Nine of the 122 pesticides and (or) pesticide degradates investigated were detected in ground-water samples, however, concentrations were one-seventieth to one-eight-hundredth the MCLs. Seventeen percent of the randomized wells sampled had at least a single detection of pesticide and pesticide degradate. Herbicides were the most frequently detected class of pesticides. The most frequently detected compound was simazine, found in 8 of the 84 of the randomized wells. Chlordiamino-*s*-triazine and deisopropyl atrazine were both found in 2 of the 84 randomized wells sampled.

Thirteen out of 63 compounds that may be indicative of the prescence of waste-water were detected in ground-water samples. Twenty-six percent of the randomized wells sampled for waste-water indicators had at least one detection. Isophorone was the most frequently detected in 6 of the 84 randomized wells. Bisphenol-A, caffeine, and indole each were detected in 3 of the 84 randomized wells.

Major and minor ions and dissolved solids (DS) samples were collected at 33 public-supply wells; 3 samples had DS concentrations above the secondary maximum contaminant level (SMCL) of 500 mg/L. Ground-water samples from 32 public-supply wells were analyzed for trace elements. Arsenic concentrations above the MCL of 10 µg/L were measured at 4 public-supply wells, boron concentrations above the detection level for the purpose of reporting (DLR) of 100 µg/L were measured at 19 wells. Iron concentrations above the SMCL of 300 µg/L were measured at 7 wells, a lead concentration above the California notification level (NL) of 15 µg/L at one well, and manganese concentrations above the SMCL of 50 µg/L were measured at 17 wells. Vanadium concentrations above the DLR of 3 µg/L were measured at 9 public-supply wells; and chromium(VI) concentrations above the DLR of 1 µg/L were measured at 48 public-supply wells.

Radon-222 was detected in all 21 ground-water samples collected, with activities ranging from 210 to 1,500 picocuries per liter (pCi/L). Fifteen radon samples were above the proposed MCL of 300 pCi/L.

Microbial constituents were analyzed in 22 ground-water samples. Total coliform was detected in three wells. Counts ranged from 2 colonies per 100 mL to 20 colonies per 100 mL. MCLs for microbial constituents are based on reoccurring detection, and will be monitored during future sampling.

Introduction

To assess the quality of ground water from public-supply wells and establish a program for monitoring trends in ground-water quality, the U.S. Geological Survey (USGS) in collaboration with the State Water Board and Lawrence Livermore National Laboratory (LLNL), implemented a statewide ground-water-quality monitoring and assessment program (*http://ca.water.usgs.gov/gama/*). The USGS developed a comprehensive approach for this effort (Belitz and others, 2003; *http://water.usgs.gov/pubs/wri/wri034166/*). The ground-water ambient monitoring and assessment (GAMA) program is a comprehensive assessment of statewide ground-water quality designed to help better understand and identify risks to ground-water resources. The assessment is based on ground-water samples collected at many locations across California in order to characterize their constituents and identify trends in ground-water quality. The results of these tests provide information for water agencies to address a variety of issues ranging in scale from local water supply to statewide resource management.

The GAMA program was developed in response to the Ground-Water Quality Monitoring Act of 2001 (CAL. WATER §§ 10780-10782.3): a public mandate to assess and monitor the quality of ground water used as public supply by municipalities in California. The goal of the Ground-Water Quality Monitoring Act of 2001 is to improve statewide ground-water monitoring and facilitate the availability of information about ground-water quality to the public.

The three main objectives of GAMA are (1) status, to assess the current quality of the ground-water resource, (2) trends, to detect changes in ground-water quality and (3) understanding, to identify the natural and human factors affecting ground-water quality (Kulongoski and Belitz, 2004). This report will assess the quality of the ground-water resource, objective (1), while subsequent interpretive reports will address the trends and understanding listed in objectives (2) and (3).

The GAMA program is unique because the data collected during the study include analyses for chemical constituents that are not normally available; these data will be especially useful for providing an early indication of potential changes in water quality. Additionally, the GAMA program will analyze a broader suite of constituents, at detection limits that are lower than those currently required by the California Department of Health Services (DHS). An understanding of these factors is important for the long term management and protection of ground-water resources.

The range of hydrologic, geologic, and climatic conditions that exist in California must be considered in an unbiased assessment of ground-water quality (Belitz and others, 2003). To accomplish this, the state was partitioned into 10 hydrogeologic provinces that have relatively similar hydrologic, geologic, and climatic characteristics (*fig. 1*). Each of these hydrologic 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). For the purpose of designing a state-wide ground-water assessment program, ground-water basins were prioritized (for sampling) based upon the number of public-supply wells in the basin (Belitz and others, 2003). Secondary consideration was given to municipal ground-water use, agricultural pumping, the number of leaking underground fuel tanks, and pesticide application within a basin. Similar adjacent ground-water basins were then combined and designated as GAMA study units. The North San Francisco Bay GAMA study unit contains 7 ground-water basins considered high priority based on the number of public-supply wells, location, agricultural use, and pesticide applications within each basin (Belitz and others, 2003).

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

Figure 1. The 10 hydrologic provinces considered for the California GAMA study (Belitz and others, 2003), with the North San Francisco Bay study unit outlined.

Purpose and Scope

The purpose of this report is to present the results of analyses for organic and inorganic constituents, microbial constituents, and general water-quality indicators from raw ground-water samples collected in the North San Francisco Bay GAMA study unit. Discussions of the factors that influence the distribution and occurrence of the compounds and microbial constituents detected in ground-water samples will be the subject of subsequent publications.

The concentrations of constituents detected in ground water sampled for this study were evaluated on the basis of state and federal drinking water regulatory standards, and constituents with concentrations greater than either primary (MCL), secondary maximum contaminant levels (SMCL), and California notification levels (NL) were identified. MCLs are established with regards to the protection of human health, whereas SMCLs are established with regards 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) were identified if concentrations in ground water were above the "detection level for the purposes of reporting" (DLR). The DLR is used for reporting constituents on the UCMR list because MCLs have not been established for these constituents. It is important to note that raw ground-water quality in this report does not indicate drinking-water quality because raw water commonly is treated or blended in order to improve water quality. In addition, an MCL violation is not determined from a single sample, but from a suite of samples with concentrations above the regulatory value. Also, ground water samples collected from hydrothermal wells and springs were excluded from regulatory water-quality discussions because these wells are not used for public drinking-water supply.

Detection frequencies were reported for the VOCs, pesticides and pesticide degradates, and waste-water indicators detected in at least one ground-water sample. Frequently detected constituents are useful in determining future trends in ground-water quality. Also presented in this report are the results and analysis of quality-control samples collected during the North San Francisco Bay GAMA study.

Acknowledgements

The authors thank the following cooperators for their support: California Water Boards, California Department of Health Services, California Department of Water Resources, and Lawrence Livermore National Laboratory.

We also thank the cooperating well owners and water purveyors for their generosity in allowing the USGS to collect samples from their wells. We thank Michael T. Wright for his assistance in organizing this report.

Hydrologic Setting of the North San Francisco Bay GAMA Study Unit

The North San Francisco Bay GAMA study unit (*figs. 1,2*) covers approximately 1,000 mi^2 in Napa, Sonoma and Marin Counties across Northern California. It lies within two hydrologic provinces, the San Francisco Bay and North Coast Hydrologic Provinces, as defined by the California Department of Water Resources (California Department of Water Resources, 2003). The NSF study unit includes 7 ground-water basins; the Napa-Sonoma Valley, Kenwood Valley, Alexander Valley, Santa Rosa Valley, Petaluma Valley, Wilson Grove Formation Highlands, Volcanic Highlands, and the Lower Russian River Valley (*fig. 2A*).

The climate in the North San Francisco Bay study unit is characterized by warm, dry summers and cool, moist winters. At the National Climate Data Center station in Sonoma, the average annual temperature is 59º F, and the average annual precipitation is 30 inches (in.), occurring as rain during the winter and early spring. However, the distribution of precipitation across the study area is dependent upon the topography and the prevailing winds, with an increase in precipitation concomitant to an increase in altitude, and most of the rain arriving with southwesterly winds (Faye, 1973).

The study area ground-water basins are drained by several rivers and their principal tributaries including the Napa-Sonoma and Kenwood Valleys by the Napa River and Sonoma Creek, respectively; the Petaluma Valley by the Petaluma River; the Santa Rosa, Alexander, and Lower Russian River Valleys by the Laguna de Santa Rosa and Russian Rivers; the Wilson Grove Formation Highlands by the Americano, Stemple, and Salmon Creeks. The Volcanic Highlands are drained by tributaries of the Napa, Sonoma, and Petaluma Rivers (*fig. 2A*).

For the purpose of this study, the 7 ground-water basins were grouped into three study areas based primarily on geology. The relatively flat lying alluvial-filled basins were combined into the Valley and Plains study area, the Wilson Grove Formation Highlands was taken as a study area, and the Volcanic Highlands was identified as the third study area (*fig. 2A*).

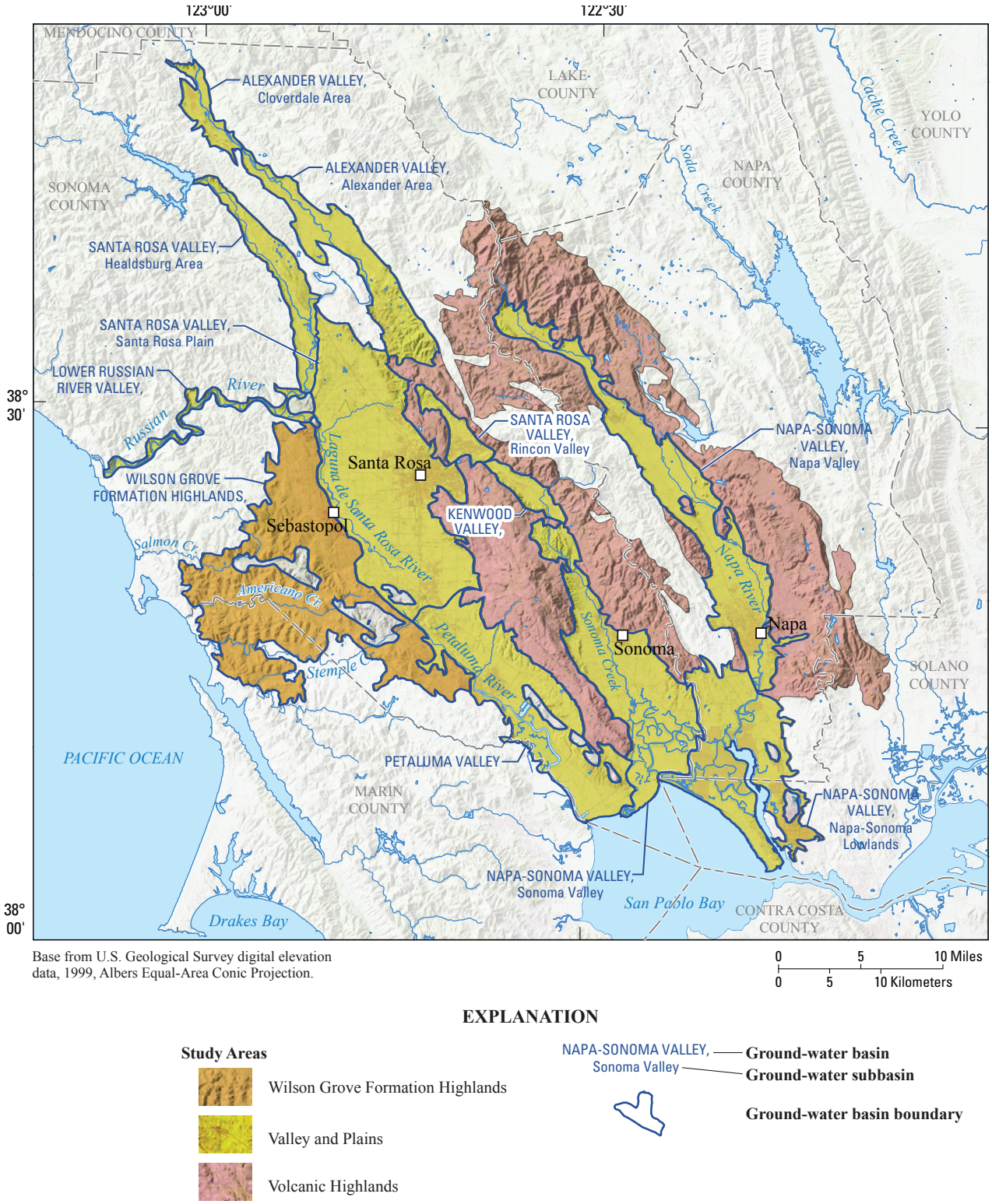
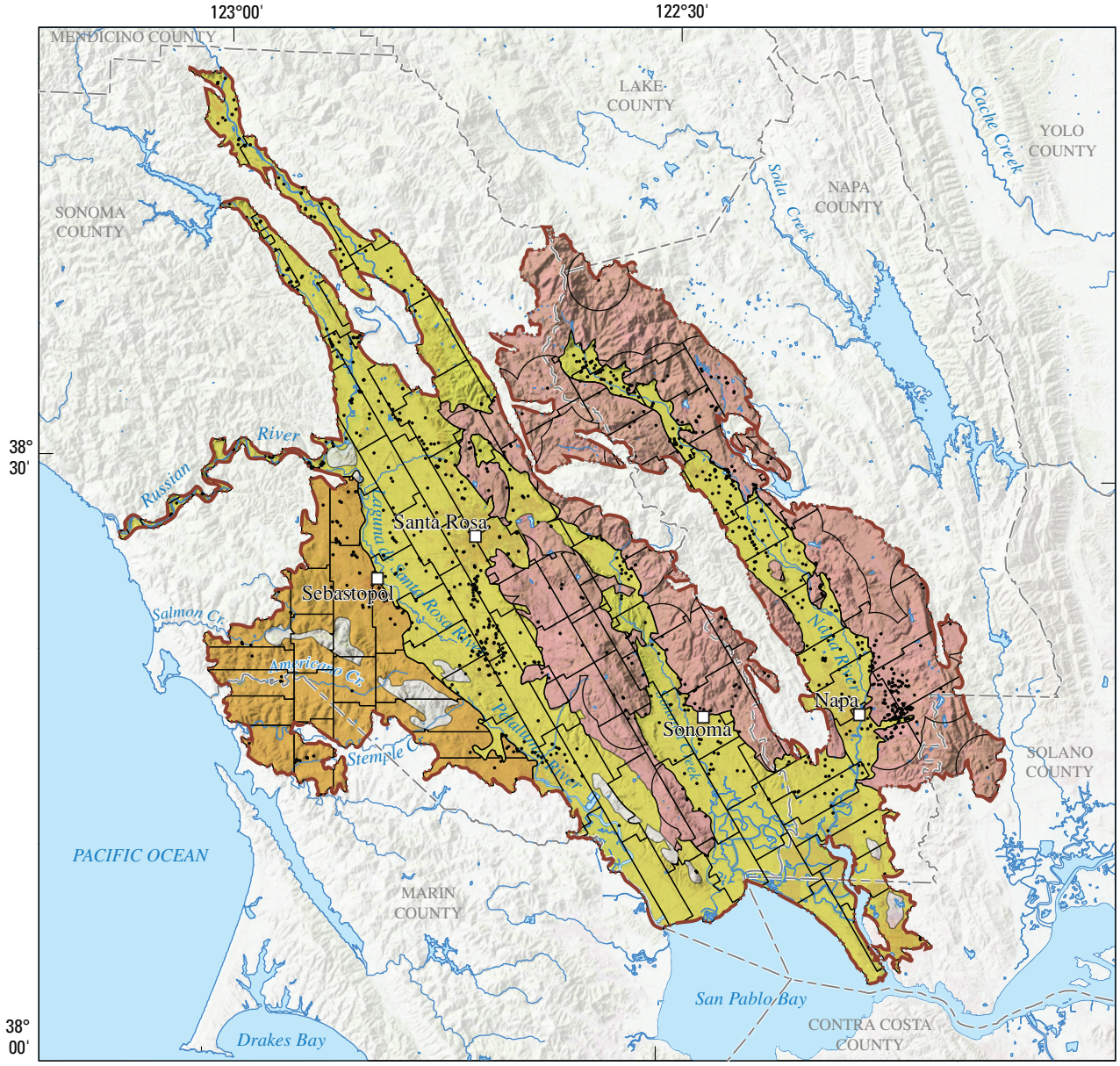


Figure 2. (*A*) the North San Francisco Bay GAMA study unit, locations of study areas, major cities, rivers, ground-water basins and subbasins and (*B*) the North San Francisco Bay GAMA study unit, target wells, and 10-square-mile randomized sampling grid cells.



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

0 5 10 Miles
0 5 10 Kilometers

EXPLANATION

North San Francisco Bay GAMA study unit boundary

Target well

Randomized sampling grid cell

Study Areas

Wilson Grove Formation Highlands

Valley and Plains

Volcanic Highlands

Figure 2.—Continued.

Valley and Plains Study Area

The Valley and Plains study area (VP) extends from Alexander Valley in the north to the San Francisco Bay in the south, and includes most of the alluvial filled basins in the NSF Study Unit (*fig. 3*). These basins result from a series of northwest-trending structural depressions in the southern part of the Coast Ranges of northern California (Faye, 1973). Mountain ranges, from 1,000 to more than 4,000 ft in altitude, bound the VP study area to the north, northwest and east, and separate the Napa Valley, Sonoma Valley and the Santa Rosa Plain. The San Pablo Bay bounds the VP study area to the south, while the Wilson Grove Formation Highlands bounds the VP study area to the west.

The VP study area covers nearly 500 mi^2, and includes the Napa, Sonoma, Santa Rosa, Kenwood, Petaluma and Alexander Valleys, as well as the Napa-Sonoma lowlands to the south near San Pablo Bay (*fig. 3*). These valleys consist of a relatively thin cover of Quaternary alluvium overlying a thick section of Pliocene Volcanics, Cretaceous sedimentary rocks, Franciscan Formation metamorphics, and Jurassic serpentine and plutonic rocks (Faye, 1973).

In these valleys, the main water bearing unit is the alluvium that underlies and forms valley floors the thickness of which increases progressively from north to south and from the periphery of the valleys towards the rivers. In most valleys, the alluvium ranges in thickness from less than 10 ft to more than 300 ft. Except for small localized areas of semiconfinement, water in the alluvium is unconfined and moves under a natural hydraulic gradient that conforms in a general way to the surface topography (Faye, 1973). Ground-water recharge to the alluvial aquifers occurs by stream-channel infiltration beneath the major rivers and their tributaries.

Volcanic Highlands Study Area

The Volcanic Highlands (VOL) study area (*fig. 4*) corresponds to hilly to mountainous areas of Pliocene volcanic deposits, which include lava flows, agglomerates, tuffs, and intercalated sediments of volcanic debris. These deposits, identified as the Sonoma Volcanics, have been subdivided in ascending order into the Mark West andesite, Sonoma tuff, and the St. Helena rhyolite (Osmont, 1905). These rocks have been folded, faulted, and eroded so that they now form a series of elongate ridges separating narrow alluvial valleys.

The VOL study area is approximately 390 mi^2 of discontinuous highlands that ring Napa Valley to the east, north, and northwest, and separate Santa Rosa Valley from Sonoma Valley, and Sonoma Valley from Napa Valley. For the purpose of this study, the VOL study area was defined as the area within about 2 mi of a public-supply well, completed in the volcanic formations.

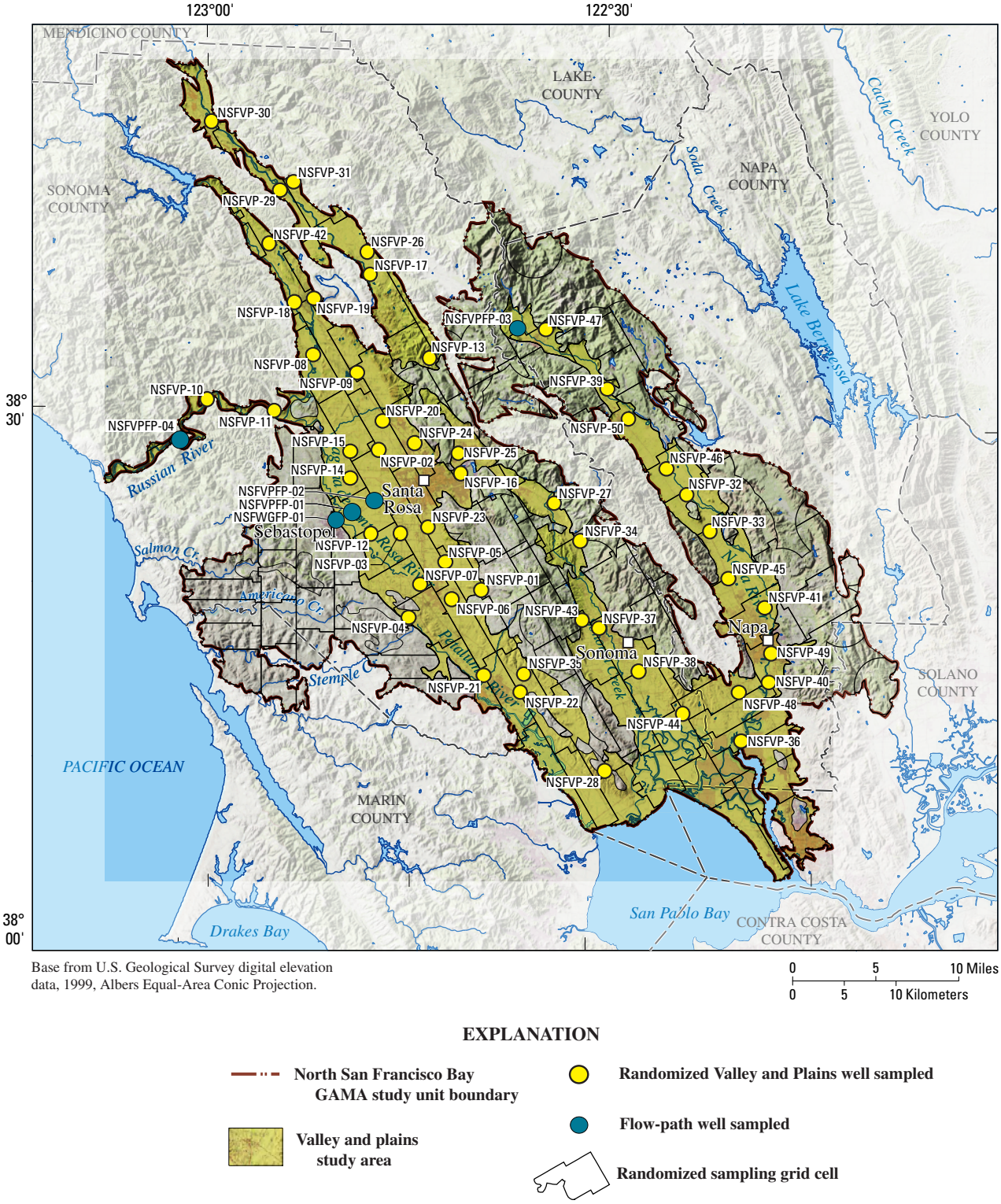
Pumice tuff, tuff breccias, and redeposited stratified tuff form the most important water bearing units in the Sonoma Volcanics, and occur interspersed with the andesitic and basaltic flows that are largely impervious and act as confining beds, which restrict the movement of ground water (Cardwell, 1958). The thickness of the Sonoma Volcanics is not uniform. On the northeast side of Kenwood valley tuff and tuff breccias deposits are up to 1,200 ft in thickness, overlying 800 ft of basalt flows.

Wilson Grove Formation Highlands Study Area

The Wilson Grove Formation Highlands (WG) study area is a coastal area characterized by gently rolling hills, broad valleys, and rounded hilltops between Santa Rosa Valley and the Pacific Ocean (*fig. 5*). The WG study area corresponds to the Wilson Grove Formation Highlands ground-water basin (California Department of Water Resources, 2003) in Marin and Sonoma counties of California. The WG study area covers approximately 140 mi^2, and is bound to the north and south by rugged coastal mountains up to 1,000 ft in altitude; to the west by the Pacific Ocean; and to the east by Santa Rosa Valley. The Wilson Grove Formation Highlands is named for the main geological unit underlying the area, the Wilson Grove Formation (Fox, 1983), and was previously described as the Merced Formation (Johnson, 1934). The marine deposits of the Wilson Grove Formation contain fine grained fossiliferous sandstones with lenses of conglomerate and sandy shale, and are underlain by Franciscan basement rock.

The Wilson Grove Formation represents the main water-bearing unit due to its extent, high porosity, and moderate transmissivity (Cardwell, 1958). The Wilson Grove Formation shallow-marine deposits, derived from the Franciscan group, range between 300 to 2000 ft total thickness.

Mean annual precipitation in the study area, at Graton, California, is 42 in. with a mean annual temperature of 57º F. The WG study area is drained by the Salmon, Americano, and Stemple Creeks (*fig. 5*). Sources of ground-water recharge include percolation of precipitation, and river and stream runoff.



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

EXPLANATION

North San Francisco Bay GAMA study unit boundary

Valley and plains study area

Randomized Valley and Plains well sampled

Flow-path well sampled

Randomized sampling grid cell

Figure 3. The Valley and Plains study area showing the locations of the randomized public-supply wells and flow-path wells sampled for the North San Francisco Bay GAMA study, California.

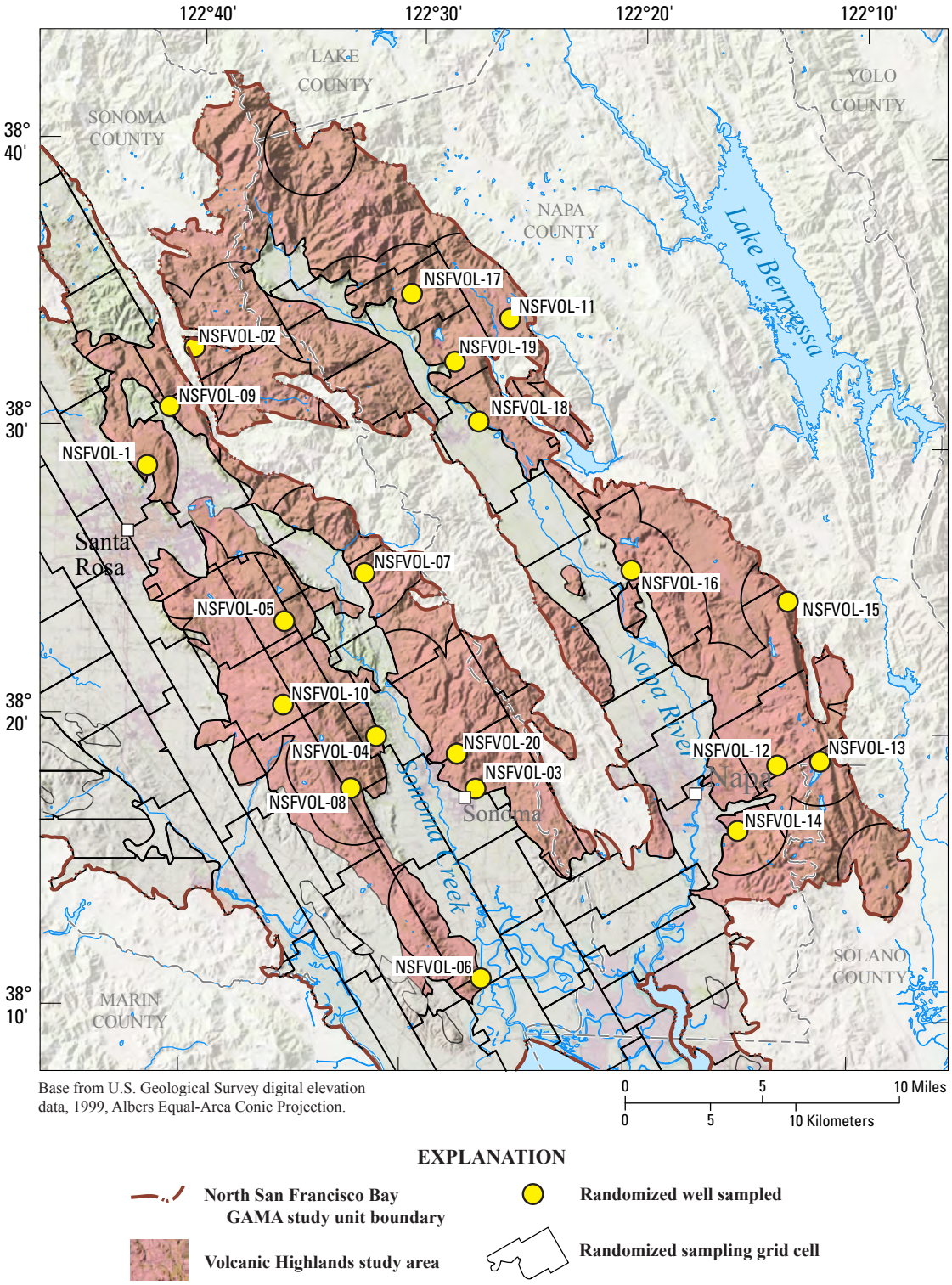


Figure 4. The Volcanic Highlands study area showing the randomized sampling grid cells and locations of the randomized public-supply wells sampled for the North San Francisco Bay GAMA study, California.

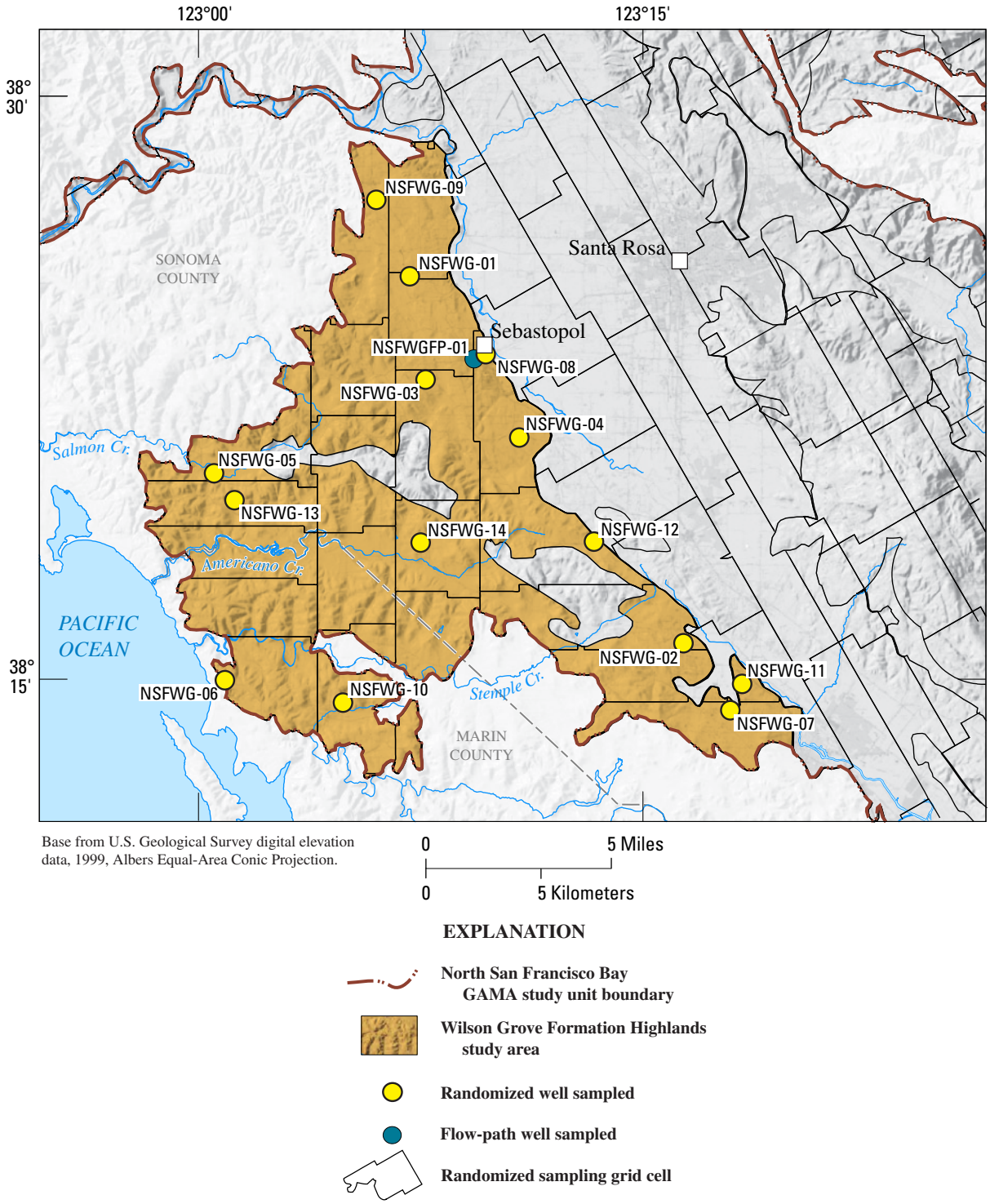


Figure 5. The Wilson Grove Formation Highlands study area, randomized sampling grid cells, and the locations of the randomized public-supply wells and flow path well sampled for the North San Francisco Bay GAMA study, California.

