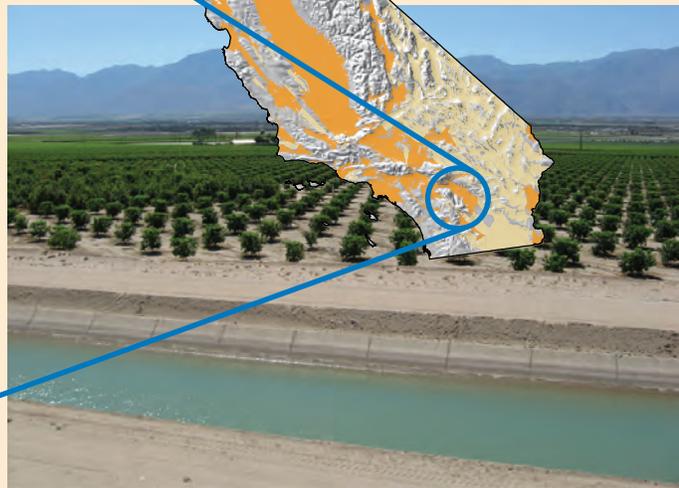


In cooperation with the California State Water Resources Control Board
A product of the California Groundwater Ambient Monitoring and Assessment (GAMA) Program

Ground-Water Quality Data in the Coachella Valley Study Unit, 2007: Results from the California GAMA Program

Data Series 373



U.S. Department of the Interior
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Top: Wind farm, San Geronio Pass, California. Photograph taken by Dara Goldrath, U.S. Geological Survey (USGS).

Middle: Coachella Canal with citrus orchard in background, Coachella Valley, California. Photograph taken by Michael T. Wright, (USGS).

Bottom left: "Mr. Rex", Cabazon, California. Photograph taken by Dara Goldrath, (USGS).

Bottom right: Irrigation well on Golf course used for sampling near Indio, California. Photograph taken by Timothy Mathany, (USGS).

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By Dara A. Goldrath, Michael T. Wright, and Kenneth Belitz

Prepared in cooperation with the California State Water Resources Control Board

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**U.S. Department of the Interior
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Abbreviations and Acronyms

AB	Assembly Bill (through the California State Assembly)
AL-US	action level (USEPA, see “Organizations”)
CAS	Chemical Abstracts Service (American Chemical Society)
COA Study Unit	Coachella Valley study unit
CSU	combined standard uncertainty
E	estimated or having a higher degree of uncertainty
GAMA	Groundwater Ambient Monitoring and Assessment program
GPS	Global Positioning System
HAL-US	Lifetime Health Advisory Level (USEPA)
HCl	hydrochloric acid
HPLC	high-performance liquid chromatography
LRL	laboratory reporting level
LSD	land-surface datum
LT-MDL	long-term method detection level
MCL-CA	maximum contaminant level (CDPH, see “Organizations”)
MCL-US	maximum contaminant level (USEPA)
MDL	method detection limit
MIMS	Membrane Inlet Mass Spectrometry
MRL	minimum reporting level
MU	method uncertainty
N	Normal (1-gram-equivalent per liter of solution)
na	not available
nc	not collected
–	not detected
NL-CA	California notification level (CDPH)
NWIS	National Water Information System (USGS, see “Organizations”)
PCFF-GAMA	personal computer field forms program designed for GAMA sampling
QC	quality control
RPD	relative percent difference
RSD	relative standard deviation
RSD5-US	risk-specific dose at 10^{-5} (USEPA)
SMCL-CA	secondary maximum contaminant level (CDPH)
SMCL-US	secondary maximum contaminant level (USEPA)
SSMDC	sample-specific minimum detectable concentration
DS	total dissolved solids
TT-US	Treatment Technique (USEPA)
V	analyte detected in sample and an associated blank; thus, data are not included in ground-water quality assessment

Abbreviations and Acronyms—Continued

Organizations

CDPH	California Department of Public Health
CDWR	California Department of Water Resources
LLNL	Lawrence Livermore National Laboratory
MWH	Montgomery Watson-Harza laboratory
NAWQA	National Water Quality Assessment (USGS)
NWQL	National Water Quality Laboratory (USGS)
SWRCB	State Water Resources Control Board (California)
TML	National Research Program Trace Metal Laboratory (USGS)
USEPA	U.S. Environmental Protection Agency
USGS	U. S. Geological Survey
UWCD	United Water Conservation District

Selected Chemical Names

CaCO_3	calcium carbonate
CFC	chlorofluorocarbon
CO_3^{-2}	carbonate
DOC	dissolved organic carbon
HCl	hydrochloric acid
HCO_3^-	bicarbonate
MTBE	methyl <i>tert</i> -butyl ether
NDMA	<i>N</i> -nitrosodimethylamine
PCE	tetrachloroethene
1,2,3-TCP	1,2,3-trichloropropane
TDS	total dissolved solids
THM	trihalomethane
VOC	volatile organic compound

Abbreviations and Acronyms—Continued

Units of Measure

cm ³ STP/g	cubic centimeters at standard temperature and pressure (0 degrees Celsius and 1 atmosphere of pressure per gram of water)
δ^iE	delta notation, the ratio of a heavier isotope of an element (<i>iE</i>) to the more common lighter isotope of that element, relative to a standard reference, expressed as per mil
ft	foot (feet)
in.	inch
kg	kilogram
L	liter
mg	milligram
mg/L	milligrams per liter (parts per million)
mi	mile
mL	milliliter
$\mu\text{g/L}$	micrograms per liter (parts per billion)
μL	microliter
μm	micrometer
$\mu\text{S/cm}$	microsiemens per centimeter
pCi/L	picocurie per liter
per mil	parts per thousand
pmc	percent modern carbon
TU	tritium unit
>	greater than
<	less than
°C	degrees Celsius
°F	degrees Fahrenheit

Notes

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

$$^{\circ}\text{F} = (1.8 \times ^{\circ}\text{C}) + 32$$

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

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

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius ($\mu\text{S/cm}$ at 25°C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter ($\mu\text{g/L}$). Milligrams per liter is equivalent to parts per million (ppm) and micrograms per liter is equivalent to parts per billion (ppb).

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Ground-Water Quality Data in the Coachella Valley Study Unit, 2007: Results from the California GAMA Program

By Dara A. Goldrath, Michael T. Wright, and Kenneth Belitz

Abstract

Ground-water quality in the approximately 820 square-mile Coachella Valley Study Unit (COA) was investigated during February and March 2007 as part of the Priority Basin Project of the Groundwater Ambient Monitoring and Assessment (GAMA) Program. The GAMA Priority Basin Project was developed in response to the Groundwater Quality Monitoring Act of 2001, and is being conducted by the U.S. Geological Survey (USGS) in cooperation with the California State Water Resources Control Board (SWRCB).

The study was designed to provide a spatially unbiased assessment of raw ground water used for public-water supplies within the Coachella Valley, and to facilitate statistically consistent comparisons of ground-water quality throughout California. Samples were collected from 35 wells in Riverside County. Nineteen of the wells were selected using a spatially distributed, randomized grid-based method to provide statistical representation of the study unit (grid wells). Sixteen additional wells were sampled to evaluate changes in water chemistry along selected ground-water flow paths, to examine land use effects on ground-water quality, and to collect water-quality data in areas where little exists. These wells were referred to as “understanding wells.”

The ground-water samples were analyzed for a large number of organic constituents (volatile organic compounds [VOC], pesticides and pesticide degradates, pharmaceutical compounds, and potential wastewater-indicator compounds), constituents of special interest (perchlorate and 1,2,3-trichloropropane [1,2,3-TCP]), naturally occurring inorganic constituents (nutrients, major and minor ions, and trace elements), radioactive constituents, and microbial indicators. Naturally occurring isotopes (uranium, tritium, carbon-14, and stable isotopes of hydrogen, oxygen, and boron), and dissolved noble gases (the last in collaboration with Lawrence Livermore National Laboratory) also were measured to help identify the source and age of the sampled ground water.

A quality-control sample (blank, replicate, or matrix spike) was collected at approximately one quarter of the wells, and the results for these samples were used to evaluate the quality of the data for the ground-water samples. Assessment of the quality-control information resulted in V-coding less than 0.1 percent of the data collected.

This study did not attempt to evaluate the quality of water delivered to consumers; after withdrawal from the ground, water typically is treated, disinfected, and (or) blended with other waters to maintain acceptable water quality. Regulatory thresholds apply to treated water that is supplied to the consumer, not to raw ground water. However, to provide some context for the results, concentrations of constituents measured in the raw ground water were compared with health-based thresholds established by the U.S. Environmental Protection Agency (USEPA) and the California Department of Public Health (CDPH) and thresholds established for aesthetic purposes (secondary maximum contaminant levels, SMCL-CA) by CDPH.

Most constituents detected in ground-water samples were at concentrations below drinking-water thresholds. Volatile organic compounds, pesticides, and pesticide degradates were detected in less than one-third of the grid well samples collected. All VOC and pesticide concentrations measured were below health-based thresholds. Potential waste-water indicators were detected in less than half of the wells sampled, and no detections were above health-based thresholds. Perchlorate was detected in seven grid wells; concentrations from two wells were above the CDPH maximum contaminant level (MCL-CA). Most detections of trace elements in samples collected from COA Study Unit wells were below water-quality thresholds. Exceptions include five samples of arsenic that were above the USEPA maximum contaminant level (MCL-US), two detections of boron above the CDPH notification level (NL-CA), and two detections of molybdenum and strontium above USEPA maximum contaminant levels (HAL-US). Concentrations of nitrite plus nitrate as nitrogen in two understanding well samples were above the USEPA maximum contaminant level (MCL-US). Activities of radon-222 in samples from seven wells were above the proposed MCL-US of 300 pCi/L; however, no samples had an activity above the proposed alternative MCL-US of 4,000 pCi/L. Most samples collected in the COA Study Unit had concentrations of major ions and total dissolved solids below the non-enforceable thresholds set for aesthetic purposes. Major ions detected at concentrations above the SMCL-CA thresholds included chloride, fluoride, sulfate, manganese, and total dissolved solids.

Introduction

Ground water comprises nearly half of the water used for public-supply in California (Hutson and others, 2004). To assess the quality of ground water in aquifers used for drinking-water supply and to establish a program for monitoring trends in ground-water quality, the State Water Resources Control Board (SWRCB), in collaboration with the U.S. Geological Survey (USGS) and Lawrence Livermore National Laboratory (LLNL), implemented the Groundwater Ambient Monitoring and Assessment (GAMA) Program (<http://www.waterboards.ca.gov/gama>). The GAMA Program consists of three projects: Priority Basin Project, conducted by the USGS (<http://ca.water.usgs.gov/gama/>); Voluntary Domestic Well Assessment, conducted by the SWRCB; and Special Studies, conducted by LLNL.

The SWRCB initiated the GAMA Priority Basin Project in response to the Ground-Water Quality Monitoring Act of 2001 (Sections 10780-10782.3 of the California Water Code, Assembly Bill 599). AB 599 is a public mandate to assess and monitor the quality of ground water used as public supply for municipalities in California. The project is a comprehensive assessment of Statewide ground-water quality designed to help better understand and identify risks to ground-water resources and to increase the availability of information about ground-water quality to the public. As part of the AB 599 process, the USGS, in collaboration with the SWRCB, developed the monitoring plan for the project (Belitz and others, 2003; State Water Resources Control Board, 2003). Key aspects of the project are inter-agency collaboration, and cooperation with local water agencies and well owners. Local participation in the project is entirely voluntary.

The GAMA Priority Basin Project is unique to California because the data are derived from the analyses of over three hundred chemical constituents using analytical methods capable of detecting very small concentrations, analyses that are not normally available. A broader understanding of ground-water composition will be especially useful for providing an early indication of changes in water quality, and for identifying the natural and human factors affecting water quality. Additionally, the GAMA Priority Basin Project will analyze a broader suite of constituents than required by the California Department of Public Health (CDPH). Understanding the occurrence and distribution of these constituents is important for the long-term management and protection of ground-water resources.

The range of hydrologic, geologic, and climatic conditions that exists in California must be considered when assessing ground-water quality. Belitz, and others (2003) partitioned the state into 10 hydrogeologic provinces, each with distinctive hydrologic, geologic, and climatic characteristics; representative regions in all 10 provinces were included in the project design (fig. 1). Eighty percent of California's approximately 16,000 public-supply wells are in ground-water basins within these hydrologic provinces. These ground-water basins, defined by the California Department of Water Resources (CDWR), generally consist of relatively permeable, unconsolidated deposits of alluvial or volcanic origin (California Department of Water Resources, 2003). Ground-water basins were prioritized for sampling according to the number of public-supply wells in the basin, with secondary consideration given to municipal ground-water use, agricultural pumping, the number of leaking underground fuel tanks, and pesticide applications within the basins (Belitz, and others, 2003). In addition, some ground-water basins, or groups of adjacent similar basins with relatively few public-supply wells, were assigned high priority status so that all hydrogeologic provinces would be represented in the subset of basins sampled. The 116 priority basins were grouped into 35 study units. Some areas not in the defined ground-water basins were included in several of the study units to represent the 20 percent of public-supply wells not located in the ground-water basins. The Coachella Valley GAMA Study Unit (hereinafter referred to as the COA Study Unit) contains four ground-water subbasins. The COA Study Unit was considered high priority for sampling in order to adequately represent the Desert hydrogeologic province (Belitz, and others, 2003).

Three types of water-quality assessments are being made using the data collected in each study unit: (1) Status: assessing the current quality of the ground-water resource, (2) Trends: detection of changes in ground-water quality and (3) Understanding: identification of the natural and human factors affecting ground-water quality (Kulongoski and Belitz, 2004). This report is one of a series of reports presenting water-quality data collected in each study unit (Wright and others, 2005; Bennett and others, 2006; Kulongoski and others, 2006; Kulongoski and Belitz, 2007; Dawson and others, 2008). Subsequent reports will present the status, trends, and understanding assessments of water-quality in the study units.



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

Provinces from Belitz and others, 2003

Figure 1. Map of the hydrogeologic provinces of California and the location of the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study unit.

Purpose and Scope

The purposes of this report are (1) to describe the study design, including the hydrogeologic setting of the COA Study Unit, (2) to detail the sampling and analytical methods, and quality assurance methods used during the study, (3) to present the results of quality-control tests, and (4) to present the analytical results for ground-water samples collected in the COA. Ground-water samples were analyzed for organic, inorganic, and microbial constituents, field parameters, and chemical tracers. The chemical and microbial data presented in this report were evaluated by comparing them with state and federal drinking water regulatory and other health-based standards that are applied to treated drinking water. Regulatory thresholds considered for this report are those established by the United States Environmental Protection Agency (USEPA) and the CDPH. The data presented in this report are intended to characterize the quality of untreated ground-water resources within the study unit, not the treated drinking water delivered to consumers by water purveyors. Discussion of the factors that influence the distribution and occurrence of the constituents detected in ground-water samples will be the subject of subsequent publications.

Hydrogeologic Setting

Knowledge of the hydrogeologic setting is important in the design of a ground-water-quality investigation. The Coachella Valley, approximately 820 square-miles, is located within the Desert Hydrogeologic Province (fig. 1) and extends from near the city of Banning to the northwestern shore of the Salton Sea (fig. 2). The COA Study Unit is positioned almost entirely in Riverside County, but sections extend into San Bernardino, San Diego, and Imperial Counties. The Coachella Valley is the northern expression of the Salton Trough, a landward extension of the Gulf of California. The Salton Trough formed in the late Cenozoic and is part of the tectonically active San Andreas Fault system (Loeltz and others, 1975). The San Bernardino Mountains, the Little San Bernardino Mountains, and the Mecca Hills form the north and the eastern boundaries of the valley and are composed of pre-Tertiary plutonic and metamorphic rocks. The San Jacinto and Santa Rosa Mountains bound the valley to the west and are composed of folded Tertiary sediments underlain by pre-Tertiary shist (Mendenhall, 1909). The Salton Sea occupies the Coachella Valley at its southern end.

The Coachella Valley has a desert climate; the mean total annual precipitation is less than five inches, on the valley floor (National Climate Data Center, 2005a or b).

The mountainous areas bordering the valley to the north and west receive as much as forty inches of precipitation a year. Temperatures range from 120°F in the summer on the valley floor to below freezing during the winter in the surrounding mountains (Reichard and Meadows, 1992); the average annual temperature is 67.5°F (National Climate Data Center, 2005a or b). Topographic relief in the area ranges from more than 10,000 feet above sea level in the surrounding mountains to 200 feet below sea level near the Salton Sea.

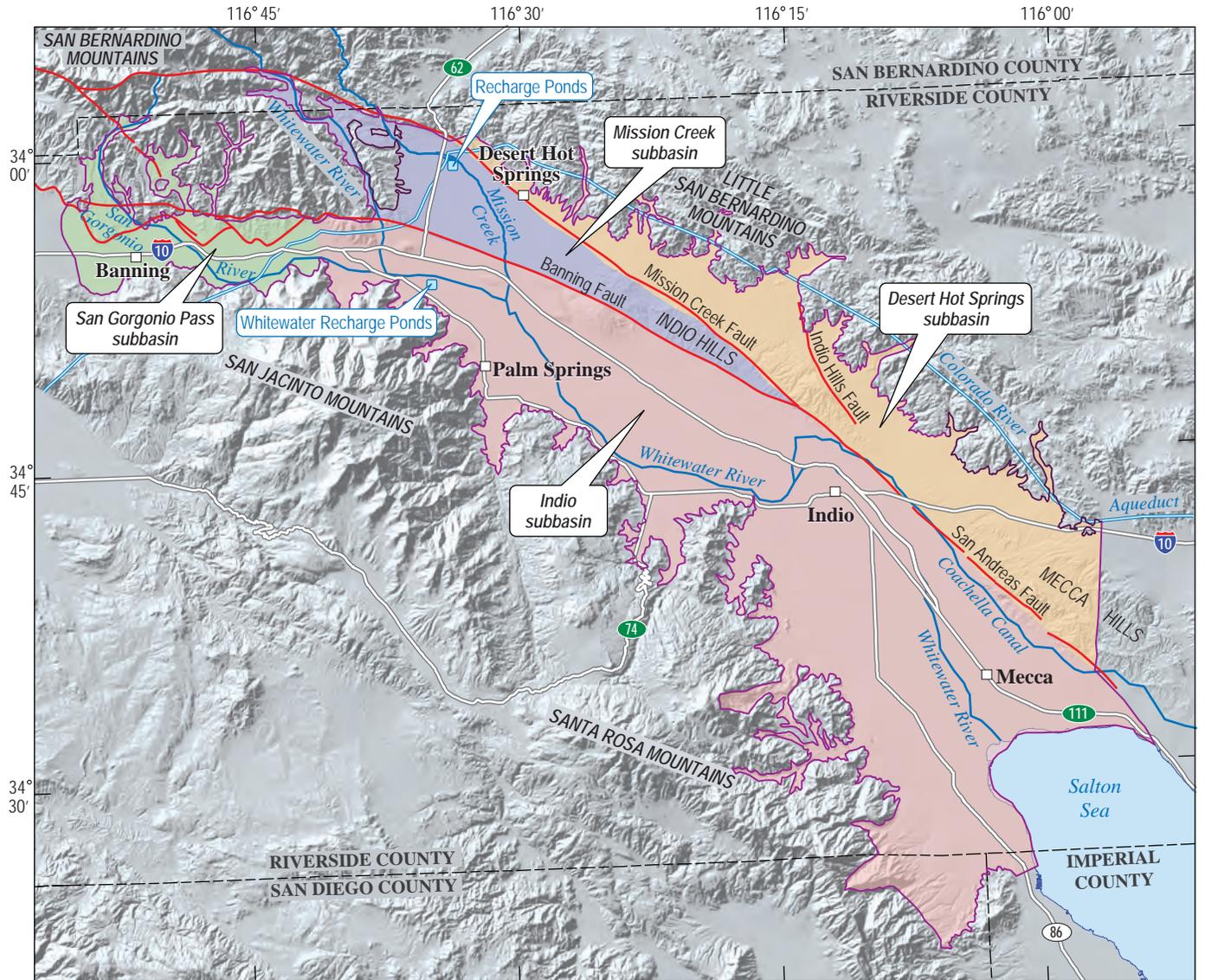
Ground-water recharge in the Coachella Valley comes from several sources including (1) precipitation on the valley floor, (2) stream-flow infiltration from the runoff of precipitation that falls on the surrounding mountains; this runoff is transported and flows to the valley floor by way of several ephemeral rivers and creeks, including the Whitewater and San Gorgonio Rivers and Mission Creek, (3) engineered recharge using Colorado River and local surface water via recharge ponds in the Indio and the Mission Creek ground-water subbasins, and (4) percolation of irrigation water in the agricultural areas of the southern Coachella Valley. Ground-water is discharged primarily through ground-water pumping.

The Coachella Valley ground-water basin has been hydrogeologically divided by the San Andreas Fault into four ground-water subbasins defined by structural boundaries: the San Gorgonio Pass subbasin, the Indio subbasin, the Mission Creek subbasin, and the Desert Hot Springs subbasin (California's Groundwater Bulletin 118, 2003).

The San Gorgonio Pass subbasin, 60 square miles in area, lies in the north-western limb of the Coachella Valley, bounded by the San Bernardino Mountains to the north and the San Jacinto Mountains to the south. Water-bearing formations include Holocene and Pleistocene age alluvium and the Pliocene to Pleistocene age San Timoteo Formation (California Department of Water Resources, 2007d).

The Indio subbasin, 525 square-miles in area, lies in the western side of the Coachella Valley. It is bounded by the San Jacinto Mountains on the west, the Santa Rosa Mountains on the southwest and the Salton Sea on the south, and the Banning Fault and the Indio Hills on the northeast. Water bearing formations in this subbasin include late Pleistocene and Holocene alluvial deposits (California Department of Water Resources, 2007a).

The Mission Creek subbasin, 76 square-miles in area, lies in the northern part of the Coachella Valley and is bounded by the San Bernardino Mountains on the west, the Banning fault on the southwest, the Indio Hills on the southeast, and the Mission Creek fault on the northeast. Water bearing formations include late Pleistocene Ocotillo Conglomerate and Holocene alluvial fan and terrace deposits (California Department of Water Resources, 2007b).



Base from U.S. Geological Survey National Elevation Dataset, 2006, Albers Equal-Area Conic Projection



EXPLANATION

- Area outside of study area**
(Not included in Study)
- Ground-water basin boundary**
(from California Department of Water Resources)
- Fault** (Modified from Matti and others, 1992)

Figure 2. Map of the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study unit showing the California Department of Water Resources defined groundwater subbasins within the study unit, locations of major cities, roads, rivers, and faults.

The Desert Hot Springs subbasin, 158 square-miles in area, lies in the northern and eastern parts of the Coachella Valley and is bounded on the northeast by the relatively nonpermeable Little San Bernardino Mountains and on the southwest by the semipermeable rocks of the Indio Hills and the Banning and Mission Creek faults. Water-bearing formations include late Pleistocene and Holocene alluvial fan deposits of the Ocotillo Conglomerate that underlie the Dillon Road Piedmont Slope. The slope is being actively deposited by weathering forces upon the Little San Bernardino Mountains. Hot thermal waters are near active fault areas, such as the Mission Creek fault (California Department of Water Resource, 2007c).

Methods

Methods used for the GAMA program were selected to achieve the following objectives: (1) design a sampling plan suitable for statistical analysis, (2) collect samples in a consistent manner, (3) analyze samples using proven and reliable laboratory methods, (4) assure the quality of the ground-water data, and (5) maintain data securely and provide relevant documentation. The [Appendix](#) to this report contains detailed descriptions of the sample collection protocols and analytical methods, the quality-assurance methods, and the results of analyses of quality-control samples.

Study Design

The wells selected for sampling in this study reflect the combination of two well selection strategies. Nineteen wells were selected using a randomized grid-based method (Scott, 1990) in order to provide a statistically unbiased, spatially-distributed assessment of the quality of ground-water resources used for public drinking water supply. Sixteen additional wells were selected to aid in the understanding of specific ground-water-quality issues in the COA Study Unit.

To select an unbiased, spatially distributed network of wells, the locations of wells listed in the statewide databases maintained by the CDPH and USGS were plotted on a regional map. A grid of 20 equal-area cells (about 40 mi² each) was then drawn over the COA Study Unit, with the objective to sample at least one public-supply well per grid cell ([fig. 3](#)). Wells in 18 of the 20 grid cells were sampled. Two grid cells had either no wells or no permission to sample wells in that cell. If a grid cell contained more than one public-supply well, each well was randomly assigned a rank. The highest ranking well that met basic sampling criteria (for example, capability of the well to pump for several hours and

availability of well-construction information) and for which permission to sample could be obtained was then sampled. If a grid cell did not contain accessible public-supply wells, domestic and irrigation wells were considered for sampling. In this way, one well was selected for 18 of the 20 qualifying grid cells to provide a spatially distributed, randomized monitoring network for the study unit. Wells sampled as part of the randomized grid-cell network are hereinafter referred to as “grid wells.” Grid wells in the COA Study Unit were numbered in the order of sample collection and assigned the prefix “COA” ([fig. 1](#)). One well, COA-10, is located next to the boundary of two grid-cells and is considered to have water quality representative of both cells ([fig. 3](#)). With this additional cell coverage, 19 of the 20 grid cells are considered to be represented in the grid cell network.

Sixteen additional wells ([fig. 3](#)) were sampled to evaluate changes in water chemistry along selected ground-water flow paths, to examine land use effects on ground-water quality, and to collect water-quality data in areas where little exists. Wells sampled as part of these studies were not included in the statistical characterization of water quality in the COA Study Unit because they were not randomly selected. These additional (nonrandomized) wells are collectively referred to as understanding wells in this report and have the prefix “COAU.”

[Table 1](#) provides the GAMA alphanumeric identification number for each well, along with the sampling schedule, well type, date sampled and well-construction information. Well locations were verified using GPS, 1:24,000 scale USGS topographic maps, comparison with existing well information in USGS and CDPH databases, and information provided by well owners.

The wells in the COA Study Unit were sampled using a tiered analytical approach. All wells were sampled for a standard set of constituents, including VOCs, pesticides and pesticide degradates, pharmaceutical compounds, perchlorate, uranium, stable isotopes of hydrogen and oxygen of water, tritium, nutrients, hexavalent chromium, major ions, and trace elements. This standard set of constituents was termed the “intermediate” schedule ([table 2](#)). Wells sampled for additional constituents are termed the “slow” schedule and include all of the constituents on the intermediate schedule plus mercury, wastewater indicator compounds, 1,2,3 TCP, radium, gross/alpha beta, radon, dissolved organic carbon, and microbial constituents ([table 2](#)). Intermediate and slow refer to the time required to sample the well for all the analytes on the associated schedule. Generally, one slow or two intermediate schedules could be sampled in one day. In the COA, 24 wells were sampled using the intermediate schedule and 11 wells were sampled using the slow schedule ([table 1](#)). Other GAMA study units use a “fast” schedule, which involved collecting fewer constituents.

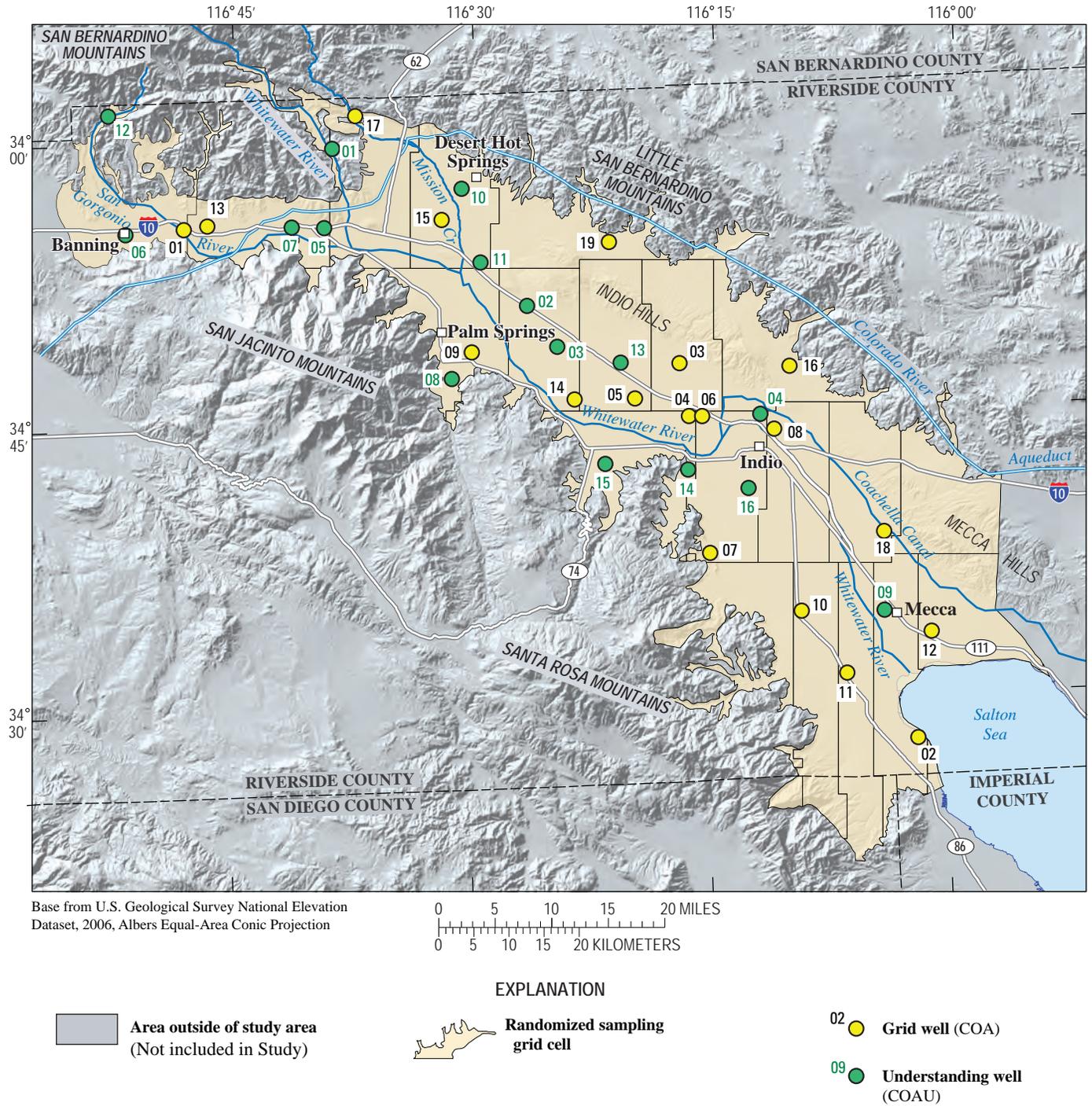


Figure 3. Map of the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study unit showing the distribution of study area grid cells, and the grid wells and understanding wells sampled.

