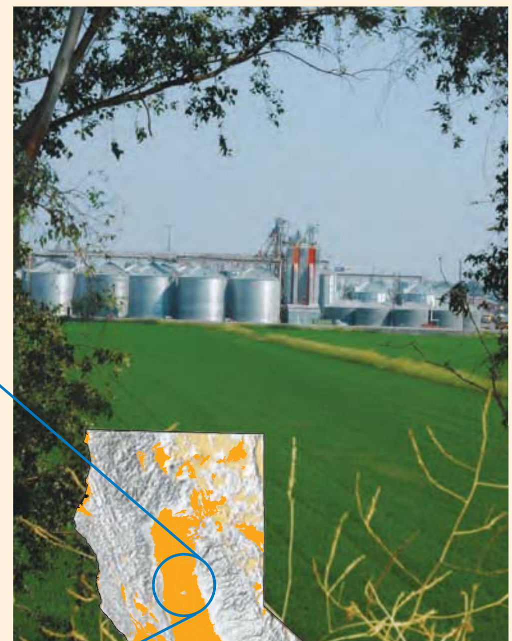
Prepared in cooperation with the California State Water Resources Control Board

Ground-Water Quality Data in the Middle Sacramento Valley Study Unit, 2006—Results from the California GAMA Program



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Cover Photographs:
Top: Rice field and grain silos in Colusa County, California, July 2008. (Photograph taken by Cathy Munday, U.S. Geological Survey.)
Bottom: Irrigation well in Butte County, California, July 2008. (Photograph taken by Michael Judd, U.S. Geological Survey.)

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Abstract

Ground-water quality in the approximately 3,340 mi^2 Middle Sacramento Valley study unit (MSACV) was investigated from June through September, 2006, as part of the California Groundwater Ambient Monitoring and Assessment (GAMA) program. The GAMA Priority Basin Assessment 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 Middle Sacramento Valley study was designed to provide a spatially unbiased assessment of raw ground-water quality within MSACV, as well as a statistically consistent basis for comparing water quality throughout California. Samples were collected from 108 wells in Butte, Colusa, Glenn, Sutter, Tehama, Yolo, and Yuba Counties. Seventy-one wells were selected using a randomized grid-based method to provide statistical representation of the study unit (grid wells), 15 wells were selected to evaluate changes in water chemistry along ground-water flow paths (flow-path wells), and 22 were shallow monitoring wells selected to assess the effects of rice agriculture, a major land use in the study unit, on ground-water chemistry (RICE wells).

The ground-water samples were analyzed for a large number of synthetic organic constituents (volatile organic compounds [VOCs], gasoline oxygenates and degradates, pesticides and pesticide degradates, and pharmaceutical compounds), constituents of special interest (perchlorate, *N*-nitrosodimethylamine [NDMA], and 1,2,3-trichloropropane [1,2,3-TCP]), inorganic constituents (nutrients, major and minor ions, and trace elements), radioactive constituents, and microbial indicators. Naturally occurring isotopes (tritium, and carbon-14, and stable isotopes of hydrogen, oxygen, nitrogen, and carbon), and dissolved noble gases also were measured to help identify the sources and ages of the sampled ground water.

Quality-control samples (blanks, replicates, laboratory matrix spikes) were collected at approximately 10 percent of the wells, and the results for these samples were used to evaluate the quality of the data for the ground-water samples. Field blanks rarely contained detectable concentrations of any constituent, suggesting that contamination was not a noticeable source of bias in the data for the ground-water samples. Differences between replicate samples were within acceptable ranges, indicating acceptably low variability. Matrix spike recoveries were within acceptable ranges for most constituents.

This study did not attempt to evaluate the quality of water delivered to consumers; after withdrawal from the ground, water typically is treated, disinfected, or 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) and thresholds established for aesthetic concerns (secondary maximum contaminant levels, SMCL-CA) by CDPH. Comparisons between data collected for this study and drinking-water thresholds are for illustrative purposes only and are not indicative of compliance or noncompliance with regulatory thresholds.

Most constituents that were detected in ground-water samples were found at concentrations below drinking-water thresholds. VOCs were detected in less than one-third and pesticides and pesticide degradates in just over one-half of the grid wells, and all detections of these constituents in samples from all wells of the MSACV study unit were below health-based thresholds. All detections of trace elements in samples from MSACV grid wells were below health-based thresholds, with the exceptions of arsenic and boron.

Arsenic concentrations were above the USEPA maximum contaminant level (MCL-US) threshold in eight grid wells, and boron concentrations were above the CDPH notification level (NL-CA) in two grid wells. Arsenic was detected above the MCL-US in two flow-path wells. Arsenic, barium, boron, molybdenum, strontium, and vanadium were detected above health-based thresholds in a few of the RICE wells; these wells are not used to supply drinking water. All detections of radioactive constituents were below health-based thresholds, although six samples had activities of radon-222 above the lower proposed MCL-US threshold. Most of the samples from the MSACV wells had concentrations of major elements, total dissolved solids, and trace elements below the non-enforceable thresholds set for aesthetic concerns. Chloride and sulfate concentrations exceeded SMCL-CA thresholds in two and one grid well, respectively. Iron, manganese, and total dissolved solids concentrations were above the SMCL-CA thresholds in 1, 12, and 6 grid wells, respectively. Nitrate (nitrite plus nitrate, as dissolved nitrogen) concentrations from two grid wells were above the MCL-US threshold. There were no detections of microbial indicators in MSACV.

Introduction

Ground water comprises nearly half of the public water supply used in California (Hutson and others, 2004). To assess the quality of ground water from public-supply wells and establish a program for monitoring trends in ground-water quality, the California State Water Resource Control Board (SWRCB), in collaboration with the U.S. Geological Survey (USGS) and Lawrence Livermore National Laboratory (LLNL), implemented a statewide Groundwater Ambient and Monitoring and Assessment (GAMA) program (http://www.waterboards.ca.gov/gama). The GAMA program consists of three projects: Priority Basin Assessment, 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 Assessment 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 interagency collaboration and cooperation with local water agencies and well owners. Local participation in the project is entirely voluntary.

The GAMA Priority Basin Assessment project is unique in California because the data collected during the study include analyses for an extensive number of chemical constituents at very low 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 Assessment project will analyze a broader suite of constituents than required by the California Department of Public Health (CDPH, formerly the California Department of Health Services). An understanding of 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 exist in California must be considered in an assessment of ground-water quality. Belitz, and others (2003) partitioned the state into 10 hydrogeologic provinces, each with distinctive hydrologic, geologic, and climatic characteristics (fig. 1), and representative regions in all 10 provinces were included in the project design. Eighty percent of California's approximately 16,000 public-supply wells are located in ground-water basins within these hydrologic provinces. These ground-water basins, defined by the California Department of Water Resources, 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 on the basis of 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 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 achieve representation of the 20 percent of public-supply wells not located in the ground-water basins.