Hydrothermal Study

The hydrothermal (HOT) study involved the characterization of 7 hydrothermal wells and 1 hydrothermal spring (*fig. 6*). Five hydrothermal wells were sampled in the northern Napa Valley near the city of Calistoga, 2 hydrothermal wells were sample in Sonoma Valley near Aqua Caliente, and 1 hydrothermal spring (NSFHOT-08) was sampled east of Saint Helena in hills composed of Cretaceous and Jurassic Franciscan complex rocks (Cardwell, 1958).

The wells and spring sampled for the hydrothermal study are used for mineral baths, not for drinking water supply. These wells are not included in the statistical treatment of the data as they are not public-supply drinking-water wells.

Methods

Sampling Design

The North San Francisco Bay study was designed to provide a spatially-unbiased assessment of ground-water quality within the study unit, as well as a statistically-consistent basis for comparing water quality in different study units. The results of this study will provide the data to assess the status, or current quality of the ground-water resource.

Ground-water basins identified by the Department of Water Resources (California Department of Water Resources, 2003) were used to define the study area boundaries (*fig. 2*), except in the case of the VOL study area (*fig. 4*). The boundary for the VOL study area was designated by the area within about 2 mi of a public-supply well, completed in the volcanic formation. For a spatially unbiased and consistent assessment of ground-water quality (Scott, 1990), each of the study areas (not including the hydrothermal study) was subdivided into grid cells approximating 10 mi^2 (*fig. 2B*).

For this assessment, the VP study area was divided into 60 grid cells, the WG study area into 20 grid cells, and the VOL study area into 20 grid cells. If a grid cell contained more than one public-supply well, each well in that grid cell was randomly assigned a rank. In each grid cell with multiple wells, the highest ranked well was given priority for sampling. In this fashion, a public-supply well was selected in each cell to provide a spatially distributed, randomized monitoring network for each study area. Wells sampled as part of the grid-cell network are hereafter referred to as randomized wells. An attempt was made to select one well per grid cell, however, some grid cells did not contain accessible wells. Wells from adjacent cells were selected to account for grid cells that had no active wells. Initial target wells (*fig. 2B*) were obtained from statewide databases maintained by the USGS and the California Department of Health Services.

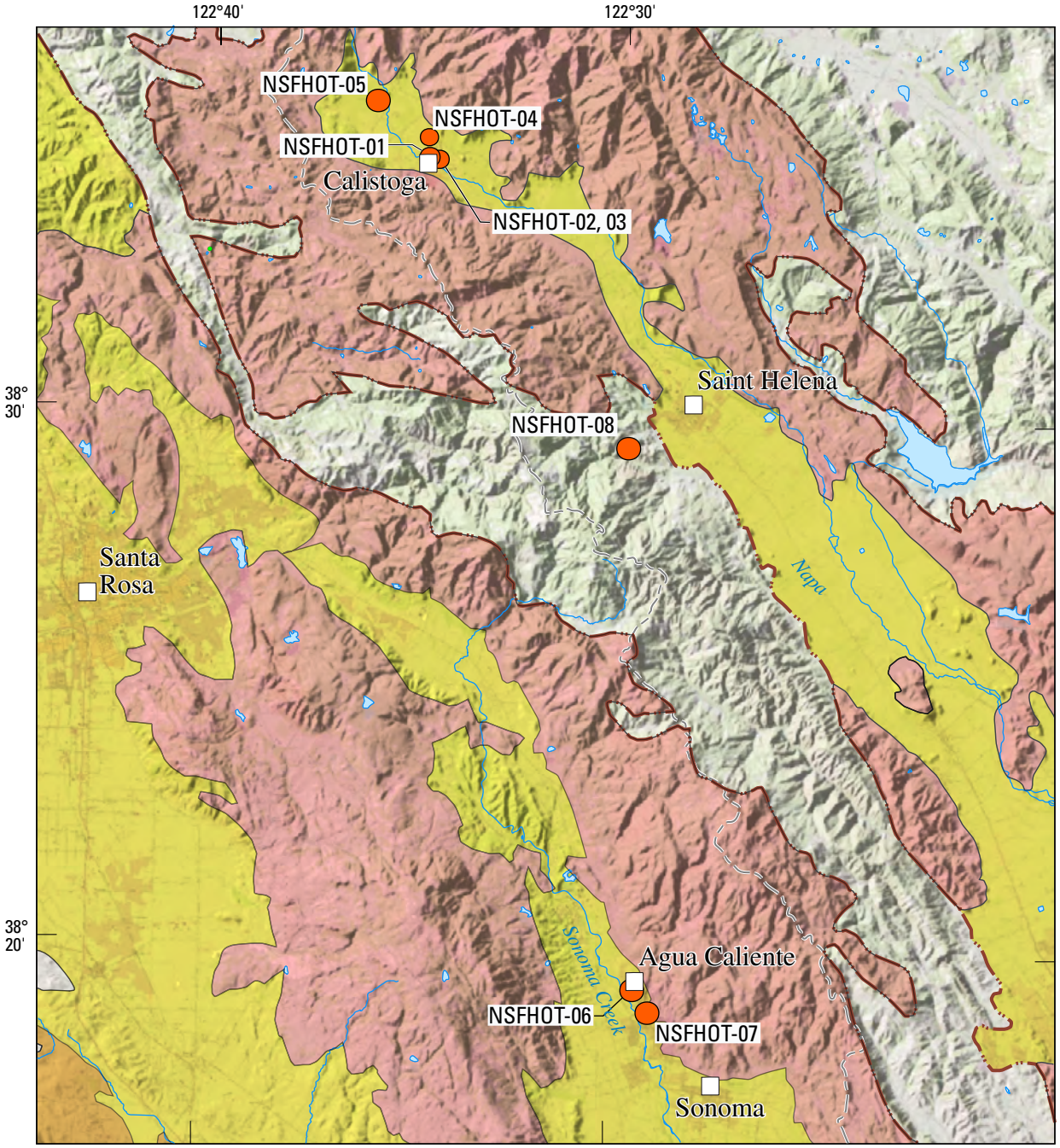
Additional wells were sampled for focused studies specific to an area, including the source of high-salinity waters in the southern lowlands area, the contribution of hydrothermal water to the ground-water system in the Napa and Sonoma Valleys (hydrothermal study), and the source and movement of ground water in the Alexander, Napa, Sonoma, and Santa Rosa Valleys (flow paths) (*figs. 3*, *4*, *6*). Wells sampled as part of the focused studies were not included in the statistical characterization of water quality in the NSF study unit.

Randomized wells sampled as part of the NSF GAMA study unit were numbered with the following prefixes based on study area: The Valley and Plains study area (NSFVP), the Wilson Grove Formation Highlands study area (NSFWG), and the Volcanic Highlands study area (NSFVOL). Additional (non randomized) wells were sampled as part of the hydrothermal study (NSFHOT), and in the Valley and Plain and Wilson Grove study areas in order to ascertain ground-water quality along flow paths; these wells were given the designations NSFVPFP and NSFWGFP.

Table 1 provides the GAMA-id (alphanumeric identification number) for each well, along with the sampling schedule, time and data sampled and well-construction information. Ground-water samples were collected from 89 public-supply wells, 7 hydrothermal wells, and 1 hydrothermal spring from August to November 2004. Of the 89 public-supply wells sampled, 54 were in the Valley and Plains study area, 15 in the Wilson Grove Formation Highlands study area, and 20 in the Volcanic Highlands study area. Seven hydrothermal wells and 1 hydrothermal spring, which are used for recreational supply, were sampled for the hydrothermal study.

For this study, raw (untreated) ground-water samples were analyzed for 88 volatile organic compounds (VOCs), 122 pesticide and pesticide degradates, 63 waste-water indicators, 25 trace elements, 9 major and minor ions, 8 isotopic constituents, 5 noble gases, 5 nutrients, 3 constituents of special interest [N-nitrosodimethylamine (NDMA), trichlorpropane (TCP), and perchlorate], dissolved organic carbon (DOC), dissolved methane, oxygen, nitrogen and carbon dioxide, and the microbial constituents coliform and coliphage (*tables 2A-L*). General water-quality indicators that were determined in the field are dissolved oxygen (DO), pH, specific conductance (SC), alkalinity, and temperature.

Results of analyses were tabulated as concentrations measured in the raw water samples. Concentrations of the constituents were compared to established maximum contaminant level (MCL), secondary maximum contaminant level (SMCL), California notification level (NL) and detection level for the purpose of reporting (DLR).



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

0 5 Miles
0 5 Kilometers

EXPLANATION

North San Francisco Bay GAMA study unit boundary

NSFHOT-05 **Hydrothermal study well or spring sampled**

Study Areas

Wilson Grove Formation Highlands

Valley and Plains

Volcanic Highlands

Figure 6. The hydrothermal study wells and spring sampled for the North San Francisco Bay GAMA study, California.

Sample Collection

Eighty-nine public-supply wells were sampled in the Valley and Plains, Wilson Grove Formation Highlands, and Volcanic Highlands study areas, which comprise the NSF study unit. During the course of this study, target wells were sampled on either an expanded, basic, basic-plus, or hydrothermal schedule (*table 3*). The expanded schedule included analyses of 361 constituents and 19 additional water-quality indicators (*tables 2A-L*). The basic schedule included analyses for 302 constituents and 2 water-quality indicators, while the basic plus schedule added major and minor ions, trace elements, and dissolved gases to the basic schedule.

An attempt was made to sample wells that were located in areas of special interest, such as along flow paths (based on potentiometric surfaces), using the expanded schedule. In the NSF study unit, 25 percent of the ground-water wells were sampled on the expanded schedule, 12 percent were sampled on the basic-plus schedule, and 63 percent on the basic schedule. Wells along flow paths were sampled using the expanded or basic-plus schedules. Wells in the Napa Valley and the Napa-Sonoma Lowlands (*fig. 3*) were sampled using the basic-plus schedule. Hydrothermal wells and springs were sampled using the hydrothermal schedule, which included dissolved gases, tritium, major and minor ions and chromium analyses.

Samples were collected using the USGS National Water Quality Assessment (NAWQA) program protocols (Koterba and others, 1995; U.S. Geological Survey, variously dated). These sampling protocols ensure that a representative sample of ground water was collected at each site and that the samples were collected and handled in a way that minimized the potential for airborne contamination of samples and (or) cross contamination between samples collected at wells. Additional details on sample collection may be found in the analytical methods references discussed in the Sample Analysis section.

Prior to sampling, each well was pumped continuously in order to purge at least three casing-volumes of water from the well. Samples were collected before filtration or chemical treatment, such as chlorination. If a chlorinating system was attached to the well, the chlorinator was shut off at least 24 hrs prior to purging and sampling the well.

For ground-water sample collection, Teflon tubing was affixed to the hosebib or sampling port closest to the well head using stainless steel fittings. For the basic schedule, samples were collected at the well head using a 12-in. length of Teflon tubing.

For the expanded schedule, the samples were collected inside an enclosed chamber located inside a mobile laboratory and connected to the well head by a 10 to 50 ft length of the Teflon tubing. Under the expanded schedule, ground water was pumped through a flow-through chamber fitted with a multi-probe meter that simultaneously measures the following water-quality indicators: DO, temperature, pH, turbidity, and specific conductivity (SC). Ground-water samples were collected when the temperature, DO, and pH values being measured remained stable for 20 minutes.

Ground-water samples were filtered in the field using a 0.45-µm capsule or disk filter. Polyethylene bottles were pre-rinsed using native water three times before sample collection. Some samples were preserved with acid, to a pH of 2 or less. Temperature sensitive samples were stored on ice prior to daily shipping to the various laboratories. The non-temperature sensitive samples for tritium, noble gases, stable isotopes, and carbon isotopes were shipped monthly, while radium isotopes, gross alpha/ beta, and radon-222 samples were shipped daily.

Volatile organic compounds (VOCs) and gasoline additives and (or) oxygenates (*tables 2A, 2B,* at the back of this report) were collected in 40-mL sample vials that were purged with three vial volumes of sample water before bottom filling to eliminate atmospheric contamination. Six normal (N) hydrochloric acid (HCl) was added as a preservative to the VOC samples, but not to the gasoline additives and (or) oxygenate samples. Pesticides, pesticide degradation products (*tables 2C*, *2D*), waste-water indicators (*table 2E*), trichloropropane (1,2,3-TCP), and N-nitrosodimethylamine (NDMA) (*table 2F*) were collected in 1-L baked amber bottles; these samples were filtered at their respective laboratories prior to analysis. Perchlorate and nutrient samples each were filtered into 125-mL polyethylene bottles (*tables 2F*, *2G*). DOC was collected at the well head after rinsing the sampling equipment using water from the sampling port that was filtered using a 50-mL syringe and 0.45-µm disk filter. The ground water sample then was filtered into a 125-mL baked glass bottle and preserved with 4.5 N sulfuric acid (*table 2G*).

Ground-water samples for the analysis of major and minor ions, and trace elements were collected by filtering ground water into two 250-mL polyethylene bottles, and then preserving one bottle with 7.5 N nitric acid (*table 2H*). Arsenic and iron speciation samples were filtered into a 250-mL polyethylene bottle that was covered with tape to prevent light exposure, and preserved with 6N HCl (*table 2I*).

Chromium, radon-222, tritium, and dissolved gases were collected from the hosebib at the well head, regardless of the sampling schedule (expanded, basic, or basic-plus). Chromium speciation samples were collected using a 10-mL syringe with an attached 0.45-µm disk filter. After the syringe was thoroughly rinsed and filled with ground water, 4 mL was forced through the disk filter, the next 2 mL of the ground water was slowly filtered into a small centrifuge vial for analysis of total chromium (*table 2I*). Hexavalent chromium, Cr(VI) was then collected by attaching a small cation exchange column to the syringe filter, and after conditioning the column with 2 mL of sample water, 2 mL was collected in a second centrifuge vial. Both vials were preserved with 10 µL of 7.5 N nitric acid (Ball and McClesky, 2003).

Tritium samples were collected at the well head by bottom filling two 1-L glass bottles with unfiltered ground water, after first rinsing the bottle with three volumes of water (*table 2J*). Stable isotopes of water were collected in 60-mL clear glass bottles filled with unfiltered water, sealed with a conical cap, and secured with electrical tape to prevent leakage and evaporation (*table 2J*). Radium isotopes and gross alpha/beta samples were collected and preserved in the same manner as major and minor ions, except 2 and 1-L aliquots of ground water were taken, respectively (*table 2J*). Mercury samples were collected by filtering ground water into a 250-mL glass bottle and preserving with 6 N HCl. Carbon isotope samples were filtered and bottom filled into two 500-mL baked glass containers that were first rinsed with three bottle volumes of ground water (*table 2J*). These samples had no headspace, and were sealed with a conical cap to avoid atmospheric contamination. Samples for alkalinity were collected by filtering ground water into a 500-mL polyethylene bottle.

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 to create back pressure, and a 10-mL sample was taken through a Teflon septum on the value 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 (mineral oil) and shaken. The vial was then placed in a cardboard tube in order to shield it from light during shipping (U.S. Geological Survey, variously dated).

Noble gases were collected in 3/8 in. ID copper tubes using reinforced nylon tubing connected to the hosebib at the wellhead (*table 2K*). Ground water was flushed through the tubing to dislodge bubbles before flow was restricted with a back pressure valve. Clamps on either side of the copper tube were then tightened, trapping a sample of ground water for analyses of noble gases (Weiss, 1968). Dissolved gas (CH_4, CO_2, O_2, Ar, and N_2) samples were collected in 40-mL, amber glass vials (USEPA VOA vials with screw-top septa). The vials were filled to the top with no headspace, and bubbles (atmospheric contamination) were carefully avoided. Samples were taken in triplicate.

Microbial constituents also were collected at the well head (*table 2L*). Prior to the collection of samples, the sampling port was sterilized using 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 sterilized 250-mL bottles were then filled with ground water for coliform analyses (total and Escherichia coliform determinations), and one sterilized 3-liter carboy was filled for coliphage analyses (F specific and somatic coliphage determinations).

Sample Analysis

Nine laboratories performed chemical and microbial analyses for the NSF GAMA study. The following analytical methods were employed for the determination of organic and inorganic analytes by the USGS National Water-Quality Laboratory (NWQL): VOCs were measured by purge and trap capillary gas chromatography-mass spectrometry (Connor and others, 1998); gasoline additives and (or) 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 indicators by polystyrene-divinylbenzene solid-phase extraction and capillary-column gas chromatography-mass spectrometry (Zaugg and others, 2002); major and minor ions, trace elements, and nutrients by inductively coupled plasma mass spectrometry (ICP-MS), graphite furnace atomic absorption (GFAA), atomic fluorescence (AF), and colorimitetry (Fishman and Friedman, 1989; Fishman, 1993; Garbarino, 1999; Garbarino and Damrau, 2001; and Patton and Kryskalla, 2003); DOC by UV-promoted persulfate oxidation and infrared spectrometry (Brenton and Arnett, 1993); radon-222 by liquid scintillation counting (American Society for Testing and Materials, 1998a,b); dissolved solids by weighing the sample residue on evaporation at 180°C (Fishman and Friedman, 1989).

The following methods were used for analyses of organic and inorganic constituents and microbial constituents by laboratories other than the NWQL: Perchlorate, NDMA, and 1,2,3-trichloropropane analysis by Montgomery Watson and Harza Laboratory using chromatography and mass spectrometry (U.S. Environmental Protection Agency, 1996; Hautman and others, 1999); stable isotopes of water by the USGS Reston Stable Isotope Laboratory using gaseous hydrogen and carbon dioxide-water equilibration (Coplen and others, 1991; Coplen, 1994); chromium, iron, and arsenic analysis by the USGS National Research Program (NRP) laboratory in Boulder, Colorado, using UV-VIS spectrophotometery and atomic absorption spectroscopy (To and others, 1998; Ball and McClesky, 2003; McCleskey and others, 2003); F-specific and somatic coliphage analysis by the USGS Ohio Microbiology Laboratory (U.S. Environmental Protection Agency, 2001); tritium analysis at the USGS NRP Laboratory, Menlo Park, California, using electrolytic enrichment-liquid scintillation method (Thatcher and others, 1977); tritium (helium-3 ingrowth method) and noble gases using accelerator mass spectrometry at LLNL (Clarke and others, 1976; Moran and others, 2002); dissolved gas (Ar, CH_4, CO_4, N_2, O_2) analyses, also at LLNL, were carried out on a Membrane Inlet Mass Spectrometer (Kana and others, 1994); radium-226, radium-228, gross alpha and beta radioactivity analysis by Eberline Analytical Services using alpha activity counting method (U.S. Environmental Protection Agency, 1980); carbon isotopes analysis by the University of Arizona at the Accelerated Mass Spectrometry Laboratory (Donahue and others, 1990; Jull, and others, 2004); total and Escherichia coliform analyzed by USGS in the mobile lab by counting colonies (U.S. Environmental Protection Agency, 2002b).

Ground-water samples for arsenic and iron were analyzed at two different laboratories; total concentrations were measured at the NWQL in Denver, Colorado, while speciation was measured at the USGS National Research Program (NRP) Lab in Boulder, Colorado. Cr also was analyzed in ground-water samples at the NRP laboratory. The NRP laboratory method determines chromium speciation, including analysis for hexavalent chromium, which is classified as an unregulated contaminant monitoring regulation (UCMR) compound.

Alkalinity and the concentrations of bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}) were measured on filtered samples by gran titration method (U.S. Geological Survey, variously dated). Turbidity, pH, SC, and temperature were measured in the field with calibrated instruments. Total coliforms and *Escherichia* coliform (*E*. coli) were counted, following a 22–24 hour incubation time, under an ultraviolet light.

Data Reporting

Laboratory Reporting Conventions

The USGS NWQL uses the laboratory reporting level (LRL) as a threshold for reporting analytical results. The LRL is set to minimize the reporting of false negatives (not detecting a compound when it is actually present in a sample) to less than 1 percent (Childress and others, 1999). The LRL is set at two-times the long-term method detection level (LT-MDL), which is the average (long term) MDL calculated from multiple analytical measurements (> 50). The method detection limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the concentration is greater than zero (at MDL there is less than 1 percent chance of a false positive) (U.S. Environmental Protection Agency, 2002a).

Detections below the LRL are reported as estimated concentrations (designated with an “E” before the value in the tables and text). For information-rich methods (including the VOC method used in this study), detections below LT-MDL also are reported as E-values. E-values also result from detections outside the range of calibration standards, for detections that did not pass laboratory quality-control analyses, and for samples that were diluted prior to analysis.

Some compound concentrations in this study are reported using minimum reporting levels (MRLs) or method uncertainties. The MRL is the smallest measurable concentration of a constituents the 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.

Constituents on Multiple Analytical Schedules

Twenty three constituents targeted in the NSF GAMA study are determined by more than one analytical schedule (*table 4*). Method preference is determined by the analyzing agency (*http://wwwnwql.cr.usgs.gov/USGS/Preferred_method_selection_procedure.html*). Results from certain analytical schedules are preferred over others because the methodology is more accurate and precise, and generally yields a greater sensitivity for a given compound. If a compound appears on multiple analytical schedules, then only the detections determined by the preferred analytical schedule are reported here.

Quality Control

Quality-control (QC) samples collected in the NSF study include source-solution blanks, field blanks, equipment blanks, replicates, and matrix and surrogate spikes. QC samples were collected to evaluate bias and variability of the water chemistry data that may have resulted from sample collection, processing, storage, transportation, and laboratory analysis.

Blanks

Blank samples (blanks) were collected using water (Nitrogen-Purged Universal blank water) certified to contain less than the LRL of MRL of the analytes investigated in the study. Three types of blanks were collected: source-solution, equipment, and field blanks. Source-solution blanks were collected to verify that the blank water used for equipment and field blanks was free of analytes. Equipment blanks were collected at the beginning of the study to determine the residual presence of analytes in the sampling equipment, such as if the fittings and tubing used to collect samples introduced contamination. The equipment blanks were collected at the beginning of the study at the USGS California Water Science Center in Sacramento, California. Field blanks were collected at 10 percent of the wells sampled to determine if procedures used in the field and (or) laboratory introduced contamination, and are analogous to equipment blanks collected in the field. Equipment and field blanks were analyzed for VOCs, pesticides, waste-water indicators, low-level nutrients, dissolved organic carbon, major and minor ions, and trace elements.

Source-solution blanks were collected at the sampling site by pouring blank water directly into sample containers that were preserved, stored, shipped, and analyzed in the same manner as the ground-water samples. For equipment and field blanks, blank water was either pumped or poured through the sampling equipment (fittings and tubing) used to collect ground water, then processed and transported using the same protocols for the ground-water samples.

If a constituent was detected in an equipment or field blank, the associated source-solution blank results were examined for similar constituent detections. If the field blank (or equipment blank) and the source-solution blank contained the constituent, then the source solution water was interpreted as the origin of the contamination in the blanks, and the field (or equipment) blank detections using the same blank water were disregarded. If a field blank detection could not be attributed to the source solution, then the ground-water samples collected prior to, and following the blank were evaluated. If the ground-water samples prior to or following the contaminated field blank had no detections, then carry-over contamination was ruled out. If an analyte was detected in a blank at a concentration greater than the concentration measured in a ground-water sample collected prior to or following the blank sample, then the ground-water value was censored (*table 5*). Censored values are indicated by a 'V' proceeding the value in the tables (*12A–C*, and *14*), and are not considered in the summary statistics. If a compound was detected in multiple equipment and (or) field blanks, and the detections could not be attributed to the source-solution water, then any ground-water sample that had a detection of the compound in question was evaluated for possible contamination.

Replicates

Sequential replicate samples assess variability that may result from the processing and analyses of inorganic and organic constituents. Relative standard deviation (RSD) of the measured values was used in determining the variability between replicate pairs for each compound (*table 6A-E*). 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). Estimated values were not used for these calculations. Values of RSD less than 20 percent are considered acceptable in this study (Fishman and Friedman, 1989). High RSD values for a compound may indicate analytical uncertainty at low concentrations, particularly for concentrations within an order of magnitude of LT-MDL or MDL.

Matrix Spikes

Addition of a spike or known concentration of a constituent to a replicate environmental sample enables the analyzing laboratory to determine the effect of the matrix, in this case ground water, on the analytical technique used to measure the constituent. 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 NSF GAMA study were added at the laboratory performing the analysis. Compounds with low recoveries (<70 percent) are of potential concern if environmental concentrations are close to the MCLs; a concentration below an MCL could be falsely indicated (*table 7A-C*). Conversely, compounds with high recoveries (>130 percent) are of potential concern if the environmental concentrations exceed MCLs: a high recovery could falsely indicate a concentration above the MCL. Recoveries between 70 to 130 percent for matrix spikes were considered acceptable in this study (Fishman and Friedman, 1989).

Surrogates

Surrogate compounds are added to environmental samples in the laboratory prior to analyses in order to evaluate the recovery of similar constituents. Surrogate compounds were added to all ground-water and quality-control samples that were analyzed for VOCs, gasoline additives and (or) oxygenates, pesticides, and waste-water indicators. Surrogates are not normally found in environmental samples 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 (or) incomplete laboratory recovery (possibly due to improper maintenance and calibration of analytical equipment) that produces a negative bias. Surrogates are used to identify general problems that may arise during sample analysis that could 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. Values outside this range indicate possible problems with the processing and analysis of samples (*table 8*) (Fishman and Friedman, 1989).

Results

Quality-Control Samples

Detections in Blanks

Equipment Blank

The equipment blank performed on August 31, 2004, contained the following VOC and waste-water indicators: ethylbenzene (E 0.06 µg/L), *m*-xylene plus *p*-xylene (0.29 µg/L), *o*-xylene (E 0.09 µg/L), toluene (0.1 µg/L), and phenol (0.6 µg/L). However, none of these constituents were observed in ground-water samples taken on the same day, prior to, or following the equipment blank detection, and therefore do not impact ground-water sample results. Also detected in the equipment blank taken on August 31, 2004, were calcium (0.01 mg/L), silica (0.04 mg/L), and arsenic (0.1 µg/L). However, the average concentrations of Ca, Si, and As observed in ground-water samples were 23 mg/L, 72 mg/L, and 13 µg/L, respectively (*table 15*). The constituents detected in the equipment blank represent less than 1 percent of observed values, hence do not impact ground-water sample results.

Field Blanks

In the NSF GAMA study unit, field blanks were collected at approximately 10 percent of the sites sampled. *Table 5* presents a summary of compound detections in field blanks. The VOCs, and their maximum concentrations, detected in field blanks include acetone (E 2.9 µg/L), carbon disulfide (E 0.07 µg/L), ethylbenzene (E 0.06 µg/L), *m*-xylene plus *p*-xylene (0.29 µg/L), *o*-xylene (0.11 µg/L), and toluene (0.11 µg/L). Ground-water samples collected prior to, and following these field blanks were free from these constituents, hence no ground-water samples were censored as a result of these blank detections.

The pesticide compound atrazine, with a maximum estimated concentration of E 0.005 µg/L, also was detected in one field blank. Ground-water samples collected prior to, and following this blank were free from atrazine, hence none were censored.

The waste-water indicators and their maximum concentrations detected in field blanks were naphthalene (E 0.04 µg/L), phenol (E 1.1 µg/L), and triclosan (E 0.08 µg/L), respectively. For the constituents naphthalene and triclosan, ground-water samples collected prior to, and following these blanks were free from these constituents, hence no ground-water samples were censored.

Eight field blank samples contained phenol with a maximum concentration of 1.1 µg/L, as did six source-solution blanks with a maximum concentration of 0.6 µg/L, and the equipment blank with a value of 0.6 µg/L. As a result of the high detection frequency for phenol in blank samples, and relatively high detection frequency for phenol in ground-water samples, minimum concentration detected E 0.23 µg/L, phenol has been removed from consideration in this study, so that further attention can be given to the analytical methodology. As a result, 48 ground-water sample detections for phenol were censored (*table 5*). Phenol concentrations observed in this study, maximum of 2.4 µg/L are far below the health advisory limit of 2,000 µg/L.

Two major ions and one minor ion were detected in field blanks, with maximum concentrations; Ca (E 0.02 mg/L), Si (0.06 mg/L), and I (0.001 mg/L), respectively. None of the ground-water samples had detections of Ca or Si lower than these values, hence none were censored. No ground-water samples prior to or following the blanks had concentrations of iodine lower than E 0.001 mg/L, hence no values were censored. Four trace elements were detected in field blanks, Al (E 0.9 µg/L), Mn (E 0.1 µg/L), Ni (E 0.07 µg/L), and Zn (E 0.5 µg/L). None of the ground-water samples had detections of Al, Ni, or Zn lower than these values, hence none were censored. Mn concentrations measured in ground-water samples ranged from 0.1 to 1,220 µg/L, however no detections in ground-water samples prior to or following the blanks had Mn concentrations lower than E 0.1 µg/L, hence no values were censored.

Dissolved organic carbon (DOC) was detected in 2 out of 3 blanks, and as a result, ground-water samples with concentrations lower than 0.4 mg/L following the second blank were censored. Four ground-water sample DOC detections: E 0.3 mg/L, 0.4 mg/L, 0.4 mg/L, and E 0.2 mg/L, following the 0.5 mg/L blank detection, were censored (*table 5*).

Variability in Replicate Samples

The majority of replicate sample pairs collected during the NSF GAMA study had relative standard deviations (RSDs) of less than 20 percent (*table 6A-E*). Twenty-three replicate sample pairs representing 8 chemical constituents, 4 replicate sample pairs of radionuclides, and 9 replicate sample pairs of gross radioactivity in water, had RSDs greater than 20 percent; see *tables 6A to 6E* for details. However, the replicate sample pairs with high RSDs had very low measured concentrations, and at these low concentrations, small deviations in measured values account for large RSDs. Since the variability in measurements occurred at low concentrations, well below MCLs, this variability was not of QC concern, and no detections were censored as a result of variability in replicate sample samples.