Sample Collection and Analysis

Samples were collected in accordance with the protocols established by the USGS National Water Quality Assessment (NAWQA) program (Koterba and others, 1995) and the USGS National Field Manual (U.S. Geological Survey, variously dated). These sampling protocols ensure that a representative sample of ground water is collected at each site, and that the samples are collected and handled in a way that minimizes the potential for contamination of samples. The methods used for sample collection are described in the Sample Collection and Analysis section of the [Appendix](#).

[Tables 3A–L](#) (see back of report) list the compounds analyzed in each constituent class. Ground-water samples were analyzed for 85 VOCs ([table 3A](#)), 58 polar pesticides and pesticide degradates ([table 3B](#)), 62 pesticides and pesticide degradates ([table 3C](#)), 14 pharmaceutical compounds ([table 3D](#)), 69 wastewater-indicator compounds ([table 3E](#)), 2 constituents of special interest ([table 3F](#)), 6 nutrients and dissolved organic carbon ([table 3G](#)), 10 major and minor ions and total dissolved solids and 25 trace elements ([table 3H](#)), arsenic, iron, and chromium species ([table 3I](#)), stable isotopes of hydrogen and oxygen of water, 9 radioactive constituents, including tritium and carbon-14 ([table 3J](#)), noble gases ([table 3K](#)), and 4 microbial constituents ([table 3L](#)). The methods used for sample analysis are described in the [Sample Collection and Analysis](#) section of the Appendix.

Data Reporting

The methods and conventions used for reporting the data are described in the [Data Reporting](#) section of the Appendix. Twenty-two constituents analyzed in this study were measured by more than one method at the USGS National Water Quality Laboratory (NWQL). For these constituents, only the results from the preferred method are reported. The preferred-method selection is described in the [Constituents on Multiple Analytical Schedules](#) section of the Appendix. Arsenic, iron, and chromium concentrations, and uranium activities were measured by more than one laboratory; both sets of results are reported.

Quality Assurance

The quality-assurance methods used for this study followed the protocols used by the USGS NAWQA program (Koterba and others, 1995), and are described in the USGS National Field Manual (U.S. Geological Survey, variously dated). The quality assurance method followed by the NWQL, the primary laboratory used to analyze samples for this study, is described by Maloney (2005) and Pirkey and Glodt (1998). Quality-control (QC) samples collected in the COA Study Unit included source-solution blanks, field blanks, replicates, and matrix and surrogate spikes. QC samples were collected

to evaluate possible bias and variability of water-quality data that may have resulted from sample collection, processing, storage, transportation, and (or) laboratory analysis. A quality-control sample was collected at approximately one quarter of the wells, and the results for these samples were used to evaluate the quality of the results of sampling and analysis for the ground-water samples. Assessment of the quality-control information resulted in V-coding less than 0.1 percent of the data collected. The quality-assurance method is described in the [Quality-Assurance](#) method of the Appendix.

Water Quality Results

Results from analyses of raw (untreated) ground-water samples from the COA Study Unit are given in [tables 4](#) through [15](#). Ground-water samples were analyzed for up to 370 constituents, and 278 of those constituents were not detected in any of the samples ([tables 3A–L](#)). The results tables present only the constituents that were detected, and list only samples that had at least one constituent detected. The tables summarizing detections of constituents analyzed using USGS NWQL schedules 2020, 2060, 2003 and 4433 ([tables 3A–C, E](#)) include the number of wells at which each analyte was detected, the frequency at which it was detected, and the total number of constituents detected at each well. Results from understanding wells were excluded from these calculations to avoid statistically over-representing the areas near these wells.

[Table 4](#) includes water-quality indicators measured in the field and at the NWQL, and [tables 5](#) through [15](#) present the results of ground-water analyses organized by compound classes:

- Organic Constituents
 - VOCs ([table 5](#))
 - Pesticides and pesticide degradates ([table 6](#))
 - Potential wastewater-indicator compounds ([table 7](#))
 - Constituents of special interest ([table 8](#))
- Inorganic constituents
 - Nutrients and dissolved organic carbon ([table 9](#))
 - Major and minor ions ([table 10](#))
 - Trace elements ([table 11](#))
 - Arsenic, iron, and chromium species ([table 12](#))
- Isotopic tracers
 - Stable isotopes and tritium and carbon-14 activities ([table 13](#))
- Radioactive constituents ([table 14](#))
- Microbial indicators ([table 15](#))

Pharmaceutical compounds have no summary table because the only compound detected was acetaminophen and the detected concentration is reported in the [Ground-Water Quality Data](#) section.

Quality-Control-Sample Results

Results of quality-control analyses (blanks, replicates, matrix spikes, and surrogates) were used to evaluate the quality of the data for the ground-water samples. Matrix-spike recoveries for most organic constituents were below acceptable limits, which may indicate that these constituents might not have been detected in some samples if they were present at very low concentrations. The quality-control results are described in the Quality-Control-Sample Results section in the [Appendix](#).

Comparison Thresholds

Concentrations of constituents detected in ground-water samples were compared with CDPH and USEPA drinking-water health-based and aesthetically-based thresholds (California Department of Public Health 2007a; U.S. Environmental Protection Agency, 2006). The chemical and microbial data presented in this report characterize the quality of the untreated ground-water resources within the COA Study Unit, and are not intended to represent the treated drinking water delivered to consumers by water purveyors. The chemical and microbial composition of treated drinking water may differ from untreated ground water because treated drinking water may be disinfected, filtered, mixed with other waters, and exposed to the atmosphere before being delivered to consumers.

The following thresholds were used for comparisons:

- **MCL– Maximum Contaminant Level.** Legally enforceable standards that apply to public-water systems and protect public health by limiting the levels of contaminants in drinking water. MCLs established by the USEPA are the minimum standards with which states are required to comply, and individual states may choose to set more stringent standards. CDPH has established MCLs for additional constituents not regulated by the USEPA and lowered the threshold concentration for constituents with MCLs established by the USEPA. In this report, a threshold set by the USEPA and adopted by CDPH is labeled “MCL-US”, and one set by CDPH that is more stringent than the MCL-US is labeled “MCL-CA”. CDPH is notified when constituents are detected at concentrations exceeding MCL-US or MCL-CA thresholds in samples collected for the GAMA Priority Basin Project.
- **AL – Action Level.** Legally enforceable standards that apply to public water systems and protect public health by limiting the levels of copper and lead in drinking water. Detection concentrations of copper or lead above thresholds trigger requirements for mandatory water treatment to reduce the corrosiveness of water to water pipes. The action levels established by the USEPA and CDPH are the same, thus the thresholds are labeled “AL-US” in this report.
- **TT – Treatment Technique.** Legally enforceable standards that apply to public-water systems and protect public health by limiting the levels of microbial constituents in drinking water. Detections of microbial constituents above thresholds trigger requirements for mandatory additional disinfection during water treatment. The action levels established by the USEPA and CDPH are the same, thus the thresholds are labeled “TT-US” in this report.
- **SMCL – Secondary Maximum Contaminant Level.** Non-enforceable standards applied to constituents that affect the aesthetic qualities of drinking water, such as taste, odor, and color, or technical qualities of drinking water, such as scaling and staining. Both the USEPA and the CDPH define SMCLs, but unlike MCLs, SMCLs established by CDPH are not required to be at least as stringent as those established by USEPA. SMCLs established by CDPH are used in this report (SMCL-CA) for all constituents that have SMCL-CA values. The SMCL-US is used for pH because no SMCL-CA has been defined.
- **NL – Notification Level.** Health-based notification levels established by CDPH for some of the constituents in drinking water that lack MCLs (NL-CA). If a constituent is detected above its NL-CA, State law requires timely notification of local governing bodies and recommends consumer notification.
- **HAL – Lifetime Health Advisory Level.** The maximum concentration of a constituent in drinking water which is not expected to cause any adverse carcinogenic effects for a lifetime of exposure. HALs are established by the USEPA (HAL-US) and are calculated assuming 2 liters (2.1 quarts) of water per day are consumed over a 70-year lifetime by a 70-kilogram (154-pound) adult and that 20 percent of a person’s exposure comes from drinking water.

- **RSD5 – Risk-Specific Dose.** The concentration of a constituent in drinking water corresponding to an excess estimated lifetime cancer risk of 1 in 100,000. RSD5 is an acronym for risk-specific dose at 10^{-5} . RSD5s are calculated by dividing the 10^{-4} cancer risk concentration established by the USEPA by ten (RSD5-US).

For constituents having an MCL, detection concentrations in ground-water samples were compared to the MCL-US or the MCL-CA. If a constituent has an SMCL, its concentration was compared to the SMCL-CA. For chloride, sulfate, specific conductance, and total dissolved solids, CDPH defines a “recommended” and an “upper” SMCL-CA; detected concentrations of these constituents in ground-water samples were compared with both levels. The SMCL-US for these constituents corresponds to the recommended SMCL-CA. Detected concentrations of constituents that lack an MCL or SMCL were compared to the NL-CA. Detected concentrations of constituents that lack an MCL, SMCL, or NL-CA were compared with the HAL-US. Detected concentrations of constituents that lack an MCL, SMCL, NL-CA, or HAL-CA were compared with the RSD5-US. Note that the result of this hierarchy of selecting comparison thresholds for constituents that have multiple types of established thresholds may not be a threshold that has the lowest concentration. The comparison thresholds used in this report are listed in [tables 3A–L](#) for all constituents analyzed and in [tables 4–15](#) for constituents detected in ground-water samples from the COA. Not all constituents analyzed for this study have established thresholds. Constituents detected at concentrations above established thresholds are marked with asterisks in the associated results table.

Ground-Water Quality Data

Field Parameters

Field and laboratory measurements of pH, specific conductance, alkalinity, and field measurements of turbidity, dissolved oxygen, and water temperature are presented in [table 4](#). Dissolved oxygen and alkalinity are used as indicators of natural processes that control water chemistry. Specific conductance is the unit electrical conductivity of the water and is proportional to the amount of total dissolved solids (TDS) in the water. The pH value indicates the acidity or basicity of the water. Specific conductance measured in the field and in the laboratory samples was above the recommended SMCL-CA for six grid wells, three of which were above the upper threshold. Two grid wells had field pH values above the SMCL-US. Laboratory pH values may be higher than field pH values because the pH of ground water often increases when exposed to the atmosphere (see [Appendix](#)).

Organic Constituents

Volatile organic compounds (VOCs) are in paints, solvents, fuels, fuel additives, refrigerants, fumigants, and disinfected water, and are characterized by their tendency to evaporate. VOCs generally persist longer in ground water than in surface water because ground water is isolated from the atmosphere. All concentrations of VOCs detected in samples from the COA Study Unit were below health-based thresholds. Concentrations ranged from less than one one-hundredth to less than one one-thousandth of the threshold values ([table 5](#)). At least one VOC was detected in 21 percent of the grid wells sampled. The only VOC detected in more than 10 percent of the grid wells was trichloromethane, also known as chloroform. Trichloromethane, a byproduct of drinking-water disinfection, tetrachloroethene (PCE), a solvent used for dry cleaning, and bromodichloromethane, another byproduct of disinfection, were detected in more than 10 percent of the understanding wells. Toluene was detected in 10 samples, but these detections were V-coded because toluene was detected in blanks also. V-coded values were not used in calculating summary statistics, and are preceded by a V in [table 5](#).

Pesticides include herbicides, insecticides, and fungicides. Pesticides are used to control weeds, insects, fungi, and other pests in agricultural, urban, and suburban settings. All detections of pesticides in samples from the COA Study Unit were at concentrations below health-based thresholds; all were less than one one-hundredth of the threshold values ([table 6](#)). There were 15 detections of pesticides and pesticide degradates in grid wells and 13 detections in understanding wells. At least one compound was detected in 32 percent of the grid wells sampled. Compounds detected in more than 10 percent of the wells were the herbicides atrazine and simazine, and the atrazine degradate deethylatrazine (CIAT). These three compounds are among the most commonly detected pesticides and pesticide degradates in ground water in the Nation (Gilliom and others, 2006).

Potential wastewater-indicator compounds were collected at wells sampled on a slow schedule ([table 3E](#)). Compounds include a wide variety of constituents, compounds analyzed for included caffeine, pyrene (a component of coal, tar and asphalt), and menthol (cigarettes, cough drops, liniment, mouthwash). All detections of potential wastewater-indicator compounds were below health-based thresholds. Phenol was detected at 29 percent of grid wells ([table 7](#)). Eleven potential wastewater-indicator compounds were detected in grid wells, and at least one potential wastewater-indicator compound was detected in 57 percent of the grid wells.

Acetaminophen, a pharmaceutical compound, was detected in one understanding well, COAU-03, at an estimated laboratory value of 0.02 $\mu\text{g/L}$. Acetaminophen is a known analgesic commonly found in many over-the-counter pain relievers.

Constituents of Special Interest

Perchlorate and 1,2,3-TCP are constituents of special interest in California because they recently have been found to be widely distributed in water supplies (California Department of Public Health, 2007b). Perchlorate was detected in 7 grid wells and 5 understanding wells in the COA; 2 of the grid wells contained concentrations above the MCL-CA ([table 8](#)). 1,2,3-TCP was not detected in any samples.

Inorganic Constituents

Unlike the organic constituents and the constituents of special interest, most of the inorganic constituents are naturally present in ground water, although their concentrations may be influenced by human activities.

Nitrogen, phosphorus, and dissolved organic carbon present in ground water can affect biological activity in aquifers and in surface water bodies that receive ground-water discharge. Nitrogen may be present in the form of ammonia, nitrite, or nitrate depending on the oxidation-reduction state of the ground water. High concentrations of nitrate can adversely affect human health, particularly the health of infants. All concentrations of nitrate, nitrite, and ammonia measured in samples from the COA Study Unit were below health-based thresholds except nitrite plus nitrate as nitrogen concentrations from two understanding wells ([table 9](#)). Concentrations of phosphorus and dissolved organic carbon were also low.

The major-ion composition, total dissolved solids (TDS) content, and levels of certain trace elements in ground water can affect the aesthetic properties of water, such as taste, color, and odor, and the technical properties, such as scaling and staining. Although there are no adverse health effects associated with these properties, they may reduce consumer satisfaction with the water or may have economic impacts. CDPH has established non-enforceable thresholds (SMCL-CA) that are based on aesthetic or technical properties rather than health-based concerns for the major ions chloride and sulfate, TDS, and several trace elements.

Samples for the analysis of major and minor ions and total dissolved solids (TDS) were collected at 35 wells in the COA Study Unit ([table 10](#)). The concentrations of chloride in all the COA Study Unit wells, except one, were below the recommended SMCL-CAs. Fluoride concentrations in five samples were above the SMCL-CAs. Sulfate concentrations in seven samples were above the SMCL-CAs recommended threshold, and one above the upper threshold ([table 10](#)). TDS concentrations in nine samples were above the recommended SMCL-CA, and one sample was above the upper SMCL-CA. Samples for the analysis of trace elements were collected at 35 wells in the COA Study Unit ([table 11](#)). Iron and manganese are trace elements whose concentrations are affected by the oxidation-reduction state of the ground water. Precipitation

of minerals containing iron or manganese may stain surfaces orange, brown, or black. Concentrations of manganese in all but one sample were below the SMCL-CA. All concentrations of iron were below the SMCL-CA.

Seventeen of the 23 trace elements analyzed in this study have health-based thresholds. Mercury was the only trace element not detected in at least one sample. Detections of trace elements in all samples from the COA Study Unit were below health-based thresholds, except five samples with arsenic concentrations above the MCL-US, two samples with boron above the NL-CA, two samples with molybdenum above the HAL-US, and two samples with strontium above the HAL-US ([table 11](#)).

Arsenic, iron, and chromium occur in different species depending on the oxidation-reduction state of the ground water. The oxidized and reduced species have different solubilities in ground water and may have different effects on human health. The relative proportions of the oxidized and reduced species of each element can be used to aid in interpretation the oxidation–reduction state of the aquifer. Concentrations of total arsenic, iron, and chromium, and the concentrations of either the reduced or the oxidized species of each element are reported on [table 12](#). The concentration of the other species can be calculated by difference. The concentrations of arsenic, iron, and chromium reported on [table 12](#) may be different than those reported on [table 11](#) because different analytical methods were used (see [Appendix](#)). The concentrations reported on [table 11](#) are considered to be more accurate.

Isotopic Tracers

The isotopic ratios of oxygen and hydrogen of water, tritium, and carbon-14 activities may be used as tracers of hydrologic processes. The isotopic ratios of oxygen and hydrogen of water ([table 13](#)) aid in the interpretation of ground-water recharge location. These stable isotopic ratios reflect the altitude, latitude, and temperature of precipitation, and the extent of evaporation of recharge water.

Tritium activities, carbon-14 activities, and helium isotopic ratios provide information about the age (time since recharge) of the ground-water. Tritium is a short-lived radioactive isotope of hydrogen that is incorporated into the water molecule. Tritium is produced in the atmosphere by the interaction of cosmic-ray produced neutrons with nitrogen-14 (Craig and Lal, 1961), by atmospheric nuclear explosions, and by the operation of nuclear reactors. Carbon-14 ([table 13](#)) is a radioactive isotope of carbon. Low levels of carbon-14 are continuously produced by interaction of cosmic radiation with the Earth's atmosphere, and incorporated into atmospheric carbon dioxide. When carbon dioxide dissolved in precipitation, surface water, and ground water is exposed to the atmosphere, it enters the hydrologic cycle.

Because carbon-14 decays with a half-life of approximately 5,700 years, low activities of carbon-14 relative to modern values generally indicate presence of ground water that is several thousand years old.

Tritium is the only isotopic tracer that has a health-based threshold. All measured tritium activities in samples from the COA Study Unit wells were less than one one-hundredth of the MCL-CA ([table 13](#)).

Radioactive Constituents

Radioactivity is the release of energy or energetic particles during changes in the structure of the nucleus of an atom. Most of the radioactivity in ground water comes from decay of naturally-occurring isotopes of uranium and thorium in minerals in the sediments or fractured rocks that comprise the aquifer matrix. Uranium and thorium decay in a series of steps, eventually forming stable isotopes of lead. Radium-226, radium-228, and radon-222 are radioactive isotopes formed during the uranium and thorium decay series. In each step in the decay series, one radioactive element turns into a different radioactive element by emitting an alpha particle or a beta particle from its nucleus. For example, radium-226 emits an alpha particle and becomes radon-222. Radium-228 emits a beta particle to form actinium-228. The alpha and beta particles emitted during radioactive decay are hazardous to human health because these energetic particles may damage cells. Radiation damage to cell DNA may increase the risk of getting cancer.

Activity is often used instead of concentration for reporting the presence of radioactive constituents. Activity of radioactive constituents in ground water is measured in units of picocuries per liter (pCi/L); one picocurie approximately equals two atoms decaying per minute. The number of atoms decaying is equal to the number of alpha or beta particles emitted.

All thirty-five wells sampled in Coachella were analyzed for uranium activities, and all reported activities were less than half of the regulatory threshold ([table 13](#)). The eleven slow-schedule samples analyzed for all radioactive constituents had activities of radium and of gross alpha/beta emitter detections less than established health-based standards. Activities of radon-222 in samples from seven wells were above the proposed MCL-US of 300 pCi/L ([table 14](#)); however, no samples had an activity above the proposed alternative MCL-US of 4,000 pCi/L. The alternative MCL-US will apply if the State or local water agency has an approved multimedia mitigation program to address radon in indoor air (U.S. Environmental Protection Agency, 1999a).

Microbial Indicators

Water is disinfected during drinking-water treatment to prevent diseases that may be spread by water-borne microbial constituents derived from human or animal wastes. The

specific viruses and bacteria responsible for diseases generally are not measured because routine analytical methods are not available. Measurements are made of more easily analyzed microbial constituents that serve as indicators of the presence of human or animal waste in water. Drinking water purveyors respond to detections of microbial indicators by applying additional disinfectants to the water.

Eleven samples were analyzed for microbial indicators. No samples contained the viral indicators F-specific and somatic coliphage and none contained the bacterial indicator *Escherichia coli* (*E. coli*). The bacterial indicator total coliforms was detected at a low level in one grid well ([table 15](#)). The threshold for total coliforms is based on recurring detections, thus the detection reported here does not necessarily exceed the MCL-US.

Future Work

Subsequent reports will be focused on assessment of the data presented in this report using a variety of statistical, qualitative, and quantitative approaches to evaluate the natural and human factors affecting ground-water quality. Water-quality data contained in the CDPH and USGS NWIS databases and water-quality data available from other State and local water agencies will be compiled, evaluated, and used to complement the data presented in this report.

Summary

Ground-water quality in the approximately 820 square-mile Coachella Valley was investigated in February and March 2007 as part of the Priority Basin Project of the Ground-Water Ambient Monitoring and Assessment (GAMA) Program. The project is a comprehensive assessment of statewide ground-water quality designed to identify and characterize risks to ground-water resources and to increase the amount of information available about ground-water quality to the public. The COA Study Unit was the sixteenth study unit sampled as part of the project.

Thirty-five ground-water samples were analyzed for a combination of VOCs, pesticides and pesticide degradates, pharmaceutical compounds, potential wastewater-indicator compounds, nutrients, major and minor ions, trace elements, radioactive constituents, and microbial indicators. Naturally occurring isotopes (stable-isotopic ratios of hydrogen, oxygen, and carbon, and activities of tritium, carbon-14, and dissolved noble gases) were measured to provide a data set that will be used to help assess the source and age of the sampled ground water. A quality-control sample (blank, replicate, or matrix spike) was collected at approximately a quarter of the wells to evaluate the quality of the results from the analysis of ground-water samples.

This study did not attempt to evaluate the quality of water delivered to consumers; after withdrawal from the ground, water typically is treated, disinfected, and blended with other waters to maintain acceptable water quality. Regulatory thresholds apply to treated water that is served to the consumer, not to raw ground water. However, to provide some context for the results, concentrations of constituents measured in the raw ground water were compared with health-based thresholds established by the U.S. Environmental Protection Agency (USEPA) and California Department of Public Health (CDPH).

Concentrations of VOCs were detected in 4 samples from grid wells and pesticides were detected in 6 samples from grid wells. All detections were less than one one-hundredth of health-based threshold concentrations. Potential wastewater indicators were detected in 4 grid well samples at levels below health-based thresholds. The pharmaceutical acetaminophen was detected in one sample in the COA study unit, but at a very low level. Perchlorate was detected in two grid wells at concentrations above the MCL-CA threshold. Two understanding wells contained concentrations of nitrite as nitrogen above established health-based thresholds. Chloride, fluoride, sulfate, manganese, and total dissolved solids were detected above the aesthetic thresholds in several samples. Several samples had concentrations of the trace elements arsenic, boron, molybdenum, and strontium above health-based thresholds. All activities of the radioactive constituents uranium and gross alpha/beta were below established thresholds, but radon-222 was detected in four grid wells and three understanding wells at activities above both the proposed and the alternative maximum contaminant levels (MCL-US). The field parameters specific conductance and pH were detected above maximum contaminant levels (SMCL-CA and SMCL-US). Future work will include assessment of the data presented in this report, using a variety of statistical, qualitative, and quantitative approaches to help determine the influences of natural and human factors on ground-water quality.

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References Cited

- American Public Health Association, 1998, Standard methods for the examination of water and wastewater (20th ed.): Washington, D.C., American Public Health Association, American Water Works Association, and Water Environment Federation, p. 3-37-3-43.
- American Society for Testing and Materials, 1998, Annual book of ASTM standards - water and environmental technology: Philadelphia, Pennsylvania, American Society for Testing and Materials, v. 11.02 (Water II), p. 664-666.
- American Society for Testing and Materials, D 3972, "Standard Test Method for Isotopic Uranium in Water by Radiochemistry," American Society for Testing and Materials International.
- Ball, J.W., and McCleskey, R.B., 2003a, A new cation-exchange method for accurate field speciation of hexavalent chromium: U.S. Geological Survey Water-Resources Investigations Report 03-4018, 17 p.
- Ball, J.W., and McCleskey, R.B., 2003b, A new cation-exchange method for accurate field speciation of hexavalent chromium: *Talanta*, v. 61, p. 305-313.
- Belitz, K., Dubrovsky, N.M., Burow, K.R., Jurgens, B., and Johnson, T., 2003, Framework for a ground-water quality monitoring and assessment program for California: U.S. Geological Survey Water-Resources Investigations Report 03-4166, 78 p.
- Bennett, G.L., V, Belitz, K., and Milby Dawson, B.J., 2006, California GAMA Program - Ground-water quality data in the northern San Joaquin basin study unit, 2005: U.S. Geological Survey Data Series 196, 122 p.
- Brenton, R.W., and Arnett, T.L., 1993, Methods of analysis by the U.S. Geological Survey National Water-Quality Laboratory - determination of dissolved organic carbon by UV-promoted persulfate oxidation and infrared spectrometry: U.S. Geological Survey Open-File Report 92-480, 12 p.
- Bushon, R.N., 2003, Fecal indicator viruses: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A7.2, accessed June 28, 2007 at <http://pubs.water.usgs.gov/twri9A7.2/>
- California Department of Water Resources, 2003, California's groundwater: California Department of Water Resources Bulletin 118, 246 p, available at <http://www.dpla2.water.ca.gov/publications/groundwater/bulletin118/Bulletin118Entire.pdf>

- California Department of Water Resources, 2007a, California Department of Water Resources Bulletin 118, individual basin descriptions, Indio subbasin, accessed December 1, 2007 at http://www.dpla2.water.ca.gov/publications/groundwater/bulletin118/basins/pdfs_desc/7-21.01.pdf
- California Department of Water Resources, 2007b, California Department of Water Resources Bulletin 118, individual basin descriptions, Mission Creek subbasin, accessed December 1, 2007 at http://www.dpla2.water.ca.gov/publications/groundwater/bulletin118/basins/pdfs_desc/7-21.02.pdf
- California Department of Water Resources, 2007c, California Department of Water Resources Bulletin 118, individual basin descriptions, Dessert Hot Springs subbasin, accessed December 1, 2006 at http://www.dpla2.water.ca.gov/publications/groundwater/bulletin118/basins/pdfs_desc/7-21.03.pdf
- California Department of Water Resources, 2007d, California Department of Water Resources Bulletin 118, individual basin descriptions, San Gorgonio Pass subbasin, accessed December 1, 2007 at http://www.dpla2.water.ca.gov/publications/groundwater/bulletin118/basins/pdfs_desc/7-21.04.pdf
- Childress, C.J.O., Foreman, W.T., Connor, B.F., and Maloney, T.J., 1999, New reporting procedures based on long-term method detection levels and some considerations for interpretations of water-quality data provided by the U.S. Geological Survey National Water Quality Laboratory: U.S. Geological Survey Open-File Report 99-193, 19 p.
- Connor, B.F., Rose, D.L., Noriega, M.C., Murtagh, L.K., and Abney, S.R., 1998, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory - determination of 86 volatile organic compounds in water by gas chromatography/mass spectrometry, including detections less than reporting limits: U.S. Geological Survey Open-File Report 97-829, 78 p.
- Coplen, T.B., Wildman, J.D., and Chen, J., 1991, Improvements in the gaseous hydrogen-water equilibrium technique for hydrogen isotope analysis: *Analytical Chemistry*, v. 63, p. 910–912.
- Coplen, T.B., 1994, Reporting of stable hydrogen, carbon, and oxygen isotopic abundances: *Pure and Applied Chemistry*, v. 66, p. 273–276.
- Coplen, T.B., Hopple, J.A., Bohlke, J.K., Peiser, H.S., Rieder, S.E., Krouse, H.R., Rosman, K.J.R., Ding, T., Vocke, R.D., Jr., Revesz, K.M., Lamberty, A., Taylor, P., and DeBierve, P., 2002, Compilation of minimum and maximum isotope ratios of selected elements in naturally occurring terrestrial materials and reagents: U.S. Geological Survey Water-Resources Investigations Report 01-4222, 98 p.
- Craig, H.D., and Lal, D., 1961, The production rate of natural tritium: *Tellus*, v. 13, p. 85–105.
- Dawson, B.J., Bennett, G.L., V, and Belitz, K., 2008, Ground-water quality data in the southern Sacramento Valley study unit, California, 2005—Results from the California GAMA Program: U.S. Geological Survey Data Series 285, 93 p.
- Donahue, D.J., Linick, T.W., and Jull, A.J.T., 1990, Ratio and background corrections for accelerator mass spectrometry radiocarbon measurements: *Radiocarbon*, v. 32, p. 135–142.
- Eaton, G.F., Hudson, G.B., and Moran, J.E., 2004, Tritium-helium-3 age-dating of groundwater in the Livermore Valley of California: American Chemical Society ACS Symposium Series, v. 868, p. 235–245.
- Epstein, S., and Mayeda, T.K., 1953, Variation of O-18 content of water from natural sources: *Geochimica et Cosmochimica Acta*, v. 4, p. 213–224.
- Faires, L.M., 1993, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory - determination of metals in water by inductively coupled plasma-mass spectrometry: U.S. Geological Survey Open-File Report 92-634, 28 p.
- Fishman, M.J., and Friedman, L.C., 1989, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 545 p.
- Fishman, M.J., 1993, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory - determination of inorganic and organic constituents in water and fluvial sediments: U.S. Geological Survey Open-File Report 93-125, 217 p.
- Firestone, R.B., Shirley, V.S., Baglin, C.M., Chu, S.Y.F., and Zipkin, J., 1996, Table of Isotopes (8th ed.): New York, John Wiley & Sons, 3168 p., available at <http://ie.lbl.gov/toipdf/toi20.pdf>
- Furlong, E.T., Anderson, B.D., Werner, S.L., Soliven, P.P., Coffey, L.J., and Burkhardt, M.R., 2001, Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory-Determination of Pesticides in Water by Graphitized Carbon-Based Solid-Phase Extraction and High-Performance Liquid Chromatography/Mass Spectrometry: U.S. Geological Survey Water-Resources Investigations Report 01-4134, 73 p.