Matrix Spike Recoveries

Tables 7A to 7C present a summary of matrix spike recoveries for the NSF GAMA study. Addition of a spike or known concentration of a constituent to an environmental sample enables the analyzing laboratory to determine the effect of the matrix, in this case ground water, on the analytical technique used to measure the constituent. Nine environmental samples were spiked with VOCs to calculate matrix spike recoveries. Acceptable spike recovery values range between 70 and 130 percent (Friedman and Erdmann, 1982) (*table 7A*). Seventy-four of the 90 spike compounds had recoveries between the acceptable range of 70 and 130 percent. Fifteen spike compounds had at least one matrix spike recovery greater than 130 percent. Six of these 15 VOCs were detected in ground-water samples; 1,1,1-trichloroethane (TCA) was detected in 1 ground-water sample, acetone was detected in 1 ground-water sample, bromodichloromethane was detected in 1 ground-water sample, bromoform (tribromomethane) was detected in 1 ground-water sample, carbon disulfide was detected in 8 ground-water samples, and tetrachloromethane (carbon tetrachloride) was detected in 1 ground-water sample. All detections in ground-water samples were at concentrations well below MCLs, and therefore are not of QC concern. Nitrosodimethylamine (NDMA) was the only spike compound that had a recovery below 70 percent, however it was not detected in ground-water samples (*table 13A*). [NOTE – low recoveries may indicate that this compound was not detected in some samples if it was present at very low concentrations].

Five environmental samples were spiked with pesticide and (or) pesticide degradate compounds in order to calculate matrix spike recoveries. Acceptable spike recovery values range between 70 and 130 percent. Seventeen of the 64 spike compounds had recoveries between the acceptable range of 70 and 130 percent (*table 7B*). Twelve spike compounds had recoveries greater than 130 percent. Of these 12 compounds, only atrazine was detected in ground-water samples. All detections in ground-water samples were at concentrations well below its MCL of 3 µg/L and, therefore, are not of QC concern. Thirty-eight spike compounds had recoveries below 70 percent. Of these 38 spike compounds, 2 were detected in ground-water samples, deethyl atrazine (DEET) and trifluralin, at concentrations below 0.007 µg/L. Hence, if the poor spike recovery, even as low as 1 percent, reflects ground-water sample constituent recovery, reported values would still be below MCLs and this would not affect water-quality reporting. A single sample also was spiked with 63 compounds. Acceptable spike recovery values range between 70 and 130 percent. Fifty-one of the 63 compounds had recoveries between the acceptable range of 70 and 130 percent (*table 7B*); 2 were above the 130 percent limit, and 10 were below the 70 percent limit. None of these 12 spike compounds with poor recoveries were detected in ground-water samples (*table 11B*). [NOTE —low recoveries may indicate that this compound was not detected in some samples if it was present at very low concentrations].

Four environmental samples were spiked with wastewater indicator compounds to calculate matrix spike recoveries. Acceptable spike recovery values range between 70 and 130 percent (Fishman and Friedman, 1989). Nine of the 63 spike compounds had recoveries between the acceptable range of 70 and 130 percent (*table 7C*). Six spike compounds had at least one matrix spike recovery greater than 130 percent; of these 6, only phenol was detected in ground-water samples. Fifty-two spike compounds had at least one matrix spike recovery below 70 percent. Of the fifty-two compounds, bisphenol-A was detected in 3 ground-water samples, *d*-limonene was detected in 1 ground-water sample, ethoxyoctylphenol (OPEO1) was detected in 1 ground-water sample, indole was detected in 3 ground-water samples, menthol was detected in 1 ground-water sample, naphthalene was detected in 1 ground-water sample, *p*-cresol was detected in 2 ground-water samples, phenol was detected in 47 ground-water samples, tetrachloroethene was detected in 3 ground-water samples, tribromomethane was detected in 2 ground-water samples, and triclosan was detected in 3 ground-water samples (*table 12A-C*). All compounds were detected at concentrations below the LT-MDL. D-limonene does not have an MCL. Hence, if the poor spike recovery, even as low as 1 percent, reflects ground-water sample constituent recovery, reported values would still be below MCLs and this would not affect water-quality reporting. [NOTE—low recoveries may indicate that this compound was not detected in some samples if it was present at very low concentrations].

Surrogate Compound Recoveries

Surrogate compounds were added to environmental samples in the laboratory and analyzed to evaluate the recovery of similar constituents. All 89 ground-water samples, 18 replicate pairs and 13 blanks analyzed for VOCs on analytical schedule 2020 had recoveries of the surrogates 1,2-dichloroethane-d4, 1-bromo-4-fluorobenzene, and toluene-d8 that were between the acceptable limit of 70 and 130 percent (*table 8*). The 89 ground-water samples, 18 replicate pairs and 13 blanks analyzed for VOCs on analytical schedule 4024 had recoveries of the surrogates 1,2-dichloroethane-d4, 1-bromo-4-fluorobenzene, toluene-d8, and isobutyl alcohol-d6 that were between the acceptable limit of 70 and 130 percent (Fishman and Friedman, 1989).

All 87 ground-water samples, 19 replicate pairs and 11 blanks analyzed for pesticide and pesticide degradates on analytical schedule 2003 had recoveries of the surrogate alpha-HCH-d6 that were between the acceptable limit of 70 and 130 percent (*table 8*). However, only 50 of the 87 ground-water samples had recoveries of the surrogate diazinon-d10 that were between the acceptable limit of 70 and 130 percent; 37 of the 87 ground-water samples, 8 of the 19 replicate pairs and 6 of the 11 blanks had recoveries of the surrogate diazinon-d10 that were below the acceptable limit of 70 percent recovery. None of the diazinon-d10 surrogate recoveries were above the acceptable limit of 130 percent in the ground-water samples, replicate pairs, and blanks. Eight of the 16 ground-water samples with detections of pesticides or pesticide degradates had recoveries of the surrogate diazinon-d10 that were below the acceptable limit of 70 percent recovery, however, the concentrations of the pesticide and pesticide degradate compounds measured in these eight ground-water samples were <0.2 µg/L, well below MCLs. Hence, if the poor surrogate recovery, even as low as 1 percent, reflects ground-water sample constituent recovery, reported values would still be below MCLs and this would not affect water-quality reporting.

The 22 ground-water samples, 7 of the 8 replicate pairs, and 4 blanks analyzed for pesticide and pesticide degradates on schedule 2003 had recoveries of the herbicide surrogate 2,4,5-T (2,4,5-trichlorophenoxyacetic acid), that were between the acceptable limit of 70 and 130 percent (*table 8*); one replicate pair had a recovery of the surrogate 2,4,5-T that was 66 percent. However, all ground-water samples with detections of pesticides or pesticide degradates had recoveries of the surrogate 2, 4, 5-T that were between the acceptable limit of 70 and 130 percent.

Twenty-one of the 22 ground-water samples, 8 replicate pairs, and 4 blanks analyzed for pesticide and pesticide degradates on schedule 2003 had recoveries of the surrogate Barban that were between the acceptable limit of 70 and 130 percent (*table 8*); one ground-water sample with a detection of pesticide or pesticide degradates had a recovery of the surrogate Barban that was 59 percent.

Thirteen of the 22 ground-water samples, 3 of the 8 replicate pairs and 1 of the 4 blanks analyzed for pesticide and pesticide degradates on schedule 2003 had recoveries of the surrogate caffeine-13C that were between the acceptable limit of 70 and 130 percent (*table 8*). Nine ground-water samples, 5 replicate pairs, and 3 blanks had recoveries of the surrogate caffeine-13C that were greater than 130 percent. Two ground-water samples with a detection of pesticide or pesticide degradates had recoveries of the surrogate caffeine-13C that were greater than 130 percent, however, no ground-water samples had measured pesticide and (or) pesticide degradates above MCL limits, and hence, amplified surrogate recovery did not affect water-quality reporting.

Two of the 89 ground-water samples, none of the 19 replicate pairs, and none of the 21 blanks analyzed for waste-water indicators on schedule 1433 had recoveries of the surrogate bisphenol A-d3 that were between the acceptable limit of 70 and 130 percent (*table 8*); 87 of the 89 ground-water samples, 19 replicate pairs and 21 blanks analyzed for waste-water indicators on schedule 1433 had recoveries of the surrogate bisphenol A-d3 that were less than the acceptable limit of 70 percent. None of the bisphenol A-d3 surrogate recoveries were above the acceptable limit of 130 percent in the ground-water samples, replicate pairs, and blanks. Fifty of the 52 ground-water samples with detections of waste-water indicators had recoveries of the surrogate bisphenol A-d3 that were below the acceptable limit of 70 percent surrogate recovery, however, the concentrations of the waste-water indicators measured in these 26 ground-water samples were <1.4 µg/L, much below MCLs. Hence, if the poor surrogate recovery, even as low as 1 percent, reflects ground-water sample constituent recovery, reported values would still be below MCLs and this would not affect water-quality reporting.

Seventy-six of the 89 ground-water samples, 15 of the 19 replicate pairs and 17 of the 21 blanks analyzed for waste-water indicators on analytical schedule 1433 had recoveries of the surrogate caffeine-13C that were between the acceptable limit of 70 and 130 percent (*table 8*); 13 of the 89 ground-water samples, 4 of the 19 replicate pairs and 4 of the 21 blanks analyzed for waste-water indicators had recoveries of the surrogate caffeine-13C that were less than the acceptable limit of 70 percent. None of the caffeine-13C surrogate recoveries were above the acceptable limit of 130 percent in the ground-water samples, replicate pairs, and blanks. Three of the 52 ground-water samples with detections of waste-water indicators had recoveries of the surrogate caffeine-13C that were below the acceptable limit of 70 percent recovery, however, concentrations of waste-water indicator constituents measured in ground-water samples were <3.0 µg/L, well below MCLs. Hence, if the poor surrogate recovery, even as low as 1 percent, reflects ground-water sample constituent recovery, reported values would still be below MCLs and this would not affect water-quality reporting.

None of the 89 ground-water samples, 19 replicate pairs and 21 blanks analyzed for waste-water indicators on analytical schedule 1433 had recoveries of the surrogate decafluorobiphenyl that were between the acceptable limit of 70 and 130 percent (*table 8*); 89 ground-water samples, 19 replicate pairs and 21 blanks analyzed for waste-water indicators had recoveries of the surrogate decafluorobiphenyl that were less than the acceptable limit of 70 percent. None of the decafluorobiphenyl surrogate recoveries were above the acceptable limit of 130 percent in the ground-water samples, replicate pairs, and blanks. Twenty-four ground-water samples with detections of waste-water indicators had recoveries of the surrogate decafluorobiphenyl that were below the acceptable limit of 70 percent recovery, however concentrations of waste-water indicators measured in ground-water samples were <3.0 µg/L, well below MCLs. Hence, if the poor surrogate recovery, even as low as 1 percent, reflects ground-water sample constituent recovery, reported values would still be below MCLs and this would not affect water-quality reporting.

Eighty-five of the 89 ground-water samples, 17 of the 19 replicate pairs and 21 blanks analyzed for waste-water indicators on analytical schedule 1433 had recoveries of the surrogate fluoranthene-d10 that were within the acceptable range of 70 and 130 percent (*table 8*); 4 of the 89 ground-water samples, 2 of the 19 replicate pairs and none of the 21 blanks analyzed for waste-water indicators had recoveries of the surrogate fluoranthene-d10 that were less than the acceptable limit of 70 percent (*table 8*). None of the fluoranthene-d10 surrogate recoveries were above the acceptable limit of 130 percent in the ground-water samples, replicate pairs, and blanks. Two of the 52 ground-water samples with detections of waste-water indicators had recoveries of the surrogate fluoranthene-d10 that were below the acceptable limit of 70 percent recovery; however, concentrations of waste-water indicators measured in ground-water samples were <3.0 µg/L, well below MCLs. Hence, if the poor surrogate recovery, even as low as 1 percent, reflects ground-water sample constituent recovery, reported values would still be below MCLs and this would not affect water-quality reporting.

All 87 ground-water samples, 12 replicate pairs and 4 blanks analyzed for constituents of special interest had recoveries of the surrogate toluene-d8 that were between the acceptable limit of 70 and 130 percent (*table 8*). Fifty-two of the 87 ground-water samples, 5 of the 12 replicate pairs and 1 of the 4 blanks analyzed for constituents of special interest had recoveries of the surrogate fluoranthene-d10 that were between the acceptable limit of 70 and 130 percent; 52 of the 87 ground-water samples, 7 of the 12 replicate pairs and 3 of the 4 blanks analyzed for constituents of special interest all had recoveries of the surrogate NDMA-d6 that were less than the acceptable limit of 70 percent. One of the 87 ground-water samples, 2 of the 12 replicate pairs and 1 of the 4 blanks analyzed for constituents of special interest had recoveries of the surrogate NDMA-d6 that were greater than the acceptable limit of 130 percent. No constituents of special interest (*table 2F*) were detected in NSF study unit ground-water samples.

Ground-Water Quality

Results from raw (untreated) ground-water analyses for the NSF GAMA study are presented in tables 9 to 22, at the end of this report. *Table 9* includes water-quality indicators measured in the field, while *tables 10–22* present the results of ground-water analyses organized by the compound types and classes: VOCs and gasoline additives and (or) oxygenates, pesticides and pesticide degradates, waste-water indicators, constituents of special interest, nutrients, major and minor ions, trace elements, arsenic and iron, chromium, isotopes and radioactivity, and microbial constituents. The summary tables present only the constituents that were detected, and only wells that had at least one compound detected. The tables are organized by study area, in which, rows list the GAMA identification number for each well. The columns list the constituents detected, the associated USGS parameter code used to identify the compound and store the information in a computerized database (NWIS), and method of measurement and the laboratory reporting level (LRL) for which the compound may be detected.

The tables include the measured concentration of each constituent, the number of wells at which it was detected, the frequency at which it was detected (in relation to the total number of randomized wells sampled in the study area), the total number of constituents detected at each well, the total number of detections in each study area, and the detection frequency by compound class. Results from the flow-path wells and hydrothermal wells are listed in the tables, but these results are not included in statistical compilations because these wells were not part of the randomized well selection.

Detections that have concentrations or activities above the maximum contaminant level (MCL) are indicated in the tables by bold font; detections that have concentrations or activities above the secondary maximum contaminant level (SMCL) are indicated in the tables by italicized and bold font; detections that have concentrations or activities above the notification level or the detection level for the purpose of reporting (DLR) are indicated in the tables by italicized font.

VOCs and Gasoline Additives and (or) Oxygenates

Analytical results of VOCs and gasoline additives and (or) oxygenates from schedules 2020 and 4024 were combined in *tables 10A-C*, which report results from the preferred analytical method. Ground-water samples for VOCs and gasoline additives and (or) oxygenates were collected at 89 public-supply wells sampled in the NSF GAMA study unit. Twenty-one VOCs and gasoline additives and (or) oxygenates were detected in 29 wells in the NSF study unit. Thirty-three percent of the 89 wells sampled had at least one detection of a VOC and gasoline additive and (or) oxygenate. Five of the 89 wells were flowpath wells and are not included in the following statistical calculations.

Seventeen of the 88 VOCs analyzed were detected in ground-water samples from randomized wells in the NSF study unit. Trichloromethane (chloroform), a disinfectant by product, was the most frequently detected VOC; it was detected in 12 of the 84 randomized wells sampled. The next most frequently detected VOC was carbon disulfide, a compound used in organic synthesis which also occurs naturally. It was detected in 8 of the 84 randomized wells. The third most frequently detected VOC, toluene, a gasoline additive, was detected in 4 of the 84 randomized wells sampled. In total, 27 wells (of the 84 total randomized wells) had 44 detections for a VOC detection frequency of 32 percent in the NSF study unit. None of the VOCs and gasoline additive and (or) oxygenate concentrations measured were greater than the concentrations established for regulatory purposes.

In the VP study area, eleven of the 88 VOCs and gasoline additives and (or) oxygenates investigated were detected in 17 ground-water samples from 50 randomized wells (*table 10A*). Trihalomethanes were the most frequently detected class of constituents in the VP study area; found in 9 of the 50 ground-water samples. Chloroform was the most frequently detected VOC; it was detected in 8 of the 50 randomized VP wells sampled. The next most frequently detected class of constituents was organic synthesis constituents, found in 8 of the wells. Carbon disulfide, a compound used in organic synthesis which also occurs naturally, was detected in 6 of the 50 randomized VP wells. The third most frequently detected class of constituents, gasoline additives and (or) oxygenates, were found in 4 of the 50 wells sampled.

In the VOL study area, eight of the 88 VOCs and gasoline additives and (or) oxygenates investigated were detected in 6 of the 20 ground-water samples from randomized wells (*table 10B*). Organic synthesis constituents were the most frequently detected class of constituents in the VOL study area; found in 3 of the 20 wells. Carbon disulfide was detected in 2 of the 20 randomized VOL wells sampled. The next most frequently detected class of constituents, gasoline additives and (or) oxygenates, were found in 2 of the 20 VOL wells; toluene and *m*-xylene plus *p*-xylene were each detected in 2 of the 20 randomized VOL wells sampled. The third most frequently detected class of constituents, trihalomethanes, were also found in 2 of the 20 VOL randomized wells sampled; chloroform was found in 2 of the 20 VOL samples.

In the WG study area, seven of the 88 VOCs or gasoline additives and (or) oxygenates investigated were detected in 4 of the 14 ground-water samples from randomized wells (*table 10C*). Trihalomethanes and solvents were the most frequently detected classes of constituents in the WG study area, each found in 2 of the 14 ground-water samples; chloroform was detected in 2 of the 14 randomized WG wells sampled. The next most frequently detected class of constituents, gasoline additives and (or) oxygenates, were found in 1 of the 14 WG wells. Ground-water samples for VOCs and gasoline additives and (or) oxygenates were not collected for the hydrothermal study.

Pesticides and Pesticide Degradates

Ground-water samples for pesticides and pesticide degradates, using analytical schedules 2003 and 2060, were collected at 89 wells in the NSF GAMA study unit. Nine pesticides and pesticide degradates were detected in 16 wells in the total NSF study unit. Sixteen of the 89 wells sampled had at least a single detection of a pesticide or pesticide degradate. Five of these 89 wells were flowpath wells and are not included in the following statistical calculations.

Nine of the 122 pesticides and pesticide degradates investigated were detected in ground-water samples from randomized wells in the NSF study unit. Simazine, an herbicide, was the most frequently detected. It was detected in 8 of the 84 ground-water samples from randomized wells. The pesticide degradates deethylatrazine and deisopropyl atrazine both were detected in 2 of the 84 randomized wells sampled. In total, 18 detections in 14 randomized wells, of the 84 were observed in the NSF study unit. None of the pesticide concentrations measured were greater than concentrations established for regulatory purposes.

In the VP study area, 4 herbicides and 3 pesticide degradates were detected in 12 of the 50 ground-water samples from randomized wells (*table 11A*). Herbicides were the most frequently detected among the pesticides and (or) pesticide degradates in the VP study area, found in 11 of the 50 ground-water samples. Simazine was the most frequently detected herbicide; it was detected in 8 of the 50 randomized VP wells sampled. The next most frequently detected class of constituents was pesticides and (or) pesticide degradates, found in 4 of the 50 wells; deethylatrazine and deisopropyl atrazine were each detected in 2 of the 50 randomized VP wells sampled.

In the VOL study area, one herbicide was detected in one of the 20 ground-water samples from randomized wells (*table 11B*). Diphenamid, an herbicide, was found in one of the ground-water samples. In the WG study area, one herbicide, diazinon, was detected in one of the 14 ground-water samples from randomized wells (*table 11C*). Ground-water samples for pesticides and pesticide degradates were not collected for the hydrothermal study.

Waste-Water Indicators

Ground-water samples for waste-water indicators, determined by analytical schedule 1433, were collected at 89 wells in the NSF GAMA study unit. Although compounds analyzed by schedule 1433 are referred to as waste-water indicators, these compounds may originate from sources other than waste water. Thirteen waste-water indicators were detected in 24 of the wells in the NSF study unit. Twenty-four of the 89 wells sampled had at least a single detection of a waste-water indicator. Forty-seven phenol detections were censored (concentration preceded by a V in *tables 12A-C)* as a result of contamination of the equipment and field blanks, reflecting problems with the analytical procedures, see Quality-control section. These results were censored from summary statistical calculations. Five of the 89 wells were flowpath wells, and also were not included in the following statistical calculations.

Thirteen of the 63 waste-water indicators analyzed were detected in at least one ground-water sample from the randomized wells. Isophorone, a solvent, was the most frequently detected constituent; it was detected in 6 of the 84 randomized wells sampled. Caffeine and bisphenol-A were both detected in 3 of the 84 randomized wells sampled. In total, 30 detections in 22 randomized wells of the 84 were observed in the NSF study unit. None of the waste-water indicators detected in this study have regulatory standards.

In the VP study area, 5 of the 63 waste-water indicators investigated were detected in 12 of the 50 ground-water samples from randomized wells (*table 12A*). Caffeine was the most frequently detected compound in the VP study area; it was detected in 4 of the 50 randomized VP wells sampled. Isophorone, a solvent, was detected in 3 of the 50 randomized wells. Triclosan, tetrachlorethene, and bromoform (tribromoethane) were all detected in 2 of the 50 randomized VP wells sampled.

In the VOL study area, eight waste-water indicators were detected in 6 of the 20 ground-water samples from the randomized wells (*table 12B*). Bisphenol-A, a flame retardant, and isophorone both were found in 2 of the 20 randomized VOL wells.

In the WG study area, five waste-water indicators were detected in 4 of the 14 ground-water samples from randomized wells (*table 12C*). Indole, a pesticide ingredient, and p-cresol, a wood preservative, were found in 2 of the 14 WG ground-water samples. Ground-water samples for waste-water indicators were not collected for the hydrothermal study.

Constituents of Special Interest

Ground-water samples for the constituents of special interest: perchlorate, 1,2,3-trichloropropane (TCP) and N-nitrosodimethylamine (NDMA), were collected at 89 wells (*table 13*), however, these constituents were not detected in any of the wells sampled.

Nutrients and Dissolved Organic Carbon

Nutrients and dissolved organic carbon (DOC) samples were collected at 22 wells (*table 14*) sampled under the expanded schedule in the NSF study unit. Ammonia was detected in 9 of the 22 wells, at concentrations ranging from an estimated value (E) of 0.03 to 3.11 mg/L. Nitrate plus nitrite was detected in 16 of the 22 ground-water samples, whereas nitrite was detected in only 6 of the 22 samples. Concentrations of nitrate plus nitrite were less than the MCL of 10 mg/L for nitrate alone; values ranged from an estimated value of 0.03 mg/L to a concentration of 3.22 mg/L. Nitrite was detected in 6 wells at concentrations that ranged from an estimated value of 0.004 mg/L to a concentration of 0.03 mg/L; much below the nitrite MCL of 1 mg/L. Dissolved phosphorus was measured in all 22 wells at concentrations that ranged from 0.008 to 0.559 mg/L. Total nitrogen, dissolved (nitrate plus nitrite plus ammonia plus organic-N) was measured in all 22 wells at concentrations that ranged from 0.04 to 3.42 mg/L. DOC was measured in all 22 wells at concentrations that ranged from E 0.2 mg/L to 1.2 mg/L. Four samples had DOC detections in the preceding blanks greater than the sample values, and hence were censored and these data were not used for summary statistical calculations. Censored values are preceded by a V in *table 14*.

Major and Minor Ions and Dissolved Solids

Major and minor ions and dissolved solids (DS) samples were collected at 33 public-supply wells, 7 hydrothermal wells, and 1 hydrothermal spring (*table 15*). Three of the public-supply wells sampled in NSF study unit had DS concentrations above the recommended SMCL of 500 mg/L, with values of 503, 685, and 1,000 mg/L respectively, and a mean value of 320 mg/L. Calcium concentrations in public-supply wells ranged from 0.9 to 53.6 mg/L, with a mean value of 25.6 mg/L. Magnesium concentrations in public-supply wells ranged from 0.1 to 50.8 mg/L, with a mean value of 15.4 mg/L. Potassium concentrations in public-supply wells ranged from 0.5 to 19.7 mg/L, with a mean value of 4.0 mg/L. Sodium concentrations in public-supply wells ranged from 8.4 to 270 mg/L, with a mean value of 53.5 mg/L. Bromide concentrations in public-supply wells ranged from 0.03 mg/L to 1.4 mg/L, with a mean value of 0.2 mg/L. Chloride concentrations in public-supply wells ranged from 4.6 to 249 mg/L; just below the SMCL of 250 mg/L, with a mean value of 32.8 mg/L. Fluoride concentrations in public-supply wells ranged from 0.1 to 0.7 mg/L, with a mean value of 0.3 mg/L; well below the MCL of 2 mg/L. Iodide concentrations in public-supply wells ranged from an estimated value of (E) 0.001 mg/L to 1.1 mg/L, with a mean value of 0.07 mg/L. Silica concentrations in public-supply wells ranged from 15.9 to 134 mg/L, with a mean value of 61.4 mg/L. Sulfate concentrations in public-supply wells ranged from 1.4 to 239 mg/L; below the SMCL of 250 mg/L.

Trace Elements

Ground-water samples for trace elements were collected at 32 public-supply wells, 7 hydrothermal wells, and 1 hydrothermal spring (*table 16*) in the NSF study unit. Aluminum was detected in 18 ground-water samples with concentrations ranging from an estimated value of 1 to a value of 7 µg/L. Antimony was detected in 4 ground-water samples with concentrations ranging from an estimated value of (E) 0.11 to a value of 0.28 µg/L. Arsenic was detected in 29 ground-water samples with concentrations ranging from an estimated value of (E) 0.1 to a concentration of 32.8 µg/L. The MCL for As will be 10 µg/L in 2006. In four public-supply wells, As concentrations were measured above 10 µg/L, with concentrations of 13.0, 17.2, 24.6 and 32.8 µg/L respectively. Barium was detected in 32 ground-water samples with concentrations ranging from 1 to 492 µg/L. Beryllium was not detected in ground-water samples from public-supply wells. Boron was detected in 32 ground-water samples with concentrations ranging from 16 to 3,830 µg/L; with 19 wells having concentrations of boron above the DLR of 100 µg/L with concentrations of between 120 and 3,830 µg/L. Cadmium was detected in 5 ground-water samples with concentrations ranging from an estimated concentration of E 0.03 to a concentration of 0.05 µg/L, all below the MCL of 5 µg/L. Chromium was detected in 6 ground-water samples with concentrations ranging from an estimated value of (E) 0.4 to a concentration of 4.4 µg/L; all below the MCL of 50 µg/L. Cobalt was detected in 31 ground-water samples with concentrations ranging from 0.019 to 0.509 µg/L. Copper was detected in 29 ground-water samples with concentrations ranging from an estimated value of (E) 0.2 to a concentration of 14.8 µg/L; below the MCL of 1,000 µg/L.

Iron was detected in 32 ground-water samples with concentrations ranging from an estimated value of (E) 4 to a value of 1,090 µg/L. Seven public-supply wells had Fe concentrations above the SMCL of 300 µg/L with concentrations between 308 to 1,090 µg/L. Lead was detected in 28 ground-water samples with concentrations ranging from an estimated value of (E) 0.05 to a concentration of 15.3 µg/L. One public-supply well had a lead concentration of 15.3, above the California notification level (NL) of 15 µg/L. Lithium was detected in 28 ground-water samples with concentrations ranging from 3 to 81 µg/L. Manganese was detected in 28 ground-water samples with concentrations ranging from an estimated value of (E) 0.1 to a concentration of 1,220 µg/L. Seventeen of the public-supply wells had concentrations above the Mn SMCL of 50 µg/L. Mercury was not detected (<0.001) in any of the public-supply wells.

Molybdenum was detected in 32 ground-water samples with concentrations ranging from an estimated value of (E) 0.2 to a concentration of 20.3 µg/L. Nickel was detected in 31 ground-water samples with concentrations ranging from an estimated value of (E) 0.05 to a concentration of 5.58 µg/L. Selenium was detected in 12 ground-water samples with concentrations ranging from an estimated value of (E) 0.2 to a concentration of 2 µg/L. Silver was detected in 2 ground-water samples with concentrations ranging from 0.26 to 0.52 µg/L. Strontium was detected in 32 ground-water samples with concentrations ranging from 29.8 to 440 µg/L. Thallium was detected in 4 ground-water samples with concentrations ranging from an estimated value of (E) 0.03 µg/L to a concentration of 0.22 µg/L; below the MCL of 2 µg/L. Tungsten was detected in 6 ground-water samples with concentrations ranging from 0.6 to 2.3 µg/L. Vanadium was detected in 30 ground-water samples with concentrations ranging from 0.2 to 19.6 µg/L. Nine wells had Vanadium concentrations above 3 µg/L, the detection level for the purposes of reporting (DLR). Zinc was detected in 31 ground-water samples with concentrations ranging from an estimated value of (E) 0.6 to a concentration of 63.8 µg/L. Uranium was detected in 26 ground-water samples with concentrations ranging from 0.04 to 3.53 µg/L. When converted from mass units to activities using the standard conversion factor of 0.67 pCi/ µg, all uranium activities were below the DHS MCL of 20 pCi/L.

Table 17 presents the results from the USGS NRP Boulder lab for total dissolved inorganic As and Fe, as well as the individual species As (III) and Fe (II) for samples collected in the NSF study unit; 4 samples from public supply wells had total As concentrations above the MCL of 10 µg/L, with concentrations of 12.0, 16.2, 22.0 and 29.8, respectively. Three samples from public supply wells had concentrations of total iron above the SMCL of 300 µg/L, with values of 301, 313 and 900 µg/L, respectively. These results agree well with samples from the same wells identified in *table 16*, which were analyzed at the USGS NWQL in Denver.

Table 18 presents Cr speciation analyses from the USGS NRP Boulder lab; total dissolved Cr and hexavalent Cr (VI). Values ranged from 0.1 to 15.6 µg/L. None of the total Cr concentrations were above regulatory levels, however, 47 wells had Cr (VI) values above 1 µg/L, the detection level for the purposes of reporting (DLR).

Isotopes, Radioactivity, and Dissolved Gases

Isotope activities, stable isotopes, and gross alpha/beta radioactivity were determined in ground-water samples collected for the NSF GAMA study unit (*table 19*). Stable isotopes of water were collected at all 93 wells. 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 21 wells. Ground-water samples for tritium, analyzed at the USGS laboratory, were collected at 89 public-supply wells.

Alpha radioactivity in 21 samples (*table 19*) ranged from below quantification limits (<0.001 pCi/L) to 2.2 pCi/L for 72-hour counts, and from below quantification limits (<0.001 pCi/L) to 3.9 pCi/L for 30 day counts; neither are above the alpha radioactivity MCL of 15 pCi/L. Beta radioactivity in 21 samples ranged from below quantification limits (<0.001 pCi/L) to 20.2 pCi/L for 72-hour counts, and from below quantification limits (<0.001 pCi/L) to 21.6 pCi/L in 30-day counts. The MCL for beta radioactivity is 50 pCi/L. Tritium was detected in 76 out of 89 samples with activities that ranged from below 1 to 9.9 pCi/L; the MCL for tritium is 20,000 pCi/L. Carbon-14, as percent modern carbon (pmc), was measured at 22 wells, and had values that ranged from 0.01 to 1.05 pmc. Radon-222 was detected in all 21 samples collected, and had activities ranging from 210 to 1,500 pCi/L. Seventy-one percent (15 samples) of the radon-222 activities were above the proposed MCL of 300 pCi/L. Radium-226 was detected in all 21 samples collected, however concentrations did not exceed 0.17 pCi/L. Radium-228 was detected in 13 out of 21 samples, with a maximum concentration of 0.63 pCi/L. No wells had activities above the combined radium-226 and radium-228 MCL of 5 pCi/L.