- Furlong, E.T., Werner, S.L., Anderson, B.D., and Cahill, J.D., 2008, Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory – Determination of human-health pharmaceuticals in filtered water by chemically modified styrene-divinylbenzene resin-based solid-phase extraction and high-performance liquid chromatography/mass spectrometry. U.S. Geological Survey Techniques and Methods, book 5, chap. A9, 56 p.
- Garbarino, J.R., 1999, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory - determination of dissolved arsenic, boron, lithium, selenium, strontium, thallium, and vanadium using inductively coupled plasma-mass spectrometry: U.S. Geological Survey Open-File Report 99-093, 31 p.
- Garbarino, J.R., and Damrau, D.L., 2001, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory - determination of organic plus inorganic mercury in filtered and unfiltered natural water with cold vapor - atomic fluorescence spectrometry: U.S. Geological Survey Water-Resources Investigations Report 01-4132, 16 p.
- Garbarino, J.R., Kanagy, J.R., and Cree, M.E., 2006, Determination of elements in natural-water, biota, sediment, and soil samples using collision/reaction cell inductively coupled plasma-mass spectrometry: U.S. Geological Survey Techniques and Methods, book 5, chap. B1, 88 p.
- Gilliom, R.J., Barbash, J.E., Crawford, C.G., Hamilton, P.A., Martin, J.D., Nakagaki, N., Nowell, L.H., Scott, J.C., Stackelberg, P.E., Thelin, G.P., and Wolock, D.M., 2006, The quality of our Nation's waters: Pesticides in the nation's streams and ground water, 1992-2001: U.S. Geological Survey Circular 1291, 172 p.
- Gran, G., 1952, Determination of the equivalence point in potentiometric titrations—Part II: The Analyst: v. 77, p. 661-671.
- Grob, R.L., ed., 1995, Modern practice of gas chromatography (3rd ed.): New York, John Wiley & Sons, 888 p.
- Hamlin, S.N., Belitz, K., Kraja, S., and Dawson, B.J., 2002, Ground-water quality in the Santa Ana watershed, California: Overview and data summary: U.S. Geological Survey Water-Resources Investigations Report 02-4243, 137 p.
- Hautman, D.P., Munch, D.J., Eaton, A.D., and Haghani, A.W., 1999, Method 314.0 Determination of perchlorate in drinking water using ion chromatography, revision 1.0: U.S. Environmental Protection Agency, accessed June 22, 2004 at <http://www.epa.gov/safewater/methods/pdfs/met314.pdf>.
- Hutson, S.S., Barber, N.L., Kenny, J.F., Linsey, K.S., Lumia, D.S., and Maupin, M.A., 2004, Estimated use of water in the United States in 2000: U.S. Geological Survey Circular 1268, 46 p.
- Jull, A.J.T., Burr, G.S., McHargue, L.R., Lange, T.E., Lifton, N.A., Beck, J.W., Donahue, D.J., and Lal, D., 2004, New frontiers in dating of geological, paleoclimatic, and anthropological applications using accelerator mass spectrometric measurements of ¹⁴C and ¹⁰Be in diverse samples: Global and Planetary Change, v. 41, p. 309–323.
- Kolpin, D.W., Furlong, E.T., Meyer, M.T., Thurman, E.M., Zaugg, S.D., Barber, L.B., and Buxton, H.T., 2002, Pharmaceuticals, hormones and other organic wastewater contaminants in U.S. streams, 1999–2000: Environmental Science & Technology, v. 36, no. 6, p. 1202–1211.
- Koterba, M.T., Wilde, F.D., and Lapham, W.W., 1995, Ground-water data-collection protocols and procedures for the National Water-Quality Assessment Program - collection and documentation of water-quality samples and related data: U.S. Geological Survey Open-File Report 95-399, 113 p.
- Kulongoski, J.T., and Belitz, K., 2004, Ground-water ambient monitoring and assessment program: U.S. Geological Survey Fact Sheet 2004-3088, 2 p.
- Kulongoski, J.T., Belitz, K., and Dawson, B.J., 2006, Ground-water quality data in the North San Francisco Bay Hydrogeologic provinces, California, 2004: Results from the California Ground-Water Ambient Monitoring and Assessment (GAMA) Program: U.S. Geological Survey Data Series 167, 100 p.
- Kulongoski, J.T., and Belitz, K., 2007, Ground-water quality data in the Monterey Bay and Salinas Valley Basins, California, 2005 – Results from the California GAMA Program: U.S. Geological Survey Data Series DS-258, 84 p.
- Lane, S.L., Flanagan, S., and Wilde, F.D., 2003, Selection of equipment for water sampling (ver. 2.0): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A2, accessed June 28, 2007, at <http://pubs.water.usgs.gov/twri9A2/>
- Lewis, M.E., 2006, Dissolved Oxygen (ver. 2.1): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A6.2, accessed June 28, 2007 at <http://pubs.water.usgs.gov/twri9A6.2/>
- Lindley, C.E., Stewart, J.T., and Sandstrom, M.W., 1996, Determination of low concentrations of acetochlor in water by automated solid-phase extraction and gas chromatography with mass selective detection: Journal of AOAC International, v. 79, no. 4, p. 962–966.

- Loeltz, O.J., Irelan, Burdge, Robinson, J.H., and Olmsted, F.H., 1975, Geohydrologic reconnaissance of the Imperial Valley, California: U.S. Geological Survey Professional Paper 486-K, 54 p.
- Madsen, J.E., Sandstrom, M.W., and Zaugg, S.D., 2003, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory - A method supplement for the determination of fipronil and degradates in water by gas chromatography/mass spectrometry: U.S. Geological Survey Open-File Report 02-462, 11 p.
- Maloney, T.J., ed., 2005, Quality management system, U.S. Geological Survey National Water Quality Laboratory: U.S. Geological Survey Open-File Report 2005-1263, 93 p., available at <http://pubs.usgs.gov/of/2005/1263/pdf/OFR2005-1263.pdf>
- McCleskey, R.B., Nordstrom, D.K., and Ball, J.W., 2003, Metal interferences and their removal prior to the determination of As(T) and As(III) in acid mine waters by hydride generation atomic absorption spectrometry: U.S. Geological Survey Water-Resources Investigations Report 03-4117.
- McLain, B., 1993, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory - determination of chromium in water by graphite furnace atomic absorption spectrophotometry: U.S. Geological Survey Open-File Report 93-449, 16 p.
- Mendenhall, W.C., 1909, Ground waters of the Indio region, California, with a sketch of the California desert: U.S. Geological Survey Water Supply Paper 225, 56 p.
- Moran, J.E., Hudson, G.B., Eaton, G.F., and Leif, R., 2002, A contamination vulnerability assessment for the Livermore-Amador and Niles Cone Groundwater Basins: Lawrence Livermore National Laboratory internal report, UCRL-AR-148831, 25 p.
- Myers, D.N., 2004, Fecal indicator bacteria (ver. 1.2): U.S. Geological Survey Techniques of Water-Resources Investigations Report, book 9, chap. A7.1, accessed June 28, 2007, at <http://pubs.water.usgs.gov/twri9A7.1/>
- National Climate Data Center, 2005a, Annual mean daily average temperature: National Oceanic and Atmospheric Administration, accessed March 5, 2008, at <http://cdo.ncdc.noaa.gov/climaps/temp0313.pdf>
- National Climate Data Center, 2005b, Annual mean total precipitation: National Oceanic and Atmospheric Administration, accessed March 5, 2008, at <http://cdo.ncdc.noaa.gov/climaps/prec0113.pdf>
- Patton, C.J., and Kryskalla, J.R., 2003, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory - evaluation of alkaline persulfate digestion as an alternative to Kjeldahl digestion for determination of total and dissolved nitrogen and phosphorous in water: U.S. Geological Survey Water-Resources Investigations Report 03-4174, 33 p.
- Pirkey, K.D., and Glodt, S.R., 1998, Quality control at the U.S. Geological Survey National Water Quality Laboratory: U.S. Geological Survey Fact-Sheet FS-026-98, 4 p., <http://pubs.er.usgs.gov/usgspubs/fs/fs02698>
- Radtke, D.B., Davis, J.V., and Wilde, F.D., 2005, Specific electrical conductance (ver. 1.2), in National Field Manual for the Collection of Water-Quality Data, Field Measurements: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A6, sec. 6.3, accessed June 28, 2007, at <http://pubs.water.usgs.gov/twri9A6.3/>
- Reichard, E.G. and Meadows, K.J., 1992, Evaluation of a ground-water flow and transport model of the upper Coachella Valley, California: U.S. Geological Survey Water-Resources Investigation Report 91-4142, 101 p.
- Rose, D.L., and Sandstrom, M.W., 2003, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory - determination of gasoline oxygenates, selected degradates, and BTEX in water by heated purge and trap/gas chromatography/mass spectrometry: U.S. Geological Survey Water-Resources Investigations Report 03-4079, 31 p.
- Rounds, S.A., 2006, Alkalinity and acid neutralizing capacity (ver. 3): U.S. Geological Survey Techniques of Water-Resources Investigations, in National Field Manual for the Collection of Water-Quality Data, Field Measurements: book 9, chap. A6, sec 6.6, accessed June 28, 2007, at <http://pubs.water.usgs.gov/twri9A6.6/>
- Sandstrom, M.W., Stoppel, M.E., Foreman, W.T., and Schroeder, M.P., 2001, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory - determination of moderate-use pesticides and selected degradates in water by C-18 solid-phase extraction and gas chromatography/mass spectrometry: U.S. Geological Survey Water-Resources Investigations Report 01-4098, 70 p.
- Scott, J.C., 1990, Computerized stratified random site selection approaches for design of a ground-water quality sampling network: U.S. Geological Survey Water-Resources Investigations Report 90-4101, 109 p.

- Shelton, J.L., Burow, K.R., Belitz, K., Dubrovsky, N.M., Land, M.T., and Gronberg, J.M., 2001, Low-level volatile organic compounds in active public supply wells as groundwater tracers in the Los Angeles physiographic basin, California, 2000: U.S. Geological Survey Water-Resources Investigations Report 01-4188, 29 p.
- State Water Resources Control Board, 2003, A comprehensive groundwater quality monitoring program for California: Assembly Bill 599 Report to the Governor and Legislature, March 2003, 100 p., available at http://www.waterboards.ca.gov/gama/docs/final_ab_599_rpt_to_legis_7_31_03.pdf
- Stookey, L.L., 1970, FerroZine - a new spectrophotometric reagent for iron: *Analytical Chemistry*, v. 42, p. 779–781.
- Stumm, W., and Morgan, J.J., 1996, *Aquatic chemistry: Chemical equilibria and rates in natural waters* (3rd ed.): New York, John Wiley & Sons, 1022 p.
- Thatcher, L.L., Janzer, V.J., and Edwards, K.W., 1977, Methods for the determination of radioactive substances in water: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A5, 95 p., available at <http://pubs.usgs.gov/twri/twri5a5/>
- Timme, P.J., 1995, National Water Quality Laboratory 1995 services catalog: U.S. Geological Survey Open-File Report 95-352, 120 p.
- To, T.B., Nordstrom, D.K., Cunningham, K.M., Ball, J.W., and McCleskey, R.B., 1998, New method for the direct determination of dissolved Fe(III) concentration in acid mine waters: *Environmental Science and Technology*, v. 33, p. 807813.
- U.S. Environmental Protection Agency, 1980, Prescribed procedures for measurement of radioactivity in drinking water: U.S. Environmental Protection Agency EPA-600-4-80-032.
- U.S. Environmental Protection Agency, 1995, Method 524.2, Measurement of purgeable organic compounds in water by capillary column gas chromatography/mass spectrometry: U.S. Environmental Protection Agency EPA/600/R-95-131.
- U.S. Environmental Protection Agency, 1996, Method 8270C - Semivolatile organic compounds by gas chromatography/mass spectrometry (rev 3), available at <http://www.nemi.gov/>
- U.S. Environmental Protection Agency, 1999a, National primary drinking water regulations, radon-222: Federal Register, v. 64, no. 211, p. 59245–59294.
- U.S. Environmental Protection Agency, 2001, Method 1601 - Male-specific (F+) and somatic Coliphage in water by two-step enrichment procedure - April 2000 Draft: U.S. Environmental Protection Agency EPA 821-R-00-009.
- U.S. Environmental Protection Agency, 2002b, Method 1604 - total coliforms and *Escherichia coli* in water by membrane filtration using a simultaneous detection technique (MI medium): U.S. Environmental Protection Agency EPA 821-R-02-024.
- U.S. Environmental Protection Agency, 2002a, Guidelines for establishing procedures for the analysis of pollutants: U.S. Code of Federal Regulations, Title 40, 136 p.
- U.S. Environmental Protection Agency, 2004, National primary drinking water regulations - analytical method for uranium: U.S. Code of Federal Regulations, Title 40, part 141, p. 31008-31013.
- U.S. Environmental Protection Agency, 2006, 2006 Edition of the drinking water standards and health advisories: U.S. Environmental Protection Agency, Office of Water EPA 822-R-06-013. Accessed June 21, 2007, at <http://www.epa.gov/waterscience/criteria/drinking/dwstandards.pdf>
- U.S. Geological Survey, variously dated, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A1-A9, available at <http://water.usgs.gov/owq/FieldManual/>
- Weiss, R.F., 1968, Piggyback sampler for dissolved gas studies on sealed water samples: *Deep Sea Research*, v. 15, p. 721-735.
- Wilde, F.D., 2006, Temperature (ver. 2) , in National Field Manual for the Collection of Water-Quality Data, Field Measurements: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A6, sec. 6.1, accessed June 28, 2007, at <http://pubs.water.usgs.gov/twri9A6.1/>
- Wilde, F.D., ed., 2004, Cleaning of equipment for water sampling (ver. 2.0), in National Field Manual for the Collection of Water-Quality Data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A3, accessed June 28, 2007, at <http://pubs.water.usgs.gov/twri9A3/>
- Wilde, F.D., Busenberg, E., and Radtke, D.B., 2006, pH (ver. 1.3): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A6.4, accessed June 28, 2007 at <http://pubs.water.usgs.gov/twri9A6.4/>
- Wilde, F.D., and Radtke, D.B., 2005, General information and guidelines (ver. 1.2): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A6.0, accessed June 28, 2007, at <http://pubs.water.usgs.gov/twri9A6.0/>

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- Wilde, F.D., Radtke, D.B., Gibs, J., and Iwatsubo, R.T., 1999, Collection of water samples: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A4, accessed June 28, 2007, at <http://pubs.water.usgs.gov/twri9A4/>
- Wilde, F.D., Radtke, D.B., Gibs, J., and Iwatsubo, R.T., 2004, Processing of water samples: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A5, accessed June 28, 2007, at <http://pubs.water.usgs.gov/twri9A5/>
- Wright, M.T., Belitz, K., and Burton, C.A., 2005, California GAMA program - ground-water quality in the San Diego drainages hydrologic province, California, 2004: U.S. Geological Survey Data Series 129, 91 p.
- Zaugg, S.D., Sandstrom, M.W., Smith, S.G., and Fehlberg, K.M., 1995, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory - Determination of pesticides in water by C-18 solid-phase extraction and capillary-column gas chromatography/mass spectrometry: U.S. Geological Survey Open-File Report 95-181, 60 p.
- Zaugg, S.D., Smith, S.G., Schroeder, M.P., Barber, L.B., and Burkhardt, M.R., 2002, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory - determination of wastewater compounds by polystyrene divinylbenzene solid-phase extraction and capillary-column gas chromatography/mass spectrometry: U.S. Geological Survey Water-Resources Investigations Report 01-4186, 37 p.

Table 1. Identification, sampling, and construction information for wells sampled for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[Sampling schedules are described in [table 2](#). Land surface datum (LSD) is a datum plane that is approximately at land surface at each well. The elevation of the LSD is described in feet above the North American Vertical Datum 1988 (NAVD 88). **Abbreviations:** COA, Coachella Valley study unit grid well; COAU, Coachella Valley study unit understanding well. ft, foot; na, not available]

GAMA well identification No.	Sampling information			Well type	Construction information		
	Date	Sampling schedule	Elevation of LSD (ft above NAVD 88)		Well depth (ft below LSD)	Top perforation (ft below LSD)	Bottom perforation (ft below LSD)
Grid wells							
COA-01	02-27-07	Slow	1,993	Production	1,200	900	1,200
COA-02	02-28-07	Slow	-211	Production	na	230	480
COA-03	02-28-07	Slow	147	Production	na	na	na
COA-04	03-01-07	Intermediate	79	Production	1,070	500	1,060
COA-05	03-05-07	Intermediate	237.23	Production	1,090	710	1,090
COA-06	03-05-07	Intermediate	52.20	Production	654	203	654
COA-07	03-06-07	Intermediate	2	Production	240	na	na
COA-08	03-06-07	Slow	-16	Production	342	258	342
COA-09	03-07-07	Slow	392	Production	na	na	na
COA-10	03-08-07	Intermediate	106	Production	na	na	na
COA-11	03-08-07	Intermediate	-110	Production	na	na	na
COA-12	03-08-07	Intermediate	-173	Production	525	445	525
COA-13	03-12-07	Intermediate	1,953	Production	890	510	870
COA-14	03-12-07	Intermediate	232	Production	820	420	820
COA-15	03-14-07	Slow	872	Production	400	180	380
COA-16	03-15-07	Slow	477	Production	650	300	650
COA-17	03-15-07	Intermediate	2,475	Production	na	na	na
COA-18	03-19-07	Intermediate	43	Production	790	280	790
COA-19	03-29-07	Intermediate	1,063	Production	na	na	na
Understanding wells							
COAU-01	02-26-07	Slow	2,218	Production	96	12	43
COAU-02	02-27-07	Intermediate	382	Production	600	288	600
COAU-03	03-01-07	Slow	332	Production	na	na	na
COAU-04	03-06-07	Intermediate	2	Production	400	280	400
COAU-05	03-07-07	Slow	1,175	Production	909	306	906
COAU-06	03-13-07	Slow	2,297.83	Production	1,130	580	1,110
COAU-07	03-13-07	Intermediate	1,353	Production	553	225	553
COAU-08	03-14-07	Intermediate	499.42	Production	730	476	726
COAU-09	03-19-07	Intermediate	183	Production	na	na	na
COAU-10	03-20-07	Intermediate	1,016	Production	1,070	410	1,050
COAU-11	03-20-07	Intermediate	589	Production	400	220	400
COAU-12	04-11-01	Intermediate	4,469.99	Production	160	55	155
COAU-13	03-26-07	Intermediate	171	Production	na	na	na
COAU-14	03-27-07	Intermediate	62	Production	550	330	530
COAU-15	03-28-07	Intermediate	344	Production	700	400	700
COAU-16	03-28-07	Intermediate	-3	Production	na	na	na

Table 2. Classes of chemical and microbial constituents and water-quality indicators collected for the slow and intermediate well sampling schedules in the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March, 2007.

Analyte classes	Analyte list table	Sampling schedule	
		Slow	Intermediate
Water-quality indicators			
Dissolved oxygen, temperature, specific conductance		X	X
pH, alkalinity		X	X
Turbidity		X	
Organic constituents			
Volatile organic compounds	3A	X	X
Polar pesticides and pesticide degradation products	3B	X	X
Pesticides and pesticide degradation products	3C	X	X
Pharmaceutical compounds	3D	X	X
Dissolved organic carbon	3G	X	
Wastewater-indicator compounds	3E	X	
Constituents of special interest			
Perchlorate	3F	X	X
1,2,3-Trichloropropane	3F	X	
Inorganic constituents			
Nutrients	3G	X	X
Major and minor ions and trace elements including mercury	3H	X	
Major and minor ions and trace elements without mercury			X
Arsenic, chromium, and iron abundances and speciation	3I	X	X
Isotopes			
Stable isotopes of hydrogen and oxygen of water	3J	X	X
Stable isotopes of carbon and carbon-14 abundance	3J	X	X
Uranium isotopes	3J	X	X
Radioactivity and noble gases			
Tritium	3J	X	X
Radium isotopes	3J	X	
Radon-222	3J	X	
Gross alpha and beta radiation	3J	X	
Noble gases	3K	X	X
Microbial constituents			
Bacterial indicators	3L	X	
Viral indicators	3L	X	

Table 3A. Volatile organic compounds, primary uses or sources, comparative thresholds, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory schedule 2020.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. This report contains CAS Registry Numbers®, which is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client ServicesSM. **Threshold type:** Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists. HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL-CA, California Department of Public Health notification level; RSD5-US, U.S. Environmental Protection Agency risk specific dose at a risk factor of 10⁻⁵. **Other abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; THM, trihalomethane; D, detected in ground-water samples (table 5); na, not available; µg/L, micrograms per liter; –, not detected]

Constituent	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type	Threshold value (µg/L)	Detection
Acetone	Solvent	81552	67-64-1	6	na	na	–
Acrylonitrile	Organic synthesis	34215	107-13-1	0.4	RSD5-US	0.6	–
Benzene	Gasoline hydrocarbon	34030	71-43-2	0.016	MCL-CA	1	–
Bromobenzene	Solvent	81555	108-86-1	0.02	na	na	–
Bromochloromethane	Fire retardant	77297	74-97-5	0.06	HAL-US	90	–
Bromodichloromethane	Disinfection by-product (THM)	32101	75-27-4	0.04	MCL-US ¹	80	D
Bromoform (Tribromomethane)	Disinfection by-product (THM)	32104	75-25-2	0.08	MCL-US ¹	80	–
2-Butanone (MEK, Methyl ethyl ketone)	Solvent	81595	78-93-3	1.6	HAL-US	4,000	–
<i>n</i> -Butylbenzene	Gasoline hydrocarbon	77342	104-51-8	0.14	NL-CA	260	–
<i>sec</i> -Butylbenzene	Gasoline hydrocarbon	77350	135-98-8	0.04	NL-CA	260	–
<i>tert</i> -Butylbenzene	Gasoline hydrocarbon	77353	98-06-6	0.08	NL-CA	260	–
Carbon disulfide	Organic synthesis	77041	75-15-0	0.06	NL-CA	160	–
Carbon tetrachloride (Tetrachloromethane)	Solvent	32102	56-23-5	0.08	MCL-CA	0.5	–
Chlorobenzene	Solvent	34301	108-90-7	0.02	MCL-CA	70	–
Chloroethane	Solvent	34311	75-00-3	0.1	na	na	–
Chloroform (Trichloromethane)	Disinfection by-product (THM)	32106	67-66-3	0.04	MCL-US ¹	80	D
Chloromethane	Refrigerant/organic synthesis	34418	74-87-3	0.1	HAL-US	30	–
3-Chloro-1-propene	Organic synthesis	78109	107-05-1	0.08	na	na	–
2-Chlorotoluene	Solvent	77275	95-49-8	0.04	NL-CA	140	–
4-Chlorotoluene	Solvent	77277	106-43-4	0.04	NL-CA	140	–
Dibromochloromethane	Disinfection by-product (THM)	32105	124-48-1	0.12	MCL-US ¹	80	–
1,2-Dibromo-3-chloropropane (DBCP)	Fumigant	82625	96-12-8	0.5	MCL-US	0.2	–
1,2-Dibromoethane (EDB)	Fumigant	77651	106-93-4	0.04	MCL-US	0.05	–
Dibromomethane	Solvent	30217	74-95-3	0.004	na	na	–
1,2-Dichlorobenzene	Solvent	34536	95-50-1	0.04	MCL-US	600	–
1,3-Dichlorobenzene	Solvent	34566	541-73-1	0.04	HAL-US	600	–
1,4-Dichlorobenzene	Fumigant	34571	106-46-7	0.04	MCL-CA	5	–
<i>trans</i> -1,4-Dichloro-2-butene	Organic synthesis	73547	110-57-6	0.6	na	na	–
Dichlorodifluoromethane (CFC-12)	Refrigerant	34668	75-71-8	0.14	NL-CA	1,000	–
1,1-Dichloroethane	Solvent	34496	75-34-3	0.06	MCL-CA	5	D
1,2-Dichloroethane	Solvent	32103	107-06-2	0.1	MCL-CA	0.5	–
1,1-Dichloroethene	Organic synthesis	34501	75-35-4	0.02	MCL-CA	6	–
<i>cis</i> -1,2-Dichloroethene	Solvent	77093	156-59-2	0.02	MCL-CA	6	–
<i>trans</i> -1,2-Dichloroethene	Solvent	34546	156-60-5	0.018	MCL-CA	10	–
Dichloromethane (Methylene chloride)	Solvent	34423	75-09-2	0.04	MCL-US	5	–
1,2-Dichloropropane	Fumigant	34541	78-87-5	0.02	MCL-US	5	–
1,3-Dichloropropane	Fumigant	77173	142-28-9	0.06	na	na	–
2,2-Dichloropropane	Fumigant	77170	594-20-7	0.06	na	na	–
1,1-Dichloropropene	Organic synthesis	77168	563-58-6	0.04	na	na	–
<i>cis</i> -1,3-Dichloropropene	Fumigant	34704	10061-01-5	0.06	RSD5-US ²	4	–
<i>trans</i> -1,3-Dichloropropene	Fumigant	34699	10061-02-6	0.1	RSD5-US ²	4	–
Diethyl ether	Solvent	81576	60-29-7	0.08	na	na	–
Diisopropyl ether (DIPE)	Gasoline oxygenate	81577	108-20-3	0.06	na	na	–

Table 3A. Volatile organic compounds, primary uses or sources, comparative thresholds, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory schedule 2020.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. This report contains CAS Registry Numbers®, which is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client ServicesSM. **Threshold type:** Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists. HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL-CA, California Department of Public Health notification level; RSD5-US, U.S. Environmental Protection Agency risk specific dose at a risk factor of 10⁻⁵. **Other abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; THM, trihalomethane; D, detected in ground-water samples (table 5); na, not available; µg/L, micrograms per liter; –, not detected]

Constituent	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type	Threshold value (µg/L)	Detection
Ethylbenzene	Gasoline hydrocarbon	34371	100-41-4	0.02	MCL-CA	300	–
Ethyl <i>tert</i> -butyl ether (ETBE)	Gasoline oxygenate	50004	637-92-3	0.04	DLR	3	–
Ethyl methacrylate	Organic synthesis	73570	97-63-2	0.14	na	na	–
1-Ethyl-2-methylbenzene (<i>o</i> -Ethyl toluene)	Gasoline hydrocarbon	77220	611-14-3	0.04	na	na	–
Hexachlorobutadiene	Organic synthesis	39702	87-68-3	0.1	RSD5-US	9	–
Hexachloroethane	Solvent	34396	67-72-1	0.14	HAL-US	1	–
2-Hexanone (<i>n</i> -Butyl methyl ketone)	Solvent	77103	591-78-6	0.4	na	na	–
Isopropylbenzene (Cumene)	Gasoline hydrocarbon	77223	98-82-8	0.04	NL-CA	770	–
4-Isopropyl-1-methylbenzene	Gasoline hydrocarbon	77356	99-87-6	0.08	na	na	–
Methyl acrylate	Organic synthesis	49991	96-33-3	0.4	na	na	–
Methyl acrylonitrile	Organic synthesis	81593	126-98-7	0.40	na	na	–
Methyl bromide (Bromomethane)	Fumigant	34413	74-83-9	0.4	HAL-US	10	–
Methyl <i>tert</i> -butyl ether (MTBE)	Gasoline oxygenate	78032	1634-04-4	0.10	MCL-CA	13	–
Methyl iodide (Iodomethane)	Organic synthesis	77424	74-88-4	0.4	na	na	–
Methyl isobutyl ketone (MIBK)	Solvent	78133	108-10-1	0.2	NL-CA	120	–
Methyl methacrylate	Organic synthesis	81597	80-62-6	0.20	na	na	–
Methyl <i>tert</i> -pentyl ether (<i>tert</i> -Amyl methyl ether, TAME)	Gasoline oxygenate	50005	994-05-8	0.04	na	na	–
Naphthalene	Gasoline hydrocarbon	34696	91-20-3	0.4	NL-CA	17	–
<i>n</i> -Propylbenzene	Solvent	77224	103-65-1	0.04	NL-CA	260	–
Styrene	Gasoline hydrocarbon	77128	100-42-5	0.04	MCL-US	100	–
1,1,1,2-Tetrachloroethane	Solvent	77562	630-20-6	0.04	HAL-US	70	–
1,1,2,2-Tetrachloroethane	Solvent	34516	79-34-5	0.1	MCL-CA	1	–
Tetrachloroethene (PCE)	Solvent	34475	127-18-4	0.04	MCL-US	5	D
Tetrahydrofuran	Solvent	81607	109-99-9	1.0	na	na	–
1,2,3,4-Tetramethylbenzene	Gasoline hydrocarbon	49999	488-23-3	0.14	na	na	–
1,2,3,5-Tetramethylbenzene	Gasoline hydrocarbon	50000	527-53-7	0.12	na	na	–
Toluene	Gasoline hydrocarbon	34010	108-88-3	0.018	MCL-CA	150	D
1,2,3-Trichlorobenzene	Organic synthesis	77613	87-61-6	0.12	na	na	–
1,2,4-Trichlorobenzene	Solvent	34551	120-82-1	0.12	MCL-CA	5	–
1,1,1-Trichloroethane	Solvent	34506	71-55-6	0.04	MCL-CA	200	–
1,1,2-Trichloroethane	Solvent	34511	79-00-5	0.04	MCL-CA	5	–
Trichloroethene (TCE)	Solvent	39180	79-01-6	0.02	MCL-US	5	D
Trichlorofluoromethane (CFC-11)	Refrigerant	34488	75-69-4	0.08	MCL-CA	150	–
1,2,3-Trichloropropane (1,2,3-TCP)	Solvent/organic synthesis	77443	96-18-4	0.12	NL-CA	0.005	–
1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113)	Refrigerant	77652	76-13-1	0.04	MCL-CA	1,200	–
1,2,3-Trimethylbenzene	Gasoline hydrocarbon	77221	526-73-8	0.08	na	na	–
1,2,4-Trimethylbenzene	Gasoline hydrocarbon	77222	95-63-6	0.04	NL-CA	330	–
1,3,5-Trimethylbenzene	Organic synthesis	77226	108-67-8	0.04	NL-CA	330	–
Vinyl bromide (Bromoethene)	Fire retardant	50002	593-60-2	0.12	na	na	–
Vinyl chloride (Chloroethene)	Organic synthesis	39175	75-01-4	0.08	MCL-CA	0.5	–
<i>m</i> - and <i>p</i> -Xylene	Gasoline hydrocarbon	85795	108-38-3 / 106-42-3	0.08	MCL-CA	³ 1,750	–
<i>o</i> -Xylene	Gasoline hydrocarbon	77135	95-47-6	0.04	MCL-CA	³ 1,750	–

¹The MCL-US, and MCL-CA thresholds for trihalomethanes are the sum of chloroform, bromoform, bromodichloromethane, and dibromochloromethane.

²The RSD5 threshold for 1,3-dichloropropene is the sum of its isomers (*cis* and *trans*).

³The MCL value is the sum of all three xylene compounds.

Table 3B. Polar pesticides and pesticide degradates, primary uses or sources, comparative thresholds, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory schedule 2060.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. This report contains CAS Registry Numbers®, which is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client ServicesSM. **Threshold type:** Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists. HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level. **Other abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; D, detected in ground-water samples (table 6); na, not available; µg/L, micrograms per liter; –, not detected]

Constituent	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type	Threshold value (µg/L)	Detection
Acifluorfen	Herbicide	49315	50594-66-6	0.06	na	na	–
Aldicarb	Insecticide	49312	116-06-3	0.04	MCL-US	4	–
Aldicarb sulfone	Degradate	49313	1646-88-4	0.08	MCL-US	3	–
Aldicarb sulfoxide	Degradate	49314	1646-87-3	0.04	MCL-US	3	–
Atrazine	Herbicide	39632	1912-24-9	0.04	MCL-CA	1	D
Bendiocarb	Insecticide	50299	22781-23-3	0.04	na	na	–
Benomyl	Fungicide	50300	17804-35-2	0.02	na	na	–
Bensulfuron-methyl	Herbicide	61693	83055-99-6	0.06	na	na	–
Bentazon	Herbicide	38711	25057-89-0	0.02	MCL-CA	18	–
Bromacil	Herbicide	04029	314-40-9	0.04	HAL-US	70	–
Bromoxynil	Herbicide	49311	1689-84-5	0.12	na	na	–
Caffeine	Stimulant	50305	58-08-2	0.04	na	na	–
Carbaryl	Herbicide	49310	63-25-2	0.02	HAL-US	700	–
Carbofuran	Herbicide	49309	1563-66-2	0.06	MCL-CA	18	–
Chloramben methyl ester	Herbicide	61188	7286-84-2	0.1	na	na	–
Chlorimuron-ethyl	Herbicide	50306	90982-32-4	0.08	na	na	–
2-Chloro-4-isopropylamino-6-amino- <i>s</i> -triazine (Deethylatrazine, CIAT)	Degradate	04040	6190-65-4	0.02	na	na	D
2-Chloro-6-ethylamino-4-amino- <i>s</i> -triazine (Deisopropylatrazine, CEAT)	Degradate	04038	1007-28-9	0.08	na	na	D
3-(4-Chlorophenyl)-1-methyl urea	Degradate	61692	5352-88-5	0.06	na	na	–
Clopyralid	Herbicide	49305	1702-17-6	0.06	na	na	–
Cycloate	Herbicide	04031	1134-23-2	0.06	na	na	–
2,4-D plus 2,4-D methyl ester	Herbicide	66496	–	0.02	MCL-US	70	–
2,4-DB (4-(2,4-Dichlorophenoxy) butyric acid)	Herbicide	38746	94-82-6	0.02	na	na	–
DCPA (Dacthal) monoacid	Degradate	49304	887-54-7	0.02	na	na	–
Dicamba	Herbicide	38442	1918-00-9	0.08	HAL-US	4,000	–
Dichlorprop	Herbicide	49302	120-36-5	0.04	na	na	–
Dinoseb	Herbicide	49301	88-85-7	0.04	MCL-CA	7	–
Diphenamid	Herbicide	04033	957-51-7	0.04	HAL-US	200	–
Diuron	Herbicide	49300	330-54-1	0.04	HAL-US	10	D
Fenuron	Herbicide	49297	101-42-8	0.04	na	na	–
Flumetsulam	Herbicide	61694	98967-40-9	0.06	na	na	–
Fluometuron	Herbicide	38811	2164-17-2	0.04	HAL-US	90	–
2-Hydroxy-4-isopropylamino-6-ethylamino- <i>s</i> -triazine (Hydroxyatrazine)	Degradate	50355	2163-68-0	0.08	na	na	–
3-Hydroxy carbofuran	Degradate	49308	16655-82-6	0.02	na	na	–
Imazaquin	Herbicide	50356	81335-37-7	0.04	na	na	–
Imazethapyr	Herbicide	50407	81335-77-5	0.04	na	na	–
Imidacloprid	Insecticide	61695	138261-41-3	0.06	na	na	–
Linuron	Herbicide	38478	330-55-2	0.04	na	na	–
MCPA (2-Methyl-4-chlorophenoxyacetic acid)	Herbicide	38482	94-74-6	0.06	HAL-US	30	–
MCPB (4-(2-Methyl-4-chlorophenoxy) butyric acid)	Herbicide	38487	94-81-5	0.2	na	na	–

Table 3B. Polar pesticides and pesticide degradates, primary uses or sources, comparative thresholds, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory schedule 2060.—Continued

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Constituent	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type	Threshold value (µg/L)	Detection
Metalaxyl	Fungicide	50359	57837-19-1	0.04	na	na	–
Methiocarb	Insecticide	38501	2032-65-7	0.04	na	na	–
Methomyl	Insecticide	49296	16752-77-5	0.06	HAL-US	200	–
Metsulfuron methyl	Herbicide	61697	74223-64-6	0.14	na	na	–
Neburon	Herbicide	49294	555-37-3	0.02	na	na	–
Nicosulfuron	Herbicide	50364	111991-09-4	0.1	na	na	–
Norflurazon	Herbicide	49293	27314-13-2	0.04	na	na	–
Oryzalin	Herbicide	49292	19044-88-3	0.04	na	na	–
Oxamyl	Insecticide	38866	23135-22-0	0.04	MCL-CA	50	–
Picloram	Herbicide	49291	06607	0.12	MCL-US	500	–
Propham	Herbicide	49236	122-42-9	0.06	HAL-US	100	–
Propiconazole	Fungicide	50471	60207-90-1	0.06	na	na	–
Propoxur	Insecticide	38538	114-26-1	0.04	HAL-US	3	–
Siduron	Herbicide	38548	1982-49-6	0.04	na	na	–
Sulfometuron methyl	Herbicide	50337	74222-97-2	0.06	na	na	–
Tebuthiuron	Herbicide	82670	34014-18-1	0.016	HAL-US	500	–
Terbacil	Herbicide	04032	5902-51-2	0.04	HAL-US	90	–
Triclopyr	Herbicide	49235	55335-06-3	0.04	na	na	–

Table 3C. Pesticides and pesticide degradates, primary uses or sources, comparative thresholds, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory schedule 2003.

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Threshold type: Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists. HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; RSD5-US, U.S. Environmental Protection Agency risk specific dose at a risk factor of 10⁻⁵. **Other abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; D, detected in ground-water samples (table 6); na, not available; µg/L, micrograms per liter; –, not detected]

Constituent	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type	Threshold value (µg/L)	Detection
Acetochlor	Herbicide	49260	34256-82-1	0.006	na	na	–
Alachlor	Herbicide	46342	15972-60-8	0.005	MCL-US	2	–
Atrazine	Herbicide	39632	1912-24-9	0.007	MCL-CA	1	D
Azinphos-methyl	Insecticide	82686	86-50-0	0.08	na	na	–
Azinphos-methyl-oxon	Insecticide degradate	61635	961-22-8	0.042	na	na	–
Benfluralin	Herbicide	82673	1861-40-1	0.01	na	na	–
Carbaryl	Insecticide	82680	63-25-2	0.06	RSD5-US	400	–
2-Chloro-2,6-diethylacetanilide	Herbicide degradate	61618	6967-29-9	0.0065	na	na	–
4-Chloro-2-methylphenol	Herbicide degradate	61633	1570-64-5	0.0050	na	na	–
Chlorpyrifos	Insecticide	38933	2921-88-2	0.005	HAL-US	2	–
Chlorpyrifos, oxygen analog	Insecticide degradate	61636	5598-15-2	0.0562	na	na	–
Cyfluthrin	Insecticide	61585	68359-37-5	0.053	na	na	–
Cypermethrin	Insecticide	61586	52315-07-8	0.046	na	na	–
Dacthal (DCPA)	Herbicide	82682	1861-32-1	0.003	HAL-US	70	–
Deethylatrazine (2-Chloro-4-isopropylamino-6-amino-s-triazine)	Herbicide degradate	04040	6190-65-4	0.014	na	na	D
Desulfinylfipronil	Insecticide degradate	62170	na	0.012	na	na	–
Desulfinylfipronil amide	Insecticide degradate	62169	na	0.029	na	na	–
Diazinon	Insecticide	39572	333-41-5	0.005	HAL-US	1	–
3,4-Dichloroaniline	Herbicide degradate	61625	95-76-1	0.0045	na	na	–
Dichlorvos	Insecticide	38775	62-73-7	0.013	na	na	–
Dicrotophos	Insecticide	38454	141-66-2	0.0843	na	na	–
Dieldrin	Insecticide	39381	60-57-1	0.009	RSD5-US	0.02	–
2,6-Diethylaniline	Herbicide degradate	82660	579-66-8	0.006	na	na	–
Dimethoate	Insecticide	82662	60-51-5	0.0061	na	na	–
Ethion	Insecticide	82346	563-12-2	0.016	na	na	–
Ethion monoxon	Insecticide degradate	61644	17356-42-2	0.021	na	na	–
2-Ethyl-6-methylaniline	Herbicide degradate	61620	24549-06-2	0.010	na	na	–
Fenamiphos	Insecticide	61591	22224-92-6	0.029	HAL-US	0.7	–
Fenamiphos sulfone	Insecticide degradate	61645	31972-44-8	0.053	na	na	–
Fenamiphos sulfoxide	Insecticide degradate	61646	31972-43-7	0.040	na	na	–
Fipronil	Insecticide	62166	120068-37-3	0.016	na	na	–
Fipronil sulfide	Insecticide degradate	62167	120067-83-6	0.013	na	na	–
Fipronil sulfone	Insecticide degradate	62168	120068-36-2	0.024	na	na	–
Fonofos	Insecticide	04095	944-22-9	0.06	HAL-US	10	–
Hexazinone	Herbicide	04025	51235-04-2	0.026	HAL-US	400	–
Iprodione	Fungicide	61593	36734-19-7	0.026	na	na	–
Isofenphos	Insecticide	61594	25311-71-1	0.011	na	na	–
Malaoxon	Insecticide degradate	61652	1634-78-2	0.039	na	na	–
Malathion	Insecticide	39532	121-75-5	0.016	HAL-US	100	–
Metalaxyl	Fungicide	61596	57837-19-1	0.0069	na	na	–
Methodathion	Insecticide	61598	950-37-8	0.0087	na	na	–
Metolachlor	Herbicide	39415	51218-45-2	0.01	HAL-US	700	–
Metribuzin	Herbicide	82630	21087-64-9	0.12	HAL-US	70	–
Myclobutanil	Fungicide	61599	88671-89-0	0.033	na	na	–
1-Naphthol	Insecticide degradate	49295	90-15-3	0.0882	na	na	–
Paraoxon-methyl	Insecticide degradate	61664	950-35-6	0.019	na	na	–
Parathion-methyl	Insecticide	82667	298-00-0	0.008	HAL-US	1	–
Pendimethalin	Herbicide	82683	40487-42-1	0.02	na	na	–

Table 3C. Pesticides and pesticide degradates, primary uses or sources, comparative thresholds, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory schedule 2003.—Continued

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Threshold type: Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists. HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; RSD5-US, U.S. Environmental Protection Agency risk specific dose at a risk factor of 10^{-5} . **Other abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; D, detected in ground-water samples ([table 6](#)); na, not available; µg/L, micrograms per liter; –, not detected]

Constituent	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type	Threshold value (µg/L)	Detection
<i>cis</i> -Permethrin	Insecticide	82687	54774-45-7	0.01	na	na	–
Phorate	Insecticide	82664	298-02-2	0.02	na	na	–
Phorate oxon	Insecticide degradate	61666	2600-69-3	0.027	na	na	–
Phosmet	Insecticide	61601	732-11-6	0.0079	na	na	–
Phosmet oxon	Insecticide degradate	61668	3735-33-9	0.0511	na	na	–
Prometon	Herbicide	04037	1610-18-0	0.01	HAL-US	100	D
Prometryn	Herbicide	04036	7287-19-6	0.0059	na	na	–
Pronamide (Propyzamide)	Herbicide	82676	23950-58-5	0.004	RSD5-US	20	–
Simazine	Herbicide	04035	122-34-9	0.006	MCL-US	4	D
Tebuthiuron	Herbicide	82670	34014-18-1	0.016	HAL-US	500	–
Terbufos	Insecticide	82675	13071-79-9	0.012	HAL-US	0.4	–
Terbufos oxon sulfone	Insecticide degradate	61674	56070-15-6	0.045	na	na	–
Terbutylazine	Herbicide	04022	5915-41-3	0.0083	na	na	–
Trifluralin	Herbicide	82661	1582-09-8	0.009	HAL-US	10	–

Table 3D. Pharmaceutical compounds, primary uses or sources, comparative thresholds, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory schedule 2080.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. This report contains CAS Registry Numbers®, which is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client ServicesSM.

Abbreviations: CAS, Chemical Abstract Service; LRL, laboratory reporting level; D, detected in ground-water samples; na, not available; µg/L, micrograms per liter; –, not detected]

Constituent	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type	Threshold value (µg/L)	Detection
Acetaminophen	Analgesic	62000	103-90-2	0.024	na	na	D
Albuterol	Anti-inflammatory; bronchodilator	62020	18559-94-9	0.14	na	na	–
Caffeine	Stimulant	50305	58-08-2	0.01	na	na	–
Carbamazapine	Anticonvulsant; analgesic; mood stabilizer	62793	298-46-4	0.0179	na	na	–
Codeine	Opioid narcotic	62003	76-57-3	0.022	na	na	–
Cotinine	Nicotine metabolite	62005	486-56-6	0.03	na	na	–
Dehydronifedipine	Antianginal metabolite	62004	67035-22-7	0.022	na	na	–
Diltiazem	Antianginal; antihypertensive	62008	42399-41-7	0.18	na	na	–
Diphenhydramine	Antihistamine	62796	58-73-1	0.023	na	na	–
1,7-Dimethylxanthine	Caffeine metabolite	62030	611-59-6	0.021	na	na	–
Sulfamethoxazole	Antibacterial, antiprotozoal	62021	723-46-6	0.024	na	na	–
Thiabendazole	Anthelmintic	62801	148-79-8	0.025	na	na	–
Trimethoprim	Antibacterial	62023	738-70-5	0.020	na	na	–
Warfarin	Anticoagulant	62024	81-81-2	0.019	na	na	–

Table 3E. Potential wastewater indicator compounds, primary uses or sources, comparative thresholds, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory schedule 4433.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. This report contains CAS Registry Numbers®, which is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client ServicesSM. **Threshold type:** Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists. HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory; NL-CA, California Department of Public Health notification level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level. **Abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; D, detected in ground-water samples (table 7); na, not available; µg/L, micrograms per liter; –, not detected]

Constituent	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type	Threshold value (µg/L)	Detection
Acetophenone	Fragrance in detergent and tobacco, flavor in beverages	62811	98-86-2	0.2	na	na	–
Acetyl hexamethyl tetrahydro naphthalene (AHTN)	Musk fragrance	62812	21145-77-7	0.2	na	na	–
Anthracene	Wood preservative, tar, diesel, crude oil, combustion product	34220	120-12-7	0.2	na	na	D
9,10-Anthraquinone	Manufactured dye/textiles, seed treatment, bird repellent	62813	84-65-1	0.2	na	na	D
Atrazine	Herbicide	39630	1912-24-9	0.2	MCL-CA	1	–
Benzo[a]pyrene	Cancer research, combustion product	34247	50-32-8	0.2	MCL-US	0.2	D
Benzophenone	Fixative for perfumes and soaps	62814	119-61-9	0.2	na	na	–
Bisphenol A	Manufactured polycarbonate resins, antioxidant, flame retardant	62816	80-05-7	0.4	na	na	–
Bromacil	Herbicide, greater than 80 percent noncrop usage on grass/brush	30234	314-40-9	0.2	HAL-US	70	–
Bromoform (tribromomethane)	Byproduct waste water treatment, military/explosives	32104	75-25-2	0.08	MCL-US	80	–
3- <i>tert</i> -Butyl-4-hydroxy anisole (BHA)	Antioxidant, general preservative	61702	25013-16-5	0.2	na	na	–
Caffeine	Beverages	81436	58-08-2	0.2	na	na	D
Camphor	Flavor, odorant, ointments	62817	76-22-2	0.2	na	na	–
Carbaryl	Insecticide, crop and garden uses	39750	63-25-2	0.2	RSD5-US	400	–
Carbazole	Insecticide, manuf. dyes, explosives, and lubricants	77571	86-74-8	0.2	na	na	–
Chlorpyrifos	Insecticide, domestic pest and termite control	38932	2921-88-2	0.2	HAL-US	2	–
Cholesterol	Fecal indicator, plant sterol	62818	57-88-5	0.8	na	na	–
3-β-Coprostanol	Carnivore fecal indicator	62806	360-68-9	0.8	na	na	–
Cotinine	Primary nicotine metabolite	61945	486-56-6	0.8	na	na	–
<i>p</i> -Cresol	Wood preservative	77146	106-44-5	0.2	na	na	–
4-Cumylphenol	Nonionic detergent metabolite	62808	599-64-4	0.2	na	na	–
Diazinon	Insecticide, greater than 40 percent nonagricultural usage, ants, flies	39570	333-41-5	0.2	HAL-US	1	–
Dichlorvos	Insecticide	30218	62-73-7	0.2	na	na	–
<i>N,N</i> -diethyl- <i>m</i> -toluamide (DEET)	Insecticide, urban uses, mosquito repellent	61947	134-62-3	0.2	na	na	–
1,4-Dichlorobenzene	Moth repellent, fumigant, deodorant	34571	106-46-7	0.04	MCL-CA	5	–
3,4-Dichlorophenyl isocyanate	Intermediate for the synthesis of organic compounds	63145	102-36-3	2	na	na	D
Diethyl phthalate	Wood stains and varnishes, plasticizer, softener	34336	84-66-2	0.2	na	na	D
2,6-Dimethylnaphthalene	Diesel/kerosene (trace in gasoline)	62085	581-42-0	0.2	na	na	D
Bis(2-ethylhexyl)phthalate	Plasticizer, softener	39100	117-81-7	2	MCL-CA	4	–
4-Nonylphenol monoethoxylates	Nonionic detergent metabolite	61704	na	2	na	na	–
4-Nonylphenol diethoxylates	Nonionic detergent metabolite	61703	na	3.2	na	na	–
4-Octylphenol diethoxylates	Nonionic detergent metabolite	61705	na	0.32	na	na	–

Table 3E. Potential wastewater indicator compounds, primary uses or sources, comparative thresholds, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory schedule 4433.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. This report contains CAS Registry Numbers®, which is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client ServicesSM.

Threshold type: Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists. HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory; NL-CA, California Department of Public Health notification level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level. **Abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; D, detected in ground-water samples (table 7); na, not available; µg/L, micrograms per liter; –, not detected]

Constituent	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type	Threshold value (µg/L)	Detection
4-Octylphenol monoethoxylates	Nonionic detergent metabolite	61706	na	1	na	na	–
Fluoranthene	Component of coal tar and asphalt	34376	206-44-0	0.2	na	na	D
Hexahydrohexamethylcyclopentabenzopyran (HHCb)	Musk fragrance	62823	1222-05-5	0.2	na	na	–
Indole	Pesticide ingredient, fragrance in coffee	62824	120-72-9	0.2	na	na	–
Isoborneol	Fragrance in perfumery, in disinfectants	62825	124-76-5	0.2	na	na	–
Isophorone	Solvent for lacquer, plastic, oil, silicon, resin	34409	78-59-1	0.2	HAL-US	100	–
Isopropylbenzene	Manufactured phenol/acetone, fuels and paint thinner	77223	98-82-8	0.04	NL-CA	770	–
Isoquinoline	Flavors and fragrances	62826	119-65-3	0.2	na	na	–
<i>d</i> -Limonene	Fungicide, antimicrobial, antiviral, fragrance in aerosols	62819	5989-27-5	0.2	na	na	–
Menthol	Cigarettes, cough drops, liniment, mouthwash	62827	89-78-1	0.2	na	na	–
Metalaxyl	Herbicide, fungicide, mildew, blight, pathogens, golf/turf	04254	57837-19-1	0.2	na	na	–
3-Methyl-1(H)-indole (Skatole)	Fragrance, stench in feces and coal tar	62807	83-34-1	0.2	na	na	–
5-Methyl-1H-benzotriazole	Antioxidant in antifreeze and deicers	61944	136-85-6	1.6	na	na	D
1-Methylnaphthalene	Gasoline, diesel fuel, or crude oil	81696	90-12-0	0.2	na	na	–
2-Methylnaphthalene	Gasoline, diesel fuel, or crude oil	30194	91-57-6	0.2	na	na	–
Methyl salicylate	Liniment, food, beverage, UV-absorbing lotion	62828	119-36-8	0.2	na	na	–
Metolachlor	Herbicide, indicator of agricultural drainage	82612	51218-45-2	0.2	HAL-US	700	–
Naphthalene	Fumigant, moth repellent, major component of gasoline	34696	91-20-3	0.4	NL-CA	17	–
4-Nonylphenol (total)	Nonionic detergent metabolite	62829	84852-15-3	1.6	na	na	–
4- <i>n</i> -Octylphenol	Nonionic detergent metabolite	62809	1806-26-4	0.2	na	na	–
4- <i>tert</i> -Octylphenol	Nonionic detergent metabolite	62810	140-66-9	0.2	na	na	–
Pentachlorophenol	Herbicide, fumigant, wood preservative, termite control	39032	87-86-5	0.8, 2	MCL-US	1	D
Phenanthrene	Manufactured explosives, tar, diesel, crude oil, combustion product	34461	85-01-8	0.2	na	na	D
Phenol	Disinfectant, product manufacturing, leachate	34694	108-95-2	0.2	HAL-US	2,000	D
Prometon	Herbicide (non-crop only) applied prior to blacktop	39056	1610-18-0	0.2	HAL-US	100	–
Pyrene	Component of coal tar and asphalt	34469	129-00-0	0.2	na	na	D
β-Sitosterol	Plant sterol	62815	83-46-5	0.8	na	na	–
β-Stigmastanol	Plant sterol	61948	19466-47-8	0.8	na	na	–
2,2',4,4'-Tetrabromodiphenyl ether	Brominated flame retardant	63147	5436-43-1	0.2	na	na	–

Table 3E. Potential wastewater indicator compounds, primary uses or sources, comparative thresholds, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory schedule 4433.—Continued

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. This report contains CAS Registry Numbers®, which is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client ServicesSM. **Threshold type:** Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists. HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory; NL-CA, California Department of Public Health notification level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level. **Abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; D, detected in ground-water samples (table 7); na, not available; µg/L, micrograms per liter; –, not detected]

Constituent	Primary use or source	USGS parameter code	CAS number	LRL (µg/L)	Threshold type	Threshold value (µg/L)	Detection
Tetrachloroethene (PCE)	Solvent, degreaser	34476	127-18-4	0.5	MCL-US	5	D
Tributyl phosphate	Antifoaming agent, flame retardant	62832	126-73-8	0.2	na	na	D
Triclosan	Disinfectant, antimicrobial	61708	3380-34-5	0.2	na	na	–
Triethyl citrate (ethyl citrate)	Cosmetics, pharmaceuticals	62833	77-93-0	0.2	na	na	–
Triphenyl phosphate	Plasticizer, resin, wax, finish, roofing paper, flame retardant	62834	115-86-6	0.2	na	na	–
Tris(2-butoxyethyl) phosphate	Flame retardant	62830	78-51-3	0.2	na	na	–
Tris(2-chloroethyl) phosphate	Plasticizer, flame retardant	62831	115-96-8	0.2	na	na	–
Tris(dichlorisopropyl) phosphate	Flame retardant	61707	13674-87-8	0.2	na	na	–

Table 3F. Constituents of special interest, primary uses or sources, comparative thresholds, and reporting information for the Montgomery Watson-Harza Laboratory.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. This report contains CAS Registry Numbers®, which is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client ServicesSM. **Threshold type:** MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL-CA, California Department of Public Health notification level. **Abbreviations:** CAS, Chemical Abstract Service; MRL, minimum reporting level; D, detected in ground-water samples (table 8); µg/L, micrograms per liter; –, not detected]

Constituent	Primary use or source	CAS number	MRL (µg/L)	Threshold type	Threshold value (µg/L)	Detection
Perchlorate	Rocket fuel, fireworks, flares	14797-73-0	0.5	MCL-CA	6	D
1,2,3-Trichloropropane (TCP)	Industrial solvent, organic synthesis	96-18-4	0.005	NL-CA	0.005	–

Table 3G. Nutrients and dissolved organic carbon, comparative thresholds, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory schedule 2755 and lab code 2613.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. This report contains CAS Registry Numbers®, which is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client ServicesSM. **Threshold type:** HAL-US, U.S. Environmental Protection Agency lifetime health advisory level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level. **Abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; D, detected in ground-water samples (table 9); µg/L, micrograms per liter]

Constituent	USGS parameter code	CAS number	LRL (mg/L)	Threshold type	Threshold value (mg/L)	Detection
Ammonia (as nitrogen)	00608	7664-41-7	0.02	HAL-US	¹ 30	D
Nitrite (as nitrogen)	00613	14797-65-0	0.002	MCL-US	1	D
Nitrite plus nitrate (as nitrogen)	00631	na	0.06	MCL-US	10	D
Total nitrogen (ammonia, nitrite, nitrate, organic nitrogen)	62854	17778-88-0	0.06	na	na	D
Orthophosphate (as phosphorus)	00671	14265-44-2	0.006	na	na	D
Dissolved organic carbon (DOC)	00681	na	0.4	na	na	D

¹Threshold is as ammonia; data and LRL are reported as nitrogen.