Tritium and noble gas samples (analyzed at LLNL) were collected at 95 wells (*table 20*). Tritium, measured by the helium ingrowth method, was detected in 93 samples. Activities ranged from below 1 to 11.0 pCi/L; the MCL for tritium is 20,000 pCi/L. Noble gas concentrations and the helium isotope ratios (helium-3/helium-4) measured in each sample are presented in *table 20*.

The dissolved gases carbon dioxide, nitrogen, argon, oxygen, and methane were measured in ground-water samples from 4 production wells in the Valley and Plains study area, and 7 hydrothermal wells as part of the hydrothermal study (*table 21*). Dissolved gas concentrations in production-well ground water are low, do not adversely affect ground-water quality, and are not regulated for water-quality purposes.

Microbial Constituents

Microbial constituents were analyzed in 22 ground-water samples collected for the North San Francisco Bay GAMA study (*table 22*). The following microbial constituents were determined: total coliform and Escherichia coliform, and the viruses F-specific coliphage and somatic coliphage. Total coliform was detected in three wells, two in the Valley and Plains study area, and one in the Wilson Grove Formation Highlands study area. Counts ranged from an estimated 2 colonies/100 mL to 20 colonies/100 mL. MCLs for microbial constituents are based on reoccurring detection, and will be monitored during future sampling.

Summary

The NSF GAMA study assessed the ground-water quality of 89 public-supply wells across the ~1,000 mi^2 study unit. Results from 84 randomized wells, statistically representative of the study unit, show that no anthropogenic constituents were detected at concentrations higher than those levels set for regulatory purposes. Naturally occurring constituents represent the only concentrations above regulatory thresholds for drinking-water supply, with concentrations of arsenic, manganese, radon-222, and microbiological contaminants in a small percentage of public-supply wells greater than recommended MCLs, and dissolved solids, iron and manganese above recommended SMCLs, boron and vanadium above the DLR, and lead above the NL.

Ground-water samples were analyzed for major and minor ions, trace elements, nutrients, volatile organic compounds (VOCs), pesticides, waste-water indicators, dissolved methane, nitrogen, carbon dioxide, and noble gases (in collaboration with Lawrence Livermore National Laboratory). Naturally occurring isotopes (tritium, carbon-14, and helium-4) also were measured in these samples to help interpret the source and age of the sampled ground water.

In this study, twenty-one of the 88 VOCs and gasoline additives and (or) oxygenates investigated were detected in ground-water samples, however, no concentrations observed were above established maximum contaminant levels (MCLs). Thirty-two percent of the randomized wells sampled during the North San Francisco Bay GAMA study had at least a single detection of VOCs or gasoline additives and (or) oxygenates. The most frequently detected compounds were chloroform found in 12 of 84 randomized wells sampled (14 percent), carbon disulfide in 8 of 84 randomized wells sampled (10 percent), and toluene in 4 of 84 randomized wells sampled (5 percent). Trihalomethanes were the most frequently detected class of VOCs.

Nine of the 122 pesticides and pesticide degradates investigated were detected in ground-water samples, however, none were above MCLs. Seventeen percent of the 84 randomized wells sampled during the NSF GAMA study had at least a single detection of pesticides and pesticide degradates. Herbicides were the most frequently detected class of pesticides. The most frequently detected compound was simazine, detected in water from 8 of the 84 (10 percent) of the randomized wells. Chlordiamino-s-triazine and deisopropyl atrazine were both found in 2 of the 84 (2 percent) randomized wells sampled.

Thirteen waste-water indicators were detected in ground-water samples in the NSF study unit. Twenty-six percent of the wells sampled for waste-water indicators had at least a single detection. Isophorone, a solvent and the most frequently detected waste-water indicator compound, was detected in 6 out of 84 randomized wells (7 percent of the wells). Bisphenol-A (plastic resins; flame retardant), caffeine (beverages), and indole (pesticide, fragrance in coffee) were each detected in 3 out of 84 randomized wells (4 percent of the wells).

Major and minor ion and dissolved solids (DS) samples were collected at 33 public-supply wells, concentrations of DS were above the secondary maximum contaminant level (SMCL) in three samples. Ground-water samples from 32 public-supply wells were analyzed for trace elements. Arsenic concentrations in 4 public-supply wells were above the MCL of 10 µg/L, boron concentrations were above the DLR of 100 µg/L in 19 samples, iron concentrations were above the SMCL of 300 µg/L in seven samples, lead concentration was above the California notification level (NL) of 15 µg/L in one pubic-supply well sample, manganese concentrations were above the SMCL of 50 µg/L in 17 wells, vanadium concentrations were above the DLR of 3 µg/L in 9 wells, and chromium (VI) concentrations were above the DLR of 1 µg/L in 47 wells.

Radon-222 was detected in all 21 ground-water samples collected, with activities ranging from 210 to 1,500 pico Curies per liter (pCi/L). Fifteen samples were above the proposed MCL of 300 pCi/L.

Microbial constituents were analyzed in 22 ground-water samples. Total coliform was detected in three wells, two in the Valley and Plains study area, and one in the Wilson Grove Formation Highlands study area. Counts ranged from 2 colonies per 100 mL to 20 colonies per 100 mL. MCLs for microbial constituents are based on reoccurring detection, and will be monitored during future sampling.

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Tables

Table 1. Identification, sampling and construction information for wells sampled for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[ft, foot; LSD, land surface datum; NA, not available; ND, no data; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study]

Sampling information						
GAMA identification No.	Date	Time	Sampling schedule	Well depth (ft below LSD)	Top of highest perforation (ft below LSD)	Bottom lowest perforation (ft below LSD)
Valley and Plains wells						
NSFVP-01	08/31/2004	0910	Basic	864	441	862
NSFVP-02	08/31/2004	1300	Basic	350	65	341
NSFVP-03	08/31/2004	1620	Basic	120	ND	ND
NSFVP-04	09/01/2004	0900	Basic	397	ND	ND
NSFVP-05	09/01/2004	1150	Basic	502	130	450
NSFVP-06	09/01/2004	1400	Basic	700	170	680
NSFVP-07	09/02/2004	0830	Basic	685	295	670
NSFVP-08	09/02/2004	1200	Basic	102	70	88
NSFVP-09	09/02/2004	1350	Basic	400	260	400
NSFVP-10	09/13/2004	1210	Expanded	99	75	95
NSFVP-11	09/13/2004	1330	Basic	80	60	70
NSFVP-12	09/13/2004	1630	Basic	808	650	800
NSFVP-13	09/14/2004	0840	Basic	ND	ND	ND
NSFVP-14	09/14/2004	1240	Basic	550	507	547
NSFVP-15	09/14/2004	1450	Basic	60	40	60
NSFVP-16	09/15/2004	0930	Basic	206	50	190
NSFVP-17	09/15/2004	1430	Basic	ND	ND	ND
NSFVP-18	09/16/2004	0940	Basic	63	48	58
NSFVP-19	09/16/2004	1040	Expanded	100	20	60
NSFVP-20	09/16/2004	1600	Basic	110	70	110
NSFVP-21	09/20/2004	1000	Basic	314	80	310
NSFVP-22	09/20/2004	1320	Basic	502	60	502
NSFVP-23	09/20/2004	1600	Basic	530	369	530
NSFVP-24	09/22/2004	1300	Basic	85	65	85
NSFVP-25	09/23/2004	1240	Basic	265	160	265
NSFVP-26	09/27/2004	1030	Expanded	600	125	600
NSFVP-27	09/28/2004	0830	Basic	372	50	372
NSFVP-28	09/28/2004	1110	Basic	216	116	216
NSFVP-29	09/28/2004	1200	Expanded	120	62	120
NSFVP-30	09/29/2004	1210	Expanded	ND	ND	ND
NSFVP-31	09/30/2004	0840	Basic	315	20	315
NSFVP-32	10/07/2004	0940	Basic-plus	400	ND	ND
NSFVP-33	10/07/2004	1320	Basic-plus	ND	ND	ND
NSFVP-34	10/18/2004	1120	Expanded	258	41	258
NSFVP-35	10/18/2004	1300	Basic-plus	300	85	300
NSFVP-36	10/19/2004	0900	Basic-plus	306	145	300
NSFVP-37	10/19/2004	1000	Expanded	360	60	350

Table 1. Identification, sampling and construction information for wells sampled for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[ft, foot; LSD, land surface datum; NA, not available; ND, no data; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study]

Sampling information						
GAMA identification No.	Date	Time	Sampling schedule	Well depth (ft below LSD)	Top of highest perforation (ft below LSD)	Bottom lowest perforation (ft below LSD)
NSFVP-38	10/20/2004	1040	Expanded	770	210	770
NSFVP-39	10/21/2004	0940	Basic-plus	460	56	460
NSFVP-40	10/21/2004	1130	Expanded	ND	ND	ND
NSFVP-41	10/21/2004	1250	Basic-plus	235	60	235
NSFVP-42	10/25/2004	1410	Basic	209	52	209
NSFVP-43	10/26/2004	1110	Basic-plus	790	690	790
NSFVP-44	10/26/2004	1520	Basic-plus	318	140	302
NSFVP-45	11/02/2004	1230	Expanded	ND	ND	ND
NSFVP-46	11/03/2004	1040	Expanded	180	40	180
NSFVP-47	11/03/2004	1230	Basic-plus	79	ND	ND
NSFVP-48	11/04/2004	1420	Basic-plus	200	60	200
NSFVP-49	11/17/2004	1400	Expanded	460	140	220
NSFVP-50	11/18/2004	1120	Expanded	199	ND	ND
NSFVPFP-01	09/14/2004	1020	Expanded	1,040	410	1,020
NSFVPFP-02	09/30/2004	1100	Expanded	231	61	231
NSFVPFP-03	10/20/2004	0920	Basic-plus	25	13	25
NSFVPFP-04	09/13/2004	0940	Basic	99	75	95
Volcanic Highlands wells						
NSFVOL-01	09/15/2004	1020	Expanded	323	ND	ND
NSFVOL-02	09/15/2004	1710	Basic	380	ND	ND
NSFVOL-03	09/27/2004	0840	Basic	ND	ND	ND
NSFVOL-04	09/27/2004	1120	Basic	542	ND	ND
NSFVOL-05	09/27/2004	1450	Basic	510	330	510
NSFVOL-06	09/28/2004	1440	Basic	280	200	280
NSFVOL-07	09/29/2004	0830	Basic	395	215	395
NSFVOL-08	09/29/2004	1130	Basic	ND	ND	ND
NSFVOL-09	09/29/2004	1440	Basic	ND	ND	ND
NSFVOL-10	10/05/2004	0940	Basic	136	76	136
NSFVOL-11	10/06/2004	0830	Basic	555	398	555
NSFVOL-12	10/06/2004	1140	Basic	368	148	368
NSFVOL-13	10/06/2004	1440	Basic	510	30	510
NSFVOL-14	10/07/2004	1140	Expanded	417	57	417
NSFVOL-15	10/07/2004	1620	Basic	115	65	113
NSFVOL-16	10/19/2004	1400	Basic	420	75	419
NSFVOL-17	10/20/2004	1230	Basic	265	ND	ND
NSFVOL-18	10/20/2004	1420	Basic	670	135	660
NSFVOL-19	11/02/2004	1100	Expanded	705	285	705
NSFVOL-20	11/04/2004	1130	Expanded	250	170	250

Table 1. Identification, sampling and construction information for wells sampled for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[ft, foot; LSD, land surface datum; NA, not available; ND, no data; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study]

Sampling information						
GAMA identification No.	Date	Time	Sampling schedule	Well depth (ft below LSD)	Top of highest perforation (ft below LSD)	Bottom lowest perforation (ft below LSD)
Wilson Grove Formation Highlands wells						
NSFWG-01	09/16/2004	1240	Basic	350	90	350
NSFWG-02	09/21/2004	1030	Basic	240	ND	ND
NSFWG-03	09/21/2004	1520	Basic	552	270	552
NSFWG-04	09/22/2004	0840	Basic	452	432	452
NSFWG-05	09/22/2004	1110	Basic	215	135	215
NSFWG-06	09/23/2004	0830	Basic	161	ND	ND
NSFWG-07	09/30/2004	1520	Basic	550	140	540
NSFWG-08	10/04/2004	1400	Expanded	600	332	600
NSFWG-09	10/04/2004	1600	Basic	ND	ND	ND
NSFWG-10	10/06/2004	1100	Expanded	ND	ND	ND
NSFWG-11	10/27/2004	1030	Basic	ND	ND	ND
NSFWG-12	10/27/2004	1250	Basic	ND	ND	ND
NSFWG-13	10/28/2004	1300	Basic	ND	ND	ND
NSFWG-14	11/04/2004	1130	Basic	295	155	295
NSFWGFP-01	10/05/2004	1120	Expanded	528	138	528
Hydrothermal study						
NSFHOT-01	10/19/2004	1410	Hydrothermal	200	ND	ND
NSFHOT-02	10/21/2004	1030	Hydrothermal	200	ND	ND
NSFHOT-03	10/21/2004	1100	Hydrothermal	45	ND	ND
NSFHOT-04	10/19/2004	1210	Hydrothermal	ND	ND	ND
NSFHOT-05	10/19/2004	1010	Hydrothermal	ND	ND	ND
NSFHOT-06	10/20/2004	1530	Hydrothermal	ND	ND	ND
NSFHOT-07	10/20/2004	1730	Hydrothermal	1,000	ND	ND
NSFHOT-08[1]	10/20/2004	1020	Hydrothermal	NA	NA	NA

[1]Hydrothermal spring.

Table 2A. Volatile organic compounds and gasoline additives and (or) oxygenates, 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]

Constituent	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	0.08
1,1,2-Trichloroethane	Solvent	79-00-5	0.04
1,1,2-Trichlorotrifluoroethane (CFC-113)	Refrigerant	76-13-1	0.038
1,1-Dichloroethane	Solvent	75-34-3	0.035
1,1-Dichloroethylene (DCE)	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	0.18
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 (DBCP)	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 (ethyl methyl ketone)	Solvent	78-93-3	2
2-Chlorotoluene	Solvent	95-49-8	0.04
2-Hexanone	Solvent	591-78-6	0.4
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
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

Table 2A. Volatile organic compounds and gasoline additives and (or) oxygenates, 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]

Constituent	Primary use/source	CAS number	LRL (µg/L)
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
cis-1,2-Dichloroethylene	Solvent	156-59-2	0.024
cis-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 *tert*-butyl ether (ETBE)	Gasoline	637-92-3	0.03
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
m- plus *p*-Xylene	Gasoline	108-38-3/106-42-3	0.06
Methyl acrylate	Organic synthesis	96-33-3	1
Methyl acrylonitrile	Organic synthesis	126-98-7	0.4
Methyl iodide	Organic synthesis	74-88-4	0.5
Methyl methacrylate	Organic synthesis	80-62-6	0.2
Methyl *tert*-Butyl ether (MTBE)	Gasoline	1634-04-4	0.1
Naphthalene	Organic synthesis	91-20-3	0.52
n-Propylbenzene	Solvent	103-65-1	0.042
o-Ethyl toluene	Hydrocarbon	611-14-3	0.06
o-Xylene	Gasoline	95-47-6	0.038
sec-Butylbenzene	Organic synthesis	135-98-8	0.06
Styrene	Organic synthesis	100-42-5	0.042
tert-Amyl methyl ether	Gasoline	994-05-8	0.04
tert-Butylbenzene	Organic synthesis	98-06-6	0.06
Tetrachloroethylene (PCE)	Solvent	127-18-4	0.03
Tetrachloromethane (carbon tetrachloride)	Solvent	56-23-5	0.06
Tetrahydrofuran	Solvent	109-99-9	1

Table 2A. Volatile organic compounds and gasoline additives and (or) oxygenates, 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]

Constituent	Primary use/source	CAS number	LRL (µg/L)
Toluene	Gasoline	108-88-3	0.02
trans-1,2-Dichloroethylene	Solvent	156-60-5	0.032
trans-1,3-Dichloropropene	Fumigant	10061-02-6	0.09
trans-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	0.08
Vinyl chloride	Organic synthesis	75-01-4	0.08

Table 2B. Gasoline oxygenates and (or) 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]

Constituent	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 (ETBE)	Gasoline oxygenate	637-92-3	0.1
Methyl acetate	Degradate	79-20-9	0.4
tert-Amyl alcohol	Degradate	75-85-4	0.43
tert-Butyl alcohol	Degradate	75-65-0	1
tert-Butyl methyl ether (MTBE)	Gasoline oxygenate	1634-04-4	0.08
tert-Amyl 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]

Constituent	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
Chlorpyrofos, 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 (DCPA)	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
Iprodione	Fungicide	36734-19-7	1.422
Isofenphos	Insecticide	25311-71-1	0.003

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—Continued.

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

Constituent	Primary use/source	CAS number	LRL (µg/L)
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 caffiene, 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]

Constituent	Primary use/source	CAS number	LRL (µg/L)
2,4-D (2,4-Dichlorophenoxyacetic acid)	Herbicide	94-75-7	0.021
2,4-D methyl ester	Herbicide	1928-38-7	0.008
2,4-DB (4-(2,4-dichlorophenoxy)butanoic acid)	Herbicide	94-82-6	0.016
2,4,5-T (2,4,5-trichlorophenoxyacetic acid)	Negative ion surrogate	93-76-5	0.1
2-Chloro-4-isopropylamino-6-amino-*s*-triazine (deethylatrazine)	Degradate	6190-65-4	0.028
2-Chloro-6-ethylamino-4-amino-*s*-triazine (deisopropylatrazine)	Degradate	1007-28-9	0.01
2-Hydroxy-4-isopropylamino-6-ethylamino-*s*-triazine (hydroxyatrazine)	Degradate	2163-68-0	0.008
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
Chlordiamino-*s*-triazine (Deethyldeisopropyl atrazine)	Degradate	3397-62-4	0.04
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
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
Imazaquin	Herbicide	81335-37-7	0.016

Table 2D. Pesticides, pesticide degradates, and caffiene, 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 2060 —Continued.

[µg/L, micrograms per liter]

Constituent	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 (2-methyl-4-chlorophenoxyacetic acid)	Herbicide	94-74-6	0.016
MCPB (2-methyl-4-chlorophenoxy butyric acid)	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 constituents, 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.

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

Constituent	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-*beta*-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-*tert*-Butyl-4-hydroxy anisole (BHA)	Antioxidant, general preservative	25013-16-5	5
4-Cumylphenol	Nonionic detergent metabolite	599-64-4	1
4-*n*-Octylphenol	Nonionic detergent metabolite	1806-26-4	1
4-*tert*-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	Manufacturing 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
beta-Sitosterol	Plant sterol	83-46-5	2
beta-Stigmastanol	Plant sterol	19466-47-8	2
Bisphenol A	Manufacturing polycarbonate resins, antioxidant, flame retardant	80-05-7	1
Bromacil	Herbicide, >80% noncrop usage on grass/brush	314-40-9	0.5
Bromoform (tribromomethane)	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
d-Limonene	Fungicide, antimicrobial, antiviral, fragrance in aerosols	5989-27-5	0.5
Fluoranthene	Component of coal tar and asphalt	206-44-0	0.5
Hexadydrohexamethylcyclopentabenzopyran (HHCB)	Musk fragrance	1222-05-5	0.5

Table 2E. Waste-water indicator constituents, 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.

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

Constituent	Primary use/source	CAS number	LRL (µg/L)
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	Manufacturing 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
4-Nonylphenol, diethoxylates	Nonionic detergent metabolite	NA	5
4-Octylphenol, diethoxylates	Nonionic detergent metabolite	NA	1
Octylphenol, monoethoxylates	Nonionic detergent metabolite	NA	1
para-Nonylphenol (total)	Nonionic detergent metabolite	84852-15-3	5
p-Cresol	Wood preservative	106-44-5	1
Pentachlorophenol	Herbicide, fumigant, wood preservative, termite control	87-86-5	2
Phenanthrene	Manufacturing 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 blacktop	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. Constituents of special interest: perchlorate, 1,2,3-tricholoropropane, and N-nitrosodimethylamine (NDMA), Chemical Abstract Service (CAS) number, and minimum reporting level (MRL) for Montgomery Watson Harza Laboratory.

[µg/L, micrograms per liter]

Constituent	Primary use/source	CAS number	MRL (µg/L)
Perchlorate	Rocket fuel, fireworks, flares	14797-73-0	0.5
1,2,3-Trichloropropane	Solvent	25735-29-9	0.005
N-Nitrosodimethylamine	Rocket fuel manuf., plasticizer	62-75-9	0.002

Table 2G. 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]

Constituent	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 2H. Major and minor 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; mg/L, milligrams per liter; µg/L, micrograms per liter]

Constituent	CAS number	LRL
Major and Minor Ions		**(µg/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
Iodide	20461-54-5	0.002
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
Dissolved solids (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 2I. 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]

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
Hexavalent chromium (VI)	11104-59-9	0.1

Table 2J. Isotopic and radioactive constituents, Chemical Abstract Service (CAS) number, reporting level type, reporting level and (or) uncertainty, and reporting units for the U.S. Geological Survey's National Water Quality Laboratory, Stable Isotope and Tritium Laboratory, Menlo Park, California[1], Stable Isotope Laboratory, Reston, Virginia[2], and the contract laboratories Eberline Analytical Services[3] and the University of Arizona, Accelerator Mass Spectrometry Laboratory[4].

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

Constituent	CAS number	Reporting level type	Reporting level/ uncertainty	Reporting units
Radon-222	14859-67-7	SSMDC	26	pCi/L
Tritium[1]	10028-17-8	SSMDC	1	pCi/L
Deuterium/protium[2]	7782-39-0/1333-74-0	MU	2	Per mil
Oxygen-18/oxygen-16[2]	NA/7782-44-7	MU	0.2	Per mil
Gross-alpha radioactivity, 72-hour count[3]	12587-46-1	SSMDC	3	pCi/L
Gross-alpha radioactivity, 30-day count[3]	12587-46-1	SSMDC	3	pCi/L
Gross-beta radioactivity, 72-hour count[3]	12587-47-2	SSMDC	4	pCi/L
Gross-beta radioactivity, 30-day count[3]	12587-47-2	SSMDC	4	pCi/L
Radium-226[3]	13982-63-3	SSMDC	0.04	pCi/L
Radium-228[3]	15262-20-1	SSMDC	1	pCi/L
Carbon-13/Carbon-12[4]	NA/7440-44-0	1 sigma	0.05	Per mil
Carbon-14[4]	14762-75-5	1 sigma	0.0015	Percent modern

Table 2K. Tritium and dissolved gases, Chemical Abstract Service (CAS) number, method uncertainty (MU) and reporting units for Lawrence Livermore National Laboratory.

[NA, not available; cm^3 STP/g, cubic centimeter of gas at standard temperature and pressure per gram of water; pCi/L, picocuries per liter]

Constituent	CAS number	MU (percent)	Unit
Tritium	10028-17-8	NA	pCi/L
Helium-3/Helium-4	NA/7440-59-7	0.75	NA
Helium-4	7440-59-7	2	cm^3 STP/g
Argon	7440-37-1	2	cm^3 STP/g
Krypton	7439-90-9	2	cm^3 STP/g
Neon	7440-01-09	2	cm^3 STP/g
Xenon	7440-63-3	2	cm^3 STP/g
Methane	74-82-8	4	cm^3 STP/g
Nitrogen	7727-37-9	2	cm^3 STP/g
Oxygen	7782-44-7	2	cm^3 STP/g
Carbon dioxide	124-38-9	4	cm^3 STP/g

Table 2L. Microbial constiuents, 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 constiuent	Primary use/source	MDL
Total coliforms	Water quality indicator/Soil, water and intestinal tracts of animals	1 colony/100ml
Escherichia 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. Classes of chemical and microbial constituents and water-quality indicators collected for the expanded, basic-plus, basic, and hydrothermal sampling schedules for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

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

Expanded schedule	Basic-plus schedule
Water-quality indicators (pH, SC, DO, temperature, alkalinity)	Water-quality indicators (SC and temperature)
Volatile organic compounds	Volatile organic compounds
Gasoline additives and oxygenates	Gasoline additives and oxygenates
Pesticides	Pesticides
Polar pesticides and degradates	Polar pesticides and degradates
Waste-water indicator constituents	Waste-water indicator constituents
Compounds of special interest (perchlorate, NDMA, trichloropropane)	Compounds of special interest (perchlorate, NDMA, trichloropropane)
Nutrients and dissolved organic carbon	Major and minor ions and trace elements
Major and minor ions and trace elements	Chromium abundance and speciation
Chromium abundance and speciation	Arsenic and iron speciation
Arsenic and iron speciation	Stable isotopes of hydrogen and oxygen
Stable isotopes of hydrogen and oxygen	Tritium[1]
Carbon isotopes	Tritium and noble gases[2]
Radium isotopes	
Radon-222	
Tritium[1]	
Tritium and noble gases[2]	
Gross alpha/beta radiation	
Microbial constituents	
Basic schedule	**Hydrothermal schedule**
Water-quality indicators (SC and temperature)	Water-quality indicators (pH, SC, DO, temperature, alkalinity)
Volatile organic compounds	Major and minor ions and trace elements
Gasoline additives and oxygenates	Chromium abundance and speciation
Pesticides	Arsenic and iron speciation
Polar pesticides and degradates	Stable isotopes of hydrogen and oxygen
Waste-water indicator constituents	Tritium[1]
Compounds of special interest (perchlorate, NDMA, trichloropropane)	Tritium and noble gases[2]
Chromium abundance and speciation	Dissolved gases[2] (nitrogen, carbon dioxide, argon, oxygen, and methane)
Stable isotopes of hydrogen and oxygen	
Tritium[1]	
Tritium and noble gases[2]	

[1]Analyzed at the U.S. Geological Survey stable isotope and tritium lab, Menlo Park, California.

[2]Analyzed at Lawrence Livermore National Laboratory, Livermore, California.

Table 4. Constituents analyzed in ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, that appear on multiple analytical schedules, primary constituent classification, analytical schedules constituent appears on, and preferred analytical schedule.

[VOC, volatile organic compound]

Constituent	Primary classification	Analytical schedules	Preferred[1] analytical schedule
Acetone	VOC	2020, 4204	2020
Diisopropyl ether	VOC	2020, 4204	2020
Methyl *tert*-butyl ether (MTBE)	VOC	2020, 4204	2020
Methyl *tert*-amyl ether	VOC	2020, 4204	2020
tert-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 (bromoform)	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

[1]Preferred analytical schedules are the most accurate and precise methods of analysis for the constituent shown.

Table 5. Quality-control summary for volatile organic compounds and gasoline additives and (or) oxygenates, pesticides and (or) pesticide degradates, waste-water indicators, major and minor ions, trace elements, and nutrients and dissolved organic carbon, detected in equipment blanks, field blanks and ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[Censored data are reported but not used in summary statistics; E, estimated value; µg/L, micrograms per liter; —, not detected]

Constituent	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 Additives and (or) Oxygenates					
Acetone	—	1/13[1]	E2.9	E3	0
Carbon disulfide	—	1/13[1]	E0.07	E0.078	0
Ethyl benzene	E0.06	4/13	E0.06	—	0
m-Xylene plus *p*-xylene	0.29	4/13[1]	0.29	E0.04	0
o-Xylene	E0.09	4/13	0.11	E0.065	0
Toluene	0.1	4/13[1]	0.11	E0.08	0
Trimethylbenzene	—	0/13[1]	—	E0.06	0
Pesticides and (or) Pesticide Degradates					
Atrazine	—	1/13[2]	E0.005	E0.006	0
Waste-Water Indicators					
Naphthalene	—	1/21	E0.04	E0.41	0
Phenol	0.6	8/21[1]	1.1	E0.23	48[3]
Triclosan	—	1/21	E0.08	E0.07	0
Major and Minor Ions					
Calcium[4]	0.01	5/5	0.014	0.86	0
Chloride[4]	—	1/5	E0.1	4.6	0
Iodide	—	1/2	E0.001	E0.001	0
Silica[4]	0.04	5/5	0.06	15.3	0
Trace Elements					
Aluminum	—	1/5	E0.9	E0.8	0
Arsenic	0.1	1/5	E0.1	E0.1	0
Manganese	—	2/5	E0.1	E0.1	0
Nickel	—	1/5	0.07	E0.05	0
Zinc	—	2/5	E0.5	0.6	0
Nutrients and Dissolved Organic Carbon					
DOC	—	2/3	0.5	0.2	4

[1]Constituents also detected in associated source solution blanks.

[2]Waste-water indicators detected in one of two associated source solution blanks.

[3]Due to ongoing problems with the analytical procedures used to determine phenol, all ground-water samples with phenol were censored.

[4]Concentration in milligrams per liter.

Table 6A. Quality-control summary of replicate volatile organic compound (VOC) and gasoline additives and (or) oxygenates, pesticides and (or) pesticide degradates, waste-water indicators, and samples for constituents of special interest with relative standard deviations greater than zero, collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[NA, not available]

Constituent[1]	Number of relative standard deviations greater than 20 percent/replicate pairs	Maximum relative standard deviation (percent)	Median of relative standard deviations greater than zero (percent)
Volatile Organic Compounds and Gasoline Oxygenates and (or) Additives (Schedules 2020 and 4204)			
All additional VOCs from Schedule 2020 and 4204	0/8	0	NA
Pesticides and (or) Pesticide Degradates (Schedules 2003 and 2060)			
Simazine	0/8	8.3	0
All additional pesticides from Schedule 2003	0/9	0	NA
All additional pesticides from Schedule 2060	0/4	0	NA
Waste-Water Indicators (Schedule 1433)			
Phenol	2/6	54	11
All additional waste-water compounds from Schedule 1433	0/8	0	NA
Constituents of Special Interest			
Perchlorate[2]	0/6	0	NA
1,2,3 - Trichloropropane[2]	0/6	0	NA
N-Nitrosodimethylamine[2]	0/6	0	NA

[1]Due to the large number of constituents, only constituents with relative standard deviations above zero are shown.

[2]Samples analyzed at Montgomery Watson Laboratories, California.

Table 6B. Quality-control summary of replicate nutrient and dissolved organic carbon samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[NA, not available]

Constituent	Number of relative standard deviations greater than 20 percent/replicate pairs	Maximum relative standard deviation (percent)	Median of relative standard deviations greater than zero (percent)
Dissolved organic carbon	0/3	0	NA
Phosphorus	0/3	0.4	0
Total nitrogen	0/3	1.2	0
Nitrate plus nitrite	0/3	1.1	0
Ammonia	0/3	0	NA
Nitrite	0/3	0	NA

Table 6C. Quality-control summary of replicate major and minor ion samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[NA, not available]

Constituent	Number of relative standard deviations greater than 20 percent/replicate pairs	Maximum relative standard deviation (percent)	Median of relative standard deviations greater than zero (percent)
Bromide	1/4	84.9	25.3
Calcium	0/4	4.0	1.6
Chloride	0/4	1.6	0.4
Fluorine	0/4	8.8	4.0
Iodide	0/3	0.0	NA
Magnesium	0/4	3.0	1.5
Potassium	0/4	3.2	2.2
Silica	0/4	4.4	1.9
Sodium	0/4	2.1	1.0
Sulfate	0/4	16.2	4.1

Table 6D. Quality-control summary of replicate trace-element samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[NA, not available]

Constituent	Number of relative standard deviations greater than 20 percent/replicate pairs	Maximum relative standard deviation (percent)	Median of relative standard deviations greater than zero (percent)
Aluminum	0/3	0	NA
Antimony	0/3	0	NA
Arsenic[1]	0/3	8.4	4.2
Arsenic[2]	0/4	7.7	1.9
Arsenic (III)[2]	0/4	6.7	1.9
Barium	0/3	0.9	0.6
Beryllium	0/3	0	NA
Boron	0/3	5.2	1.1
Cadmium	0/3	0	NA
Chromium[1]	0/3	7.4	0
Chromium[2]	5/11	53	27
Chromium (VI)[2]	6/13	96	31
Cobalt	0/3	4.3	3.8
Copper	0/3	20	19
Iron[1]	0/4	6.6	3.1
Iron[2]	1/4	57	15
Iron (II)[2]	1/4	61	17
Lead	0/3	18	4.2
Lithium	0/3	2.2	1.2
Manganese	0/3	1.7	0.6
Mercury	0/3	0	NA
Molybdenum	0/3	13	0
Nickel	0/3	4.2	3.6
Selenium	0/3	0	NA
Silver	0/3	0	NA
Strontium	0/3	0.7	0.6
Thallium	0/0	0	NA
Tungsten	0/4	0	NA
Uranium	0/3	13	0
Vanadium	1/3	46	2.4
Zinc	0/3	17	1.4

[1]Samples analyzed at U.S. Geological Survey national water-quality laboratory, Denver, Colorado.