Table 3H. Major and minor ions and trace elements, comparative thresholds, and reporting information for the U.S. Geological Survey (USGS) National Water Quality Laboratory schedule 1948.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. This report contains CAS Registry Numbers®, which is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client ServicesSM. **Threshold type:** Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists. SMCL-CA, California Department of Public Health secondary maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; NL-CA, California Department of Public Health notification level; AL-US, U.S. Environmental Protection Agency action level. **Abbreviations:** CAS, Chemical Abstract Service; LRL, laboratory reporting level; D, detected in ground-water samples (table 10 and 11); µg/L, micrograms per liter; –, not detected]

Constituent	USGS parameter code	CAS number	LRL	Threshold type	Threshold value	Detection
Major and minor ions (mg/L)						
Bromide	71870	24959-67-9	0.02	na	na	D
Calcium	00915	7440-70-2	0.02	na	na	D
Chloride	00940	16887-00-6	0.12	SMCL-CA	¹ 250 (500)	D
Fluoride	00950	16984-48-8	0.10	MCL-CA	2	D
Iodide	78165	7553-56-2	0.002	na	na	D
Magnesium	00925	7439-95-4	0.014	na	na	D
Potassium	00935	7440-09-7	0.04	na	na	D
Silica	00955	7631-86-9	0.018	na	na	D
Sodium	00930	7440-23-5	0.20	na	na	D
Sulfate	00945	14808-79-8	0.18	SMCL-CA	¹ 250 (500)	D
Residue on evaporation (total dissolved solids, TDS)	70300	na	10	SMCL-CA	¹ 500 (1,000)	D
Trace elements (µg/L)						
Aluminum	01106	7429-90-5	1.6	MCL-CA	1,000	D
Antimony	01095	7440-36-0	0.06	MCL-US	6	D
Arsenic	01000	7440-38-2	0.12	MCL-US	10	D
Barium	01005	7440-39-3	0.08	MCL-CA	1,000	D
Beryllium	01010	7440-41-7	0.06	MCL-US	4	D
Boron	01020	7440-42-8	8	NL-CA	1,000	D
Cadmium	01025	7440-43-9	0.04	MCL-US	5	D
Chromium	01030	7440-47-3	0.12	MCL-CA	50	D
Cobalt	01035	7440-48-4	0.04	na	na	D
Copper	01040	7440-50-8	0.4	AL-US	1,300	D
Iron	01046	7439-89-6	6	SMCL-CA	300	D
Lead	01049	7439-92-1	0.12	AL-US	15	D
Lithium	01130	7439-93-2	0.6	na	na	D
Manganese	01056	7439-96-5	0.2	SMCL-CA	50	D
Mercury	71890	7439-97-6	0.010	MCL-US	2	–
Molybdenum	01060	7439-98-7	0.12	HAL-US	40	D
Nickel	01065	7440-02-0	0.06	MCL-CA	100	D
Selenium	01145	7782-49-2	0.08	MCL-US	50	D
Silver	01075	7440-22-4	0.1	SMCL-CA	100	–
Strontium	01080	7440-24-6	0.4	HAL-US	4,000	D
Thallium	01057	7440-28-0	0.04	MCL-US	2	–
Tungsten	01155	7440-33-7	0.06	na	na	D
Uranium	22703	7440-61-1	0.04	MCL-US	30	D
Vanadium	01085	7440-62-2	0.04	NL-CA	50	D
Zinc	01090	7440-66-6	0.6	SMCL-CA	5,000	D

¹The recommended SMCL-CA thresholds for chloride, sulfate, and TDS are listed with the upper SMCL-CA thresholds in parentheses.

Table 3I. Arsenic, chromium, and iron species, comparative thresholds, and reporting information for the U.S. Geological Survey (USGS) Trace Metal Laboratory, Boulder, Colorado.

[The five-digit USGS parameter code is used to uniquely identify a specific constituents or property. This report contains CAS Registry Numbers®, which is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client ServicesSM. **Threshold type:** Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists. MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; HAL-US, U.S. Environmental Protection Agency lifetime health advisory level. **Abbreviations:** CAS, Chemical Abstract Service; MDL, method detection limit; D, detected in ground-water samples ([table 12](#)); mg/L, micrograms per liter; na, not available]

Constituent (valance state)	USGS parameter code	CAS number	MDL (µg/L)	Threshold type	Threshold level (µg/L)	Detection
Arsenic(III)	99034	22569-72-8	1	na	na	D
Arsenic (total)	01000	7440-38-2	0.5	MCL-US	10	D
Chromium(VI)	01032	18540-29-9	1	na	na	D
Chromium (total)	01030	7440-47-3	1	MCL-CA	50	D
Iron(II)	01047	7439-89-6	2	na	na	D
Iron (total)	01046	7439-89-6	2	HAL-US	300	D

Table 3J. Isotopic, tritium, and radioactive constituents, comparative thresholds, and reporting information for laboratories.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. This report contains CAS Registry Numbers®, which is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client ServicesSM. Stable isotope ratios are reported in the standard delta notation (δ), the ratio of a heavier isotope to more common lighter isotope of that element, relative to a standard reference material. **Threshold type:** Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists. MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level. **Abbreviations:** CAS, Chemical Abstract Service; CSU, combined standard uncertainty; CV, critical value; MU, method uncertainty; SSMDC, sample specific minimum detectable concentration; MRL, minimum reporting level; na, not available; pCi/L, picocuries per liter; D, detected in ground-water samples (tables 13 and 14)]

Constituent	USGS parameter code	CAS number	Reporting level type	Reporting level or uncertainty	Threshold type	Threshold value	Reporting units	Detection
Stable isotope ratios (per mil)								
$\delta^2\text{H}$ of water ¹	82082	na	MU	2	na	na	per mil	D
$\delta^{18}\text{O}$ of water ¹	82085	na	MU	0.20	na	na	per mil	D
$\delta^{13}\text{C}$ of dissolved carbonates ²	82081	na	1 sigma	0.05	na	na	D	
Radioactive constituents (percent modern)								
¹⁴ Carbon-14 ³	49933	14762-75-5	1 sigma	0.0015	na	na	percent modern	D
Radioactive constituents (pCi/L)								
Radon-222 ⁴	82303	14859-67-7	SSMDC	CSU and CV Proposed	MCL-US	⁵ 300 (4,000)	pCi/L	D
Tritium ^{6,7}	07000	10028-17-8	MRL	1	MCL-CA	20,000	pCi/L	D
Gross-alpha radioactivity, 72 hr count ⁸	62636	12587-46-1	SSMDC	CSU and CV	MCL-US	15	pCi/L	D
Gross-alpha radioactivity, 30 day count ⁸	62639	12587-46-1	SSMDC	CSU and CV	MCL-US	15	pCi/L	D
Gross-beta radioactivity, 72 hr count ⁸	62642	12587-47-2	SSMDC	CSU and CV	MCL-CA	50	pCi/L	D
Gross-beta radioactivity, 30 day count ⁸	62645	12587-47-2	SSMDC	CSU and CV	MCL-CA	50	pCi/L	D
Radium-226 ⁸	09511	13982-63-3	SSMDC	CSU and CV	MCL-US	⁹ 5	pCi/L	D
Radium-228 ⁸	81366	15262-20-1	SSMDC	CSU and CV	MCL-US	⁹ 5	pCi/L	D
Uranium-234 ⁸	22610	13966-29-5	SSMDC	0.1	MCL-CA	20	pCi/L	D
Uranium-235 ⁸	22620	15117-96-1	SSMDC	0.1	MCL-CA	20	pCi/L	D
Uranium-238 ⁸	22603	7440-61-1	SSMDC	0.1	MCL-CA	20	pCi/L	D

¹USGS Stable Isotope Laboratory, Reston, Virginia.

²University of Waterloo (contract laboratory).

³University of Arizona, Accelerator Mass Spectrometry Laboratory (contract laboratory).

⁴USGS National Water Quality Laboratory.

⁵Two MCLs have been proposed for Radon-222. The proposed alternative MCL is in parentheses.

⁶USGS Stable Isotope and Tritium Laboratory, Menlo Park, California.

⁷Lawrence Livermore National Laboratory.

⁸Eberline Analytical Services (contract laboratory).

⁹The MCL-US threshold for radium is the sum of radium-226 and radium-228.

Table 3K. Noble gas constituents, comparison thresholds, and reporting information for the Lawrence Livermore National Laboratory.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. This report contains CAS Registry Numbers®, which is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client ServicesSM.

Abbreviations: CAS, Chemical Abstract Service; cm³ STP/g, cubic centimeters of gas at standard temperature and pressure per gram of water; pCi/L, picocurie per liter, na, not applicable]

Constituent	USGS parameter code	CAS number	MU (percent)	Reporting units	Threshold type	Threshold value (pCi/L)	Detection
Argon	na	7440-37-1	2	cm ³ STP/g	na	na	No data
Helium-3 / Helium-4 ratio	na	na/7440-59-7	0.75	na	na	na	No data
Helium-4	na	7440-59-7	2	cm ³ STP/g	na	na	No data
Krypton	na	7439-90-9	2	cm ³ STP/g	na	na	No data
Neon	na	7440-01-09	2	cm ³ STP/g	na	na	No data
Xenon	na	7440-63-3	2	cm ³ STP/g	na	na	No data

Table 3L. Microbial constituents, comparison thresholds, and reporting information for the U.S. Geological Survey Ohio Microbiology Laboratory parameter codes 90901, 90900, 99335, and 99332.

[The five-digit USGS parameter code is used to uniquely identify a specific constituent or property. This report contains CAS Registry Numbers®, which is a Registered Trademark of the American Chemical Society. CAS recommends the verification of the CAS Registry Numbers through CAS Client ServicesSM. **Threshold type:** TT-US, U.S. Environmental Protection Agency treatment technique: a required process intended to reduce the level of contamination in drinking water; MCL-US, U.S. Environmental Protection Agency maximum contaminant level. **Abbreviations:** CAS, Chemical Abstract Service; MDL, method detection level; mL, milliliter; D, detected in groundwater samples ([table 15](#)); –, not detected]

Constituent	USGS parameter code	Primary source	MDL	Threshold type	Threshold value	Detection
<i>Escherichia coli</i>	90901	Sewage and animal waste indicator / intestinal tracts of humans and animals	1 colony / 100 mL	TT-US	Zero	–
Total coliform, including fecal coliform and <i>E. coli</i>	90900	Water-quality indicator / soil, water and intestinal tracts of animals	1 colony / 100 mL	MCL-US	5 percent of samples positive per month	D
F-specific coliphage	99335	Viral indicator / intestinal tracts of warm-blooded animals	na	TT-US	99.99 percent killed / inactivated	–
Somatic coliphage	99332	Viral indicator / fecal contaminated waters	na	TT-US	99.99 percent killed / inactivated	–

Table 4. Water-quality indicators in samples collected for the Coachella Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[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. Samples from all 35 wells were analyzed (19 grid wells and 16 understanding wells), but only samples with detections are listed. **Abbreviations:** COA, Coachella Valley study unit grid well; COAU, Coachella Valley study unit understanding well; °C, degrees Celsius; mg/L, milligram per liter; TT, treatment technique; MCL-CA, maximum contaminant level California Department of Public Health; SMCL-US, secondary maximum contaminant level U.S. Environmental Protection Agency; na, not applicable; nc, sample not collected; NTU, nephelometric turbidity unit; µS/cm, microsiemens per centimeter; CaCO₃, calcium carbonate]

GAMA well identification No.	Turbidity, field (NTU) (63676)	Dissolved oxygen, field (mg/L) (00300)	Water temperature, field (°C) (00010)	pH, lab (standard units) (00403)	pH, field (standard units) (00400)	Specific conductance, lab (µS/cm at 25°C) (90095)	Specific conductance, field (µS/cm at 25°C) (00095)	Alkalinity, lab (mg/L as CaCO ₃) (29801)	Alkalinity, field (mg/L as CaCO ₃) (29802)
Threshold type	TT/MCL-CA	na	na	SMCL-US	SMCL-US	SMCL-CA ¹	SMCL-CA ¹	na	na
Threshold level	1/5	na	na	6.5 - 8.5	6.5 - 8.5	900 (1,600)	900 (1,600)	na	na
Grid wells									
COA-01	0.1	10.9	18.8	7.6	7.6	411	411	178	174
COA-02	0.1	0.4	35.2	7.4	8.0	* 5,570	* 5,580	40	37.6
COA-03	0.1	1.5	20.5	7.3	8.0	649	649	96	90.8
COA-04	nc	6.2	21.5	8.0	8.1	304	300	123	nc
COA-05	nc	6.4	21.1	7.8	8.0	315	297	133	nc
COA-06	nc	0.3	23.6	7.7	7.7	605	617	162	nc
COA-07	nc	19.5	24.8	7.5	7.4	* 1,759	* 1,760	98	nc
COA-08	0.1	0.6	26.5	8.0	8.0	702	703	84	81.3
COA-09	0.1	9.7	19.0	7.7	7.6	369	316	111	110
COA-10	nc	0.1	25.2	*9.2	*9.2	230	232	62	nc
COA-11	nc	0.1	33.0	*9.1	*9.1	701	733	35	nc
COA-12	nc	<0.2	26.2	*8.6	8.5	746	710	123	nc
COA-13	nc	7.4	19.0	7.7	7.7	382	357	169	nc
COA-14	nc	7.1	21.1	7.9	7.9	409	392	137	nc
COA-15	0.1	4.9	26.5	7.8	7.8	478	487	125	121
COA-16	0.5	2.7	34.9	8.1	8.1	* 1,330	* 1,340	90	87.3
COA-17	nc	7.9	20.9	7.6	7.5	* 1,113	* 1,120	218	nc
COA-18	nc	4.1	33.0	8.0	8.0	* 1,487	* 1,490	87	nc
COA-19	nc	0.2	44.4	8.4	8.4	* 1,639	* 1,670	38	nc
Understanding wells									
COAU-01	0.1	7.3	16.8	7.9	7.5	393.5	389	165	160
COAU-02	nc	6.5	24.9	7.8	7.8	557	552	127	nc
COAU-03	0.1	10.5	20.5	7.4	7.7	422.9	425	150	146
COAU-04	nc	0.3	29.2	7.9	8.0	* 1,482	* 1,550	84	nc
COAU-05	0.1	7.2	20.4	7.8	7.6	451	442	189	221
COAU-06	0.4	6.1	21.5	7.8	7.7	370	360	152	149
COAU-07	nc	6.9	21.8	7.7	7.3	406	382	164	nc
COAU-08	nc	9.2	18.3	6.4	7.1	451	447	145	nc
COAU-09	nc	0.4	24.5	*8.9	*9.1	231	229	70	nc
COAU-10	nc	6.0	29.0	7.9	7.6	735	702	144	nc
COAU-11	nc	6.8	26.7	7.9	7.7	432	437	127	nc
COAU-12	nc	6.0	12.5	7.4	7.2	367	350	167	nc
COAU-13	nc	6.7	21.7	8.0	7.9	339	335	133	nc
COAU-14	nc	4.5	23.4	7.9	7.8	776	780	98	nc
COAU-15	nc	6.0	24.3	7.6	7.5	* 1,015	* 1,000	212	nc
COAU-16	nc	5.6	21.6	8.0	7.9	357	372	111	nc

* Value was above threshold.

¹ The SMCL-CA for specific conductance has recommended and upper threshold values. The upper value is shown in parentheses.

Table 5. Volatile organic compounds (VOC) detected in ground-water samples collected for the Coachella Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[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. Samples from all 35 wells were analyzed (19 grid wells and 16 understanding wells), but only samples with detections are listed. **Abbreviations:** COA, Coachella Valley study unit grid well; COAU, Coachella Valley study unit understanding well; LRL, laboratory reporting level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; E, estimated value; V, analyte detected in sample and an associated blank—thus data are not included in ground-water-quality assessment; µg/L, microgram per liter; –, not detected; percentage values are detection frequencies in the grid wells]

GAMA well identification No.	Chloroform (Trichloro-methane)C (µg/L) (32106)	Toluene (µg/L) (34010)	Tetrachloro-ethene (µg/L) (34475)	Bromodichloro-methane (µg/L) (32101)	1,1-Dichloro-ethane (µg/L) (34496)	Trichloro-ethene (µg/L) (39180)	VOC detections per well
LRL	[0.04]	[0.018]	[0.04]	[0.04]	[0.06]	[0.02]	
Threshold type ¹	MCL-US	MCL-CA	MCL-US	MCL-US	MCL-CA	MCL-US	
Threshold level	² 80	150	5	80	5	5	
Grid wells							
COA-01	–	V0.01	–	–	–	–	0
COA-02	–	V0.01	–	–	–	–	0
COA-05	–	V0.01	–	–	–	–	0
COA-07	–	V0.01	–	–	–	–	0
COA-08	–	V0.07	–	–	–	–	0
COA-09	0.13	–	–	–	–	–	1
COA-11	–	V0.01	–	–	–	–	0
COA-14	E0.06	–	E0.04	–	–	–	2
COA-15	0.37	V0.02	–	–	–	–	1
COA-18	E0.03	V0.01	–	–	–	–	1
Number of detections	4	0	1	0	0	0	4
Detection frequency (percent)	21	0	5	0	0	0	³ 21
Understanding wells							
COAU-03	E0.02	V0.08	–	–	–	–	1
COAU-05	–	V0.01	–	–	–	–	0
COAU-07	E0.09	–	0.19	–	E0.04	E0.01	4
COAU-11	0.23	–	–	E0.05	–	–	2
COAU-15	0.54	–	0.31	E0.07	–	–	3

¹Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

²The MCL-US threshold for trihalomethanes is the sum of chloroform, bromoform, bromodichloromethane, and dibromochloromethane.

³Frequency of detection of at least one VOC in the grid wells. Detections with V remark codes are not included in calculation for frequency of detection.

Table 6. Pesticides and pesticide degradates detected in samples collected for the Coachella Valley Ground-Water Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[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. Samples from all 35 wells were analyzed (19 grid wells and 16 understanding wells), but only samples with detections are listed. **Abbreviations:** COA, Coachella Valley study unit grid well; COAU, Coachella Valley study unit understanding well; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; E, estimated value; LRL, laboratory reporting level; µg/L, microgram per liter; –, not detected; percentage values are detection frequencies for grid wells]

GAMA well identification No.	2-Chloro-4-isopropylamino-6-amino-s-triazine (µg/L) (04040)	Atrazine (µg/L) (39632)	Simazine (µg/L) (04035)	Diuron (µg/L) (49300)	2-Chloro-6-ethylamino-4-amino-s-triazine (µg/L) (04038)	Prometon (µg/L) (04037)	Pesticide detections per well
LRL	[0.02]	[0.04]	[0.006]	[0.04]	[0.08]	[0.01]	
Threshold type ¹	na	MCL-CA	MCL-US	RSD5-US	na	HAL-US	
Threshold level	na	1	4	20	na	100	
Grid wells							
COA-01	E 0.012	E 0.006	E 0.004	–	–	–	3
COA-07	E 0.005	–	–	–	–	–	1
COA-09	E 0.006	0.008	0.016	0.05	E 0.01	–	5
COA-14	E 0.007	E 0.006	0.013	–	–	–	3
COA-15	–	E 0.005	–	–	–	–	1
COA-18	E 0.006	–	E 0.004	–	–	–	2
Number of detections	5	4	4	1	1	0	6
Detection frequency (percent)	26	21	21	5	5	0	23 ²
Understanding wells							
COAU-04	E 0.007	–	–	–	–	–	1
COAU-05	E 0.005	E 0.006	E 0.005	–	–	–	3
COAU-06	E 0.008	0.008	E 0.005	–	–	–	3
COAU-07	E 0.008	0.019	0.011	–	–	–	3
COAU-15	E 0.006	–	0.015	–	–	E 0.01	3

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

² Frequency of detection of at least one pesticide in the grid wells.

Table 7. Potential wastewater indicator compounds detected in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[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. Samples from eleven slow wells were analyzed, but only samples with detections are listed. **Abbreviations:** COA Coachella Valley grid well; COAU, Coachella Valley Understanding well; HAL, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-US, U.S. Environmental Protection Agency defined maximum contaminant level; MCL-CA, California Department of Public Health defined maximum contaminant level; E, estimated value; LRL, laboratory reporting level; µg/L, microgram per liter; -, not detected; percentage values are detection frequencies]

GAMA well identification No.	Anthracene (µg/L) (34220)	Phe-nanthrene (µg/L) (34461)	Phenol (µg/L) (34694)	2,6-Di-methyl-naphthalene (µg/L) (62805)	3,4-Di-chloro-phenyl-isocyanate (µg/L) (63145)	9,10-Anthra-quinone (µg/L) (62813)	Diethyl phthalate (µg/L) (34336)	Fluoran-thene (µg/L) (34376)	Penta-chloro-phenol (µg/L) (39032)	Pyrene (µg/L) (34469)	Tributyl phosphate (µg/L) (62832)	Benzof[a] pyrene (µg/L) (34247)	Number of detections
LRL	[0.2]	[0.2]	[0.2]	[0.2]	[2]	[0.2]	[0.2]	[0.2]	[0.8]	[0.2]	[0.2]	[0.2]	[0.2]
Threshold type ¹	na	na	HAL-US	na	na	na	na	na	MCL-US	na	na	na	MCL-US
Threshold level	na	na	2000	na	na	na	na	na	1	na	na	na	0.2
Grid wells													
COA-03	-	-	E 0.1	-	-	-	-	-	-	-	-	-	1
COA-09	0.01	0.05	-	-	E 0.26	-	-	E 0.1	-	E 0.1	-	-	5
COA-15	-	-	E 0.1	-	-	0.005	0.5	-	0.02	-	0.02	-	5
COA-16	-	-	-	0.007	-	-	-	-	-	-	-	-	1
Number of detections	1	1	2	1	1	1	1	1	1	1	1	0	4
Detection frequency (percent)	14	14	29	14	14	14	14	14	14	14	14	0	257
Understanding wells													
COAU-05	-	0.03	-	-	-	-	-	E 0.1	-	E 0.1	-	0.03	4
COAU-06	-	-	E 0.1	-	-	-	-	-	-	-	-	-	1

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

² Frequency of detection of at least one potential wastewater indicator compound in grid wells.

Table 8. Constituents of special interest (Perchlorate, and 1,2,3-Trichloropropane [1,2,3-TCP]) detected in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[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. Samples from all 35 wells were analyzed for perchlorate; samples from the 11 slow wells were analyzed for 1,2,3-TCP; only wells with at least one detection are listed. **Abbreviations:** COA, Coachella Valley study unit grid well; COAU, Coachella Valley study unit understanding well; MRL, method reporting level; MCL-CA, California Department of Public Health maximum contaminant level; µg/L, microgram per liter]

GAMA identification No.	Perchlorate (µg/L) (61209)
Threshold type ¹	MCL-CA
Threshold level	6
MRL	0.5
Grid wells	
COA-07	*9.0
COA-08	0.54
COA-09	0.58
COA-11	*6.1
COA-15	0.85
COA-16	0.62
COA-18	2.0
Number of wells with detections	7
Detection frequency (percent)	² 37
Understanding wells	
COAU-03	0.85
COAU-06	0.8
COAU-14	0.7
COAU-15	1.2
COAU-16	0.67

*Indicates value above threshold level.

¹Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

²Frequency of detection of percholorate in the grid wells.

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Table 9. Nutrients and dissolved organic carbon detected in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[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. Samples from all 35 wells were analyzed (19 grid wells and 16 understanding wells), but only samples with detections are listed. **Abbreviations:** COA, Coachella Valley study unit grid well; COAU, Coachella Valley study unit understanding well; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; E, estimated value; LRL, laboratory reporting level; mg/L, milligram per liter; na, not available; nc, not collected; -, not detected]

GAMA well identification No.	Ammonia, as nitrogen (mg/L) (00608)	Nitrite plus nitrate, as nitrogen (mg/L) (00631)	Nitrite, as nitrogen (mg/L) (00613)	Total nitrogen (nitrate + nitrite + ammonia + organic-nitrogen) as nitrogen (mg/L) (62854)	Orthophosphate as phosphorus (mg/L) (00671)	Dissolved organic carbon (DOC) (mg/L) (00681)
Threshold type ¹	HAL-US	MCL-US	MCL-US	na	na	na
Threshold level	² 24.7	10	1	na	na	na
LRL	[0.02]	[0.06]	[0.002]	[0.06]	[0.006]	[0.4]
Grid wells						
COA-01	-	2.02	-	2.02	0.019	E0.2
COA-02	1.42	0.12	0.033	1.57	0.007	-
COA-03	-	1.26	-	1.28	0.01	-
COA-04	-	0.60	-	0.60	0.011	NC
COA-05	-	0.63	-	0.62	0.011	NC
COA-06	-	0.50	-	0.54	0.015	NC
COA-07	-	7.12	-	7.19	0.006	NC
COA-08	-	0.61	-	0.61	0.01	-
COA-09	-	2.38	-	2.32	0.02	E0.2
COA-10	-	0.23	0.005	0.26	0.012	NC
COA-11	0.054	1.36	0.033	1.39	0.006	NC
COA-12	0.133	-	E0.002	0.19	0.02	NC
COA-13	-	1.81	-	1.73	0.022	NC
COA-14	-	4.54	-	4.57	0.012	NC
COA-15	-	1.23	-	1.19	0.018	-
COA-16	-	3.98	-	4.04	E0.006	E0.4
COA-17	-	0.39	-	0.36	0.008	NC
COA-18	-	2.93	E0.001	2.89	E0.005	NC
COA-19	-	0.08	E0.002	0.11	0.006	NC
Understanding wells						
COAU-01	-	0.46	-	0.46	0.008	E0.2
COAU-02	-	0.64	-	0.66	0.022	NC
COAU-03	-	1.06	-	1.08	0.015	E0.2
COAU-04	-	1.18	-	1.23	0.006	NC
COAU-05	-	0.82	-	0.85	0.021	E0.2
COAU-06	-	2.02	-	1.98	0.03	-
COAU-07	-	2.81	-	2.81	0.017	NC
COAU-08	-	0.92	-	0.91	0.022	NC
COAU-09	0.03	E0.04	0.003	0.09	0.017	NC
COAU-10	-	0.95	-	1.04	0.015	NC
COAU-11	-	0.57	-	0.60	0.04	NC
COAU-12	-	0.56	-	0.60	E0.005	NC
COAU-13	-	0.60	-	0.69	0.013	NC
COAU-14	-	* 14.3	-	14.80	0.012	NC
COAU-15	-	* 13.8	-	14.40	0.022	NC
COAU-16	-	0.82	-	0.83	0.014	NC

* Value above regulatory threshold.

¹Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

²The HAL-US is 30 mg/L “as ammonia.” To facilitate comparison to the analytical results, we have converted and reported this HAL-US as 24.7 mg/L “as nitrogen.”

Table 10. Major and minor ions and total dissolved solids detected in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[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. Samples from all 35 wells were analyzed (19 grid wells and 16 understanding wells), but only samples with detections are listed. **Abbreviations:** COA, Coachella Valley study unit grid well; COAU, Coachella Valley study unit understanding well; MCL-CA, California Department of Public Health maximum contaminant level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; LRL, laboratory reporting level; mg/L, milligram per liter; nc, not collected; na, not available; -, not detected]

GAMA identification No.	Calcium (mg/L) (00915)	Magnesium (mg/L) (00925)	Potassium (mg/L) (00935)	Sodium (mg/L) (00930)	Bicarbonate (mg/L) (63786)	Carbonate (mg/L) (63788)	Bromide (mg/L) (71870)	Chloride (mg/L) (00940)	Fluoride (mg/L) (00950)	Iodide (mg/L) (71865)	Silica (mg/L) (00955)	Sulfate (mg/L) (00945)	Total dissolved solids (TDS) (mg/L) (70300)
Threshold type ¹	[0.02]	[0.014]	[0.04]	[0.2]	1	1	[0.02]	SMCL-CA ² 250 (500)	MCL-CA 2	na	na	SMCL-CA ² 250 (500)	SMCL-CA ² 500 (1000)
Threshold level	[0.02]	[0.014]	[0.04]	[0.2]	1	1	[0.02]	[0.12]	[0.1]	[0.002]	[0.018]	[0.18]	[10]
LRL													
Grid wells													
COA-01	48.9	11.5	2.55	20.5	211	0.4	0.04	8.93	0.78	-	21.7	20.0	250
COA-02	250	37.5	8.08	838	45	0.2	1.01	**1,300	*3.60	0.197	13.5	**901	**3,480
COA-03	42.8	8.10	7.33	72.0	110	0.5	0.09	29.3	1.47	-	17.3	163	418
COA-04	28.8	5.54	4.59	25.3	nc	nc	0.03	8.28	0.70	-	17.5	19.3	179
COA-05	28.4	7.29	4.26	24.4	nc	nc	0.03	7.74	0.65	-	17.5	17.5	187
COA-06	67.2	10.2	6.62	34.3	nc	nc	0.11	34.2	0.57	0.002	21.2	94.3	377
COA-07	183	18.5	14.1	157	nc	nc	0.25	203	0.16	0.003	17.3	*498	**1,220
COA-08	44.7	9.90	7.79	74.1	98	0.8	0.09	40.7	0.96	-	15.4	181	448
COA-09	43.3	5.23	2.91	17.7	133	0.4	0.1	23	0.15	-	27	30.8	243
COA-10	4.57	0.056	1.07	44.9	nc	nc	0.04	11	0.82	0.004	13.2	29.3	155
COA-11	8.87	0.091	1.25	131	nc	nc	0.1	90.9	0.73	0.004	15.9	143	422
COA-12	15.6	1.14	1.63	155	nc	nc	0.09	50.5	*6.99	0.080	14.9	174	*509
COA-13	49.2	10.6	3.17	14.6	nc	nc	0.02	6.27	0.41	-	21.8	19.0	226
COA-14	50.2	8.70	3.69	20.5	nc	nc	0.06	12.9	0.53	-	20.6	35.5	259
COA-15	38.3	5.77	7.09	49.5	146	0.7	0.11	29.5	0.57	-	19.4	69.0	302
COA-16	31.7	6.28	8.36	224	104	1	0.3	88.9	*3.21	0.022	16.8	*385	*840
COA-17	106	39.5	8.55	82.2	nc	nc	0.08	22.6	1.62	E	17.6	*348	*797
COA-18	53.5	5.41	4.61	239	nc	nc	0.19	212	1.03	0.002	15	*287	*909
COA-19	39.2	1.00	6.27	280	nc	nc	0.14	120	*8.08	0.043	22.5	**514	**1,070

Table 10. Major and minor ions and total dissolved solids detected in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.—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. Samples from all 35 wells were analyzed (19 grid wells and 16 understanding wells), but only samples with detections are listed. **Abbreviations:** COA, Coachella Valley study unit grid well; COAU, Coachella Valley study unit understanding well; MCL-CA, California Department of Public Health maximum contaminant level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; LRL, laboratory reporting level; mg/L, milligram per liter; nc, not collected; na, not available; -, not detected]

GAMA identification No.	Calcium (mg/L) (00915)	Magnesium (mg/L) (00925)	Potassium (mg/L) (00935)	Sodium (mg/L) (00930)	Bicarbonate (mg/L) (63786)	Carbonate (mg/L) (63788)	Bromide (mg/L) (71870)	Chloride (mg/L) (00940)	Fluoride (mg/L) (00950)	Iodide (mg/L) (71865)	Silica (mg/L) (00955)	Sulfate (mg/L) (00945)	Total dissolved solids (TDS) (mg/L) (70300)
Threshold type ¹	na	na	na	na	na	na	na	SMCL-CA ²	MCL-CA	na	na	SMCL-CA ²	SMCL-CA ²
Threshold level	na	na	na	na	na	na	na	250 (500)	2	na	na	250 (500)	500 (1000)
LRL	[0.02]	[0.014]	[0.04]	[0.2]	1	1	[0.02]	[0.12]	[0.1]	[0.002]	[0.018]	[0.18]	[10]
Understanding wells													
COAU-01	51.5	13.1	4.40	13.9	195	0.3	-	2.28	1.11	-	15.6	37.2	239
COAU-02	41.3	6.11	6.32	62.5	nc	nc	0.07	15.6	0.85	-	20.8	125	369
COAU-03	50.0	10.2	4.50	20.6	176	0.6	0.05	14.7	0.74	-	20.1	46.1	267
COAU-04	39.1	5.97	6.93	239	nc	nc	0.22	128	*2.33	0.014	13.7	*408	*936
COAU-05	50.3	12.7	3.59	20.4	183	0.6	0.05	12.6	0.98	-	22.7	28.4	281
COAU-06	32.8	8.18	1.58	32.4	181	0.6	0.05	12.7	0.50	-	23.7	15.7	223
COAU-07	44.8	10.1	2.71	24.9	nc	nc	0.04	15	0.46	-	26.5	18.9	250
COAU-08	52.2	7.46	3.64	28.4	nc	nc	0.07	14.1	0.29	-	30.1	65.4	301
COAU-09	7.79	0.053	0.69	43.0	nc	nc	0.03	7.38	1.14	0.011	14.4	28.6	156
COAU-10	48.2	13.4	7.73	78.6	nc	nc	0.09	19.6	0.78	-	19.4	199	488
COAU-11	29.2	4.76	5.65	53.8	nc	nc	-	12.5	0.89	-	22.2	67.2	265
COAU-12	39.7	16.9	3.49	9.4	nc	nc	-	2.32	0.47	-	13.7	24.5	208
COAU-13	38.0	5.90	4.66	20.4	nc	nc	0.04	6.89	0.79	-	18.9	27.2	204
COAU-14	89.1	11.0	5.46	44.7	nc	nc	0.27	63.5	0.17	-	18.4	129	490
COAU-15	93.9	19.6	4.93	86.4	nc	nc	0.31	74.4	0.48	0.005	25.1	146	*679
COAU-16	35.3	4.82	4.05	28.6	nc	nc	0.04	14.2	0.56	-	18.2	37.3	220

*Value exceeds recommended threshold.

**Value exceeds upper threshold.

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

² The SMCL-CA for chloride, sulfate, and total dissolved solids have recommended and upper threshold values. The upper value is shown in parentheses.

Table 11. Trace elements detected in ground-water samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[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. Samples from all 35 wells were analyzed for all constituents except mercury, which was analyzed for in samples from the 11 slow wells and was not detected. **Abbreviations:** COA, Coachella Valley study unit grid-well; COAU, Coachella Valley study unit Understanding well; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL-CA, California Department of Public Health notification level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; E, estimated value; µg/L, laboratory reporting level; LRL, laboratory reporting level; -, not detected]

GAMA well identification No.	Aluminum (µg/L) (01106) [1.6]	Antimony (µg/L) (01095) [0.06]	Arsenic (µg/L) (01000) [0.12]	Barium (µg/L) (01005) [0.08]	Beryllium (µg/L) (01010) [0.06]	Boron (µg/L) (01020) [8]	Cadmium (µg/L) (01025) [0.04]	Chromium (µg/L) (01030) [0.12]	Cobalt (µg/L) (01035) [0.04]	Copper (µg/L) (01040) [0.4]	Iron (µg/L) (01046) [6]
Threshold type ¹	MCL-CA	MCL-US	MCL-US	MCL-CA	MCL-US	NL-CA	MCL-US	MCL-CA	na	AL-US	SMCL-CA
Threshold level	1,000	6	10	1,000	4	1,000	5	50	na	1,300	300
[LRL]	[1.6]	[0.06]	[0.12]	[0.08]	[0.06]	[8]	[0.04]	[0.12]	[0.04]	[0.4]	[6]
Grid wells											
COA-01	E 1.1	-	0.23	14	-	16	-	4.8	-	0.49	-
COA-02	10.2	E 0.09	*48.8	41	-	* 1,510	E 0.09	-	-	-	74
COA-03	2.5	-	0.86	39	-	81	0.05	15.5	-	-	E 4
COA-04	2.4	-	0.62	34	-	14	E 0.02	15.1	-	1.6	-
COA-05	1.9	-	0.42	28	-	16	E 0.02	11.5	-	1.1	-
COA-06	1.6	-	0.52	88	0.1	27	E 0.02	3.3	-	1.7	E 4
COA-07	E 1.4	-	0.39	72	-	151	-	8.0	E 0.02	0.72	21
COA-08	3.4	-	1.0	60	-	70	E 0.03	10.9	-	-	8
COA-09	E 0.9	-	0.13	56	-	17	-	2.5	-	-	-
COA-10	20.7	0.08	* 21.3	5	-	27	-	3.5	-	-	-
COA-11	16.0	0.15	* 12.8	26	-	37	-	-	-	-	22
COA-12	4.5	0.07	* 27.5	40	-	242	0.05	-	-	-	26
COA-13	1.6	-	0.18	19	-	9	E 0.02	4.5	-	E 0.36	-
COA-14	E 1.2	-	0.29	38	-	16	E 0.03	3.7	-	1.4	E 3
COA-15	3.1	-	0.38	46	-	30	0.04	13.4	-	0.87	E 4
COA-16	6.9	-	0.86	27	-	688	0.08	3.0	-	0.4	45
COA-17	E 1.1	-	E 0.06	30	-	68	0.11	0.76	E 0.02	0.52	-
COA-18	E 4.7	0.07	1.7	48	-	247	0.04	1.9	-	0.65	6
COA-19	11.8	-	2.7	23	-	* 1,270	0.06	0.66	-	0.66	11

Table 11. Trace elements detected in ground-water samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.—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. Samples from all 35 wells were analyzed for all constituents except mercury, which was analyzed for in samples from the 11 slow wells and was not detected. **Abbreviations:** COA, Coachella Valley study unit grid-well; COAU, Coachella Valley study unit Understanding well; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL-CA, California Department of Public Health notification level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; E, estimated value; LRL, laboratory reporting level; µg/L, microgram per liter; —, not detected]

GAMA well identification No.	Aluminum (µg/L) (01106) [1.6]	Antimony (µg/L) (01095) [0.06]	Arsenic (µg/L) (01000) [0.12]	Barium (µg/L) (01005) [0.08]	Beryllium (µg/L) (01010) [0.06]	Boron (µg/L) (01020) [8]	Cadmium (µg/L) (01025) [0.04]	Chromium (µg/L) (01030) [0.12]	Cobalt (µg/L) (01035) [0.04]	Copper (µg/L) (01040) [0.4]	Iron (µg/L) (01046) [6]
Threshold type ¹	MCL-CA	MCL-US	MCL-US	MCL-CA	MCL-US	NL-CA	MCL-US	MCL-CA	na	AL-US	SMCL-CA
Threshold level [LRL]	1,000 [1.6]	6 [0.06]	10 [0.12]	1,000 [0.08]	4 [0.06]	1,000 [8]	5 [0.04]	50 [0.12]	na [0.04]	1,300 [0.4]	300 [6]
Understanding wells											
COAU-01	E1.4	—	0.23	19	—	12	0.06	0.61	—	5	—
COAU-02	3.5	—	0.55	35	—	58	0.06	9.6	—	0.65	—
COAU-03	E1.5	—	0.26	38	—	14	—	5.2	—	2.0	—
COAU-04	6.1	—	2.3	37	—	677	0.05	3.1	—	0.83	7
COAU-05	1.6	—	0.36	21	—	18	—	5.3	—	1.2	8
COAU-06	E1.0	—	0.55	25	—	17	—	12.1	—	4.2	—
COAU-07	E1.2	—	0.15	18	—	20	—	4.8	—	0.66	—
COAU-08	2.5	—	0.37	79	—	32	E0.02	0.28	—	1.2	—
COAU-09	14.3	E0.05	* 15.5	7	—	31	0.05	—	—	E0.32	10
COAU-10	2.8	—	0.52	34	—	56	0.04	17	—	3.9	11
COAU-11	1.9	0.08	0.87	27	—	44	0.04	7.3	—	3.4	—
COAU-12	E0.9	—	—	7	—	E6	E0.03	0.56	—	4.3	E4
COAU-13	1.7	—	0.34	35	—	14	E0.03	8.6	—	0.96	—
COAU-14	2.9	—	0.47	112	—	27	—	8.3	—	1.4	E4
COAU-15	E1.3	—	0.36	115	—	282	—	3.4	—	2.8	E4
COAU-16	1.6	—	0.70	45	—	18	E0.02	10.1	—	0.57	—

Table 11. Trace elements detected in ground-water samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.—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. Samples from all 35 wells were analyzed for all constituents except mercury, which was analyzed for in samples from the 11 slow wells and was not detected. **Abbreviations:** COA, Coachella Valley study unit grid-well; COAU, Coachella Valley study unit Understanding well; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL-CA, California Department of Public Health notification level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; E, estimated value; LRL, laboratory reporting level; µg/L, microgram per liter; —, not detected]

GAMA well identification No.	Lead (µg/L) (01049) [0.12]	Lithium (µg/L) (01130) [0.6]	Manganese (µg/L) (01056) [0.2]	Molybdenum (µg/L) (01060) [0.12]	Nickel (µg/L) (01065) [0.06]	Selenium (µg/L) (01145) [0.08]	Strontium (µg/L) (01080) [0.4]	Tungsten (µg/L) (01155) [0.06]	Uranium (µg/L) (22703) [0.04]	Vanadium (µg/L) (01085) [0.04]	Zinc (µg/L) (01090) [0.6]
[LRL]	MCL-US	na	SMCL-CA	HAL-US	MCL-CA	MCL-US	HAL-US	na	MCL-US	NL-CA	SMCL-CA
Threshold type ¹	15	na	50	40	100	50	4,000	na	30	50	5,000
Threshold level	[0.12]	[0.6]	[0.2]	[0.12]	[0.06]	[0.08]	[0.4]	[0.06]	[0.04]	[0.04]	[0.6]
Grid wells											
COA-01	0.16	1.2	—	7.3	E0.03	0.41	188	0.3	3.24	7.4	3.7
COA-02	—	352	*57.2	36.1	0.27	0.78	*5,990	15.3	0.33	0.75	5.8
COA-03	E0.06	6.1	E0.1	22.1	E0.04	1.3	530	2.5	4.27	14.6	E0.3
COA-04	0.28	1.3	—	12.8	0.08	0.43	228	3.8	7.28	15.4	1.7
COA-05	1.53	1.3	—	10.0	E0.05	0.37	182	3.9	5.17	12.7	4.6
COA-06	0.73	1.1	0.3	9.9	0.12	3.2	474	2.8	18.3	10.9	5.7
COA-07	0.24	20.2	1.6	0.7	0.25	14.0	3,760	0.69	11.2	8.0	15.8
COA-08	0.18	4.4	0.2	20.1	E0.05	1.8	704	13.7	3.36	17.2	1.4
COA-09	—	1.9	E0.1	4.0	0.06	0.81	258	4.4	7.43	5.3	E0.43
COA-10	—	3.0	0.6	10.3	—	0.56	95	1.8	1.52	46.8	1.3
COA-11	—	8.7	4.0	8.0	E0.03	3.6	151	1.4	0.06	13.0	1.4
COA-12	0.12	12.9	5.0	37.7	0.08	0.13	277	21.4	3.62	6.1	1.1
COA-13	E0.07	E0.6	—	6.8	E0.04	0.47	184	E0.04	1.87	5.8	5.8
COA-14	0.32	1.2	—	9.0	E0.05	0.82	210	0.23	8.99	5.6	1.6
COA-15	0.74	1.8	E0.2	17.9	E0.05	1.6	259	1.1	5.58	11.5	2.2
COA-16	0.41	5.9	1.6	*49.4	0.07	2.2	690	0.4	4.78	26.3	73.5
COA-17	E0.08	2.2	E0.1	*54.9	0.14	0.64	893	0.46	28.1	2.8	169.0
COA-18	0.67	37.9	E0.1	12.2	0.16	8.0	1,750	0.9	13.5	5.1	5.5
COA-19	0.15	13.2	0.4	32	E0.05	0.12	494	31.4	0.04	34.3	4.7

Table 11. Trace elements detected in ground-water samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.—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. Samples from all 35 wells were analyzed for all constituents except mercury, which was analyzed for in samples from the 11 slow wells and was not detected. **Abbreviations:** COA, Coachella Valley study unit grid-well; COAU, Coachella Valley study unit Understanding well; HAL-US, U.S. Environmental Protection Agency Lifetime Health Advisory; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; NL-CA, California Department of Public Health notification level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; E, estimated value; LRL, laboratory reporting level; µg/L, microgram per liter; -, not detected]

GAMA well identification No.	Lead (µg/L) (01049) [0.12]	Lithium (µg/L) (01130) [0.6]	Manganese (µg/L) (01056) [0.2]	Molybdenum (µg/L) (01060) [0.12]	Nickel (µg/L) (01065) [0.06]	Selenium (µg/L) (01145) [0.08]	Strontium (µg/L) (01080) [0.4]	Tungsten (µg/L) (01155) [0.06]	Uranium (µg/L) (22703) [0.04]	Vanadium (µg/L) (01085) [0.04]	Zinc (µg/L) (01090) [0.6]
[LRL]	MCL-US	na	SMCL-CA	HAL-US	MCL-CA	MCL-US	HAL-US	na	MCL-US	NL-CA	SMCL-CA
Threshold type ¹	15	na	50	40	100	50	4,000	na	30	50	5,000
Threshold level	[0.12]	[0.6]	[0.2]	[0.12]	[0.06]	[0.08]	[0.4]	[0.06]	[0.04]	[0.04]	[0.6]
Understanding wells											
COAU-01	0.21	1.5	-	18.8	0.09	0.35	194	0.09	11.1	3.0	5.2
COAU-02	0.17	2.2	E0.1	28.2	0.07	0.78	271	0.46	8.29	12.0	5.2
COAU-03	0.30	0.8	-	9.9	0.09	0.73	259	1.9	11.5	5.6	3.4
COAU-04	0.51	6.5	0.4	39.1	0.08	1.3	* 12,100	24.9	9.19	34.7	15.1
COAU-05	0.55	1.7	E0.2	10.2	0.06	0.46	205	1.9	7.03	7.1	12.3
COAU-06	0.67	3.7	E0.1	3.0	E0.04	0.41	182	0.06	1.36	10.5	2.8
COAU-07	0.31	2.2	-	6.2	0.06	0.55	184	0.4	3.3	5.0	E0.55
COAU-08	0.17	4.9	-	5.5	0.08	0.58	252	0.19	11.1	3.2	12.6
COAU-09	0.23	1.4	0.8	18.1	E0.03	-	104	4.8	1.4	2.0	1.3
COAU-10	1.89	3.2	E0.2	27.3	E0.03	1.1	306	8.6	7.94	13.3	12.9
COAU-11	0.72	1.1	E0.3	36.7	E0.04	0.79	205	11.2	5.61	15.5	6.9
COAU-12	0.67	-	0.4	8.2	0.2	0.27	74.4	0.2	1.24	1.1	3.7
COAU-13	0.18	1.0	-	16.0	-	0.55	219	0.25	10.7	7.5	1.9
COAU-14	1.51	5.0	E0.1	3.2	E0.04	5.9	643	0.25	4.75	9.6	4.1
COAU-15	0.46	7.4	0.2	3.9	E0.05	3.5	574	0.15	8.12	7.8	3.5
COAU-16	-	1.9	-	10.1	E0.04	0.9	295	0.37	5.59	14.4	1.8

*Value exceeds threshold.

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

Table 12. Species of inorganic arsenic, iron, and chromium in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[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. Samples from all 35 wells were analyzed for chromium, arsenic, and iron; only wells with at least one detection are listed. Analyses were made by the U.S. Geological Survey Trace Metals Laboratory (laboratory entity code USGSTMCO). **Abbreviations:** COA, Coachella Valley study unit grid well; COAU, Coachella Valley study unit understanding well; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; MCL-CA, California Department of Public Health maximum contaminant level; SMCL-CA, California Department of Public Health secondary maximum contaminant level; MDL, method detection level; µg/L, microgram per liter; –, not detected]

GAMA well identification No.	Iron (µg/L) (01046)	Iron(II) (µg/L) (01047)	Arsenic (µg/L) (99033)	Arsenic(III) (µg/L) (99034)	Chromium (µg/L) (01030)	Chromium(VI) (µg/L) (01032)
Threshold type ¹	SMCL-CA	na	MCL-US	na	MCL-CA	na
Threshold level [MDL]	300 [2]	na [2]	10 [0.5]	na [1]	50 [1]	na [1]
Grid wells						
COA-01	3	–	–	–	5	4
COA-02	72	10	*23	6.9	–	–
COA-03	–	–	–	–	17	16
COA-04	–	–	–	–	15	15
COA-05	–	–	–	–	12	10
COA-06	3	3	–	–	3	2
COA-07	20	2	–	–	9	7
COA-08	–	–	–	–	11	10
COA-09	–	–	–	–	1	1
COA-10	–	–	9.9	–	2	2
COA-11	21	–	6.1	–	–	–
COA-12	25	7	*20	17	–	–
COA-13	–	–	1.3	–	6	1
COA-14	–	–	–	–	5	3
COA-15	5	–	0.7	–	15	10
COA-16	48	3	–	–	3	2
COA-17	2	–	–	–	–	–
COA-18	4	–	–	–	2	2
COA-19	14	–	1.4	–	1	–
Understanding wells						
COAU-02	4	–	2.4	–	9	9
COAU-03	–	–	–	–	5	4
COAU-04	6	4	1.2	–	3	3
COAU-05	5	–	–	–	4	3
COAU-06	–	–	–	–	16	14
COAU-07	–	–	–	–	5	5
COAU-09	9	3	9.0	–	–	–
COAU-10	10	–	0.8	–	17	17
COAU-11	2	–	–	–	8	6
COAU-12	4	–	–	–	–	–
COAU-13	–	–	1.3	–	9	7
COAU-14	7	–	1.1	–	8	7
COAU-15	5	–	–	–	3	4
COAU-16	–	–	–	–	10	9

*Value exceeds threshold.

¹Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

Table 13. Stable isotopic ratios, tritium, uranium and carbon-14 activities in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[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. Samples from all 35 wells were analyzed for stable isotopes of water and uranium, tritium and carbon. Stable isotope ratios are reported in the standard delta notation (δ), the ratio of a heavier isotope to more common lighter isotope of that element, relative to a standard reference material.

Abbreviations: COA, Coachella Valley study unit grid well; COAU, Coachella Valley study unit understanding well; MCL-CA, California Department of Public Health maximum contaminant level; pCi/L, picocurie per liter; nc, not collected]

GAMA well identification No.	$\delta^2\text{H}$ (per mil) (82082) ¹	$\delta^{18}\text{O}$ (per mil) (82085) ²	Tritium (pCi/L) (07000) ³	Uranium-234 (per mil) (22610)	Uranium-235 (per mil) (22620)	Uranium-238 (per mil) (82081) ³	$\delta^{13}\text{C}$ (per mil) (82081) ⁴	Carbon-14 (percent modern) (49933) ⁵
Threshold type ¹	na	na	MCL-CA	MCL-CA	MCL-CA	MCL-CA	na	na
Threshold level	na	na	20,000	20	20	20	na	na
Grid wells								
COA-01	-61.10	-9.11	4.2	1.119	E0.056	1.001	-12.84	89.15
COA-02	-75.50	-10.76	<1	0.188	<0.054	E0.096	-5.58	4.150
COA-03	-75.20	-10.40	<1	1.506	E0.104	1.244	-10.62	59.03
COA-04	-63.70	-9.48	<1	2.580	E0.158	2.410	-14.89	84.86
COA-05	-63.20	-9.49	<1	1.740	E0.092	1.649	-14.10	79.63
COA-06	-68.80	-9.78	<1	6.730	0.560	6.030	-13.26	82.85
COA-07	-91.30	-11.32	52.8	4.310	0.181	3.320	-12.63	80.69
COA-08	-76.50	-10.54	<1	1.183	E0.058	1.245	-11.17	53.13
COA-09	-74.10	-10.54	8.1	2.730	0.114	2.460	-10.72	96.11
COA-10	-64.50	-9.43	<1	0.394	<0.034	0.356	nc	nc
COA-11	-75.70	-10.23	8.0	E0.023	<0.034	<0.035	-9.28	11.41
COA-12	-72.20	-10.28	<1	1.458	E0.096	1.090	-4.94	2.430
COA-13	-65.50	-9.53	6.1	0.654	E0.022	0.582	-12.42	84.93
COA-14	-74.40	-10.52	1.0	2.860	0.146	2.760	-11.04	92.86
COA-15	-69.70	-9.74	<1	1.934	E0.116	1.817	-11.96	105.1
COA-16	-79.10	-9.97	<1	1.817	0.111	1.482	-9.74	69.78
COA-17	-78.50	-10.72	4.8	9.530	0.526	9.180	-11.80	11.11
COA-18	-82.20	-10.51	15.0	4.570	0.230	4.100	-11.26	71.18
COA-19	-88.70	-11.17	<1	0.018	<0.04	<0.033	-9.87	10.90
Understanding wells								
COAU-01	-75.60	-10.80	6.7	3.330	0.163	3.350	-12.4	101.5
COAU-02	-75.80	-10.56	<1	2.370	0.122	2.410	-10.95	71.62
COAU-03	-71.40	-10.02	5.8	3.950	0.163	3.730	-11.52	88.73
COAU-04	-76.70	-10.32	2.6	3.180	0.174	2.960	-11.98	46.75
COAU-05	-63.70	-9.37	<1	2.800	E0.118	2.740	-13.25	88.00
COAU-06	-58.10	-8.54	<1	0.622	E0.031	0.464	-17.05	68.69
COAU-07	-62.30	-9.05	4.5	1.395	E0.083	0.972	-12.83	87.63
COAU-08	-68.00	-9.59	4.8	4.190	E0.115	3.740	-10.09	113.3
COAU-09	-67.70	-9.76	<1	0.392	E0.016	0.301	-10.89	35.76
COAU-10	-78.00	-10.61	<1	2.420	E0.083	2.620	-10.18	82.14
COAU-11	-74.90	-10.48	<1	1.797	0.142	1.573	-11.02	73.45
COAU-12	-68.40	-10.17	7.0	0.436	E0.014	0.382	nc	nc
COAU-13	-69.40	-10.09	<1	3.240	E0.115	3.140	-11.26	83.34
COAU-14	-69.50	-10.05	<1	1.594	E0.039	1.576	-10.17	82.94
COAU-15	-67.10	-9.13	2.9	3.220	E0.106	2.400	-12.61	98.76
COAU-16	-72.20	-10.34	3.5	1.920	0.145	1.669	-11.14	79.36

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

² USGS Stable Isotope Laboratory, Reston, Virginia (USGSSIVA).

³ USGS Stable Isotope and Tritium Laboratory, Menlo Park, California (USGSH3CA).

⁴ University of Waterloo (contract laboratory) (CAN-UWIL).

⁵ University of Arizona, Accelerator Mass Spectrometry Laboratory (contract laboratory) (AZ-UAMSL).

Table 14. Radioactive constituents detected in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February to March 2007.

[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. Samples from the eleven slow wells were analyzed. Analyses made by Eberline Services (laboratory entity code CA-EBRL). **Abbreviations:** COA, Coachella Valley study unit grid well; COAU, Coachella Valley study unit understanding well; MCL-CA, California Department of Public Health maximum contaminant level; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; E, estimated value; pCi/L, picocurie per liter; <, less than]

GAMA well identification No.	Radium-226 (pCi/L) (09511)	Radium-228 (pCi/L) (81366)	Radon-222 (pCi/L) (82303)	Alpha radioactivity, 72-hour count (pCi/L) (62636)	Alpha radioactivity, 30-day count (pCi/L) (62639)	Beta radioactivity, 72-hour count (pCi/L) (62642)	Beta radioactivity, 30-day count (pCi/L) (62645)
Threshold type ¹	MCL-US	MCL-US	Proposed MCL-US	MCL-US	MCL-US	MCL-US	MCL-US
Threshold level	² 5	² 5	³ 300 (4,000)	15	15	50.00	50.00
Grid wells							
COA-01	E 0.03	<0.49	*540	<2.3	<2.1	2.6	2.9
COA-02	0.24	0.76	230.00	<20	<22.0	6.8	10.5
COA-03	E 0.05	0.46	300.00	E 3.1	E 5.0	7.0	10.5
COA-08	0.08	<0.55	180.00	5.1	E 3.6	7.1	8.5
COA-09	E 0.04	<0.55	*400	4.7	4.9	2.3	4.6
COA-15	0.11	E 0.34	*460	6.8	6.0	7.2	8.5
COA-16	E 0.04	E 0.33	*620	E 5.4	E 2.9	8.5	9.3
Understanding wells							
COAU-01	E 0.05	<0.67	*910	E 6.7	E 4.2	4.3	7.0
COAU-03	E 0.05	E 0.23	270.00	8.5	6.3	4.3	6.5
COAU-05	E 0.04	<0.44	*460	E 3.7	E 1.7	3.3	5.4
COAU-06	E 0.03	<0.66	*380	E 2.6	<2.0	E 1.0	E 1.8

* Value exceeds lower threshold.