[2]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 North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[NA, not available]

Constituent	Number of relative standard deviations greater than 20 percent/replicate pairs	Maximum relative standard deviation (percent)	Median of relative standard deviations greater than zero (percent)
Alpha radioactivity, 30 day count	3/3	138	57
Alpha radioactivity, 72 hour count	3/3	36	31
Beta radioactivity, 30 day count	2/3	39	33
Beta radioactivity, 72 hour count	1/3	25	13
Radon-222	0/3	2.1	1.0
Radium-226	1/3	48	20
Radium-228	3/3	110	54
Deuterium/Protium	0/10	3.2	0.6
Tritium[1]	4/11	137	31
Tritium[2]	0/9	19	10
Carbon-13/Carbon-12	NA	NA	NA
Carbon-14 percent modern	1/6	33	0.3
Oxygen-18/Oxygen-16	0/10	1.4	0.5
He[1]	0/10	6.6	0.5
Ne[1]	0/10	5.9	1.7
Ar[1]	0/10	11	0.4
Kr[1]	0/10	3.6	1.6
Xe[1]	0/10	2.2	0.6

[1]Analysis done at Lawrence Livermore National Laboratory, Livermore, California.

[2]Analysis done at U.S. Geological Survey, Menlo Park, California.

Table 7A. Quality-control summary of volatile organic compounds (VOCs), gasoline additives and oxygenates, NDMA and 1,2,3-trichloropropane matrix spike recoveries in samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[Bold values indicate recovery values outside acceptable range, 70 to 130 percent]

Constituent	Number of spike samples	Minimum recovey (percent)	Maximum recovey (percent)	Median recovey (percent)
1,1,1,2-Tetrachloroethane	9	94	120	111
1,1,1-Trichloroethane (TCA)[1]	9	104	**135**	128
1,1,2,2-Tetrachloroethane	9	98	123	110
1,1,2-Trichloroethane	9	106	**136**	114
1,1,2-Trichlorotrifluoroethane (CFC-113)	9	96	129	112
1,1-Dichloroethane[1]	9	104	127	118
1,1-Dichloroethylene (DCE)	9	102	130	111
1,1-Dichloropropene	9	109	**132**	118
1,2,3,4-Tetramethylbenzene	9	87	115	104
1,2,3,5-Tetramethylbenzene (isodurene)	9	92	128	117
1,2,3-Trichlorobenzene[1]	9	86	113	102
1,2,3-Trichloropropane	9	97	127	111
1,2,3-Trimethylbenzene[1]	9	87	113	103
1,2,4-Trichlorobenzene	9	82	112	96
1,2,4-Trimethylbenzene	9	93	117	108
1,2-Dibromo-3-chloropropane (DBCP)	9	95	111	106
1,2-Dibromoethane	9	95	123	110
1,2-Dichlorobenzene	9	95	111	105
1,2-Dichloroethane	9	107	**137**	126
1,2-Dichloropropane	9	93	120	105
1,3,5-Trimethylbenzene	9	82	112	101
1,3-Dichlorobenzene	9	90	109	101
1,3-Dichloropropane	9	97	118	107
1,4-Dichlorobenzene	9	90	107	99
1,2,3-Tricholorpropane (TCP)[2]	10	93	101	95
2,2-Dichloropropane	9	104	126	117
2-Chlorotoluene	9	91	113	103
2-Hexanone	9	101	127	115
3-Chloropropene	9	102	125	114
4-Chlorotoluene	9	89	113	101
4-Isopropyl-1-methylbenzene	9	89	110	101
4-Methyl-2-pentanone	9	94	118	110
Acetone[1,3]	9	111	**149**	126
Acrylonitrile	9	100	122	113
Benzene	9	100	120	111
Bromobenzene	9	90	108	101
Bromochloromethane[1]	9	99	119	109
Bromodichloromethane	9	111	**136**	121
Bromoethene	9	102	**131**	113
Bromoform (tribromomethane)[1]	9	101	**132**	115

Table 7A. Quality-control summary of volatile organic compounds (VOCs), gasoline additives and oxygenates, NDMA and 1,2,3-trichloropropane matrix spike recoveries in samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[Bold values indicate recovery values outside acceptable range, 70 to 130 percent]

Constituent	Number of spike samples	Minimum recovey (percent)	Maximum recovey (percent)	Median recovey (percent)
Bromomethane	9	88	**148**	123
Butylbenzene	9	76	103	91
Carbon disulfide[1]	9	80	**153**	96
Chlorobenzene	9	94	114	106
Chloroethane	9	96	122	113
Chloroform (trichloromethane)[1]	9	102	119	113
Chloromethane	9	91	128	105
cis-1,2-Dichloroethylene[1]	9	95	119	108
cis-1,3-Dichloropropene	9	89	109	98
Dibromochloromethane[1]	9	101	125	115
Dibromomethane	9	104	124	111
Dichlorodifluoromethane (CFC-12)	9	81	124	104
Dichloromethane (methylene chloride)	9	95	116	109
Diethyl ether	9	94	128	113
Diisopropyl ether[1]	9	98	115	111
Ethyl methacrylate	9	95	114	102
Ethyl *tert*-butyl ether (ETBE)[1]	9	111	**135**	123
Ethylbenzene	9	96	115	106
Hexachlorobutadiene	9	92	116	98
Hexachloroethane	9	98	117	112
Isopropylbenzene	9	100	119	108
m- and *p*-Xylene[1]	9	96	114	102
Methyl acetate	9	98	112	104
Methyl acrylate	9	100	128	112
Methyl acrylonitrile	9	97	122	112
Methyl iodide	9	80	126	99
Methyl methacrylate	9	91	111	100
Methyl *tert*-butyl ether (MTBE)[1,3]	9	97	127	113
Naphthalene	9	75	106	98
Nitrosodimethylamine[2] (NDMA)	10	**56**	90	73
n-Propylbenzene	9	87	113	102
o-Ethyl toluene	9	91	109	100
o-Xylene[1]	9	94	114	104
sec-Butylbenzene	9	98	114	104
Styrene	9	87	111	107
tert-Amyl methyl ether[1]	9	96	123	111
tert-Amyl alcohol	9	93	111	101
tert-Butyl alcohol	9	93	117	105
tert-Butyl ethyl ether[1]	9	104	128	116
tert-Butylbenzene	9	104	127	115

Table 7A. Quality-control summary of volatile organic compounds (VOCs), gasoline additives and oxygenates, NDMA and 1,2,3-trichloropropane matrix spike recoveries in samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[Bold values indicate recovery values outside acceptable range, 70 to 130 percent]

Constituent	Number of spike samples	Minimum recovey (percent)	Maximum recovey (percent)	Median recovey (percent)
Tetrachloroethylene (PCE)[1]	9	97	121	106
Tetrachloromethane (carbon tetrachloride)[1]	9	100	**138**	134
Tetrahydrofuran[1]	9	96	125	118
Toluene[1]	9	96	115	106
trans-1,2-Dichloroethylene	9	96	118	107
trans-1,3-Dichloropropene	9	94	116	111
trans-1,4-Dichloro-2-butene	9	114	**155**	141
Trichloroethylene (TCE)[1]	9	99	121	112
Trichlorofluoromethane (CFC-11)	9	107	**148**	134
Vinyl chloride	9	110	**145**	121

[1]Constituent detected in ground-water samples.

[2]Constituent analyzed by Montgomery Watson on the constituents of special interest schedule.

[3]Constituent 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 in samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[Bold values indicate spike recoveries outside the acceptable range, 70 to 130 percent; NA, not available]

Constituent	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)	Single value (percent)
1-Naphthol	5	**8**	24	16	NA
2,6-Diethylaniline	5	80	115	98	NA
2-Chloro-2’,6’-diethylacetanilide	5	80	130	91	NA
2-Chloro-4-isopropylamino-6-amino-*s*-triazine (deethyl atrazine)[1]	5	**36**	70	43	NA
2-Ethyl-6-methylaniline	5	71	104	95	NA
3,4-Dichloroaniline	5	**43**	92	81	NA
4-Chloro-2-methylphenol	5	**53**	100	69	NA
Acetochlor	5	70	125	91	NA
Alachlor	5	77	127	97	NA
Atrazine[1]	5	91	**134**	106	NA
Azinphos-methyl	5	**50**	**134**	62	NA
Azinphos-methyl oxygen analog	5	**31**	111	42	NA
Benfluralin, water	5	**54**	68	57	NA
Carbaryl	5	77	112	98	NA
Chlorpyrifos	5	76	122	86	NA
Chlorpyrifos oxygen analog	5	**15**	52	50	NA
cis-Permethrin	5	**33**	80	46	NA
Cyfluthrin	5	**29**	116	42	NA
Cypermethrin	5	**27**	93	35	NA
dacthal (DCPA)	5	97	**143**	118	NA
Desulfinyl fipronil	5	79	129	94	NA
Desulfinylfipronil amide	5	**57**	127	66	NA
Diazinon[1]	5	82	119	86	NA
Diazinon oxygen analog	5	**58**	86	63	NA
Dichlorvos	5	**19**	68	46	NA
Dicrotophos	5	**12**	32	26	NA
Dieldrin	5	86	**270**	108	NA
Dimethoate	5	**17**	27	27	NA
Ethion	5	**44**	107	62	NA
Ethion monoxon	5	72	**139**	77	NA
Fenamiphos	5	**31**	**131**	63	NA
Fenamiphos sulfone	5	**40**	**148**	62	NA
Fenamiphos sulfoxide	5	**19**	94	56	NA
Fipronil	5	**67**	82	81	NA
Fipronil sulfide	5	**69**	111	85	NA
Fipronil sulfone	5	**52**	118	77	NA
Fonofos	5	72	105	97	NA
Fonofos oxygen analog	5	**57**	83	58	NA
Hexazinone	5	**44**	111	61	NA
Iprodione	5	**52**	100	83	NA

Table 7B. Quality-control summary of matrix pesticide spike recoveries in samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[Bold values indicate spike recoveries outside the acceptable range, 70 to 130 percent; NA, not available]

Constituent	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)	Single value (percent)
Isofenphos	5	**65**	101	80	NA
Malaoxon	5	**61**	78	69	NA
Malathion	5	103	**142**	107	NA
Metalaxyl	5	73	110	85	NA
Methidathion	5	75	**149**	82	NA
Methyl paraoxon	5	**53**	68	59	NA
Methyl parathion	5	**62**	86	76	NA
Metolachlor	5	109	**143**	113	NA
Metribuzin	5	**60**	90	66	NA
Myclobutanil	5	**67**	128	76	NA
Pendimethalin	5	78	88	84	NA
Phorate	5	**15**	70	30	NA
Phorate oxygen analog	5	**34**	70	48	NA
Phosmet	5	**13**	63	31	NA
Phosmet oxygen analog	5	**10**	52	21	NA
Prometon	5	74	115	85	NA
Prometryn	5	72	108	81	NA
Pronamide	5	74	118	91	NA
Simazine[1]	5	85	123	95	NA
Tebuthiuron	5	82	**163**	100	NA
Terbufos	5	**39**	71	59	NA
Terbufos oxygen analog sulfone	5	75	85	78	NA
Terbuthylazine	5	89	**136**	107	NA
Trifluralin[1]	5	**55**	77	68	NA
2,4-D (2,4-Dichlorophenoxyacetic acid)	1	NA	NA	NA	108
2,4-D methyl ester	1	NA	NA	NA	96
2,4-DB (4-(2,4-dichlorophenoxy)butanoic acid)	1	NA	NA	NA	91
2-Chloro-4-isopropylamino-6-amino-*s*-triazine (deethyl atrazine)[1]	1	NA	NA	NA	86
2-Chloro-6-ethylamino-4-amino-s-triazine (deisopropyl atrazine)[1]	1	NA	NA	NA	83
2-Hydroxy-4-isopropylamino-6-ethylamino-*s*-triazine (hydroyatrazine)	1	NA	NA	NA	126
3-Hydroxy carbofuran	1	NA	NA	NA	93
3-Ketocarbofuran	1	NA	NA	NA	**14**
Acifluorfen	1	NA	NA	NA	112
Aldicarb	1	NA	NA	NA	**62**
Aldicarb sulfone	1	NA	NA	NA	**69**
Aldicarb sulfoxide	1	NA	NA	NA	**67**
Atrazine[1]	1	NA	NA	NA	97
Bendiocarb	1	NA	NA	NA	101
Benomyl	1	NA	NA	NA	**63**
Bensulfuron	1	NA	NA	NA	128

Table 7B. Quality-control summary of matrix pesticide spike recoveries in samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[Bold values indicate spike recoveries outside the acceptable range, 70 to 130 percent; NA, not available]

Constituent	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)	Single value (percent)
Bentazon	1	NA	NA	NA	70
Bromacil	1	NA	NA	NA	87
Bromoxynil	1	NA	NA	NA	71
Caffeine	1	NA	NA	NA	84
Carbaryl	1	NA	NA	NA	96
Carbofuran	1	NA	NA	NA	95
Chloramben methyl ester	1	NA	NA	NA	83
Chlorimuron	1	NA	NA	NA	**160**
Chlorodiamino-s-triazine	1	NA	NA	NA	121
Chlorothalonil	1	NA	NA	NA	**13**
Clopyralid	1	NA	NA	NA	**50**
Cycloate	1	NA	NA	NA	85
Dacthal monoacid	1	NA	NA	NA	102
Dicamba	1	NA	NA	NA	87
Dichlorprop	1	NA	NA	NA	95
Dinoseb	1	NA	NA	NA	107
Diphenamid[1]	1	NA	NA	NA	96
Diuron	1	NA	NA	NA	101
Fenuron	1	NA	NA	NA	93
Flumetsulam	1	NA	NA	NA	**137**
Fluometuron	1	NA	NA	NA	97
Imazaquin	1	NA	NA	NA	110
Imazethapyr	1	NA	NA	NA	108
Imidacloprid	1	NA	NA	NA	116
Linuron	1	NA	NA	NA	94
MCPA	1	NA	NA	NA	95
MCPB	1	NA	NA	NA	102
Metalaxyl	1	NA	NA	NA	95
Methiocarb	1	NA	NA	NA	98
Methomyl	1	NA	NA	NA	**58**
Metsulfuron	1	NA	NA	NA	94
N-(4-Chlorophenyl)-N’-methylurea	1	NA	NA	NA	**66**
Neburon	1	NA	NA	NA	97
Nicosulfuron	1	NA	NA	NA	101
Norflurazon	1	NA	NA	NA	99
Oryzalin	1	NA	NA	NA	79
Oxamyl	1	NA	NA	NA	92
Picloram	1	NA	NA	NA	79
Propham	1	NA	NA	NA	99

Table 7B. Quality-control summary of matrix pesticide spike recoveries in samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[Bold values indicate spike recoveries outside the acceptable range, 70 to 130 percent; NA, not available]

Constituent	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)	Single value (percent)
Propiconazole	1	NA	NA	NA	86
Propoxur	1	NA	NA	NA	93
Siduron	1	NA	NA	NA	105
Sulfometuron[1]	1	NA	NA	NA	120
Tebuthiuron	1	NA	NA	NA	103
Terbacil	1	NA	NA	NA	91
Tribenuron methyl	1	NA	NA	NA	**0**
Triclopyr	1	NA	NA	NA	103

[1]Constituent detected in ground-water samples.

Table 7C. Quality-control summary of matrix waste-water indicators spike recoveries in samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[Bold values indicate spike recoveries outside the acceptable range, 70 to 130 percent]

Constituent	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovey (percent)
1,4-Dichlorobenzene	4	**43**	70	57
1-Methylnaphthalene	4	**61**	90	80
2,6-Dimethylnaphthalene	4	**57**	93	85
2-Methylnaphthalene	4	**57**	98	84
3-*beta*-Coprostanol	4	**23**	92	56
3-Methyl-1H-indole (skatol)	4	**54**	120	96
3-*tert*-Butyl-4-hydroxyanisole (BHA)	4	**11**	33	21
4-Cumylphenol, water	4	**48**	98	85
4-Nonylphenol	4	**41**	101	58
4-Octylphenol	4	**41**	89	69
4-*tert*-Octylphenol	4	**46**	98	85
5-Methyl-1H-benzotriazole	4	**22**	85	54
9,10-Anthraquinone	4	**38**	97	79
Acetophenone	4	**63**	112	110
Acetyl hexamethyl tetrahydro naphthalene (tonalide)	4	**61**	122	96
Anthracene, water	4	70	111	98
Benzo[a]pyrene	4	**52**	91	72
Benzophenone	4	**57**	120	104
beta-Sitosterol	4	**0**	73	49
beta-Stigmastanol	4	**0**	65	51
Bisphenol A[1]	4	**32**	102	77
Bromacil	4	77	108	106
Caffeine[1]	4	73	120	102
Camphor	4	73	99	92
Carbaryl	4	**30**	87	69
Carbazole	4	70	120	100
Chlorpyrifos	4	**61**	112	90
Cholesterol	4	**42**	78	59
Cotinine	4	**55**	108	83
DEET	4	**59**	120	103
Diazinon[1]	4	70	**133**	103
Dichlorvos	3	**0**	3	2
Diethoxynonylphenol NPEO2 total)	4	**38**	114	107
Diethoxyoctylphenol (OPEO2)	4	**32**	**174**	44
d-Limonene[1]	4	**16**	55	36
Ethoxyoctylphenol (OPEO1)[1]	4	**27**	106	40
Fluoranthene	4	77	120	102
Hexahydrohexamethyl cyclopentabenzopyran (galaxolide)	4	**55**	122	81
Indole, water[1]	4	**57**	92	79
Isoborneol, water	4	**64**	102	92
Isophorone[1]	4	70	107	101

Table 7C. Quality-control summary of matrix waste-water indicators spike recoveries in samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[Bold values indicate spike recoveries outside the acceptable range, 70 to 130 percent]

Constituent	Number of spike samples	Minimum recovery (percent)	Maximum recovery (percent)	Median recovey (percent)
Isopropylbenzene (Cumene)	4	**25**	56	38
Isoquinoline	4	**46**	97	86
Menthol[1]	4	**50**	104	79
Metalaxyl	4	**68**	**133**	111
Methyl salicylate	4	**57**	102	98
Metolachlor	4	**64**	122	103
Naphthalene[1]	4	**55**	90	76
p-Cresol[1]	4	**50**	111	95
Pentachlorophenol	4	**31**	86	72
Phenanthrene	4	**68**	107	95
Phenol[1]	4	**67**	**189**	155
Prometon	4	**54**	122	98
Pyrene	4	**66**	99	94
Tetrachloroethene[1]	4	**16**	36	24
Tribromomethane[1]	4	**50**	78	65
Tributyl phosphate	4	**48**	**143**	105
Triclosan[1]	4	**52**	100	95
Triethyl citrate	4	**54**	120	109
Triphenyl phosphate[1]	4	73	112	104
Tris(2-butoxyethyl) phosphate	4	75	**152**	122
Tris(2-chloroethyl) phosphate	4	**64**	120	107
Tris(dichloroisopropyl) phosphate	4	73	112	101

[1]Constituent detected in ground-water samples.

Table 8. Summary of surrogate recoveries for ground-water and quality-control analyses of volatile organic compounds, gasoline additives and (or) oxygenates, pesticides and (or) pesticide degradates, waste-water indicators, and constituents of special interest in samples collected for the North San Francisco Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

Surrogate	Analytical schedule	Constituent class	Number of analyses (environmental, blank, replicate)	Number of surrogate recoveries below 70 percent (environmental, blank, replicate)	Number of surrogate recoveries between 70 and 130 percent (environmental, blank, replicate)	Number of surrogate recoveries above 130 percent (environmental, blank, replicate)
1,2-Dichloroethane-d4	2020	Volatile organic compound	89, 13, 18	0, 0, 0	89, 13, 18	0, 0, 0
1-Bromo-4-fluorobenzene	2020	Volatile organic compound	89, 13, 18	0, 0, 0	89, 13, 18	0, 0, 0
Toluene-d8	2020	Volatile organic compound	89, 13, 18	0, 0, 0	89, 13, 18	0, 0, 0
1,2-Dichloroethane-d4	4024	Gasoline additive/oxygenate	89, 13, 18	0, 0, 0	89, 13, 18	0, 0, 0
1-Bromo-4-fluorobenzene	4024	Gasoline additive/oxygenate	89, 13, 18	0, 0, 0	89, 13, 18	0, 0, 0
Toluene-d8	4024	Gasoline additive/oxygenate	89, 13, 18	0, 0, 0	89, 13, 18	0, 0, 0
Isobutyl alcohol-d6	4024	Gasoline additive/oxygenate	89, 12, 17	0, 0, 0	89, 12, 17	0, 0, 0
alpha-HCH-d6	2003	Pesticides and/or degradate	87, 11, 19	0, 0, 0	87, 11, 19	0, 0, 0
Diazinon-d10	2003	Pesticides and/or degradate	87, 11, 19	37, 6, 8	50, 5, 11	0, 0, 0
2,4,5-T(2,4,5-trichlorophenoxyacetic acid)	2060	Pesticides and/or degradate	22, 4, 8	0, 0, 1	22, 4, 7	0, 0, 0
Barban	2060	Pesticides and/or degradate	22, 4, 8	1, 0, 0	21, 4, 8	0, 0, 0
Caffeine-^{13}C	2060	Pesticides and/or degradate	22, 4, 8	0, 0, 0	13, 1, 3	9, 3, 5
Bisphenol A-d3	1433	Waste-water indicator	89, 21, 19	87, 21, 19	2, 0, 0	0, 0, 0
Caffeine-^{13}C	1433	Waste-water indicator	89, 21, 19	13, 4, 4	76, 17, 15	0, 0, 0
Decafluorobiphenyl	1433	Waste-water indicator	89, 21, 19	89, 21, 19	0, 0, 0	0, 0, 0
Fluoranthene-d10	1433	Waste-water indicator	89, 21, 19	4, 0, 2	85, 21, 17	0, 0, 0
Toluene-d8	MWL[1]	Constituent of special interest	87, 4, 12	0, 0, 0	87, 4, 12	0, 0, 0
NDMA-D6	MWL[1]	Constituent of special interest	87, 4, 12	52, 3, 7	34, 0, 3	1, 1, 2

[1]Constituent analyzed at Montgomery Watson Harza Laboratory.

Table 9. Water-quality indicators determined in the field for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[The five-digit number below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; NTRU, nephelometric turbidity unit; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; µS/cm, microsiemens per centimeter; °C, degrees celsius; mg/L, milligrams per liter; mm, millimeter; NC, sample not collected; M, presence verified not quantified; —, not detected]

GAMA identification No.	Turbidity (NTRU) (63676)	Barometric pressure (mm of mercury) (00025)	Dissolved oxygen (mg/L) (00300)	pH, field (standard units) (00400)	Specific conductance, field (µScm@25°C) (00095)	Water temperature (°C) (00010)	Total hardness (mg/L as $CaCO_3$) (00900)	Alkalinity, dissolved (mg/L as $CaCO_3$) (29802)	Bicarbonate, dissolved (mg/L as HCO_3) (63786)	Carbonate, dissolved (mg/L as CO_3) (63788)
Valley and Plains wells										
NSFVP-01	NC	NC	NC	NC	617	23.0	NC	NC	NC	NC
NSFVP-02	NC	NC	NC	NC	380	19.8	NC	NC	NC	NC
NSFVP-03	NC	NC	NC	NC	570	NC	NC	NC	NC	NC
NSFVP-04	NC	NC	NC	NC	180	20.0	NC	NC	NC	NC
NSFVP-05	NC	NC	NC	NC	451	19.6	NC	NC	NC	NC
NSFVP-06	NC	NC	NC	NC	361	18.5	NC	NC	NC	NC
NSFVP-07	NC	NC	NC	NC	483	24.7	NC	NC	NC	NC
NSFVP-08	NC	NC	NC	NC	256	17.6	NC	NC	NC	NC
NSFVP-09	NC	NC	NC	NC	334	24.4	NC	NC	NC	NC
NSFVP-10	0.2	759	0.1	6.5	337	16.5	170	163	198	M
NSFVP-11	NC	NC	NC	NC	244	20.9	NC	NC	NC	NC
NSFVP-12	NC	NC	NC	NC	278	25.4	NC	NC	NC	NC
NSFVP-13	NC	NC	NC	NC	304	23.6	NC	NC	NC	NC
NSFVP-14	NC	NC	NC	NC	348	28.3	NC	NC	NC	NC
NSFVP-15	NC	NC	NC	NC	563	19.2	NC	NC	NC	NC
NSFVP-16	NC	NC	NC	NC	506	27.3	NC	NC	NC	NC
NSFVP-17	NC	NC	NC	NC	310	17.8	NC	NC	NC	NC
NSFVP-18	NC	NC	NC	NC	164	15.5	NC	NC	NC	NC
NSFVP-19	0.1	756	0.4	6.7	269	22.9	130	125	152	M
NSFVP-20	NC	NC	NC	NC	612	17.2	NC	NC	NC	NC
NSFVP-21	NC	NC	NC	NC	753	17.5	NC	NC	NC	NC
NSFVP-22	NC	NC	NC	NC	614	18.5	NC	NC	NC	NC
NSFVP-23	NC	NC	NC	NC	713	21.0	NC	NC	NC	NC
NSFVP-24	NC	NC	NC	NC	817	19.0	NC	NC	NC	NC

Table 9. Water-quality indicators determined in the field for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[The five-digit number below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; NTRU, nephelometric turbidity unit; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; µS/cm, microsiemens per centimeter; °C, degrees celsius; mg/L, milligrams per liter; mm, millimeter; NC, sample not collected; M, presence verified not quantified; —, not detected]

GAMA identification No.	Turbidity (NTRU) (63676)	Barometric pressure (mm of mercury) (00025)	Dissolved oxygen (mg/L) (00300)	pH, field (standard units) (00400)	Specific conductance, field (µScm@25°C) (00095)	Water temperature (°C) (00010)	Total hardness (mg/L as $CaCO_3$) (00900)	Alkalinity, dissolved (mg/L as $CaCO_3$) (29802)	Bicarbonate, dissolved (mg/L as HCO_3) (63786)	Carbonate, dissolved (mg/L as CO_3) (63788)
NSFVP-25	NC	NC	NC	NC	366	22.0	NC	NC	NC	NC
NSFVP-26	1.0	756	0.1	7.4	640	22.0	170	298	361	1
NSFVP-27	NC	NC	NC	NC	408	17.3	NC	NC	NC	NC
NSFVP-28	NC	NC	NC	NC	869	20.1	NC	NC	NC	NC
NSFVP-29	—	756	5.7	6.8	362	16.7	190	167	203	M
NSFVP-30	—	753	0.6	7.2	440	18.0	200	189	229	M
NSFVP-31	NC	NC	NC	NC	488	19.6	NC	NC	NC	NC
NSFVP-32	NC	NC	NC	NC	441	35.4	130	NC	NC	NC
NSFVP-33	NC	NC	NC	NC	318	21.2	130	NC	NC	NC
NSFVP-34	2.0	750	0.2	7.3	211	19.4	50	90.5	110	M
NSFVP-35	NC	NC	NC	NC	499	19.3	120	NC	NC	NC
NSFVP-36	NC	NC	NC	NC	1,250	18.6	340	NC	NC	NC
NSFVP-37	3.0	748	3.5	6.8	345	19.3	120	124	152	M
NSFVP-38	0.2	753	0.1	8.2	734	25.7	20	381	454	5
NSFVP-39	NC	NC	NC	NC	332	20.0	70	NC	NC	NC
NSFVP-40	0.1	760	M	7.6	621	33.0	170	158	191	1
NSFVP-41	NC	NC	NC	NC	510	20.4	170	NC	NC	NC
NSFVP-42	NC	NC	NC	NC	240	20.0	NC	NC	NC	NC
NSFVP-43	NC	NC	NC	NC	383	27.6	100	NC	NC	NC
NSFVP-44	NC	NC	NC	NC	1,680	21.0	180	NC	NC	NC
NSFVP-45	—	767	0.3	7.5	460	28.0	60	230	279	1
NSFVP-46	0.3	762	1.1	6.5	406	18.1	170	144	176	—
NSFVP-47	NC	NC	NC	6.4	299	18.1	90	NC	48	—
NSFVP-48	NC	762	NC	7.7	758	19.8	110	NC	19	—
NSFVP-49	—	769	0.1	7.4	605	19.6	100	280	340	1

Table 9. Water-quality indicators determined in the field for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[The five-digit number below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; NTRU, nephelometric turbidity unit; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; µS/cm, microsiemens per centimeter; °C, degrees celsius; mg/L, milligrams per liter; mm, millimeter; NC, sample not collected; M, presence verified not quantified; —, not detected]

GAMA identification No.	Turbidity (NTRU) (63676)	Barometric pressure (mm of mercury) (00025)	Dissolved oxygen (mg/L) (00300)	pH, field (standard units) (00400)	Specific conductance, field (µScm@25°C) (00095)	Water temperature (°C) (00010)	Total hardness (mg/L as $CaCO_3$) (00900)	Alkalinity, dissolved (mg/L as $CaCO_3$) (29802)	Bicarbonate, dissolved (mg/L as HCO_3) (63786)	Carbonate, dissolved (mg/L as CO_3) (63788)
NSFVP-50	—	764	0.7	7.2	394	18.6	140	197	240	M
NSFVPFP-01	0.1	758	0.1	8.0	259	28.0	60	105	126	1
NSFVPFP-02	2.0	757	0.3	7.4	619	18.0	230	225	273	1
NSFVPFP-03	NC	NC	NC	NC	567	18.2	240	NC	NC	NC
NSFVPFP-04	NC	NC	NC	NC	325	15.7	NC	NC	NC	NC
Volcanic Highlands wells										
NSFVOL-01	2.8	750	3.2	6.6	210	23.5	90	107	130	—
NSFVOL-02	NC	NC	NC	NC	724	23.2	NC	NC	NC	NC
NSFVOL-03	NC	NC	NC	NC	190	26.8	NC	NC	NC	NC
NSFVOL-04	NC	NC	NC	NC	274	NC	NC	NC	NC	NC
NSFVOL-05	NC	NC	NC	NC	138	20.0	NC	NC	NC	NC
NSFVOL-06	NC	NC	NC	NC	544	24.2	NC	NC	NC	NC
NSFVOL-07	NC	NC	NC	NC	215	22.5	NC	NC	NC	NC
NSFVOL-08	NC	NC	NC	NC	296	22.0	NC	NC	NC	NC
NSFVOL-09	NC	NC	NC	NC	317	26.0	NC	NC	NC	NC
NSFVOL-10	NC	NC	NC	NC	227	14.3	NC	NC	NC	NC
NSFVOL-11	NC	NC	NC	NC	103	17.0	NC	NC	NC	NC
NSFVOL-12	NC	NC	NC	NC	251	24.6	NC	NC	NC	NC
NSFVOL-13	NC	NC	NC	NC	158	17.8	NC	NC	NC	NC
NSFVOL-14	—	760	4.3	6.5	191	21.5	60	66	80	—
NSFVOL-15	NC	NC	NC	NC	177	17.7	NC	NC	NC	NC
NSFVOL-16	NC	NC	NC	NC	710	25.8	NC	NC	NC	NC
NSFVOL-17	NC	NC	NC	NC	424	24.6	NC	NC	NC	NC
NSFVOL-18	NC	NC	NC	NC	397	26.7	NC	NC	NC	NC
NSFVOL-19	1.7	750	1.9	6.4	156	24.8	50	152	93	—