¹ Maximum contaminant level thresholds are listed as MCL-US when the MCL-US and MCL-CA are identical, and as MCL-CA when the MCL-CA is lower than the MCL-US or no MCL-US exists.

² The MCL-US threshold for radium is the sum of those for radium-226 and radium-228.

³ Two MCLs have been proposed for Radon-222. The proposed alternative MCL is in parentheses.

Table 15. Microbial indicators detected in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[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. Samples from the 11 wells analyzed using the slow schedule. **Abbreviations:** COA, Coachella Valley study unit grid well; TT-US, U.S. Environmental Protection Agency treatment technique; MCL-US, U.S. Environmental Protection Agency maximum contaminant level; mL, milliliter, –, not detected]

GAMA well identification No.	Coliphage F-specific (99335)	Coliphage somatic (99332)	<i>E. coli</i> colonies/100 mL (90901)	Total coliforms colonies/100mL (90900)
Threshold type	TT-US	TT-US	TT-US	MCL-US
Threshold level	99.9% Killed/Inactive	99.9% Killed/Inactive	No fecal coliforms are allowed	5%
COA-08	–	–	–	4

Appendix

This appendix includes discussions of the methods used to collect and analyze ground-water samples and report the data for the COA Study Unit. These methods were selected to obtain representative samples of the ground water from each well and to minimize the potential for contamination of the samples or bias in the data. Procedures used to collect and assess quality-control data and the results of the quality-control assessments also are discussed.

Sample Collection and Analysis

Ground-water samples were collected using standard and modified USGS protocols from the USGS NAWQA program (Koterba and others, 1995) and the USGS National Field Manual (U.S. Geological Survey, variously dated), as well as protocols described by Weiss (1968), Shelton and others, (2001), and Ball and McClesky (2003a,b). Before sampling, each well was pumped continuously until at least three casing-volumes of water was purged from the well (Wilde and others, 1999). Samples were collected using Teflon tubing with brass and stainless-steel fittings attached to a sampling point on the well discharge pipe as close to the well as possible. The sampling point was always located upstream of any well-head treatment system or water storage tank. If a chlorinating system was attached to the well, the chlorinator was shut off at least 24 hours before purging and sampling the well in order to clear all chlorine out of the system. For the intermediate schedules, samples were collected at the well head using a foot-long length of Teflon tubing. Samples collected using the slow schedule were within an enclosed chamber located inside a mobile laboratory and connected to the well head by a 10- to 50- foot length of the Teflon tubing (Lane and others, 2003). All fittings and lengths of tubing were cleaned between sampling events (Wilde, 2004).

For the field measurements, ground water was pumped through a flow-through chamber fitted with a multi-probe meter that simultaneously measures the water-quality indicators: dissolved oxygen, temperature, pH, and specific conductance. At sites where the slow schedule was used, turbidity readings were taken using a Hatch kit. Field measurements were made in accordance with protocols in the USGS National Field Manual (Wilde and Radtke, 2005; Wilde, 2006; Lewis, 2006; Radtke and others, 2005; Wilde and others, 2006). All sensors on the multi-probe meter were calibrated daily. Measured temperature, dissolved oxygen, pH, and specific conductance values were recorded at 3- to 5-minute intervals for at least 30 minutes, and after these values remained stable for 20 minutes, samples to be analyzed in the laboratory were collected. Field measurements and instrument calibrations were recorded by hand on field

record sheets and electronically in PCFF-GAMA, a software package designed by the USGS with support from the GAMA program. Analytical service requests and chain of custody documentation also were managed by PCFF-GAMA. Information from PCFF-GAMA was uploaded directly into NWIS at the end of each week that samples were collected.

For analyses requiring filtered water, ground-water was diverted through a 0.45- μm pore size vented capsule filter, a disk filter, or a baked glass-fiber filter, depending on the protocol for the analysis (Wilde and others, 1999; Wilde and others, 2004). Before samples were collected, polyethylene sample bottles were pre-rinsed using deionized water three times during the bottle set preparation and then once with native well water before sample collection. Samples requiring acidification were acidified to a pH of 2 or less with the appropriate acids using ampoules of certified, traceable concentrated acids obtained from the USGS National Water Quality Laboratory (NWQL).

Temperature-sensitive samples, VOCs, pesticides, pharmaceutical compounds, potential wastewater-indicator compounds, compounds of special interest, dissolved organic carbon, radium, nutrients, major and minor trace elements, and nitrogen and oxygen isotopes were stored on ice until they were shipped to the appropriate laboratory. The non-temperature sensitive samples for tritium, noble gases, chromium speciation, and stable isotopes were shipped monthly with the exception of gross alpha and beta radioactivity samples and radon-222 samples, which were shipped daily.

Detailed sampling protocols for individual analyses and groups of analytes are described by Koterba and others (1995) and in the USGS National Field Manual (Wilde and others, 1999; Wilde and others, 2004), and the references for analytical methods listed in [table A1](#); only brief descriptions are given here. Volatile organic compounds (VOCs) and 1,2,3-trichloropropane (1,2,3-TCP) samples 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 (6 N) hydrochloric acid (HCl) was added as a preservative to the VOC samples but not to the 1,2,3-TCP samples. The perchlorate sample was collected in a 125-mL polyethylene bottle. Tritium samples were collected by bottom-filling two 1-L polyethylene bottles with unfiltered ground water, after first overfilling the bottle with three volumes of water. Stable isotopes of hydrogen and oxygen 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.

Samples containing pesticides and pesticide degradation products, pharmaceuticals, and potential wastewater indicators were collected in 1-L baked amber bottles. Pesticide and pharmaceutical samples were filtered through a glass fiber filter.

Ground-water samples for major and minor ions, trace elements, alkalinity, and total dissolved solids analyses were collected by filling one 250-mL polyethylene bottle with raw ground water and one 500-mL and one 250-mL polyethylene bottle with filtered ground water (Wilde and others, 2004). The filter used was a Whatman capsule filter, pre-rinsed with deionized water. The 250-mL filtered sample was then preserved with 7.5 N nitric acid. Mercury samples were collected by filtering ground water into a 250-mL glass bottle; the water was then preserved with 6 N hydrochloric acid. Arsenic and iron speciation samples were collected together, filtered into one 250-mL polyethylene bottle that was covered with tape to prevent light exposure, and preserved with 6 N Hydrochloric acid. The nutrient sample was filtered into a 125-mL brown polyethylene bottle. Radium isotopes, uranium, and gross alpha and beta radiation samples were filtered into 1-L polyethylene bottles and acidified with nitric acid. Carbon isotope samples were filtered and bottom filled into two 500-mL glass bottles that were first overfilled with three bottle volumes of ground water. These samples had no headspace and were sealed with a conical cap to avoid atmospheric contamination. Samples for field alkalinity titrations were collected by filtering ground water into a 500-mL polyethylene bottle.

Chromium, radon-222, dissolved noble gases, and microbial constituents were collected from the hose bib at the well head, regardless of the sampling schedule (intermediate or slow). DOC was collected at slow schedule sites after rinsing the sampling equipment with blank water (Wilde and others, 2004). Using a 50-mL syringe and 0.45- μm disk filter, the ground-water sample was filtered into a 125-mL baked glass bottle and preserved with 4.5 N sulfuric acid. 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, 2 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. Hexavalent chromium, Cr(VI), was then collected by attaching a small cation-exchange column to the syringe filter, and after conditioning the column with 3 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, 2003a,b).

To collect radon-222, a stainless steel and Teflon valve assembly was attached to the sampling port at the well head (Wilde and others, 2004). The valve was partially closed to create back pressure, and a 10-mL sample was collected through a Teflon septum on the valve assembly using a glass syringe rinsed with ground water and affixed with a stainless steel needle. The sample was then injected into a 25-mL vial partially filled with scintillation mixture (mineral oil) and shaken. The vial was then sealed with electrical tape and placed in a cardboard tube in order to shield it from light during shipping.

Noble gases were collected in 3/8-in copper tubes using reinforced nylon tubing connected to the hose bib at the wellhead. Ground water was flushed through the tubing to dislodge bubbles before flow was restricted by 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).

Samples for analysis of microbial constituents also were collected at the well head (Myers, 2004; Bushon, 2003). Before samples were collected, 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 coli* form determinations), and one sterilized 3-liter carboy was filled for coliphage analyses (F specific and somatic coliphage determinations).

Turbidity, alkalinity, total coliforms and *Escherichia coli* were measured in the mobile laboratory at the well site. Turbidity was measured in the field with a calibrated turbidity meter. Total coliforms and *Escherichia coli* plates were prepared using sterilized equipment and reagents (Myers, 2004). The bacteria on the plates were counted under an ultraviolet light, following a 22–24 hour incubation time. Alkalinity and concentrations of bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}) were measured on filtered samples by Gran's titration method (Gran, 1952, Rounds, 2006, Stumm and Morgan, 1996).

Concentrations of HCO_3^- and CO_3^{2-} were also calculated from the laboratory alkalinity and pH measurements. Calculations were made using the advanced speciation method (<http://or.water.usgs.gov/alk/methods.html>), with pK_1 ($-\log_{10}$ of the first acid dissociation constant for H_2CO_3) = 6.35, pK_2 ($-\log_{10}$ of the second acid dissociation constant for H_2CO_3) = 10.33, and pK_w ($-\log_{10}$ of the acid dissociation constant for water) = 14.

Ten laboratories analyzed chemical and microbial samples for this study (see [table A1](#)), although most of the samples were analyzed at the NWQL or by laboratories contracted by the NWQL. The NWQL maintains a rigorous quality assurance program (Maloney, 2005). Laboratory quality-control samples, including method blanks, continuing calibration verification standards, standard reference samples, reagent spikes, external certified reference materials, and external blind proficiency samples, are analyzed regularly. Method detection limits are continuously tested and laboratory reporting levels updated accordingly. NWQL maintains National Environmental Laboratory Accreditation Program (NELAP) and other certifications. In addition, the Branch of Quality Systems within the USGS Office of Water Quality maintains independent oversight of quality assurance at the NWQL and laboratories contracted by the NWQL. The Branch of Quality Systems also runs a national field quality assurance program that includes annual testing of all USGS

field personal for proficiency in making field water-quality measurements (<http://bqs.usgs.gov/nfqa/>). Results for analyses made at the NWQL or by laboratories contracted by the NWQL are uploaded directly into NWIS by the NWQL. Laboratory quality-control data are also stored in NWIS or available from the NWQL upon request.

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 usually set at two times the long-term method detection level (LT-MDL). The LT-MDL is derived from the standard deviation of at least 24 MDL determinations made over an extended period of time. 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). The USGS NWQL monitors and updates LT-MDL and LRL values regularly and the values listed in this report were in effect during the period ground-water samples from the COA Study Unit were analyzed (February and March, 2007).

Detections between the LRL and the LT-MDL are reported as estimated concentrations (designated with an “E” before the values in the tables and text). For information-rich methods, detections below the LRL have a high certainty of detection, but the precise concentration is uncertain. Information-rich methods are those that use gas chromatography or high-performance liquid chromatography (HPLC) with mass spectrometry detection (for VOCs, pesticides, pharmaceuticals, and wastewater-indicators). Compounds are identified by the presence of characteristic fragmentation patterns in their mass spectra in addition to being quantified by measurement of peak areas at their associated chromatographic retention times. E-values also may result from detections outside the range of calibration standards, for detections that did not meet all laboratory quality-control criteria, and for samples that were diluted before being analyzed (Childress and others, 1999).

Some compound concentrations in this study are reported using minimum reporting levels (MRL) or method uncertainties (MU). The MRL is the smallest measurable concentration of a constituent that may be reliably reported using a given analytical method (Timme, 1995). The MU generally indicates the precision of a particular analytical measurement; it gives a range of values in which the true value will be found.

Detections that may have resulted from inadvertent sample contamination are reported with a “V” before the values in the tables. The potential for sample contamination was assessed using results from field, source-solution, and laboratory blanks.

The reporting levels for radiochemical constituents (gross-alpha radioactivity, gross-beta radioactivity, radium-226, radium-228, and uranium) were based on a sample-specific minimum detectable concentration (SSMDC), a sample-specific critical value, and the combined standard uncertainty (CSU) (U.S. Environmental Protection Agency, 2004; Bennett and others, 2006). A result above the critical value represents a greater-than-95-percent certainty that the result is greater than zero (significantly different from the instrument’s background response to a blank sample), and a result above the SSMDC represents a greater-than-95-percent certainty that the result is greater than the critical value. Using these reporting level elements, three unique cases were possible when screening the raw analytical data. If the analytical result was less than the critical value (case 1), the analyte was considered not detected, and the concentration was reported as less than the SSMDC. If the analytical result was greater than the critical value, the ratio of the CSU to the analytical result was calculated as a percent (percent relative CSU). For those samples with percent relative CSU greater than 20 percent (case 2), concentrations were reported as estimated values (designated by an “E” preceding the value). For those samples with percent relative CSU less than 20 percent (case 3), concentrations were reported as given.

Stable isotopic compositions of oxygen, hydrogen, and carbon are reported as relative isotope ratios in units of per mil using the standard delta notation (Coplen and others, 2002):

$$\delta^i E = \left[\frac{R_{\text{sample}}}{R_{\text{reference}}} - 1 \right] \bullet 1,000 \text{ per mil}, \quad (1)$$

where

i is the atomic mass of the heavier isotope of the element,

E is the element (O for oxygen, C for carbon, or H for hydrogen),

R_{sample} is the ratio of the abundance of the heavier isotope of the element (^{18}O , ^{13}C , or ^2H) to the lighter isotope of the element (^{16}O , ^{12}C , or ^1H) in the sample and,

$R_{\text{reference}}$ is the ratio of the abundance of the heavier isotope of the element to the lighter isotope of the element in the reference material hydrogen.

The reference material for oxygen and hydrogen is Vienna Standard Mean Ocean Water (VSMOW), which is assigned $\delta^{18}\text{O}$ and $\delta^2\text{H}$ values of 0 per mil (note that $\delta^2\text{H}$ is also written as δD because the common name of the heavier isotope of hydrogen, hydrogen-2, is deuterium). The reference material for carbon is Vienna Pee Dee Belemnite (VPDB), which is assigned a $\delta^{13}\text{C}$ value of 0 per mil. Positive values indicate enrichment of the heavier isotope and negative values indicate depletion of the heavier isotope, compared to the ratios observed in the standard reference material.

Constituents on Multiple Analytical Schedules

Seventeen constituents targeted in this study were determined by more than one USGS NWQL analytical schedule or more than one laboratory (table A2). The preferred methods for 17 constituents analyzed under multiple analytical schedules at the NWQL were selected on the basis of the procedure recommended by the NWQL (http://www.nwql.cr.usgs.gov/USGS/Preferred_method_selection_procedure.html). Only constituents determined by the preferred method are reported. For example, this report uses Schedule 2060 (table 3B) as the preferred method for caffeine because it has the lower detection limit than the other analytical methods.

The standard methods used by the NWQL to analyze arsenic, chromium, and iron concentrations are preferred over the research methods used by the USGS Trace Metal Laboratory. The concentrations measured by the Trace Metal Laboratory are used only to calculate ratios of redox species

for each element, $\frac{\text{As(V)}}{\text{As(III)}}$ for arsenic, $\frac{\text{Cr(VI)}}{\text{Cr(III)}}$ for chromium,

and $\frac{\text{Fe(III)}}{\text{Fe(II)}}$ for iron. For example:

$$\frac{\text{Fe(III)}}{\text{Fe(II)}} = \frac{\text{Fe(T)} - \text{Fe(II)}}{\text{Fe(II)}}, \quad (2)$$

where

Fe(T) is the total iron concentration (measured),

Fe(II) is the concentration of ferrous iron (measured),

and

Fe(III) is the concentration of ferric iron (calculated).

Quality-Assurance Method

The quality-assurance process used for this study followed the protocols used by the USGS NAWQA program (Koterba and others, 1995) and described in the USGS National Field Manual (U.S. Geological Survey, variously dated). The quality-assurance method followed by the NWQL, the primary laboratory used to analyze samples for the study, is described by Maloney (2005), and Pirkey and Glodt (1998).

Quality-control (QC) samples collected in the COA Study Unit included source-solution blanks, field blanks, replicates, and matrix and surrogate spikes. QC samples were collected to evaluate contamination, and bias and variability of the data that may have resulted from the sample collection, processing, storage, transportation, and laboratory analysis.

Blanks

Blank samples (blanks) were collected using blank water certified by the NWQL to contain less than the LRL or MRL of the analytes investigated in the study. Two types of blanks were collected: source-solution and field blanks. Source-solution blanks were collected to verify that the blank water used for the field blanks was free of analytes. Field and source solution blanks were collected at approximately 10 percent of the wells sampled to determine if equipment or procedures used in the field or laboratory introduced contamination. Source solution blanks were analyzed only if there were detections in the field blank. Field blanks were analyzed for VOCs, pesticides, perchlorate, pharmaceuticals, nutrients, major and minor ions, trace elements, nutrients, wastewater compounds, 1,2,3 TCP, radium, and dissolved organic carbon. Source-solution blanks were collected at the sampling site by pouring blank water directly into sample bottles that were preserved, stored, shipped, and analyzed in the same manner as the ground-water samples. Field blanks were collected by pumping or pouring blank water through the sampling equipment (fittings and tubing) that was to be used in collecting ground water samples, field blank samples were then processed and transported using the same protocols for the ground-water samples.

Contamination in blanks may originate from several different types of sources, including the source-solution water, the previous sample, known sources specific to a field site, and field or laboratory equipment or processes. These different sources of contamination require different strategies for V-coding detections in environmental samples on the basis of detections in field blanks.

Detections in source-solution blanks were used to evaluate potential contamination of the source-solution water. If a constituent was detected in a source-solution blank at a concentration similar to or greater than the lowest concentration detected in the paired field blank, the source-solution water was considered to be the origin of the contamination and the field blank detection was disregarded.

The equipment used to collect samples from wells sampled with the slow schedule was different than the equipment used to collect samples from wells sampled with intermediate schedules; therefore, detections in field blanks collected at slow wells were compared with detections in ground-water samples from slow wells, and detections in

field blanks collected at intermediate wells were compared with detections in ground water samples from intermediate wells. If the constituent was not detected in the ground-water sample collected prior to the contaminated field blank, then contamination of that field blank due to carry-over was ruled out. If non-detections were reported in field blanks or ground-water samples collected after ground-water samples containing high concentrations of the constituent, then carry-over contamination was considered unlikely in the whole dataset. If carry-over contamination in the dataset could not be ruled out, then all detections in ground-water samples and field blanks collected after a ground-water sample containing a high concentration of the constituent were examined for potential V-coding. V-coded values are indicated by a 'V' preceding the value in the data tables, and are excluded from the summary statistics.

Contamination from known sources may produce distinctive patterns of detections in field blanks and ground-water samples, particularly for the VOCs. Substances that may be encountered at the field site, such as lubricants (for example, WD-40), cements used on PVC-piping, exhaust fumes from pump engines, and the methanol used to clean sample lines, contain recognizable associations of VOC constituents. If a recognizable association of VOC constituents was detected in a field blank and the field notes indicated that a known source was present and may have affected collection of the field blank, the field blank was not used to V-code detections of individual VOCs in ground-water samples. If a recognizable association of VOC constituents was detected in a ground-water sample and the field notes indicated that a known source was present and may have affected sample collection, the detections in the ground-water sample were examined for potential V-coding. However, detecting these co-occurring VOC constituents in ground-water samples does not necessarily indicate contamination during sample collection, because these VOC constituents also may occur together in ground water naturally.

If a field blank detection could not be attributed to the source-solution, carryover, or a specific problem recorded in the field notes, that field blank was used to V-code detections in all ground water samples collected with the same equipment. If the concentration of an analyte detected in a field blank was greater than the concentration measured in a ground-water sample collected before or after the blank sample, the ground-water value was V-coded. V-coded values are indicated by a 'V' preceding the value in the tables, and are excluded from the summary statistics. If a compound was detected in multiple field blanks and the detections could not be attributed to the source-solution water, any ground-water sample that had a detection of that compound was evaluated for possible inadvertent contamination.

Replicates

Sequential replicate samples were collected to assess variability that may result from processing and analyzing 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 A4). The RSD is defined as the standard deviation divided by the mean concentration for each replicate pair of samples, multiplied by 100 percent. If one value in a sample pair was reported as a non-detection and the other value was reported as an estimate below or equal to the LRL or MRL, the RSD was set to zero because the values are analytically identical. If one value for 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 (Hamlin and others, 2002). Values of RSD less than 20 percent were considered acceptable in this study. An RSD value of 20 percent corresponds to a relative percent difference (RPD) value of 29 percent. High RSD values for a compound at low concentrations may indicate analytical uncertainty, particularly for concentrations within an order of magnitude of LT-MDL or MDL. Sequential replicate samples were collected at approximately 10 percent of the wells sampled.

Matrix Spikes

Addition of a known concentration of a constituent ('spike') to a replicate environmental sample enables the analyzing laboratory to determine the effect of the matrix, in this case groundwater, on the analytical technique used to measure the constituent. The known compounds added in matrix spikes are the same as those being analyzed for in the method. This enables an analysis of matrix interferences on a compound by compound basis. Matrix spikes were added at the laboratory performing the analysis. Compounds with low recoveries are of potential concern if environmental concentrations are close to the MCLs; a concentration below an MCL could be falsely indicated. Conversely, compounds with high recoveries are of potential concern if the environmental concentrations were above MCLs: a high recovery could falsely indicate a concentration above the MCL.

Matrix spikes were performed for VOCs, pesticide compounds, pharmaceutical compounds, potential wastewater-indicator compounds, 1,2,3-TCP, radium and gross alpha/beta, and coliphage because the analytical methods for these constituents are chromatographic methods, which may be susceptible to matrix interferences. Acceptable ranges for matrix-spike recoveries are based on the acceptable ranges

established for laboratory “set” spike recoveries. Laboratory set spikes are aliquots of laboratory blank water to which the same spike solution used for the matrix spikes has been added. One set spike is analyzed with each set of samples. Acceptable ranges for set spike recoveries are 70 to 130 percent for NWQL schedules 2020 and 1433 (Connor and others, 1998; Rose and Sandstrom, 2003; Zaugg and others, 2002), 60 to 120 percent for NWQL schedules 2003 and 2060 (Sandstrom and others, 2001; Furlong and others, 2008), and 60 to 130 percent for NWQL schedule 2080 (Kolpin and others, 2002). These ranges were used to define 70 to 130 percent as the acceptable range for matrix-spike recoveries for organic compounds in this study.

Surrogates

Surrogate compounds are added to environmental samples in the laboratory before analysis in order to monitor the performance of the analytical methods for each sample. Surrogate compounds were added to all ground-water and quality-control samples that were analyzed for VOCs, pesticide compounds, pharmaceutical compounds, potential wastewater-indicator compounds, and 1,2,3-TCP ([table A6](#)). Most of the surrogate compounds are deuterated analogs of compounds being analyzed. For example, the surrogate toluene-d8 used for the VOC analytical method has the same chemical structure as toluene, except that the eight hydrogen-1 atoms on the molecule have been replaced by deuterium (hydrogen-2). Toluene-d8 and toluene behave very similarly in the analytical procedure, but the small mass difference between the two results in slightly different chromatographic retention times; thus, the use of a toluene-d8 surrogate does not interfere with the analysis of toluene (Grob, 1995). Only 0.015 percent of hydrogen atoms are deuterium (Firestone and others, 1996); deuterated compounds like toluene-d8 do not occur naturally and are not found in environmental samples. Surrogates are used to identify general problems that may arise during sample analysis that could affect the analysis results for all compounds in that sample. Potential problems include matrix interferences (such as high levels of dissolved organic carbon) that produce a positive bias, or incomplete laboratory recovery (possibly because of improper maintenance and calibration of analytical equipment) that produces a negative bias. 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 (Connor and others, 1998; Sandstrom and others, 2001).

Quality-Control Sample Results

Detections in Field and Source-Solution Blanks

Field and source solution blanks were collected at approximately 10 percent of the sites sampled in the COA Study Unit. [Table A3](#) gives a summary of detections in field blanks. Four VOCs were detected in field blanks; toluene, *m*- and *p*-xylene, *o*-xylene and ethylbenzene. Toluene was detected in all three source solution and field blanks at concentrations equal to or below 0.33 µg/L. Low levels of toluene were detected in source-solution and field blanks in many of the earlier study units also (Wright and others, 2005; Kulongoski and others, 2006; Bennett and others, 2006; Dawson and others, 2008; Kulongoski and Belitz, 2007). Because of the persistent detections of toluene in blanks, all concentrations of toluene detected in environmental samples were V-coded. No ethyl-benzene or xylenes were detected in the environmental samples; therefore, the blank detections were disregarded.

Three other constituents were detected in field blanks: mercury, radium-226 and -228. One field blank contained 0.01 µg/L of mercury, but mercury was not detected in any environmental samples. Radium-226 and -228 was detected at activities of 0.016 and 0.01 pCi/L in one field blank ([table A3](#)).

No constituents were detected in field blanks for the following analyte groups: pesticides and pesticide degradates, pharmaceutical compounds, perchlorate and 1,2,3-TCP, major and minor ions, nutrients, and dissolved organic carbon.

Variability in Replicate Samples

[Table A4](#) summarizes the results of replicate analyses of constituents detected in ground-water samples collected in the COA Study Unit. Constituents not detected by replicate analyses are not reported in [table A4](#). Concentrations or activities in the environmental and replicate samples are reported for all replicate analyses with RSD values greater than 20 percent. Most of replicate sample pairs collected during the COA Study Unit had RSDs of less than 20 percent. Constituent classes with replicate sample pairs with RSDs greater than 20 percent were VOCs, pharmaceuticals, and trace elements. No data were V-coded as a result of variability in replicate analyses.

Matrix-Spike Recoveries

Tables A5A–A5D summarize matrix-spike recoveries for the COA Study Unit. 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. Three environmental samples were spiked with VOCs (table A5A). Most of the spike compounds had median recoveries within the acceptable range of 70 to 130 percent. Bromomethane had one spike matrix recovery greater than 130 percent and hexachlorobutadiene had one spike matrix recovery below 70 percent. Neither compound was detected in environmental samples.

Three environmental samples were spiked with polar pesticide and pesticide degradate compounds (NWQL schedule 2060, table 3B). Most of the spike compounds had median recoveries within the acceptable range of 70 through 130 percent (table A5B). Two compounds, bendiocarb and oxamyl, had a recovery greater than 130 percent; however, neither compound was detected in ground-water samples. Twelve spike compounds had at least one median recovery below 70 percent. Of the compounds with low spike recoveries, 2-chloro-4-isopropylamino-6-amino-s-triazine (CIAT), 2-Chloro-6-ethylamino-4-amino-s-triazine (CEAT), and atrazine were detected in ground-water samples. [NOTE – low recoveries may indicate that the compound might not have been detected in some samples if it was present at very low concentrations].

Three ground-water samples were spiked with pesticide and pesticide degradate compounds (NWQL schedule 2003, table 3C). Most of the spike compounds had median recoveries within the acceptable range of 70 to 130 percent (table A5C). The compound CIAT again had a low recovery. One spike compound had a recovery greater than 130 percent. The median recovery was below 70 percent for seventeen compounds.

Three ground-water samples were spiked with pharmaceutical compounds (NWQL schedule 2080, table 3D). All but one pharmaceutical compound had median recoveries within the acceptable range of 70 to 130 percent (table A5D).

The compound acetaminophen, which was detected in a ground-water sample, had acceptable recoveries in all three spiked samples.

One ground-water sample was spiked with potential wastewater-indicator compounds (NWQL schedule 4433, table 3E). Fifty-five of the sixty-eight compounds had recoveries less than 70 percent and ten had recoveries greater than 130 percent (table A5E). Of the compounds detected in ground-water samples, eleven had recoveries below 70 percent, one had an acceptable recovery, and two were greater than 130 percent.