Table 9. Water-quality indicators determined in the field for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[The five-digit number below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; NTRU, nephelometric turbidity unit; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; µS/cm, microsiemens per centimeter; °C, degrees celsius; mg/L, milligrams per liter; mm, millimeter; NC, sample not collected; M, presence verified not quantified; —, not detected]

GAMA identification No.	Turbidity (NTRU) (63676)	Barometric pressure (mm of mercury) (00025)	Dissolved oxygen (mg/L) (00300)	pH, field (standard units) (00400)	Specific conductance, field (µScm@25°C) (00095)	Water temperature (°C) (00010)	Total hardness (mg/L as $CaCO_3$) (00900)	Alkalinity, dissolved (mg/L as $CaCO_3$) (29802)	Bicarbonate, dissolved (mg/L as HCO_3) (63786)	Carbonate, dissolved (mg/L as CO_3) (63788)
NSFVOL-20	—	755	2.9	7.4	222	25.2	40	102	124	M
Wilson Grove Formation Highlands wells										
NSFWG-01	NC	NC	NC	NC	265	18.6	NC	NC	NC	NC
NSFWG-02	NC	NC	NC	NC	606	18.0	NC	NC	NC	NC
NSFWG-03	NC	NC	NC	NC	260	16.5	NC	NC	NC	NC
NSFWG-04	NC	NC	NC	NC	216	21.5	NC	NC	NC	NC
NSFWG-05	NC	NC	NC	NC	676	18.0	NC	NC	NC	NC
NSFWG-06	NC	NC	NC	NC	383	15.7	NC	NC	NC	NC
NSFWG-07	NC	NC	NC	NC	518	20.5	NC	NC	NC	NC
NSFWG-08	—	761	0.8	7.4	391	19.0	160	162	197	M
NSFWG-09	NC	NC	NC	NC	267	18.1	NC	NC	NC	NC
NSFWG-10	—	760	0.1	9.4	447	23.0	0	193	177	28
NSFWG-11	NC	NC	NC	NC	426	20.5	NC	NC	NC	NC
NSFWG-12	NC	NC	NC	NC	277	19.5	NC	NC	NC	NC
NSFWG-13	NC	NC	NC	NC	727	19.5	NC	NC	NC	NC
NSFWG-14	NC	761	NC	NC	722	18.7	NC	NC	NC	NC
NSFWGFP-01	—	761	0.2	7.5	363	19.5	140	143	174	M
Hydrothermal study										
NSFHOT-01	NC	NC	NC	7.8	1,090	81.0	20	NC	NC	NC
NSFHOT-02	NC	NC	NC	7.5	942	60.0	10	NC	NC	NC
NSFHOT-03	NC	NC	NC	6.9	774	29.5	110	NC	NC	NC
NSFHOT-04	NC	NC	NC	7.3	970	63.0	20	NC	NC	NC

Table 9. Water-quality indicators determined in the field for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[The five-digit number below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; NTRU, nephelometric turbidity unit; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; µS/cm, microsiemens per centimeter; °C, degrees celsius; mg/L, milligrams per liter; mm, millimeter; NC, sample not collected; M, presence verified not quantified; —, not detected]

GAMA identification No.	Turbidity (NTRU) (63676)	Barometric pressure (mm of mercury) (00025)	Dissolved oxygen (mg/L) (00300)	pH, field (standard units) (00400)	Specific conductance, field (µScm@25°C) (00095)	Water temperature (°C) (00010)	Total hardness (mg/L as $CaCO_3$) (00900)	Alkalinity, dissolved (mg/L as $CaCO_3$) (29802)	Bicarbonate, dissolved (mg/L as HCO_3) (63786)	Carbonate, dissolved (mg/L as CO_3) (63788)
NSFHOT-05	NC	NC	NC	8.0	985	97.5	20	NC	NC	NC
NSFHOT-06	NC	NC	NC	7.5	1,290	34.3	130	NC	NC	NC
NSFHOT-07	NC	NC	NC	8.3	2,020	41.5	20	NC	NC	NC
NSFHOT-08	NC	NC	NC	8.7	1,170	35.5	20	NC	NC	NC

Table 10A. Results of analyses for volatile organic compounds (VOCs) and gasoline additives and (or) oxygenates in ground-water samples collected in the Valley and Plains study area of the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; µg/L, microgram per liter; E, estimated value; —, not detected; percentage values are detection frequencies]

Class:	Trihalomethanes (18 percent of wells)			Organic synthesis (16 percent of wells)		Gasoline additives (6 percent of wells)
GAMA identification No.	Chloroform (Trichloromethane) (µg/L) (32106)	1,1,1-Trichloroethane (TCA) (µg/L) (34506)	1,1,2-Trichlorotrifluoroethane (CFC-113) (µg/L) (77652)	Carbon disulfide (µg/L) (77041)	1,2,4-Trimethylbenzene (µg/L) (77222)	Toluene (µg/L) (34010)
[LRL]	[0.02]	[0.03]	[0.04]	[0.04]	[0.06]	[0.05 (0.02)]
Valley and Plains wells (50 randomized wells sampled)						
NSFVP-08	—	—	—	E0.06	—	—
NSFVP-15	—	—	—	—	—	—
NSFVP-18	E0.02	—	—	—	—	—
NSFVP-23	E0.02	—	0.19	—	—	—
NSFVP-27	E0.02	—	—	—	—	—
NSFVP-31	0.11	—	—	—	E0.03	—
NSFVP-36	—	—	—	0.33	—	—
NSFVP-37	E0.06	—	—	—	—	—
NSFVP-39	—	—	—	0.13	—	—
NSFVP-40	—	—	—	—	E0.06	E0.01
NSFVP-41	E0.02	—	—	—	—	—
NSFVP-45	—	—	—	E0.08	—	—
NSFVP-46	—	E0.02	—	—	—	—
NSFVP-47	E0.03	—	—	—	—	—
NSFVP-48	—	—	—	E0.08	—	—
NSFVP-49	—	—	—	E0.03	—	—
NSFVP-50	E0.08	—	—	—	—	—
Number of wells with detections	8	1	1	6	2	1
Detection frequency (percent)	16	2	2	12	4	2
Valley and Plains flow-path well						
NSFVPFP-03[1]	—	—	—	—	—	E0.01

[S]*See footnote at end of table.*

Table 10A. Results of analyses for volatile organic compounds (VOCs) and gasoline additives and (or) oxygenates in ground-water samples collected in the Valley and Plains study area of the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; µg/L, microgram per liter; E, estimated value; —, not detected; percentage values are detection frequencies]

Class:	Gasoline additives and oxygenates (6 percent of wells)		Solvents (4 percent of wells)				Detections per well	
GAMA identification No.	*m*-Xylene plus *p*-xylene (µg/L) (85795)	*tert*-Butyl methyl ether (MTBE) (µg/L) (78032)	1,1-Dichloroethane (µg/L) (34496)	2-Butanone (ethyl methyl ketone) (µg/L) (81595)	Tetrachloromethane (Carbon tetrachloride) (µg/L) (32102)	Tetrahydrofuran (µg/L) (81607)		
[LRL]	[0.06]	[0.2 (0.1)]	[0.04]	[4 (2)]	[0.06]	[2.2 (1)]		
Valley and Plains wells (50 randomized wells sampled)								
NSFVP-08	—	—	—	—	—	—	1	
NSFVP-15	—	E0.1	—	—	—	—	1	
NSFVP-18	—	—	—	—	—	—	1	
NSFVP-23	—	—	—	—	—	—	2	
NSFVP-27	—	—	—	—	—	—	1	
NSFVP-31	—	—	—	—	—	—	2	
NSFVP-36	—	—	—	—	—	—	1	
NSFVP-37	—	—	—	—	E0.03	—	2	
NSFVP-39	—	—	—	—	—	—	1	
NSFVP-40	—	—	—	—	—	—	2	
NSFVP-41	—	—	—	—	—	—	1	
NSFVP-45	E0.04	—	—	—	—	—	2	
NSFVP-46	—	—	—	—	—	—	1	
NSFVP-47	—	—	—	—	—	—	1	
NSFVP-48	—	—	—	2.3	—	7	3	
NSFVP-49	—	—	—	—	—	—	1	
NSFVP-50	—	—	—	—	—	—	1	
Number of wells with detections	1	1	0	1	1	1	24	Total detections
Detection frequency (percent)	2	2	0	2	2	2	17	Total wells
Valley and Plains flow-path well								
NSFVPFP-03[1]	—	—	E0.03	—	—	—	2	

[1]Flowpath wells were not included in statistical calculations.

Table 10B. Results of analyses for volatile organic compounds (VOCs) and gasoline additives and (or) oxygenates in ground-water samples collected in the Volcanic Highlands study area of the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVOL, Volcanic Highlands study area; mg/L, microgram per liter; E, estimated value; —, not detected; percentage values are detection frequencies]

Class:	Organic synthesis (15 percent of wells)		Gasoline additives and oxygenates (10 percent of wells)				Trihalo-methanes (10 percent of wells)	Solvents (5 percent of wells)	Detections per well	
GAMA identification No.	Carbon disulfide (µg/L) (77041)	1,2,4-Tri-methyl-benzene (µg/L) (77222)	*m*-Xylene plus *p*-xylene (µg/L) (85795)	Toluene (µg/L) (34010)	Benzene (µg/L) (34030)	*o*-Xylene (µg/L) (77135)	Chloroform (Trichloro-methane) (µg/L) (32106)	2-Butanone (ethyl methyl ketone) (µg/L) (81595)		
[LRL]	[0.04]	[0.06]	[0.06]	[0.05 (0.02)]	[0.02]	[0.04]	[0.02]	[4 (2)]		
Volcanic Highlands wells (20 randomized wells sampled)										
NSFVOL-02	—	—	E0.06	E0.08	0.60	E0.06	—	E1.1	5	
NSFVOL-03	—	—	—	—	—	—	0.50	—	1	
NSFVOL-09	E0.05	—	—	—	—	—	—	—	1	
NSFVOL-11	—	—	—	—	—	—	E0.06	—	1	
NSFVOL-17	0.37	—	—	—	—	—	—	—	1	
NSFVOL-20	—	E0.02	E0.05	E0.02	—	—	—	—	3	
Number of wells with detections	2	1	2	2	1	1	2	1	12	Total detections
Detection frequency (percent)	10	5	10	10	5	5	10	5	6	Total wells

Table 10C. Results of analyses for volatile organic compounds (VOCs) and gasoline additives and (or) oxygenates in ground-water samples collected in the Wilson Grove Formation Highlands study area of the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property. LRL, laboratory reporting level; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; µg/L, microgram per liter; E, estimated value; —, not detected; percentage values are detection frequencies]

Class	Trihalomethanes (14 percent of wells)				Solvents (14 percent of wells)					Gasoline additives and oxygenates (7 percent of wells)		
GAMA identification No.	Chloroform (Trichloromethane) (µg/L) (32106)	Bromodichloromethane (µg/L) (32101)	Dibromochloromethane (µg/L) (32105)	Bromoform (Tribromomethane) (µg/L) (32104)	Acetone (µg/L) (81552)	cis-1,2-Dichloroethylene (µg/L) (77093)	Tetrachloroethylene (PCE) (µg/L) (34475)	Tetrahydrofuran (µg/L) (81607)	Trichloroethylene (TCE) (µg/L) (39180)	Toluene (µg/L) (34010)	Detections per well	
[LRL]	[0.024]	[0.03]	[0.1]	[0.1]	[6]	[0.02]	[0.06 (0.03)]	[2.2 (1)]	[0.04]	[0.05 (0.02)]		
Wilson Grove Formation Highlands wells (14 randomized wells sampled)												
NSFWG-05	—	—	—	—	E3	—	—	—	—	—	1	
NSFWG-06	0.44	0.28	0.4	0.34	—	—	—	—	—	—	4	
NSFWG-08	E0.02	—	—	—	—	—	—	—	—	—	1	
NSFWG-14	—	—	—	—	—	—	—	2.0	—	E0.02	2	
Number of wells with detections	2	1	1	1	1	0	0	1	0	1	8	Total detections
Detection frequency (percent)	14	7	7	7	7	0	0	7	0	7	4	Total wells
Wilson Grove Formation Highlands flow-path well												
NSFWGFP-01[1]	—	—	—	—	—	0.15	2.67	—	0.4	—	3	
Hydrothermal study not sampled												

[1]Flowpath wells were not included in statistical calculations.

Table 11A. Pesticides and (or) pesticide degredates detected in ground-water samples collected in the Valley and Plains study area of the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; µg/L, microgram per liter; E, estimated value; —, not detected; M, presence verified, not quantified; percentage values are detection frequencies]

Class:	Herbicides (22 percent of wells)				Pesticide degradates (8 percent of wells)				
GAMA identification No.	Simazine (µg/L) (04035)	Atrazine (µg/L) (39632)	Trifluralin (µg/L) (82661)	Sulfometuron-methyl[1] (µg/L) (50337)	Deethylatrazine (µg/L) (04040)	Deisopropyl atrazine[1] (µg/L) (04038)	Chlordiamino-*s*-triazine[1] (µg/L) (04039)	Detections per well	
[LRL]	[0.005]	[0.007]	[0.009]	[0.009(0.04)]	[0.006]	[0.01 (0.08)]	[0.04]		
Valley and Plains wells (50 randomized wells sampled)									
NSFVP-06	—	—	E0.006	—	—	—	—	1	
NSFVP-08	0.01	—	—	—	—	—	—	1	
NSFVP-10	0.006	—	—	—	—	—	—	1	
NSFVP-11	0.052	—	—	—	—	—	—	1	
NSFVP-17	E0.003	—	—	—	—	—	—	1	
NSFVP-18	0.018	—	—	—	—	—	—	1	
NSFVP-19	0.016	—	—	—	—	E0.01	—	2	
NSFVP-21	—	E0.007	—	—	E0.006	—	—	2	
NSFVP-22	—	—	—	—	E0.005	—	—	1	
NSFVP-29	0.009	—	—	—	—	M	E0.01	3	
NSFVP-47	0.011	—	—	—	—	—	—	1	
NSFVP-38	—	—	—	0.052	—	—	—	1	
Number of wells with detections	8	1	1	0	2	2	1	15	Total detections
Detection frequency (percent)	16	2	2	0	4	4	2	12	Total wells
Valley and Plains flow-path well									
NSFVPFP-03[2]	E0.004	—	—	—	—	—	—	1	

[1]Constituent analyzed under pesticide schedule 2060.

[2]Flowpath wells were not included in statistical calculations.

Table 11B. Pesticides and (or) pesticide degredates detected in ground-water samples collected in the Volcanic Highlands study area of the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVOL, Volcanic Highlands study area; µg/L, microgram per liter; M, presence verified, not quantified; percentage values are detection frequencies]

Class	Herbicide (5 percent of wells)	Detections per well	
GAMA identification No.	Diphenamid[1] (µg/L) (04033)		
[LRL]	[0.01]		
Volcanic Highlands wells (20 wells sampled)			
NSFVOL-01	M	1	
Number of wells with detections	1	1	Total detections
Detection frequency (percent)	5	1	Total wells

[1]Constituent analyzed by pesticide schedule 2060.

Table 11C. Pesticides and (or) pesticide degradates detected in ground-water samples collected in the Wilson Grove Formation Highlands study area of the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; µg/L, microgram per liter; E, estimated value; —, not Formation detected; percentage values are detection frequencies]

Class	Herbicides (7 percent of wells)		Detections per well	
GAMA identification No.	Diazinon (µg/L) (39572)	Atrazine (µg/L) (39632)		
[LRL]	[0.005]	[0.007]		
Wilson Grove Formation Highlands wells (14 randomized wells sampled)				
NSFWG-07	0.108	—	1	
Number of wells with detections	1	0	1	Total detections
Detection frequency (percent)	7	0	1	Total wells
Wilson Grove Formation Highlands flow-path well				
NSFWGFP-01[1]	—	E0.006	1	
Hydrothermal study (not sampled)				

[1]Flowpath wells were not included in statistical calculations.

Table 12A. Waste-water indicators measured in ground-water samples collected in the Valley and Plains study area of the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[The five-digit number in parentheses below the compound name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; µg/L, microgram per liter; E, estimated value; —, not detected; V, value censored due to contamination and not included in ground-water quality analyses; M, presence verified but not quantified]

GAMA identification No.	Phenol[1] (µg/L) (34466)	Caffeine[2] (µg/L) (50305)	Isophorone (µg/L) (34409)	Triclosan (µg/L) (62090)	Tetrachloroethylene (µg/L) (34476)	Bromoform (µg/L) (34288)	Detections per well	
[LRL]	[0.5]	[0.010 (0.5)]	[0.5]	[1]	[0.5]	[0.5]		
Valley and Plains wells (50 randomized wells sampled)								
NSFVP-12	VE0.4	—	—	—	—	—	0	
NSFVP-13	V0.5	M	—	—	—	—	1	
NSFVP-14	V0.8	—	—	M	—	—	1	
NSFVP-15	V1.1	M	—	—	—	—	1	
NSFVP-18	V0.9	—	—	—	—	—	0	
NSFVP-20	V0.8	—	—	—	—	—	0	
NSFVP-21	VE0.4	—	—	—	M	—	1	
NSFVP-22	V1.5	—	—	—	—	—	0	
NSFVP-24	V0.6	—	—	—	—	—	0	
NSFVP-26	VE0.3	—	—	—	—	—	0	
NSFVP-27	V0.6	—	—	—	—	—	0	
NSFVP-29	V1.3	—	—	M	M	—	2	
NSFVP-31	VE0.3	—	—	—	—	M	1	
NSFVP-32	V1.6	—	—	—	—	—	0	
NSFVP-34	VE0.3	—	—	—	—	—	0	
NSFVP-35	V1.0	—	—	—	—	—	0	
NSFVP-36	V0.5	—	—	—	—	—	0	
NSFVP-37	—	—	—	—	—	E0.5	1	
NSFVP-38	V2.0	0.067	—	—	—	—	1	
NSFVP-39	V0.7	—	M	—	—	—	1	
NSFVP-40	VE0.4	—	M	—	—	—	1	
NSFVP-41	VE0.4	—	M	—	—	—	1	
NSFVP-44	VE1.1	—	—	—	—	—	0	
NSFVP-46	V0.8	—	—	—	—	—	0	
NSFVP-47	V1.0	—	—	—	—	—	0	
NSFVP-49	—	0.029	—	—	—	—	1	
Number of wells with detections[3]	0[1]	4	3	2	2	2	13	Total detections
Detection frequency (percent)[3]	0[1]	8	6	4	4	4	12	Total wells
Valley and Plains flow-path well								
NSFVPFP-01[3]	VE0.4	—	—	M	—	—	1	
NSFVPFP-02[3]	—	0.017	—	—	—	—	1	
NSFVPFP-03[3]	V1.0	—	M	—	—	—	1	
NSFVPFP-04[3]	V0.7	—	—	—	—	—	0	

[1]Due to high phenol contents in the blank samples, phenol detecions have been censored.

[2]Caffeine concentraion determined by the preferred analysis method, pesticide analytical schedule 2060.

[3]Flowpath wells were not included in statistical calculations.

Table 12B. Waste-water indicators measured in ground-water samples collected in the Volcanic Highlands study area of the North San Francisco Bay Ground- Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVOL, Volcanic Highlands study area; µg/L, microgram per liter; E, estimated value; v, value censored due to contamination and not included in ground-water quality analyses;—, not detected; M, presence verified but not quantified]

GAMA identification No.	Phenol[1] (µg/L) (34466)	Bisphenol A (µg/L) (62069)	Isophorone (µg/L) (34409)	Caffeine[2] (µg/L) (50305)	*d*-Limonene (µg/L) (62073)	Octyl-phenol, mono-ethoxy- (OPEO1) (µg/L) (61706)	Indole (µg/L) (62076)	Napthalene (µg/L) (34443)	Triphenyl phosphate (µg/L) (62092)	Detections per well	
[LRL]	[0.5]	[1]	[0.5]	[0.010(0.5)]	[0.5]	[1]	[0.5]	[0.5]	[0.5]		
Volcanic Highlands wells (20 wells sampled)											
NSFVOL-01	V0.5	—	—	E0.0076	—	—	—	—	—	1	
NSFVOL-02	V0.9	M	—	—	—	M	—	E0.4	—	3	
NSFVOL-04	V2.4	—	—	—	—	—	—	—	—	0	
NSFVOL-06	V0.5	—	—	—	—	—	—	—	—	0	
NSFVOL-07	V1.0	—	—	—	—	—	—	—	—	0	
NSFVOL-09	V2.4	—	—	—	—	—	—	—	—	0	
NSFVOL-10	V0.8	—	—	—	—	—	—	—	—	0	
NSFVOL-15	V0.9	—	—	—	—	—	—	—	—	0	
NSFVOL-16	VE0.3	—	—	—	—	—	E0.1	—	—	1	
NSFVOL-17	VE0.2	M	M	—	—	—	—	—	E0.1	3	
NSFVOL-18	VE0.4	—	M	—	—	—	—	—	—	1	
NSFVOL-19	—	—	—	—	E0.1	—	—	—	—	1	
Number of wells with detections	0[1]	2	2	1	1	1	1	1	1	10	Total detec-tions
Detection frequency (percent)	0[1]	10	10	5	5	5	5	5	5	6	Total wells

[1]Due to high phenol contents in the blank samples, phenol detecions have been censored.

[2]Caffeine concentraion determined by the preferred analysis method, pesticide analytical schedule 2060.

Table 12C. Waste-water indicators measured in ground-water samples collected in the Wilson Grove Formation Highlands study area of the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[The five-digit number in parentheses below the compound name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; µg/L, microgram per liter; E, estimated value; V, value censored due to contamination and not included in ground-water quality analyses; —, not detected; M, presence verified but not quantified]

GAMA identification No.	Phenol[1] (µg/L) (34466)	Indole (µg/L) (62076)	*p*-Cresol (µg/L) (62084)	Bisphenol A (µg/L) (62069)	Isophorone (µg/L) (34409)	Menthol (µg/L) (62080)	Tetrachloro-ethylene (µg/L) (34476)	Detections per well	
[LRL]	[0.5]	[0.5]	[1]	[1]	[0.5]	[0.5]	[0.5]		
Wilson Grove Formation Highlands wells (14 randomized wells sampled)									
NSFWG-02	V1.4	—	—	—	—	—	—	0	
NSFWG-03	VE0.3	—	M	—	—	—	—	1	
NSFWG-04	V0.7	—	—	—	—	E0.2	—	1	
NSFWG-05	V0.7	E0.1	—	—	—	—	—	1	
NSFWG-07	V0.8	—	—	—	—	—	—	0	
NSFWG-08	VE0.2	—	—	—	—	—	—	0	
NSFWG-09	VE0.7	—	—	—	—	—	—	0	
NSFWG-10	V1.1	—	—	—	—	—	—	0	
NSFWG-13	VE1.1	1.4	M	M	M	—	—	4	
Number of wells with detections	0[1]	2	2	1	1	1	0	7	Total detections
Detection frequency (percent)	0[1]	14	14	7	7	7	0	4	Total wells
Wilson Grove Formation Highlands flow-path well									
NSFWGFP-01[2]	VE1.0	—	—	—	—	—	E1.3	1	
Hydrothermal study (not sampled)									

[1]Due to high phenol contents in the blank samples, phenol detecions have been censored.

[2]Flowpath wells were not included in statistical calculations.

Table 13. Results of analyses for the constituents of special interest: perchlorate, trichloropropane (1,2,3-TCP), N-nitrosodimethylamine (NDMA) in ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[MRL, minimum reporting level; µg/L, micrograms per liter]

GAMA identification No.	Perchlorate (µg/L)	1,2,3-Trichlor-propane (µg/L)	N-nitroso-dimethylamine (NDMA) (µg/L)
[MRL]	[0.5]	[0.005]	[0.002]
Valley and Plains wells	Not detected	Not detected	Not detected
Volcanic Highlands wells	Not detected	Not detected	Not detected
Wilson Grove Formation Highlands wells	Not detected	Not detected	Not detected
Hydrothermal study	Not sampled	Not sampled	Not sampled

Table 14. Nutrients and dissolved organic carbon in ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; mg/L, milligram per liter; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; E, estimated value; V, value censored due to contamination and not included in ground-water quality analyses; —, not detected]

GAMA identification No.	Ammonia, dissolved (mg/L as N) (00608)	Nitrate plus nitrite, dissolved (mg/L as N) (00631)	Nitrite, dissolved (mg/L as N) (00613)	Phosphorus, dissolved (mg/L as P) (00671)	Total nitrogen (nitrate + nitrite + ammonia + organic-N), dissolved (62854)	Dissolved organic carbon (mg/L) (00681)
[LRL]	[0.04]	[0.06]	[0.008]	[0.006]	[0.03]	[0.3]
Valley and Plains wells (15 wells sampled)						
NSFVP-10	—	0.31	—	0.019	0.32	0.6
NSFVP-19	—	0.09	—	0.021	0.12	0.6
NSFVP-26	0.16	E0.04	—	0.090	0.21	E0.2
NSFVP-29[1]	—	1.89	—	0.010	1.78	E0.3
NSFVP-30[1]	—	0.62	—	0.034	0.61	E0.2
NSFVP-34[1]	0.07	—	—	0.318	E0.06	E0.3
NSFVP-37	—	3.22	—	0.112	3.42	0.4
NSFVP-38	0.22	E0.06	—	0.146	0.28	1.1
NSFVP-40	0.27	—	—	0.024	0.27	0.4
NSFVP-45	2.50	—	E0.004	0.023	2.84	V0.4[2]
NSFVP-46[1]	—	2.48	—	0.012	2.44	V0.4[2]
NSFVP-49	3.11	—	E0.004	0.559	3.14	1.2
NSFVP-50	0.10	E0.05	E0.007	0.329	0.16	0.4
NSFVPFP-01	E0.03	—	—	0.094	0.04	0.4
NSFVPFP-02	—	1.55	0.030	0.099	1.56	0.4
Volcanic Highlands wells (4 wells sampled)						
NSFVOL-01	—	E0.05	—	0.191	0.07	E0.2
NSFVOL-14[1]	—	0.79	—	0.180	0.76	0.9
NSFVOL-19	—	E0.03	E0.004	0.059	E0.06	VE0.3[2]
NSFVOL-20[1]	—	0.10	—	0.061	0.09	VE0.2[2]
Wilson Grove Formation Highlands wells (3 wells sampled)						
NSFWG-08[1]	—	1.21	0.008	0.053	1.20	0.4
NSFWG-10	0.14	—	—	0.027	0.16	0.5
NSFWGFP-01	—	0.06	—	0.008	0.09	E0.3

[1]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 criteria of a 10-percent relative percent difference.

[2]Detection in blank, value censored.

Table 15. Major and minor ions and dissolved solids in ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; mg/L, milligram per liter; NC, sample not collected; E, estimated value; —, not detected; values in bold indicate concentrations above maximum contaminant level (MCL); values in bold and italics indicate concentrations above the recommended secondary maximum contaminant level (SMCL)]

GAMA identification No.	Dissolved solids (residue on evaporation) (mg/L) (70300)	Calcium, dissolved (mg/L) (00915)	Magnesium, dissolved (mg/L) (00925)	Potassium, dissolved (mg/L) (00935)	Sodium, dissolved (mg/L) (00930)	Bromide, dissolved (mg/L) (71870)	Chloride, dissolved (mg/L) (00940)	Fluoride, dissolved (mg/L) (00950)	Iodide, dissolved (mg/L) (71865)	Silica, dissolved (mg/L) (00955)	Sulfate, dissolved (mg/L) (00945)
[LRL]	[10]	[0.01]	[0.008]	[0.16]	[0.1]	[0.02]	[0.2]	[0.2]	[0.002]	[0.04]	[0.2]
Valley and Plains wells											
NSFVP-10	213	23.2	26.3	0.94	10.9	0.06	6.73	NC	0.005	29.6	11.3
NSFVP-19	162	22.8	18.7	1.20	8.39	0.03	5.19	NC	0.004	22.5	9.6
NSFVP-26	381	34.5	19.2	1.30	76.7	0.11	13.2	0.3	0.069	38.1	21.7
NSFVP-29	231	35.7	24.8	0.90	9.06	0.17	5.94	—	E0.001	24.9	26.2
NSFVP-30	254	38.4	24.5	0.99	13.3	0.07	9.82	—	0.007	24.8	19.1
NSFVP-32	375	29.6	14.7	9.93	40.2	0.10	9.34	0.3	0.012	134	32.1
NSFVP-33	270	26.0	15.6	3.48	19.6	0.14	8.52	0.2	0.011	94.4	19.3
NSFVP-34	185	9.14	6.26	4.70	23.4	0.07	10.6	0.3	0.020	85.3	2.6
NSFVP-35	318	25.1	12.6	2.20	58.8	0.07	30.8	0.2	0.003	74.6	21.2
NSFVP-36	***685***	51.6	50.8	7.14	148	1.44	249	0.2	0.260	46.8	12.4
NSFVP-37	255	25.1	14.7	1.32	28.5	0.12	23.0	0.2	0.002	67.8	14.8
NSFVP-38	***503***	6.26	1.51	2.29	177	0.10	25.5	0.4	0.140	52.9	1.7
NSFVP-39	267	13.9	7.88	6.79	42.3	0.09	7.00	0.4	0.077	105	5.5
NSFVP-40	428	34.5	21.0	5.68	57.8	0.37	99.1	0.4	0.047	110	3.2
NSFVP-41	313	33.0	20.9	2.09	39.2	0.19	42.4	0.2	0.015	50.2	23.6
NSFVP-43	269	27.6	7.07	3.52	49.0	0.16	7.70	0.2	0.010	54.7	12.0
NSFVP-44	***1,000***	36.5	21.6	3.03	270	0.99	191	0.1	1.100	27.9	239
NSFVP-45	399	15.5	5.95	19.7	77.9	0.06	6.83	0.7	0.009	126	19.9
NSFVP-46	249	32.7	22.4	0.59	21.5	0.71	9.88	0.1	0.003	29.7	43.7
NSFVP-47	194	22.9	7.47	0.55	25.4	0.14	21.3	0.6	0.005	33.1	37.9
NSFVP-48	464	18.6	16.2	13.2	113	0.11	62.9	0.2	0.180	47.6	14.9
NSFVP-49	417	20.0	11.0	9.02	104	0.16	42.5	0.2	0.077	64.3	7.1
NSFVP-50	261	18.9	22.7	8.19	27.1	0.07	5.10	0.3	0.038	69.5	3.8

Table 15. Major and minor ions and dissolved solids in ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; mg/L, milligram per liter; NC, sample not collected; E, estimated value; —, not detected; values in bold indicate concentrations above maximum contaminant level (MCL); values in bold and italics indicate concentrations above the recommended secondary maximum contaminant level (SMCL)]

GAMA identification No.	Dissolved solids (residue on evaporation) (mg/L) (70300)	Calcium, dissolved (mg/L) (00915)	Magnesium, dissolved (mg/L) (00925)	Potassium, dissolved (mg/L) (00935)	Sodium, dissolved (mg/L) (00930)	Bromide, dissolved (mg/L) (71870)	Chloride, dissolved (mg/L) (00940)	Fluoride, dissolved (mg/L) (00950)	Iodide, dissolved (mg/L) (71865)	Silica, dissolved (mg/L) (00955)	Sulfate, dissolved (mg/L) (00945)
[LRL]	[10]	[0.01]	[0.008]	[0.16]	[0.1]	[0.02]	[0.2]	[0.2]	[0.002]	[0.04]	[0.2]
NSFVPFP-01	179	17.5	3.6	1.50	30.2	0.05	13.2	NC	0.006	54.4	4.7
NSFVPFP-02	364	44.2	29.4	1.90	40.0	0.13	47.2	—	0.024	38.0	15.4
NSFVPFP-03	346	28.4	40.1	2.67	31.0	0.25	41.7	0.3	0.011	52.9	32.7
Volcanic Highlands wells											
NSFVOL-01	214	19.2	10.8	1.70	12.9	0.03	5.55	NC	E0.001	98.5	1.4
NSFVOL-14	185	12.8	7.57	2.18	13.4	0.03	7.79	0.2	0.004	87.0	7.4
NSFVOL-19	184	7.34	8.10	4.41	15.9	0.04	5.34	0.3	0.002	97.9	5.9
NSFVOL-20	197	8.96	4.09	4.34	31.3	0.03	4.62	0.3	E0.001	87.0	4.6
Wilson Grove Formation Highlands wells											
NSFWG-08	263	53.6	6.38	1.24	18.2	0.06	13.2	E0.1	0.004	42.2	20.3
NSFWG-10	291	0.86	0.056	0.46	111	0.09	34.2	0.1	0.006	15.9	5.9
NSFWGFP-01	242	50.0	3.77	1.33	22.0	0.08	15.4	E0.1	0.007	37.9	15.9
Hydrothermal study[1]											
NSFHOT-01	***646***	7.63	0.134	7.54	186	0.80	183	**10.2**	0.2999	108	30.8
NSFHOT-02	***685***	5.04	0.274	8.37	185	0.73	190	**9.6**	0.334	165	1.0
NSFHOT-03	***539***	22.3	12.9	8.93	138	0.16	51	1.9	0.010	84	58.3
NSFHOT-04	***670***	4.31	0.883	7.90	174	0.90	194	**10.6**	0.351	164	27.4
NSFHOT-05	***648***	6.32	0.015	7.91	173	0.75	187	**11.3**	0.226	151	10.8
NSFHOT-06	***673***	39.7	6.33	17.5	208	0.37	***255***	2.0	0.190	85.6	14.0
NSFHOT-07	***1,230***	9.01	0.078	20.2	381	2.44	***578***	**8.5**	1.61	100	40.5
NSFHOT-08	***750***	5.50	0.901	3.30	224	0.90	207	**6.0**	0.522	49.5	114

[1]Not considered for drinking water-quality standards.

Table 16. Trace elements in ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; values in bold indicate concentrations that exceed the maximum contaminant level (MCL); values in bold and italics indicate concentrations that are above the secondary maximum contaminant level (SMCL), or for iron, the California notification level (NL); values in italics indicate concentrations above the detection levels for the purpose of reporting (DLR); µg/L, microgram per liter; E, estimated value; M, presence of compound verified but not quanitifed; NC, sample not collected; —, not detected]

GAMA identification No.	Aluminum, dissolved (µg/L) (01106)	Antimony, dissolved (µg/L) (01095)	Arsenic, dissolved (µg/L) (01000)	Barium, dissolved (µg/L) (01005)	Beryllium, dissolved (µg/L) (01010)	Boron, dissolved (µg/L) (01020)	Cadmium, dissolved (µg/L) (01025)	Chromium, dissolved (µg/L) (01030)	Cobalt, dissolved (µg/L) (01035)	Copper, dissolved (µg/L) (01040)	Iron, dissolved (µg/L) (01046)	Lead, dissolved (µg/L) (01049)
[LRL]	[2]	[0.2]	[0.2]	[0.2]	[4]	[8]	[0.04]	[0.8]	[0.014]	[0.4]	[6]	[0.08]
Valley and Plains wells												
NSFVP-10	—	—	0.3	100	—	*323*	—	—	0.141	E0.4	117	E0.05
NSFVP-19	—	—	0.4	100	—	*331*	—	—	0.072	1.8	9.8	2.07
NSFVP-26	—	—	1.5	247	—	*124*	—	—	0.113	1.0	20.6	0.09
NSFVP-29	—	—	E0.1	172	—	*258*	—	0.9	0.127	2.3	—	1.02
NSFVP-30	E1	—	0.5	203	—	*1,350*	—	—	0.155	0.6	13.1	0.32
NSFVP-32	M	—	8.8	69	—	*283*	—	—	0.258	4.5	E5	4.12
NSFVP-33	—	—	3.8	31	—	29	—	—	0.139	—	***1,090***	7.97
NSFVP-34	—	—	7.1	35	—	*120*	—	—	0.072	E0.4	***999***	—
NSFVP-35	E1	0.28	8	35	—	*171*	—	—	0.067	0.7	17	0.38
NSFVP-36	—	—	5.7	492	—	*136*	—	—	0.141	E0.3	***671***	1.07
NSFVP-37	—	—	3.4	64	—	73	—	1.4	0.056	3.4	E6	0.37
NSFVP-38	E1	—	**17.2**	69	—	*3,830*	E0.04	—	0.031	3.3	12	0.73
NSFVP-39	M	—	6	27	—	*293*	—	—	0.096	E0.3	43	2.68
NSFVP-40	E1	—	—	13	—	*474*	—	—	0.067	—	***331***	—
NSFVP-41	—	—	2.6	148	—	52	—	—	0.331	13.1	—	1.77
NSFVP-44	E1	—	3.3	121	—	*819*	0.04	—	0.092	1.4	***310***	—
NSFVP-45	—	0.27	**32.8**	56	—	*496*	—	—	0.033	E0.2	135	0.77
NSFVP-46	M	—	—	106	—	70	—	—	0.079	0.5	22	0.35
NSFVP-47	4	—	E0.2	19	—	*627*	—	—	0.052	14.8	—	***15.30***
NSFVP-48	M	—	4.9	194	—	*380*	—	—	0.061	E0.3	***714***	0.08
NSFVP-49	2	—	**24.6**	115	—	*316*	0.05	—	0.216	E0.3	***362***	0.24
NSFVP-50	—	E0.15	7.7	71	—	*109*	—	—	0.205	—	57	E0.07
NSFVPFP-01	E1	—	1.0	9	—	53	—	4.4	0.080	0.4	36.5	0.58
NSFVPFP-02	—	—	2.2	223	—	93	—	—	0.138	0.5	—	0.27
NSFVPFP-03	—	—	1.3	70	—	*825*	E 0.03	—	0.509	2.5	E4	0.29

Table 16. Trace elements in ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; values in bold indicate concentrations that exceed the maximum contaminant level (MCL); values in bold and italics indicate concentrations that are above the secondary maximum contaminant level (SMCL), or for iron, the California notification level (NL); values in italics indicate concentrations above the detection levels for the purpose of reporting (DLR); µg/L, microgram per liter; E, estimated value; M, presence of compound verified but not quanitifed; NC, sample not collected; —, not detected]

GAMA identification No.	Aluminum, dissolved (µg/L) (01106)	Antimony, dissolved (µg/L) (01095)	Arsenic, dissolved (µg/L) (01000)	Barium, dissolved (µg/L) (01005)	Beryllium, dissolved (µg/L) (01010)	Boron, dissolved (µg/L) (01020)	Cadmium, dissolved (µg/L) (01025)	Chromium, dissolved (µg/L) (01030)	Cobalt, dissolved (µg/L) (01035)	Copper, dissolved (µg/L) (01040)	Iron, dissolved (µg/L) (01046)	Lead, dissolved (µg/L) (01049)
[LRL]	[2]	[0.2]	[0.2]	[0.2]	[4]	[8]	[0.04]	[0.8]	[0.014]	[0.4]	[6]	[0.08]
Volcanic Highlands wells												
NSFVOL-01	—	—	1.4	8	—	28	—	1	0.048	2.8	79.6	0.73
NSFVOL-14	M	—	7.1	6	—	18	—	E0.4	0.132	3.5	—	2.79
NSFVOL-19	M	E0.11	1.3	49	—	42	—	—	0.436	0.6	235	0.35
NSFVOL-20	—	—	5.6	9	—	71	0.04	—	0.019	0.4	E4	0.63
Wilson Grove Formation Highlands wells												
NSFWG-08	E1	—	**13.0**	1	—	16	—	1.6	0.17	0.9	40	0.11
NSFWG-10	7	—	—	18	—	42	—	—	—	E0.3	—	—
NSFWGFP-01	—	—	4.8	4	—	22	—	—	0.14	E0.4	29	0.59
Hydrothermal study[1]												
NSFHOT-01	17	**387**	**70.5**	M	0.31	*9,590*	—	—	0.017	0.6	45	E0.06
NSFHOT-02	6	**201**	**50.2**	M	0.08	*11,000*	—	—	E0.012	0.5	28	—
NSFHOT-03	E1	0.24	**30.9**	25	—	*2,530*	0.13	—	0.144	1.3	E4	—
NSFHOT-04	6	**6.93**	**64.6**	M	0.15	*11,200*	—	—	0.018	1.0	272	E0.04
NSFHOT-05	126	**95.6**	**128**	1	0.15	*11,100*	E0.02	—	0.016	0.6	14	0.11
NSFHOT-06	2	1.67	**12.4**	14	—	*3,570*	—	—	0.094	1.2	***302***	E0.04
NSFHOT-07	5	E0.19	3.0	20	—	*15,700*	E0.03	—	0.023	E0.3	41	0.19
NSFHOT-08	30	—	—	7	—	*28,500*	—	—	0.031	1.0	10	—

[1]*See footnote at end of table.*

Table 16. Trace elements in ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; values in bold indicate concentrations that exceed the maximum contaminant level (MCL); values in bold and italics indicate concentrations that are above the secondary maximum contaminant level (SMCL), or for iron, the California notification level (NL); values in italics indicate concentrations above the detection levels for the purpose of reporting (DLR); µg/L, microgram per liter; E, estimated value; M, presence of compound verified but not quanitifed; NC, sample not collected; —, not detected]

GAMA identification No.	Lithium, dissolved (µg/L) (01130)	Manganese, dissolved (µg/L) (01056)	Mercury, dissolved (µg/L) (71890)	Molybdenum, dissolved (µg/L) (01060)	Nickel, dissolved (µg/L) (01065)	Selenium, dissolved (µg/L) (01145)	Silver, dissolved (µg/L) (01075)	Strontium, dissolved (µg/L) (01080)	Thallium, dissolved (µg/L) (01057)	Tungsten, dissolved (µg/L) (01155)	Vanadium, dissolved (µg/L) (01085)	Zinc, dissolved (µg/L) (01090)	Uranium, dissolved (µg/L) (22703)
[LRL}	[0.6]	[0.2]	[2]	[0.4]	[0.06]	[0.4]	[0.2]	[0.4]	[0.04]	[0.5]	[0.7]	[0.6]	[0.04]
Valley and Plains wells													
NSFVP-10	3.5	***203***	—	0.5	3.02	—	—	195	—	—	0.9	2.5	0.05
NSFVP-19	3.4	42.2	—	0.6	1.76	—	—	214	—	—	1.2	9.2	0.14
NSFVP-26	14.6	***241***	—	4.5	0.39	—	—	264	E0.03	—	2.7	5	0.51
NSFVP-29	6.5	E0.1	—	E0.2	2.48	—	—	352	—	—	1.4	49.7	0.09
NSFVP-30	18.8	36.8	—	0.7	2.23	0.7	—	379	—	—	1.9	6.3	0.19
NSFVP-32	52.5	***129***	NC	1.5	0.24	E0.2	—	124	—	0.9	1.5	4.2	0.1
NSFVP-33	14.1	***139***	NC	0.5	1.03	—	—	127	—	—	—	19	—
NSFVP-34	4.7	***434***	—	1.8	0.26	—	—	30.9	—	—	1.3	20.1	—
NSFVP-35	27.5	3.6	NC	5.1	0.69	1.6	—	384	—	—	*7.4*	10.1	3.53
NSFVP-36	33.8	***1,220***	NC	1	0.65	2	0.26	440	—	—	0.4	49.8	0.07
NSFVP-37	25.6	6.4	—	0.6	1.49	0.7	0.52	134	—	—	*11.2*	5.6	0.25
NSFVP-38	61.3	14.5	—	13.7	0.25	0.5	—	83.9	—	—	1.0	5.9	0.11
NSFVP-39	68.9	***78.1***	—	1.8	0.34	—	—	39.8	0.22	0.9	*3.7*	9.4	1
NSFVP-40	80.9	40.1	—	1.8	1.23	—	—	127	—	0.7	0.6	15.6	0.04
NSFVP-41	33.5	***928***	NC	1.6	0.62	—	—	262	—	—	*3.1*	5.8	0.25
NSFVP-44	68.3	***137***	NC	20	0.63	E0.3	—	384	—	—	0.4	29.6	0.26
NSFVP-45	72	***50.1***	—	8.4	0.68	—	—	84.6	—	2.3	2.0	13.2	—
NSFVP-46	6.2	1.6	—	0.6	2	1	—	278	—	—	1.5	18.8	0.06
NSFVP-47	12.3	0.4	—	E0.4	0.4	—	—	98.9	—	—	0.6	34.3	—
NSFVP-48	17.2	***151***	—	0.7	5.21	0.7	—	213	—	0.8	0.7	0.7	—
NSFVP-49	72.9	***435***	—	20.3	0.66	—	—	142	—	—	0.9	4.3	0.92
NSFVP-50	2.9	***687***	—	5.7	0.62	—	—	131	—	—	*6.4*	8.9	1.57

Table 16. Trace elements in ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; values in bold indicate concentrations that exceed the maximum contaminant level (MCL); values in bold and italics indicate concentrations that are above the secondary maximum contaminant level (SMCL), or for iron, the California notification level (NL); values in italics indicate concentrations above the detection levels for the purpose of reporting (DLR); µg/L, microgram per liter; E, estimated value; M, presence of compound verified but not quanitifed; NC, sample not collected; —, not detected]

GAMA identification No.	Lithium, dissolved (µg/L) (01130)	Manganese, dissolved (µg/L) (01056)	Mercury, dissolved (µg/L) (71890)	Molybdenum, dissolved (µg/L) (01060)	Nickel, dissolved (µg/L) (01065)	Selenium, dissolved (µg/L) (01145)	Silver, dissolved (µg/L) (01075)	Strontium, dissolved (µg/L) (01080)	Thallium, dissolved (µg/L) (01057)	Tungsten, dissolved (µg/L) (01155)	Vanadium, dissolved (µg/L) (01085)	Zinc, dissolved (µg/L) (01090)	Uranium, dissolved (µg/L) (22703)
[LRL}	[0.6]	[0.2]	[2]	[0.4]	[0.06]	[0.4]	[0.2]	[0.4]	[0.04]	[0.5]	[0.7]	[0.6]	[0.04]
NSFVPFP-01	20.5	***66.4***	—	1.1	E0.05	—	—	86.2	0.04	—	—	E0.6	0.06
NSFVPFP-02	10.8	***355***	—	1.1	0.3	—	—	276	—	—	*10.0*	1.9	0.95
NSFVPFP-03	4.8	***938***	NC	1.3	5.58	1.7	—	167	—	—	1.4	2.2	0.32
Volcanic Highlands wells													
NSFVOL-01	10.3	4.8	—	E0.2	0.46	—	—	61.9	—	—	*19.6*	3.5	0.09
NSFVOL-14	11.2	10.7	—	1.5	0.76	—	—	38	—	—	*15.4*	8.2	0.13
NSFVOL-19	23.2	***123***	—	0.6	3.72	—	—	33.5	E0.03	—	1.5	63.8	0.06
NSFVOL-20	42.3	0.3	—	1.9	0.25	—	—	29.8	—	0.6	*11.6*	15	0.07
Wilson Grove Formation Highlands wells													
NSFWG-08	12.4	12.9	—	1.2	1.08	E0.3	—	198	—	—	1.1	1.7	0.08
NSFWG-10	26.3	0.5	—	0.7	—	0.5	—	36	—	—	0.2	—	—
NSFWGFP-01	10.6	16	—	0.7	0.43	—	—	188	—	—	1.7	4.2	0.14
Hydrothermal study[1]													
NSFHOT-01	1,920	12.4	0.125	6.5	0.27	0.8	—	110	0.04	112	0.6	0.6	—
NSFHOT-02	1,450	17.2	0.017	6.2	0.17	—	—	39.6	—	138	—	—	—
NSFHOT-03	224	***559***	—	3.4	1.21	0.7	—	102	—	2.0	*9.3*	1.4	0.85
NSFHOT-04	1,440	***88.8***	0.099	3.4	0.57	0.7	—	34.5	—	234	E0.1	26.8	—
NSFHOT-05	1,720	2.8	0.402	10.3	0.2	—	NC	54.9	—	152	0.7	15.7	—
NSFHOT-06	703	***373***	E0.006	2.8	0.5	0.4	—	161	—	7.6	0.2	8.8	0.04
NSFHOT-07	1,650	11.9	—	13.2	0.21	1.4	—	21.8	—	54.0	—	—	—
NSFHOT-08	322	6.1	0.402	<0.4	0.26	0.7	NC	225	—	25.0	0.3	0.9	—

[1]Not considered for drinking water-quality standards.

Table 17. Inorganic arsenic and iron-speciation results measured at the U.S. Geological Survey National Research Program in ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[MDL, method detection limit; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWG, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; values in bold indicate concentrations that exceed the maximum oontaminant level (MCL); values in bold and italics indicate concentrations that are above the secondary maximum contaminant level (SMCL), or for iron, the California notification level (NL); µg/L, microgram per liter; —, not detected]

GAMA identification No.	Arsenic, dissolved (µg/L)	Arsenic (III), dissolved (µg/L)	Iron, dissolved (µg/L)	Iron (II), dissolved (µg/L)
[MDL]	[0.5]	[1]	[1]	[1]
Valley and Plains wells				
NSFVP-10	—	—	—	—
NSFVP-19	—	—	10	8
NSFVP-29	—	—	—	—
NSFVP-30	—	—	11	8
NSFVP-34	7.7	6.7	***900***	860
NSFVP-37	3.1	—	2	—
NSFVP-38	**16.2**	2.8	9	7
NSFVP-40	—	—	***301***	277
NSFVP-45	**29.8**	25.1	122	91
NSFVP-46	—	—	19	15
NSFVP-49	**22.0**	22.0	***313***	313
NSFVP-50	7.2	—	50	34
NSFVPFP-01	1.2	—	36	30
NSFVPFP-02	2.1	—	2	—
Volcanic Highlands wells				
NSFVOL-01	1.5	—	68	58
NSFVOL-05	1.6	—	12	5
NSFVOL-14	7.0	—	2	2
NSFVOL-19	1.2	1.1	180	179
NSFVOL-20	5.7	—	2	—
Wilson Grove Formation Highlands wells				
NSFWG-08	**12.0**	3.4	37	7
NSFWG-10	—	—	19	—
NSFWGFP-01	4.5	—	28	26
Hydrothermal study[1]				
NSFHOT-01	**35.7**	36.0	41	41
NSFHOT-02	**45.0**	45.0	23	23
NSFHOT-03	**28.1**	2.5	4	2
NSFHOT-04	**53.0**	53.0	247	210
NSFHOT-05	**81.0**	78.0	10	10
NSFHOT-06	**10.0**	5.6	***315***	174
NSFHOT-07	4.3	3.6	31	27

[1]Not considered for drinking water-quality standards.

Table 18. Chromium-speciation results measured by the U.S. Geological Survey National Research Progam for ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November, 2004.

[MDL, method detection limit; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; values in italics indicate concentrations above the detection levels for the purpose of reporting (DLR); µg/L, microgram per liter; —, not detected]

GAMA identification No.	Chromium, dissolved (µg/L)	Chromium (VI) (hexavalent), dissolved (µg/L)
[MDL]	[0.1]	[0.1]
Valley and Plains wells		
NSFVP-01	0.8	0.2
NSFVP-02	0.9	0.5
NSFVP-03	0.4	0.6
NSFVP-04	0.5	—
NSFVP-05	1.1	0.4
NSFVP-06	5.0	*3.4*
NSFVP-07	—	—
NSFVP-08	0.7	0.5
NSFVP-09	0.2	0.2
NSFVP-10	0.2	0.4
NSFVP-11	—	—
NSFVP-12	0.1	0.3
NSFVP-13	0.2	0.2
NSFVP-14	0.1	0.1
NSFVP-15	0.3	0.2
NSFVP-16	0.2	—
NSFVP-17	—	0.5
NSFVP-18	2.2	*2.5*
NSFVP-19	0.2	0.2
NSFVP-20	2.1	*2.5*
NSFVP-21	6.4	*6.6*
NSFVP-22	10.0	*11.6*
NSFVP-23	5.9	*7.8*
NSFVP-24	5.1	*4.4*
NSFVP-25	5.5	*4.3*
NSFVP-26	—	0.4
NSFVP-27	11.5	*9.3*
NSFVP-28	4.5	*4.0*
NSFVP-29	3.1	*7.9*
NSFVP-30	0.4	0.5
NSFVP-31	5.8	*6.3*
NSFVP-32	14.8	*13.2*
NSFVP-33	13.7	*14.7*
NSFVP-34	3.5	*3.1*
NSFVP-35	1.1	0.6
NSFVP-36	0.8	0.4
NSFVP-37	4.9	*3.9*

Table 18. Chromium speciation results measured by the U.S. Geological Survey National Research Progam for ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November, 2004—Continued.

[MDL, method detection limit; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; values in italics indicate concentrations above the detection levels for the purpose of reporting (DLR); µg/L, microgram per liter; —, not detected]

GAMA identification No.	Chromium, dissolved (µg/L)	Chromium (VI) (hexavalent), dissolved (µg/L)
[MDL]	[0.1]	[0.1]
NSFVP-38	3.9	*3.0*
NSFVP-39	0.2	—
NSFVP-40	3.5	*2.8*
NSFVP-41	0.4	—
NSFVP-42	—	—
NSFVP-43	0.6	0.3
NSFVP-44	3.1	—
NSFVP-45	0.9	0.2
NSFVP-46	3.4	*3.2*
NSFVP-47	0.6	0.7
NSFVP-48	4.9	*3.5*
NSFVP-49	3.9	*3.3*
NSFVP-50	3.3	*5.6*
NSFVPFP-01	0.7	0.1
NSFVPFP-02	0.3	0.3
NSFVPFP-03	0.3	0.3
NSFVPFP-04	—	0.4
Volcanic Highlands wells		
NSFVOL-01	1.2	0.8
NSFVOL-02	0.3	—
NSFVOL-03	5.0	*4.7*
NSFVOL-04	4.8	*5.3*
NSFVOL-05	4.9	*6.6*
NSFVOL-06	6.0	*5.1*
NSFVOL-07	6.1	*5.5*
NSFVOL-08	5.0	*4.5*
NSFVOL-09	5.3	*5.8*
NSFVOL-10	13.0	*10.2*
NSFVOL-11	12.2	*10.4*
NSFVOL-12	12.6	*10.2*
NSFVOL-13	12.9	*11.3*
NSFVOL-14	1.4	*3.4*
NSFVOL-15	17.1	*15.6*
NSFVOL-16	0.6	0.2
NSFVOL-17	0.3	—
NSFVOL-18	1.0	—
NSFVOL-19	3.4	*3.1*
NSFVOL-20	0.5	0.7

Table 18. Chromium speciation results measured by the U.S. Geological Survey National Research Progam for ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November, 2004—Continued.

[MDL, method detection limit; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; values in italics indicate concentrations above the detection levels for the purpose of reporting (DLR); µg/L, microgram per liter; —, not detected]

GAMA identification No.	Chromium, dissolved (µg/L)	Chromium (VI) (hexavalent), dissolved (µg/L)
[MDL]	[0.1]	[0.1]
Wilson Grove Formation Highlands wells		
NSFWG-01	1.7	*1.8*
NSFWG-02	5.9	*4.4*
NSFWG-03	6.1	*6.9*
NSFWG-04	4.3	*3.4*
NSFWG-05	4.4	*4.6*
NSFWG-06	7.4	*4.4*
NSFWG-07	6.4	*6.3*
NSFWG-08	2.3	*1.6*
NSFWG-09	13.4	*8.9*
NSFWG-10	2.7	*2.5*
NSFWG-11	0.7	—
NSFWG-12	1.9	0.4
NSFWG-13	0.2	0.2
NSFWG-14	4.0	*3.0*
NSFWGFP-01	2.9	*1.5*
Hydrothermal study[1]		
NSFHOT-01	0.7	—
NSFHOT-02	0.2	0.1
NSFHOT-03	—	—
NSFHOT-04	0.4	—
NSFHOT-05	5.6	0.4
NSFHOT-06	—	—
NSFHOT-07	0.2	—
NSFHOT-08	—	—

[1]Not considered for drinking water-quality standards.

Table 19. Isotopes and radioactivity measured in ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; values in bold indicate concentrations that exceed the proposed maximum contaminant level (MCL); pCi/L, picocuries per liter; NC, sample not collected; <, less than; —, not detected]

GAMA identification No.	Alpha radioactivity, 72-hour count (pCi/L) (62636)	Alpha radioactivity, 30-day count (pCi/L) (62369)	Beta radioactivity, 72-hour count (pCi/L) (62642)	Beta radioactivity, 30-day count (pCi/L) (62645)	Tritium (pCi/L) (07000)	Tritium 2-sigma combined uncertainty (pCi/L) (75985)	Carbon-14 (percent modern) (49933)
Valley and Plains wells							
NSFVP-01	NC	NC	NC	NC	1.6	0.6	NC
NSFVP-02	NC	NC	NC	NC	2.2	0.6	NC
NSFVP-03	NC	NC	NC	NC	1.9	0.6	NC
NSFVP-04	NC	NC	NC	NC	<1.0	0.6	NC
NSFVP-05	NC	NC	NC	NC	<1.0	0.6	NC
NSFVP-06	NC	NC	NC	NC	1.6	0.6	NC
NSFVP-07	NC	NC	NC	NC	1.0	1.0	NC
NSFVP-08	NC	NC	NC	NC	7.4	0.6	NC
NSFVP-09	NC	NC	NC	NC	<1.0	0.6	NC
NSFVP-10	<3	<3	<4	—	7.4	1.0	1.04
NSFVP-11	NC	NC	NC	NC	6.4	1.0	NC
NSFVP-12	NC	NC	NC	NC	—	0.6	NC
NSFVP-13	NC	NC	NC	NC	<1.0	0.6	NC
NSFVP-14	NC	NC	NC	NC	<1.0	0.8	NC
NSFVP-15	NC	NC	NC	NC	5.1	1.0	NC
NSFVP-16	NC	NC	NC	NC	—	0.6	NC
NSFVP-17	NC	NC	NC	NC	6.7	1.0	NC
NSFVP-18	NC	NC	NC	NC	6.4	1.0	NC
NSFVP-19	—	—	<4	<4	6.7	1.0	0.97
NSFVP-20	NC	NC	NC	NC	6.7	1.0	NC
NSFVP-21	NC	NC	NC	NC	8.0	1.6	NC
NSFVP-22	NC	NC	NC	NC	6.4	1.0	NC
NSFVP-23	NC	NC	NC	NC	1.9	0.6	NC
NSFVP-24	NC	NC	NC	NC	<1.0	0.6	NC
NSFVP-25	NC	NC	NC	NC	<1.0	0.8	NC
NSFVP-26	<3	<3	<4	<4	—	0.6	0.13
NSFVP-27	NC	NC	NC	NC	4.8	0.6	NC
NSFVP-28	NC	NC	NC	NC	5.4	1.0	NC
NSFVP-29	<3	<3	<4	<4	7.4	1.0	1.05
NSFVP-30	—	<3	<4	<4	8.3	1.0	0.70
NSFVP-31	NC	NC	NC	NC	4.5	0.6	NC
NSFVP-32	NC	NC	NC	NC	1.3	1.0	NC
NSFVP-33	NC	NC	NC	NC	2.6	1.0	NC

Table 19. Isotope and radioactivity measured in ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; values in bold indicate concentrations that exceed the proposed maximum contaminant level (MCL); pCi/L, picocuries per liter; NC, sample not collected; <, less than; —, not detected]

GAMA identification No.	Alpha radioactivity, 72-hour count (pCi/L) (62636)	Alpha radioactivity, 30-day count (pCi/L) (62369)	Beta radioactivity, 72-hour count (pCi/L) (62642)	Beta radioactivity, 30-day count (pCi/L) (62645)	Tritium (pCi/L) (07000)	Tritium 2-sigma combined uncertainty (pCi/L) (75985)	Carbon-14 (percent modern) (49933)
NSFVP-34	<3	<3	5	4	—	0.6	0.20
NSFVP-35	NC	NC	NC	NC	2.9	0.6	NC
NSFVP-36	NC	NC	NC	NC	<1.0	0.6	NC
NSFVP-37	<3	<3	<4	<4	5.8	1.0	0.97
NSFVP-38	<3	<3	<4	4	—	0.6	0.01
NSFVP-39	NC	NC	NC	NC	1.9	1.0	NC
NSFVP-40	<3	4	7	8	—	0.6	0.13
NSFVP-41	NC	NC	NC	NC	7.0	1.0	NC
NSFVP-42	NC	NC	NC	NC	<1.0	0.6	NC
NSFVP-43	NC	NC	NC	NC	<1.0	0.6	NC
NSFVP-44	NC	NC	NC	NC	—	0.6	NC
NSFVP-45	—	—	20	22	1.0	0.6	0.07
NSFVP-46	<3	—	—	—	7.4	1.0	NC
NSFVP-47	NC	NC	NC	NC	7.7	0.6	NC
NSFVP-48	NC	NC	NC	NC	<1.0	0.6	NC
NSFVP-49	<3	<3	10	11	—	0.6	0.02
NSFVP-50	<3	<3	9	9	<1.0	0.6	0.19
NSFVPFP-01	<3	—	<4	<4	<1.0	0.6	0.24
NSFVPFP-02	<3	<3	<4	<4	1.6	0.6	0.85
NSFVPFP-03	NC	NC	NC	NC	7.7	1.0	NC
NSFVPFP-04	NC	NC	NC	NC	8.0	1.0	NC
Volcanic Highlands wells							
NSFVOL-01	<3	—	<4	<4	<1.0	0.6	0.69
NSFVOL-02	NC	NC	NC	NC	1.6	0.6	NC
NSFVOL-03	NC	NC	NC	NC	<1.0	0.6	NC
NSFVOL-04	NC	NC	NC	NC	<1.0	0.6	NC
NSFVOL-05	NC	NC	NC	NC	2.2	0.8	NC
NSFVOL-06	NC	NC	NC	NC	<1.0	0.6	NC
NSFVOL-07	NC	NC	NC	NC	1.0	0.6	NC
NSFVOL-08	NC	NC	NC	NC	—	1.0	NC
NSFVOL-09	NC	NC	NC	NC	<1.0	0.6	NC
NSFVOL-10	NC	NC	NC	NC	7.7	1.0	NC
NSFVOL-11	NC	NC	NC	NC	2.9	0.6	NC
NSFVOL-12	NC	NC	NC	NC	—	0.6	NC