Surrogate Compound Recoveries

Surrogate compounds were added to field blanks and environmental samples in the laboratory to evaluate the recovery of similar constituents. Table A6 lists the surrogate, the NWQL analytical schedule on which it was applied, the number of analyses for blank and environmental samples, the number of surrogate recoveries below 70 percent, and the number of surrogate recoveries above 130 percent. Blank and environmental samples were considered separately to assess whether the matrices of environmental samples affect surrogate recoveries.

Differences between surrogate recoveries in blank and environmental samples occurred for VOCs, pesticide and pesticide degradates, and potential waste-water indicator compounds. Surrogate recoveries for these analytical classes were lower in the environmental samples (below the 70 percent lower limit) than they were in the blank samples. This result indicates matrix inferences may be biasing analyte concentrations lower than they actually are. All surrogates recovered in the analyses of pharmaceutical compounds were in the acceptable range of 70 to 130 percent recovery. No samples had recoveries of surrogates greater than 130 percent. A high recovery for a surrogate suggests that the measured concentrations of analytes eluting near the surrogate may be biased to higher internal laboratory quality-control samples for pharmaceutical compounds.

Table A1. Analytical methods used to determine organic, inorganic, and microbial constituents by the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) and contract laboratories.

[MI agar, supplemented nutrient agar in which coliforms (total and *Escherichia*) produce distinctly different fluorescence under ultraviolet lighting; UV, ultraviolet; VOCs, volatile organic compounds]

Analyte	Analytical Method	Laboratory and analytical schedule	Citation(s)
Water-quality indicators			
Field parameters	Calibrated field meters and test kits	USGS field measurement	U.S. Geological Survey, variously dated
Organic constituents			
VOCs	Purge and trap capillary gas chromatography/mass spectrometry	NWQL, schedule 2020	Connor and others, 1998
Pesticides and pesticide degradates	Solid-phase extraction and gas chromatography/mass spectrometry	NWQL, schedule 2003	Zaugg and others, 1995; Lindley and others, 1996; Madsen and others, 2003; Sandstrom and others, 2001
Polar pesticides and degradates	Solid-phase extraction and high-performance liquid chromatography (HPLC)/mass spectrometry with selective-ion monitoring	NWQL, Schedule 2060	Furlong and others, 2001
Pharmaceuticals	Solid-phase extraction and HPLC/mass spectrometry	NWQL, schedule 2080	Kolpin and others, 2002
Potential wastewater-indicators	Solid-phase extraction and gas chromatography/mass spectrometry	NWQL, schedule 4433	Zaugg and others, 2002
Constituents of special interest			
Perchlorate	Chromatography and mass spectrometry	Montgomery Watson-Harza Laboratory	Hautman and others, 1999
1,2,3-Trichloropropane	Gas chromatography/electron capture detector	Montgomery Watson-Harza Laboratory	U.S. Environmental Protection Agency, 1995
Inorganic constituents			
Nutrients	Alkaline persulfate digestion, Kjeldahl digestion	NWQL, schedule 2755	Fishman and others, 1993; Patton and Kryskalla, 2003
Dissolved organic carbon	UV-promoted persulfate oxidation and infrared spectrometry	NWQL, schedule 2613	Brenton and Arnett, 1993
Major and minor ions, trace elements and nutrients	Atomic absorption spectrometry, colorimetry, ion-exchange chromatography, inductively-coupled plasma atomic emission spectrometry and mass spectrometry	NWQL, schedule 1948	Fishman and Friedman, 1989; Fishman, 1993; Faires, 1993; McLain, 1993; Garbarino, 1999; Garbarino and Damrau, 2001; American Public Health Association, 1998; Garbarino and others, 2006
Chromium, arsenic and iron speciation	Various techniques of ultraviolet visible (UV-VIS) spectrophotometry and atomic absorbance spectroscopy	USGS Trace Metal Laboratory, Boulder, Colorado	Stookey, 1970; To and others, 1998; Ball and McCleskey, 2003a and 2003b; McCleskey and others, 2003

Table A1. Analytical methods used to determine organic, inorganic, and microbial constituents by the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL) and contract laboratories.—Continued

[MI agar, supplemented nutrient agar in which coliforms (total and *Escherichia*) produce distinctly different fluorescence under ultraviolet lighting; UV, ultraviolet; VOCs, volatile organic compounds]

Analyte	Analytical Method	Laboratory and analytical schedule	Citation(s)
Isotopes			
Carbon isotopes	Accelerator mass spectrometry	University of Waterloo, Environmental Isotope Lab; University of Arizona Accelerator Mass Spectrometry Lab	Donahue and others, 1990; Jull and others, 2004
Stable isotopes of hydrogen and oxygen in water	Gaseous hydrogen and carbon dioxide-water equilibration and stable-isotope mass spectrometry	USGS Stable Isotope Laboratory, Reston, Virginia	Epstein and Mayeda, 1953; Coplen and others, 1991 ; Coplen, 1994
Uranium Isotopes	Chemical separations and alpha-particle spectrometry	Eberline Analytical Services (CA-EBERL), NWQL Schedule 1130	American Society for Testing Materials, 2002 (D3972)
Radioactivity and gases			
Tritium	Electrolytic enrichment-liquid scintillation	USGS Stable Isotope and Tritium Laboratory, Menlo Park, California	Thatcher and others, 1977
Tritium and noble gases	Helium-3 in-growth and mass spectrometry	Lawrence Livermore National Laboratory	Moran and others, 2002; Eaton and others, 2004
Radon-222	Liquid scintillation counting	NWQL, schedule 1369	American Society for Testing and Materials, 1998
Radium 226/228	Alpha activity counting	Eberline Analytical Services, NWQL method 1262	U.S. Environmental Protection Agency, 1980 (USEPA methods 903 and 904)
Gross alpha and beta radioactivity	Alpha and beta activity counting	Eberline Analytical Services, NWQL method 1792	U.S. Environmental Protection Agency, 1980 (USEPA method 900.0)
Microbial constituents			
F-specific and somatic coliphage	Single-agar layer (SAL) and two-step enrichment methods	USGS Ohio Water Microbiology Laboratory	U.S. Environmental Protection Agency, 2001
Total and <i>Escherichia</i> coliform	Membrane filter technique with "MI agar"	USGS field measurement	U.S. Environmental Protection Agency, 2002

Table A2. Preferred analytical schedules for constituents appearing on multiple schedules for samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[Preferred analytical schedules are the methods of analysis with the greatest accuracy and precision out of the ones used for the compound in question. **Abbreviations:** TML, U.S. Geological Survey Trace Metal Laboratory; VOC, volatile organic compound]

Constituent	Primary constituent classification	Analytical schedules	Preferred analytical schedule
Results from preferred method reported			
Atrazine	Pesticide	2003, 2060, 4433	2003
Bromoform (Tribromomethane)	VOC	2020, 4433	2020
Caffeine	Potential wastewater indicator	4433, 2060, 2080	2060
Carbaryl	Pesticide	2003, 2060, 4433	2003
Chlorpyrifos	Pesticide	2003, 4433	2003
Cotinine	Potential wastewater indicator	2080, 4433	2080
Deethylatrazine (2-Chloro-4-isopropylamino-6-amino-s-triazine)	Pesticide degradate	2003, 2060	2003
Diazinon	Pesticide	2003, 4433	2003
1,4-Dichlorobenzene	VOC, pesticide	2020, 4433	2020
Dichlorvos	Pesticide	2003, 4433	2003
Isopropylbenzene	VOC	2020, 4433	2020
Metalaxyl	Pesticide	2003, 2060, 4433	2003
Metolachlor	Pesticide	2003, 4433	2003
Naphthalene	VOC	2020, 4433	2020
Perchloroethene (PCE)	VOC	2020, 4433	2020
Prometon	Pesticide	2003, 4433	2003
Tebuthiuron	Herbicide	2003, 2060	2003
Results from both methods reported (different USGS parameter codes)			
Alkalinity	Water-quality indicator	Field, 1948	Field
Arsenic, total	Trace element	1948, TML	1948
Chromium, total	Trace element	1948, TML	1948
Iron, total	Trace element	1948, TML	1948
pH	Water-quality indicator	field, 1948	field
Specific conductance	Water-quality indicator	field, 1948	field

Table A3. Constituents detected in field blanks collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[V-coded data are reported but not used in summary statistics. **Abbreviations:** pCi/L, picocurie per liter; mg/L, milligram per liter; µg/L, microgram per liter]

Constituent	Number of source solution blank detections/analyses	Number of field blank detections/analyses	Maximum concentration detected in blanks	Minimum concentration detected in ground-water samples	Number of ground-water samples V-coded
Organic constituents (µg/L)					
Ethylbenzene	1/3	0/3	0.01	0	0
<i>m</i> -Xylene plus <i>p</i> -xylene	2/3	2/3	0.03	0	0
<i>o</i> -Xylene	0/3	1/3	0.01	0	0
Toluene	3/3	3/3	0.33	0.01	10
Inorganic constituents (mg/L)					
Mercury	0/3	1/1	0.01	0	0
Radium-226 (pCi/L)	0/3	1/1	0.02	0.24	0
Radium-228 (pCi/L)	0/3	1/1	0.01	0.76	0

Table A4. Quality-control summary for replicate analyses of constituents detected in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[Abbreviations: na, not applicable; TU, tritium unit; <, less than; mg/L, milligram per liter; µg, microgram per liter; pCi/L, picocurie per liter; RSD, relative standard deviation]

Constituent	Number of RSDs greater than 20 percent / number of replicate pairs	Maximum RSD (percent)	Concentrations for replicates with RSD greater than zero (environmental, replicate) (mg/L)
Volatile organic compounds, gasoline oxygenates and additives from schedules 2020			
<i>n</i> -Butylbenzene	3/3	24	<0.14; 0.1
Hexachloroethane	3/3	24	<0.14; 0.1
Ethyl methacrylate	3/3	24	<0.14; 0.1
1,3-Dichloropropane	3/3	35	<0.06; 0.1
1,2,3,4-Tetramethylbenzene	3/3	24	<0.14; 0.1
All additional VOCs from schedule 2020	0/3	<20	na
Pesticides and pesticide degradates from schedules 2003 and 2060			
All additional pesticides and pesticide degradates from schedule 2003	0/3	<20	na
All additional pesticides and pesticide degradates from schedule 2060	0/3	<20	na
Potential wastewater-indicator compounds from schedule 4433			
All wastewater-indicator compounds from schedule 4433	0/1	na	na
Pharmaceutical compounds			
Sulfamethoxazole	1/3	106	0.0237; 0.0034
Constituents of special interest ¹			
Perchlorate and 1,2,3-Trichloropropane	0/3	<20	na
Major ions, minor ions, trace elements, and nutrients			
Cadmium (µg/L)	1/3	28	0.09; 0.66
Copper (µg/L)	1/3	24	1.55; 1.1
Lead (µg/L)	1/3	24	0.28; 0.2
Nickel (µg/L)	1/3	33	0.08; 0.05
All additional major ions, minor ions, trace elements, and nutrients from schedules 1948 and 2755	0/3	<20	na
Isotopes, radioactivity, and noble gases			
²²⁶ Radium-226 (pCi/L)	na	na	na
²²⁸ Radium-228 (pCi/L)	na	na	na
Tritium ³ (TU)	0/3	<20	na
Alpha radioactivity, 72-hour count ² (pCi/L)	na	na	na
Beta radioactivity, 72-hour count ² (pCi/L)	na	na	na
USGS Trace Metals Laboratory			
Iron(II)	1/3	94	10; <2
Microbial indicators			
F-specific and somatic coliphage	0/1	<20	na
<i>E. Coli</i> , and total coliforms	0/1	<20	na

¹Analyzed at Montgomery Watson-Harza Laboratories, Monrovia, California.

²Analyzed at Eberline Analytical Services, Richmond, California.

³Analyzed at U.S. Geological Survey, Menlo Park, California.

Table A5A. Quality-control summary for matrix-spike recoveries of volatile organic compounds (VOCs) in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[Acceptable recovery range is between 70 and 130 percent.]

Constituent	Number of spike samples	Recovery (percent)		
		Minimum	Maximum	Median
Acetone	3	94	103	99
Acrylonitrile	3	99	101	99
Benzene	3	98	101	101
Bromobenzene	3	95	99	106
Bromochloromethane	3	101	107	104
Bromodichloromethane ¹	3	95	117	112
Bromoethene	3	108	112	111
Bromoform (tribromomethane)	3	92	108	92
Bromomethane	3	95	151	137
2-Butanone (ethyl methyl ketone)	3	92	99	97
Butylbenzene (<i>n</i> -Butylbenzene)	3	71	81	75
<i>sec</i> -Butylbenzene	3	89	98	91
<i>tert</i> -Butylbenzene	3	92	104	99
Carbon disulfide	3	75	84	81
Chlorobenzene	3	95	105	100
Chloroethane	3	94	103	100
Chloroform (trichloromethane) ¹	3	105	108	108
Chloromethane	3	95	104	102
3-Chloropropene	3	112	119	113
2-Chlorotoluene	3	95	101	96
4-Chlorotoluene	3	91	99	91
Dibromochloromethane	3	93	106	101
1,2-Dibromo-3-chloropropane (DBCP)	3	90	96	91
1,2-Dibromoethane (EDB)	3	95	109	108
Dibromomethane	3	99	106	104
1,2-Dichlorobenzene	3	93	101	96
1,3-Dichlorobenzene	3	89	99	92
1,4-Dichlorobenzene	3	89	96	86
<i>trans</i> -1,4-Dichloro-2-butene	3	87	93	93
Dichlorodifluoromethane (CFC-12)	3	71	87	78
1,1-Dichloroethane ¹	3	101	110	106
1,2-Dichloroethane	3	96	104	102
<i>cis</i> -1,2-Dichloroethene	3	103	109	104
<i>trans</i> -1,2-Dichloroethene	3	96	103	102
1,1-Dichloropropene	3	92	96	92
1,2-Dichloropropane	3	100	107	104
1,3-Dichloropropane	3	99	108	104
<i>cis</i> -1,3-Dichloropropene	3	89	96	93
<i>trans</i> -1,3-Dichloropropene	3	88	92	89
2,2-Dichloropropane	3	77	85	84
Diethyl ether	3	99	105	103
Diisopropyl ether	3	97	99	98
Ethylbenzene	3	94	100	95
Ethyl <i>tert</i> -butyl ether (ETBE, <i>tert</i> -butyl ethyl ether)	3	93	94	97
Ethyl methacrylate	3	94	99	95
<i>o</i> -Ethyl toluene (2-Ethyltoluene)	3	89	96	91
Hexachlorobutadiene	3	63	71	67
Hexachloroethane	3	88	99	92
2-Hexanone (<i>n</i> -Butyl methyl ketone)	3	100	104	104
Isopropylbenzene	3	93	107	101
4-Isopropyltoluene (p-isopropyltoluene)	3	82	91	86
Methyl acrylate	3	99	102	100
Methyl acrylonitrile	3	102	105	105
Methyl <i>tert</i> -butyl ether (MTBE)	3	98	104	101
Methyl iodide (iodomethane)	3	107	113	107

Table A5A. Quality-control summary for matrix-spike recoveries of volatile organic compounds (VOCs) in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.—Continued

[Acceptable recovery range is between 70 and 130 percent.]

Constituent	Number of spike samples	Recovery (percent)		
		Minimum	Maximum	Median
Methyl methacrylate	3	96	100	97
4-Methyl-2-pentanone (MIBK, isobutyl methyl ketone)	3	96	102	97
Methyl <i>tert</i> -pentyl ether	3	94	102	97
Naphthalene	3	81	102	91
<i>n</i> -Propylbenzene	3	88	95	89
Styrene	3	89	96	98
1,1,1,2-Tetrachloroethane	3	95	109	106
1,1,2,2-Tetrachloroethane	3	99	105	95
Tetrachloroethene (PCE) ¹	3	89	101	95
Tetrachloromethane (carbon tetrachloride)	3	95	102	106
Tetrahydrofuran	3	100	106	100
1,2,3,4-Tetramethylbenzene	3	80	97	87
1,2,3,5-Tetramethylbenzene (isodurene)	3	88	103	93
Toluene ¹	3	83	111	103
1,2,3-Trichlorobenzene	3	86	98	90
1,2,4-Trichlorobenzene	3	79	89	81
1,1,1-Trichloroethane (TCA)	3	97	109	106
1,1,2-Trichloroethane	3	96	105	103
Trichloroethene (TCE) ¹	3	92	102	99
Trichlorofluoromethane (CFC-11)	3	100	104	103
1,2,3-Trichloropropane (1,2,3-TCP)	3	90	106	102
1,1,2-Trichlorotrifluoroethane (CFC-113)	3	82	85	83
1,2,3-Trimethylbenzene	3	94	105	98
1,2,4-Trimethylbenzene	3	91	101	95
1,3,5-Trimethylbenzene	3	88	97	92
Vinyl chloride	3	102	108	104
<i>m</i> - and <i>p</i> -Xylene	3	92	100	95
<i>o</i> -Xylene	3	91	100	96

¹Constituents detected in ground-water samples.

Table A5B. Quality-control summary for matrix-spike recoveries of pesticides and pesticide degradates from schedules 2060 in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[Acceptable recovery range is between 70 and 130 percent.]

Constituent	Number of spike samples	Recovery (percent)		
		Minimum	Maximum	Median
Acifluorfen	3	73	80	75
Aldicarb sulfone	3	37	74	62
Aldicarb sulfoxide	3	59	100	84
Aldicarb	3	14	85	71
Atrazine ¹	3	53	83	74
Bendiocarb	3	76	165	76
Benomyl	3	67	79	73
Bensulfuron-methyl	3	67	83	71
Bentazon	3	62	80	75
Bromacil	3	73	86	84
Bromoxynil	3	57	78	78
Caffeine	3	58	87	85
Carbaryl	3	81	109	81
Carbofuran	3	81	95	86
2-Chloro-4-isopropylamino-6-amino-s-triazine (CIAT) ¹	3	42	83	61
2-Chloro-6-ethylamino-4-amino-s-triazine (CEAT) ¹	3	33	78	61
Chloramben, methyl ester	3	73	85	81
Chlorimuron-ethyl	3	40	58	55
Chlorodiamino-s-triazine (CAAT)	3	59	98	81
Clopyralid	3	30	87	65
Cycloate	3	61	73	69
2,4-D	3	85	92	91
2,4-D methyl ester	3	63	96	80
2,4-DB	3	59	64	70
Dacthal monoacid	3	73	82	81
Dicamba	3	63	76	69
Dichlorprop	3	79	86	82
Dinoseb	3	68	71	68
Diphenamid	3	85	98	88
Diuron ¹	3	85	107	89
Fenuron	3	83	93	87
Flumetsulam	3	67	98	84
Fluometuron	3	82	91	83
3-Hydroxycarbofuran	3	83	110	85
2-Hydroxy-4-isopropylamino-6-ethylamino-s-triazine (OIET)	3	64	94	93
Imazaquin	3	69	98	73
Imazethapyr	3	74	104	79
Imidacloprid	3	71	87	83
Linuron	3	80	86	85
MCPA	3	74	78	83
MCPB	3	62	70	64
Metalaxyl	3	85	87	89
Methiocarb	3	81	124	83
Methomyl	3	71	108	92
Metsulfuron methyl	3	4	49	21
3-(4-Chlorophenyl)-1-methyl urea	3	64	87	67
Neburon	3	76	91	81
Nicosulfuron	3	62	90	81
Norflurazon	3	83	92	87
Oryzalin	3	66	82	81
Oxamyl	3	71	133	85
Picloram	2	70	75	na

Table A5B. Quality-control summary for matrix-spike recoveries of pesticides and pesticide degradates from schedules 2060 in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.—Continued

[Acceptable recovery range is between 70 and 130 percent.]

Constituent	Number of spike samples	Recovery (percent)		
		Minimum	Maximum	Median
Propham	3	77	88	88
Propiconazole	3	74	83	78
Propoxur (Baygon)	3	80	99	84
Siduron	3	84	91	91
Sulfometuron-methyl	3	59	71	68
Tebuthiuron	3	85	96	85
Terbacil	3	68	87	84
Triclopyr	3	78	84	81

¹Constituent detected in ground-water samples.

Table A5C. Quality-control summary for matrix-spike recoveries of pesticides and pesticide degradates from schedule 2003 in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February to March 2007.

[Acceptable recovery range is between 70 and 130 percent.]

Constituent	Number of spike samples	Recovery (percent)		
		Minimum	Maximum	Median
Acetochlor	3	98	111	103
Alachlor	3	97	106	102
Atrazine ¹	3	94	101	95
Azinphos-methyl oxygen analog	3	45	85	64
Azinphos-methyl	3	92	121	113
Benfluralin, water	3	34	76	67
Carbaryl	3	104	122	113
Chlorpyrifos oxygen analog	3	40	48	47
2-Chloro-2',6'-diethylacetanilide	3	91	101	94
2-Chloro-4-isopropylamino-6-amino-s-triazine (CIAT) ¹	3	44	50	48
4-Chloro-2-methylphenol	3	46	63	59
Chlorpyrifos	3	91	99	98
<i>cis</i> -Permethrin	3	65	82	67
Cyfluthrin	3	51	72	57
Cypermethrin	3	50	76	60
Dacthal (DCPA)	3	96	103	97
Desulfinylfipronil amide	3	85	110	99
Desulfinyl fipronil	3	84	98	89
Diazinon oxygen analog	3	86	103	86
Diazinon	3	88	96	95
3,4-Dichloroaniline	3	77	85	79
Dicrotophos	3	30	42	38
Dieldrin	3	100	107	107
Dimethoate	3	32	39	34
2,6-Diethylaniline	3	89	99	95
Ethion monoxon	3	86	111	95
Ethion	3	80	98	86
2-Ethyl-6-methylaniline	3	87	96	93
Fenamiphos sulfone	3	68	72	104
Fenamiphos sulfoxide	3	16	38	28
Fenamiphos	3	87	145	96
Fipronil sulfide	3	77	93	80
Fipronil sulfone	3	67	82	74
Fipronil	3	89	113	93
Fonofos	3	87	94	91
Hexazinone	3	65	83	70
Iprodione	3	57	75	65
Isfenphos	3	100	118	108
Malaoxon	3	92	106	101
Malathion	3	89	102	98
Metalaxyl	3	89	99	91
Methidathion	3	92	106	101
Methyl paraoxon	3	52	67	61
Methyl parathion	3	74	89	83
Metolachlor	3	98	108	103
Metribuzin	3	70	82	77
Myclobutanil	3	94	111	97
1-Naphthol	3	23	33	25
Pendimethalin	3	79	101	91
Phorate oxygen analog	3	107	125	117
Phorate	3	78	90	85
Phosmet oxygen analog	3	5	16	6
Phosmet	3	11	27	12
Prometon ¹	3	88	98	89
Prometryn	3	98	110	102

Table A5C. Quality-control summary for matrix-spike recoveries of pesticides and pesticide degradates from schedule 2003 in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February to March 2007.—Continued

[Acceptable recovery range is between 70 and 130 percent.]

Constituent	Number of spike samples	Recovery (percent)		
		Minimum	Maximum	Median
Propyzamide (Pronamide)	3	82	95	87
Simazine ¹	3	101	111	101
Tebuthiuron	3	79	107	81
Terbufos oxygen analog sulfone	3	80	96	83
Terbufos	3	88	104	98
Terbuthylazine	3	94	102	96
Trifluralin	3	68	82	70
Dichlorvos	3	25	65	32
Tribufos	3	78	98	82

¹Constituents detected in ground-water samples.

Table A5D. Quality-control summary for matrix-spike recoveries of pharmaceutical compounds in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[Acceptable recovery range is between 70 and 130 percent.]

Constituent	Number of spike samples	Recovery (percent)		
		Minimum	Maximum	Median
Acetaminophen ¹	3	89	100	94
Albuterol	3	86	96	90
Caffeine	3	107	117	108
Carbamazepine	3	91	109	106
Codeine	3	78	97	85
Cotinine	3	89	92	90
Dehydronifedipine	3	93	108	106
Diltiazem	3	38	59	44
1,7-Dimethylxanthine	3	83	97	89
Diphenhydramine	3	68	79	73
Sulfamethoxazole	3	58	112	72
Thiabendazole	3	78	91	82
Trimethoprim	3	95	104	101
Warfarin	3	57	92	90

¹Constituent detected in ground-water samples.

Table A5E. Quality-control summary for matrix-spike recoveries of potential wastewater-indicator compounds in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[Acceptable recovery range is between 70 and 130 percent. Only one matrix spike collected from slow wells.]

Constituent	Recovery (percent)	Constituent	Recovery (percent)
Acetophenone	42	Indole	39
Acetyl hexamethyl tetrahydro naphthalene (AHTN)	54	Isoborneol	53
Anthracene, water ¹	42	Isophorone	44
9,10-Anthraquinone ¹	55	Isopropylbenzene	9
Atrazine	47	Isoquinoline	42
Benzo[a]pyrene ¹	44	Menthol	58
Benzophenone	49	Metalaxyl	49
β-Sitosterol	184	1-Methylnaphthalene	36
β-Stigmastanol	156	5-Methyl-1H-benzotriazole ¹	424
bis(2-Ethylhexyl) phthalate	58	2-Methylnaphthalene	34
Bisphenol A	68	3-Methyl-1(H)-indole (Skatole)	43
Bromacil	208	Methyl salicylate	45
Bromoform	21	Metolachlor	46
3-tert-Butyl-4-hydroxyanisole (BHA)	28	4- <i>n</i> -Octylphenol	52
Caffeine ¹	44	4- <i>tert</i> -Octylphenol	54
Camphor	38	4-Octylphenol diethoxylates	50
Carbaryl	40	Naphthalene	33
Carbazole	45	4-Nonylphenol diethoxylates	843
Chlorpyrifos	45	Nonylphenol (total)	400
Cholesterol	225	<i>p</i> -Cresol	44
Cotinine	121	para-Nonylphenol (total)	403
3-β-Coprostanol	290	Pentachlorophenol ¹	140
4-Cumylphenol, water	55	Phenanthrene ¹	44
DEET	53	Phenol ¹	46
Diazinon	47	Prometon	50
1,4-Dichlorobenzene (p-dichlorobenzene)	24	Pyrene ¹	43
3,4- Dichlorophenyl isocyanate ¹	81	2,2',4,4'- Tetrabromodiphenyl ether	25
4-Octylphenol monoethoxylates	101	Tributyl phosphate ¹	53
Dichlorvos	42	Triclosan	60
Diethyl phthalate ¹	51	Triethyl citrate (ethyl citrate)	49
2,6-Dimethylnaphthalene ¹	35	Triphenyl phosphate	46
<i>d</i> -Limonene	8	Tris(2-butoxyethyl) phosphate	49
Fluoranthene ¹	45	Tris(2-chloroethyl) phosphate	48
Hexahydrohexamethyl cyclopentabenzopyran (HHCB)	51	Tris(dichloroisopropyl) phosphate	41

¹Constituents detected in ground-water samples.

Table A6. Quality-control summary for surrogate recoveries of volatile organic compounds, pesticides and pesticide degradates, pharmaceutical compounds, potential wastewater-indicator compounds, and constituents of special interest in samples collected for the Coachella Valley Groundwater Ambient Monitoring and Assessment (GAMA) study, California, February and March 2007.

[Abbreviation: MWH, Montgomery Watson-Harza Laboratory; VOC, volatile organic compound]

Surrogate	Analytical schedule	Constituent or constituent class analyzed	Number of blank analyses	Median recovery in blanks (percent)	Number of surrogate recoveries		Number of environmental sample analyses	Median recovery in samples (percent)	Number of surrogate recoveries	
					Below 70 percent in blanks	Above 130 percent in blanks			Below 70 percent in samples	Above 130 percent in samples
1-Bromo-4-fluorobenzene	2020	VOC	3	86	0	0	35	86	3	0
1,2-Dichloroethane-d4	2020	VOC	3	102	0	0	35	109	0	0
Toluene-d8	2020	VOC	3	98	0	0	35	99	0	0
Diazinon-d10	2003	Pesticide	3	115	0	0	35	101	1	0
alpha-HCH-d6	2003	Pesticide	3	94	0	0	35	84	0	0
2,4,5-T	2060	Pesticide	3	74	0	0	35	75	13	0
Barban	2060	Pesticide	3	86	0	0	35	88	0	0
Caffeine- ¹³ C	2060	Pesticide	3	90	0	0	35	100	3	0
Toluene-d8	MWH	1,2,3-TCP	1	102	0	0	11	103	0	0
Ethyl nicotinate-d4	2080	Pharmaceutical	3	99	0	0	35	96	0	0
Carbamazapine-d10	2080	Pharmaceutical	3	94	0	0	35	96	0	0
Caffeine- ¹³ C	4433	Potential wastewater-indicator	1	35	1	0	12	75	3	0
Bisphenol A-d3, surrogate	4433	Potential wastewater-indicator	1	30	1	0	12	70	5	0
Decafluorobiphenyl	4433	Potential wastewater-indicator	1	20	1	0	12	62	8	0
Fluoranthene-d10	4433	Potential wastewater-indicator	1	40	1	0	12	84	1	0

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