Table 19. Isotope and radioactivity measured in ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; values in bold indicate concentrations that exceed the proposed maximum contaminant level (MCL); pCi/L, picocuries per liter; NC, sample not collected; <, less than; —, not detected]

GAMA identification No.	Alpha radioactivity, 72-hour count (pCi/L) (62636)	Alpha radioactivity, 30-day count (pCi/L) (62369)	Beta radioactivity, 72-hour count (pCi/L) (62642)	Beta radioactivity, 30-day count (pCi/L) (62645)	Tritium (pCi/L) (07000)	Tritium 2-sigma combined uncertainty (pCi/L) (75985)	Carbon-14 (percent modern) (49933)
NSFVOL-13	NC	NC	NC	NC	9.9	1.0	NC
NSFVOL-14	<3	—	<4	<4	4.2	0.6	0.93
NSFVOL-15	NC	NC	NC	NC	<1.0	1.0	NC
NSFVOL-16	NC	NC	NC	NC	<1.0	1.0	NC
NSFVOL-17	NC	NC	NC	NC	1.6	0.6	NC
NSFVOL-18	NC	NC	NC	NC	1.0	1.0	NC
NSFVOL-19	—	<3	5	5	<1.0	0.6	0.52
NSFVOL-20	<3	<3	6	6	1.0	0.6	0.48
Wilson Grove Formation Highlands wells							
NSFWG-01	NC	NC	NC	NC	2.9	0.8	NC
NSFWG-02	NC	NC	NC	NC	1.9	0.8	NC
NSFWG-03	NC	NC	NC	NC	—	0.8	NC
NSFWG-04	NC	NC	NC	NC	<1.0	0.8	NC
NSFWG-05	NC	NC	NC	NC	<1.0	0.8	NC
NSFWG-06	NC	NC	NC	NC	6.1	1.0	NC
NSFWG-07	NC	NC	NC	NC	<1.0	0.6	NC
NSFWG-08	—	—	<4	<4	2.6	0.6	0.57
NSFWG-09	NC	NC	NC	NC	1.3	0.6	0.88
NSFWG-10	—	—	—	<4	—	0.6	0.23
NSFWG-11	NC	NC	NC	NC	—	1.0	NC
NSFWG-12	NC	NC	NC	NC	—	0.6	NC
NSFWG-13	NC	NC	NC	NC	<1.0	0.6	NC
NSFWG-14	<3	NC	NC	NC	1.0		NC
NSFWGFP-01	NC	NC	NC	NC	2.2	0.6	0.45
Hydrothermal study							
NSFHOT-01	NC	NC	NC	NC	NC	NC	NC
NSFHOT-02	NC	NC	NC	NC	NC	NC	NC
NSFHOT-03	NC	NC	NC	NC	NC	NC	NC
NSFHOT-04	NC	NC	NC	NC	NC	NC	NC
NSFHOT-05	NC	NC	NC	NC	NC	NC	NC
NSFHOT-06	NC	NC	NC	NC	NC	NC	NC
NSFHOT-07	NC	NC	NC	NC	NC	NC	NC
NSFHOT-08	NC	NC	NC	NC	NC	NC	NC

Table 19. Isotope and radioactivity measured in ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; values in bold indicate concentrations that exceed the proposed maximum contaminant level (MCL); pCi/L, picocuries per liter; NC, sample not collected; <, less than; —, not detected]

GAMA identification No.	Radon-222 (pCi/L) (82303)	Radon-222 2-sigma combined uncertainty (pCi/L) (76002)	Radium-226 (pCi/L) (09511)	Radium-228 (pCi/L) (81366)	Deuterium/ protium (per mil) (82082)	Carbon-13/ carbon-12 (per mil) (82081)	Oxygen-18/ oxygen-16 (per mil) (82085)
Valley and Plains wells							
NSFVP-01	NC	NC	NC	NC	–41	NC	–6.2
NSFVP-02	NC	NC	NC	NC	–36	NC	–5.7
NSFVP-03	NC	NC	NC	NC	–38	NC	–5.9
NSFVP-04	NC	NC	NC	NC	–39	NC	–6.0
NSFVP-05	NC	NC	NC	NC	–41	NC	–6.3
NSFVP-06	NC	NC	NC	NC	–40	NC	–6.0
NSFVP-07	NC	NC	NC	NC	–42	NC	–6.3
NSFVP-08	NC	NC	NC	NC	–41	NC	–6.2
NSFVP-09	NC	NC	NC	NC	–41	NC	–6.4
NSFVP-10	280	22	0.16	<1	–40	–19.44	–6.3
NSFVP-11	NC	NC	NC	NC	–45	NC	–6.7
NSFVP-12	NC	NC	NC	NC	–36	NC	–5.7
NSFVP-13	NC	NC	NC	NC	–39	NC	–6.3
NSFVP-14	NC	NC	NC	NC	–43	NC	–6.5
NSFVP-15	NC	NC	NC	NC	–36	NC	–5.8
NSFVP-16	NC	NC	NC	NC	–43	NC	–6.6
NSFVP-17	NC	NC	NC	NC	–47	NC	–7.2
NSFVP-18	NC	NC	NC	NC	–37	NC	–5.9
NSFVP-19	240	22	0.05	—	–51	–15.68	–7.4
NSFVP-20	NC	NC	NC	NC	–38	NC	–6.0
NSFVP-21	NC	NC	NC	NC	–39	NC	–6.0
NSFVP-22	NC	NC	NC	NC	–39	NC	–5.9
NSFVP-23	NC	NC	NC	NC	–41	NC	–6.3
NSFVP-24	NC	NC	NC	NC	–39	NC	–6.2
NSFVP-25	NC	NC	NC	NC	–41	NC	–6.5
NSFVP-26	**570**	27	0.08	<1	–44	–17.64	–6.9
NSFVP-27	NC	NC	NC	NC	–42	NC	–6.7
NSFVP-28	NC	NC	NC	NC	–40	NC	–6.3
NSFVP-29	**330**	24	0.07	<1	–44	–17.85	–7.0
NSFVP-30	**380**	24	0.08	—	–46	–13.97	–7.0
NSFVP-31	NC	NC	NC	NC	–41	NC	–6.4
NSFVP-32	NC	NC	NC	NC	–44	NC	–6.8
NSFVP-33	NC	NC	NC	NC	–40	NC	–6.4

Table 19. Isotope and radioactivity measured in ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; values in bold indicate concentrations that exceed the proposed maximum contaminant level (MCL); pCi/L, picocuries per liter; NC, sample not collected; <, less than; —, not detected]

GAMA identification No.	Radon-222 (pCi/L) (82303)	Radon-222 2-sigma combined uncertainty (pCi/L) (76002)	Radium-226 (pCi/L) (09511)	Radium-228 (pCi/L) (81366)	Deuterium/ protium (per mil) (82082)	Carbon-13/ carbon-12 (per mil) (82081)	Oxygen-18/ oxygen-16 (per mil) (82085)
NSFVP-34	**1,200**	36	0.07	<1	–47	–17.58	–7.1
NSFVP-35	NC	NC	NC	NC	–40	NC	–5.9
NSFVP-36	NC	NC	NC	NC	–53	NC	–7.7
NSFVP-37	**770**	30	0.05	—	–39	–19.98	–6.0
NSFVP-38	**680**	29	0.06	<1	–50	–14.62	–7.8
NSFVP-39	NC	NC	NC	NC	–47	NC	–7.1
NSFVP-40	250	21	0.08	<1	–47	–15.57	–7.0
NSFVP-41	NC	NC	NC	NC	–40	NC	–6.0
NSFVP-42	NC	NC	NC	NC	–40	NC	–6.5
NSFVP-43	NC	NC	NC	NC	–40	NC	–6.3
NSFVP-44	NC	NC	NC	NC	–48	NC	–7.2
NSFVP-45	**1,100**	35	0.17	<1	–52	–13.63	–7.8
NSFVP-46	**1,000**	32	0.09	—	–43	NC	–6.4
NSFVP-47	NC	NC	NC	NC	–40	NC	–6.1
NSFVP-48	NC	NC	NC	NC	–41	NC	–6.4
NSFVP-49	**990**	32	0.09	<1	–51	–17.1	–7.5
NSFVP-50	**940**	34	0.07	<1	–49	–19.31	–7.2
NSFVPFP-01	260	22	0.09	—	–39	–19.53	–6.3
NSFVPFP-02	**670**	28	0.09	—	–39	–18.12	–5.9
NSFVPFP-03	NC	NC	NC	NC	–41	NC	–6.3
NSFVPFP-04	NC	NC	NC	NC	–39	NC	–6.1
Volcanic Highlands wells							
NSFVOL-01	**670**	28	0.08	—	–41	–19.88	–6.5
NSFVOL-02	NC	NC	NC	NC	NC	NC	NC
NSFVOL-03	NC	NC	NC	NC	NC	NC	NC
NSFVOL-04	NC	NC	NC	NC	NC	NC	NC
NSFVOL-05	NC	NC	NC	NC	–43	NC	–6.7
NSFVOL-06	NC	NC	NC	NC	–45	NC	–6.9
NSFVOL-07	NC	NC	NC	NC	–42	NC	–6.6
NSFVOL-08	NC	NC	NC	NC	–42	NC	–6.8
NSFVOL-09	NC	NC	NC	NC	–41	NC	–6.6
NSFVOL-10	NC	NC	NC	NC	–42	NC	–6.8
NSFVOL-11	NC	NC	NC	NC	–46	NC	–7.3
NSFVOL-12	NC	NC	NC	NC	–50	NC	–7.7

Table 19. Isotope and radioactivity measured in ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[The five-digit number in parentheses below the constituent name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property; LRL, laboratory reporting level; NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; values in bold indicate concentrations that exceed the proposed maximum contaminant level (MCL); pCi/L, picocuries per liter; NC, sample not collected; <, less than; —, not detected]

GAMA identification No.	Radon-222 (pCi/L) (82303)	Radon-222 2-sigma combined uncertainty (pCi/L) (76002)	Radium-226 (pCi/L) (09511)	Radium-228 (pCi/L) (81366)	Deuterium/ protium (per mil) (82082)	Carbon-13/ carbon-12 (per mil) (82081)	Oxygen-18/ oxygen-16 (per mil) (82085)
NSFVOL-13	NC	NC	NC	NC	–34	NC	–4.5
NSFVOL-14	**400**	23	0.07	<1	–40	–17.6	–6.1
NSFVOL-15	NC	NC	NC	NC	–45	NC	–7.2
NSFVOL-16	NC	NC	NC	NC	–47	NC	–7.1
NSFVOL-17	NC	NC	NC	NC	–46	NC	–7.1
NSFVOL-18	NC	NC	NC	NC	–48	NC	–7.2
NSFVOL-19	**670**	29	0.14	<1	–47	–13.12	–7.4
NSFVOL-20	**1,500**	39	0.10	<1	–45	–19.11	–7.0
Wilson Grove Formation Highlands wells							
NSFWG-01	NC	NC	NC	NC	–37	NC	–6.2
NSFWG-02	NC	NC	NC	NC	–37	NC	–5.9
NSFWG-03	NC	NC	NC	NC	–37	NC	–6.2
NSFWG-04	NC	NC	NC	NC	NC	NC	NC
NSFWG-05	NC	NC	NC	NC	–41	NC	–6.7
NSFWG-06	NC	NC	NC	NC	–32	NC	–5.4
NSFWG-07	NC	NC	NC	NC	–44	NC	–6.6
NSFWG-08	210	21	0.10	<1	–38	–17.99	–6.1
NSFWG-09	NC	NC	NC	NC	–38	–20.46	–6.1
NSFWG-10	210	22	0.05	—	–36	–18.11	–5.8
NSFWG-11	NC	NC	NC	NC	–37	NC	–5.9
NSFWG-12	NC	NC	NC	NC	–38	NC	–5.9
NSFWG-13	NC	NC	NC	NC	–35	NC	–5.6
NSFWG-14	NC	NC	NC	NC	–35	NC	–5.5
NSFWGFP-01	NC	NC	NC	NC	–38	–15.48	–6.1
Hydrothermal study							
NSFHOT-01	NC	NC	NC	NC	–51	NC	–7.8
NSFHOT-02	NC	NC	NC	NC	–53	NC	–8.3
NSFHOT-03	NC	NC	NC	NC	–41	NC	–6.2
NSFHOT-04	NC	NC	NC	NC	–54	NC	–8.2
NSFHOT-05	NC	NC	NC	NC	–53	NC	–8.3
NSFHOT-06	NC	NC	NC	NC	–42	NC	–6.1
NSFHOT-07	NC	NC	NC	NC	–52	NC	–7.6
NSFHOT-08	NC	NC	NC	NC	–51	NC	–7.5

Table 20. Tritium and noble gas results, analyzed at the Lawrence Livermore National Laboratory for samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; cm^3 STP $g^{-1}H_2O$, cubic centimeters at standard temperature and pressure, per gram of water; pCi/L, picocuries per liter; NC, sample not collected; <, less than; —, not detected]

GAMA identification No.	Collection date	Tritium (pCi/L)	Tritium, measurement uncertainty (+/-) (pCi/L)	Dissolved gas analysis date	Helium-3/ Helium-4 (atom ratio)	Helium-4	Neon	Argon	Krypton	Xenon
						(cm^3 STP $g^{-1}H_2O$)				
					x 10^{-6}	x 10^{-7}	x 10^{-7}	x 10^{-4}	x 10^{-8}	x 10^{-8}
Valley and Plains wells										
NSFVP-01	08/31/2004	1.82	0.2	12/15/2004	2.47	2.45	2.06	3.65	8.90	1.24
NSFVP-02	08/31/2004	2.06	0.2	12/15/2004	1.40	0.53	2.14	3.66	8.56	1.14
NSFVP-03	08/31/2004	1.91	0.2	12/15/2004	1.29	0.79	2.32	3.84	8.74	1.17
NSFVP-04	09/01/2004	<1.0	0.1	12/15/2004	1.19	0.57	2.07	3.50	8.18	1.11
NSFVP-05	09/01/2004	<1.0	0.2	12/15/2004	1.44	3.08	2.50	4.11	9.19	1.27
NSFVP-06	09/01/2004	1.21	0.2	12/15/2004	1.44	0.89	2.96	4.32	9.58	1.25
NSFVP-07	09/02/2004	<1.0	0.1	12/16/2004	0.94	0.98	2.57	4.04	8.99	1.21
NSFVP-08	09/02/2004	7.71	0.4	12/16/2004	1.46	0.52	2.05	3.50	7.91	1.09
NSFVP-09	09/02/2004	<1.0	0.9	12/16/2004	1.05	0.78	2.53	4.03	8.88	1.23
NSFVP-10	09/13/2004	8.34	0.4	12/17/2004	1.16	0.79	2.51	4.00	8.91	1.19
NSFVP-11	09/13/2004	7.96	0.4	12/16/2004	1.36	0.44	1.88	3.07	6.84	0.94
NSFVP-12	09/13/2004	<1.0	0.2	03/04/2005	1.38	0.44	1.91	3.14	6.98	0.92
NSFVP-13	09/14/2004	3.18	1.0	12/16/2004	1.23	0.60	2.35	3.75	8.22	1.13
NSFVP-14	09/14/2004	—	0.2	12/16/2004	1.02	2.55	2.47	4.15	9.61	1.31
NSFVP-15	09/14/2004	5.59	0.4	12/17/2004	1.45	1.61	5.99	6.47	12.14	1.44
NSFVP-16	09/15/2004	1.50	0.2	03/04/2005	3.57	2.60	2.92	9.00	7.96	1.17
NSFVP-17	09/15/2004	7.65	0.4	12/17/2004	1.33	0.53	2.08	3.44	7.82	1.07
NSFVP-18	09/16/2004	8.35	0.4	12/17/2004	1.35	0.45	2.04	3.47	7.98	1.15
NSFVP-19	09/16/2004	9.03	0.5	12/18/2004	1.34	0.54	2.06	3.13	6.91	0.92
NSFVP-20	09/16/2004	7.56	0.4	12/18/2004	1.42	0.77	2.67	4.13	9.03	1.23
NSFVP-21	09/20/2004	7.06	0.4	12/21/2004	1.54	0.81	3.20	4.42	9.22	1.24
NSFVP-22	09/20/2004	5.54	0.3	12/21/2004	1.45	0.85	2.70	4.01	8.54	1.15
NSFVP-23	09/20/2004	2.57	0.2	12/21/2004	0.72	2.62	2.49	4.68	8.71	1.25
NSFVP-24	09/22/2004	<1.0	0.2	12/22/2004	1.50	1.20	2.41	3.83	8.50	1.15
NSFVP-25	09/23/2004	<1.0	0.2	12/22/2004	1.18	0.80	2.49	3.71	8.47	1.09

Table 20. Tritium and noble gas results, analyzed at the Lawrence Livermore National Laboratory for samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; cm^3 STP $g^{-1}H_2O$, cubic centimeters at standard temperature and pressure, per gram of water; pCi/L, picocuries per liter; NC, sample not collected; <, less than; —, not detected]

GAMA identification No.	Collection date	Tritium (pCi/L)	Tritium, measurement uncertainty (+/-) (pCi/L)	Dissolved gas analysis date	Helium-3/ Helium-4 (atom ratio)	Helium-4	Neon	Argon	Krypton	Xenon
						(cm^3 STP $g^{-1}H_2O$)				
					x 10^{-6}	x 10^{-7}	x 10^{-7}	x 10^{-4}	x 10^{-8}	x 10^{-8}
NSFVP-26	09/27/2004	<1.0	0.2	12/22/2004	0.81	1.91	2.64	4.07	8.70	1.19
NSFVP-27	09/28/2004	2.24	0.3	12/22/2004	1.20	0.86	2.53	3.97	8.78	1.18
NSFVP-28	09/28/2004	2.72	0.3	12/23/2004	1.15	1.28	3.04	4.26	8.95	1.15
NSFVP-29	09/28/2004	7.90	0.4	12/23/2004	1.43	0.47	2.00	3.46	7.83	1.07
NSFVP-30	09/29/2004	7.78	0.5	12/29/2004	1.13	0.90	2.18	3.61	8.32	1.11
NSFVP-31	09/30/2004	4.50	0.3	12/29/2004	1.56	0.89	2.82	4.23	8.97	1.16
NSFVP-32	10/07/2004	1.30	0.2	12/30/2004	2.19	1.70	2.70	4.13	9.07	1.19
NSFVP-33	10/07/2004	2.62	0.2	01/03/2005	1.26	0.85	2.95	4.10	8.84	1.16
NSFVP-34	10/18/2004	—	0.1	03/04/2005	3.98	6.80	2.03	3.11	7.17	0.95
NSFVP-35	10/18/2004	3.71	0.2	01/03/2005	1.47	0.68	2.69	4.05	8.91	1.19
NSFVP-36	10/19/2004	<1.0	0.1	01/03/2005	0.45	2.22	2.33	4.04	9.32	1.29
NSFVP-37	10/19/2004	6.28	0.3	11/04/2004	1.88	0.70	2.45	3.98	8.65	1.14
NSFVP-38	10/20/2004	<1.0	0.2	11/05/2004	1.61	12.77	2.22	3.69	8.33	1.17
NSFVP-39	10/21/2004	2.03	0.2	03/05/2005	1.64	1.11	2.33	3.65	8.28	1.10
NSFVP-40	10/21/2004	<1.0	0.1	11/05/2004	5.01	7.06	2.14	3.57	7.97	1.15
NSFVP-41	10/21/2004	7.81	0.4	03/05/205	1.38	1.96	2.69	3.94	8.63	1.13
NSFVP-42	10/25/2004	<1.0	0.1	03/05/2005	1.37	0.64	2.72	4.09	9.15	1.18
NSFVP-43	10/26/2004	<1.0	0.1	03/03/2005	1.12	0.73	2.42	3.81	8.73	1.15
NSFVP-44	10/26/2004	<1.0	0.1	NC	NC	NC	NC	NC	NC	NC
NSFVP-45	11/02/2004	<1.0	0.1	03/04/2005	0.29	3.56	2.93	4.34	9.71	1.25
NSFVP-46	11/03/2004	6.86	0.5	03/02/2005	4.13	1.82	2.50	3.83	8.48	1.10
NSFVP-47	11/03/2004	7.15	0.3	03/02/2005	1.71	0.49	1.85	3.18	7.19	0.98
NSFVP-48	11/04/2004	<1.0	0.1	03/04/2005	0.55	3.26	2.26	5.97	7.86	1.15
NSFVP-49	11/17/2004	NC	NC	03/03/2005	6.47	18.42	2.38	8.88	7.99	1.30
NSFVP-50	11/18/2004	NC	NC	03/03/2005	0.89	1.19	2.65	4.11	9.30	1.22

Table 20. Tritium and noble gas results, analyzed at the Lawrence Livermore National Laboratory for samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; cm^3 STP $g^{-1}H_2O$, cubic centimeters at standard temperature and pressure, per gram of water; pCi/L, picocuries per liter; NC, sample not collected; <, less than; —, not detected]

GAMA identification No.	Collection date	Tritium (pCi/L)	Tritium, measurement uncertainty (+/-) (pCi/L)	Dissolved gas analysis date	Helium-3/ Helium-4 (atom ratio)	Helium-4	Neon	Argon	Krypton	Xenon
						(cm^3 STP $g^{-1}H_2O$)				
					x 10^{-6}	x 10^{-7}	x 10^{-7}	x 10^{-4}	x 10^{-8}	x 10^{-8}
NSFVPFP-01	09/14/2004	<1.0	0.2	12/17/2004	0.85	1.43	2.63	4.12	9.08	1.25
NSFVPFP-02	09/30/2004	3.29	0.2	12/28/2004	1.35	0.76	2.80	4.26	9.33	1.23
NSFVPFP-03	10/20/2004	8.73	0.4	01/04/2005	0.53	12.29	2.09	3.68	8.32	1.11
NSFVPFP-04	09/13/2004	8.23	0.4	12/16/2004	1.30	0.65	2.32	3.81	8.78	1.21
Volcanic Highlands wells										
NSFVOL-01	09/15/2004	<1.0	0.2	12/17/2004	1.28	0.63	2.49	3.62	8.07	1.10
NSFVOL-02	09/15/2004	3.14	0.2	NC	NC	NC	NC	NC	NC	NC
NSFVOL-03	09/27/2004	<1.0	0.2	12/22/2004	0.75	1.72	2.18	3.37	7.36	0.98
NSFVOL-04	09/27/2004	<1.0	0.2	12/22/2004	1.36	0.72	2.58	4.08	8.92	1.23
NSFVOL-05	09/27/2004	1.14	0.2	12/22/2004	1.40	0.56	2.32	3.73	8.37	1.13
NSFVOL-06	09/29/2004	<1.0	0.2	12/23/2004	0.83	2.56	2.74	4.07	8.69	1.15
NSFVOL-07	09/29/2004	<1.0	0.1	12/28/2004	1.22	0.67	2.45	3.71	8.20	1.06
NSFVOL-08	09/29/2004	<1.0	0.2	12/29/2004	1.27	0.68	2.62	3.76	8.17	1.08
NSFVOL-09	09/29/2004	<1.0	0.4	12/29/2004	1.13	0.73	2.50	3.73	8.45	1.12
NSFVOL-10	10/05/2004	8.01	0.4	12/30/2004	1.36	0.57	2.43	3.78	8.52	1.18
NSFVOL-11	10/06/2004	2.91	0.2	12/30/2004	1.32	0.59	2.37	3.78	8.44	1.13
NSFVOL-12	10/06/2004	<1.0	0.1	12/30/2004	1.21	0.81	2.28	3.58	8.17	1.09
NSFVOL-13	10/06/2004	10.98	0.5	12/30/2004	1.61	0.76	3.04	4.13	8.69	1.18
NSFVOL-14	10/07/2004	5.20	0.3	01/03/2005	1.44	0.58	2.50	3.83	8.35	1.14
NSFVOL-15	10/07/2004	1.09	0.2	01/03/2005	1.35	0.70	2.56	3.91	8.53	1.17
NSFVOL-16	10/19/2004	<1.0	0.1	01/03/2005	3.43	4.30	2.38	4.42	6.67	0.96
NSFVOL-17	10/20/2004	1.70	0.2	01/04/2005	1.16	0.78	2.72	4.05	8.98	1.19
NSFVOL-18	10/20/2004	<1.0	0.4	01/04/2005	1.83	1.87	2.23	3.57	8.22	1.11
NSFVOL-19	11/02/2004	1.67	0.2	03/04/2005	1.26	0.75	2.83	3.78	8.24	1.08
NSFVOL-20	11/04/2004	1.11	0.1	03/03/2005	1.21	0.57	2.25	4.03	9.47	1.28

Table 20. Tritium and noble gas results, analyzed at the Lawrence Livermore National Laboratory for samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004—Continued.

[NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; NSFHOT, hydrothermal study; cm^3 STP $g^{-1}H_2O$, cubic centimeters at standard temperature and pressure, per gram of water; pCi/L, picocuries per liter; NC, sample not collected; <, less than; —, not detected]

GAMA identification No.	Collection date	Tritium (pCi/L)	Tritium, measurement uncertainty (+/-) (pCi/L)	Dissolved gas analysis date	Helium-3/ Helium-4 (atom ratio)	Helium-4	Neon	Argon	Krypton	Xenon
						(cm^3 STP $g^{-1}H_2O$)				
					x 10^{-6}	x 10^{-7}	x 10^{-7}	x 10^{-4}	x 10^{-8}	x 10^{-8}
Wilson Grove Formation Highlands wells										
NSFWG-01	09/16/2004	2.79	0.3	12/18/2004	1.50	0.60	2.61	3.94	8.85	1.19
NSFWG-02	09/21/2004	1.76	0.2	12/21/2004	1.38	0.44	1.84	3.33	7.67	1.08
NSFWG-03	09/21/2004	<1.0	0.1	12/21/2004	1.35	0.65	2.74	4.05	8.83	1.17
NSFWG-04	09/22/2004	—	—	12/21/2004	1.31	0.83	3.29	4.54	9.50	1.22
NSFWG-05	09/22/2004	<1.0	0.1	NC	NC	NC	NC	NC	NC	NC
NSFWG-06	09/23/2004	5.95	0.4	NC	NC	NC	NC	NC	NC	NC
NSFWG-07	09/30/2004	<1.0	0.1	12/28/2004	0.82	1.57	2.31	3.88	9.00	1.21
NSFWG-08	10/04/2004	2.77	0.2	12/28/2004	1.42	0.79	3.05	4.31	9.02	1.19
NSFWG-09	10/04/2004	1.50	0.2	12/30/2004	1.39	0.57	2.50	3.86	8.57	1.14
NSFWG-10	10/06/2004	<1.0	0.1	NC	NC	NC	NC	NC	NC	NC
NSFWG-11	10/27/2004	<1.0	0.1	12/30/2004	1.15	0.73	2.34	3.79	8.39	1.13
NSFWG-12	10/27/2004	<1.0	0.1	01/04/2005	1.14	0.64	2.25	3.74	8.44	1.15
NSFWG-13	10/28/2004	<1.0	0.1	NC	NC	NC	NC	NC	NC	NC
NSFWG-14	11/04/2004	<1.0	0.1	03/02/2005	0.71	0.95	2.04	3.40	8.06	1.10
NSFWGFP-01	10/05/2004	2.61	0.2	12/30/2004	1.38	0.69	2.65	4.04	8.91	1.19
Hydrothermal study										
NSFHOT-01	10/19/2004	1.61	0.2	11/05/2004	6.90	15.38	1.22	1.87	5.14	0.61
NSFHOT-02	10/21/2004	<1.0	0.1	11/05/2004	6.94	20.52	1.46	2.00	6.22	0.63
NSFHOT-03	10/21/2004	9.05	0.4	03/02/2005	2.35	0.85	2.79	3.66	7.62	0.96
NSFHOT-04	10/19/2004	<1.0	0.2	11/04/2004	6.86	18.88	1.10	1.69	4.06	0.56
NSFHOT-05	10/19/2004	<1.0	0.2	03/04/2005	7.01	0.90	0.07	1.35	0.79	0.07
NSFHOT-06	10/20/2004	3.77	0.3	11/05/2004	3.77	38.90	2.14	3.51	7.50	1.09
NSFHOT-07	10/20/2004	—	—	NC	NC	NC	NC	NC	NC	NC
NSFHOT-08	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC

Table 21. Concentrations of the dissolved gases: carbon dioxide, nitrogen, argon, oxygen, and methane analyzed at Lawrence Livermore National Laboratory in samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[cm^3 STP g^{-1} H_20, centimeters cubed at standard temperature and pressure, per gram of water; NSFVP, Valley and Plains study area; NSFHOT, hydrothermal study]

GAMA identification No.	Carbon dioxide	Nitrogen	Argon	Oxygen	Methane
	(cm^3 STP g^{-1} H_20)				
	x 10^{-2}	x 10^{-2}	x 10^{-2}	x 10^{-2}	x 10^{-4}
Valley and Plains wells					
NSFVP-34	35.5	4.71	4.31	1.16	0.41
NSFVP-37	117	6.05	5.08	2.31	0.32
NSFVP-38	16.7	4.48	4.20	0.72	4.87
NSFVP-40	29.6	4.54	4.17	0.43	8.03
Hydrothermal study					
NSFHOT-01	14.2	1.05	1.10	0.56	44.0
NSFHOT-02	22.7	1.97	1.49	0.41	97.3
NSFHOT-03	283	4.75	3.86	1.42	0.66
NSFHOT-04	50.8	2.18	2.01	1.21	103
NSFHOT-05	4.58	0.36	0.44	0.45	3.35
NSFHOT-06	22.1	4.35	3.76	0.60	98.4
NSFHOT-07	4.94	3.41	1.89	0.71	313

Table 22. Microbial analyses of ground-water samples collected for the North San Francisco Bay Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, August to November 2004.

[The five-digit number below the compound name is the U.S. Geological Survey parameter code used to uniquely identify a specific constituent or property. NSFVP, Valley and Plains study area; NSFVPFP, Valley and Plains flow-path well; NSFVOL, Volcanic Highlands study area; NSFWG, Wilson Grove Formation Highlands study area; NSFWGFP, Wilson Grove Formation Highlands flow-path well; ml, milliliter; NR, not reported; —, not detected]

GAMA identification No.	Coliphage F-specific (99335)	Coliphage somatic (99332)	*E.* coli (colonies/ 100ml) (90901)	Total coliforms (colonies/100ml) (90900)
Valley and Plains wells				
NSFVP-10	—	—	—	—
NSFVP-19	—	—	—	—
NSFVP-26	—	—	—	—
NSFVP-29	—	—	—	—
NSFVP-30	—	—	—	—
NSFVP-34	—	—	—	—
NSFVP-37	—	—	—	—
NSFVP-38	—	—	NR	E2
NSFVP-40	—	—	—	—
NSFVP-45	—	—	—	—
NSFVP-46	—	—	—	9
NSFVP-49	—	—	—	—
NSFVP-50	—	—	—	—
NSFVPFP-01	—	—	—	—
NSFVPFP-02	—	—	—	—
Volcanic Highlands wells				
NSFVOL-01	—	—	—	—
NSFVOL-14	—	—	—	—
NSFVOL-19	—	—	—	—
NSFVOL-20	—	—	—	—
Wilson Grove Highlands Formation wells				
NSFWG-08	—	—	—	—
NSFWG-10	—	—	—	20
NSFWGFP-01	—	—	—	—
Hydrothermal study (not collected)				