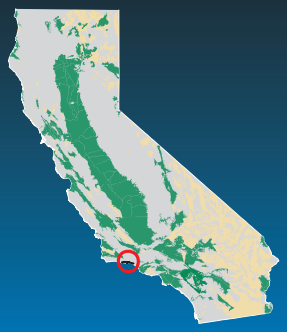
U.S. Geological Survey and the California State Water Resources Control Board

Groundwater Quality in the Santa Barbara Coastal Plain, California



Groundwater provides more than 40 percent of California's drinking water. To protect this vital resource, the State of California established the Groundwater Ambient Monitoring and Assessment (GAMA) Program. The Priority Basin Project of the GAMA Program provides a comprehensive assessment of the State's groundwater quality and increases public access to groundwater-quality information. The Santa Barbara Coastal Plain is one of the study units.

The Santa Barbara Study Unit

The Santa Barbara study unit covers more than 48 square miles in the Transverse and Selected Peninsular Ranges hydrogeologic province and includes parts of Santa Barbara and Ventura Counties (Davis and Kulongoski, 2016). The study unit is flanked by the Santa Ynez Mountains on the north and the Pacific Ocean on the south. The study unit consists of five coastal plain groundwater basins (California Department of Water Resources, 2003). These five groundwater basins are Goleta, Foothill, Santa Barbara, Carpinteria, and Montecito, from west to east.

The climate in the study unit is classified as Mediterranean, with hot, dry summers and cool, moist winters. Average annual rainfall in the study unit is about 17 inches. The study unit is drained by Mission Creek and other intermittent streams that flow from the Santa Ynez Mountains in the north to the south, where they terminate in the Pacific Ocean.

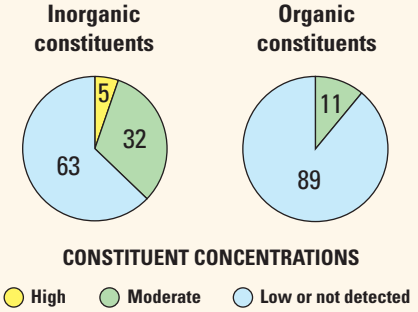
Base modified from U.S. Geological Survey and State digital data, various scales
National Elevation Dataset 2006, Albers Equal Area Projection
North American Datum of 1983

The main water-bearing units of the primary aquifer system in the Santa Barbara study unit consist of alluvium of Quaternary age (Davis and Kulongoski, 2016). Other water bearing units include the Santa Barbara and Casitas Formations, which underlie the alluvial deposits. The primary aquifer system in the study unit is defined as those parts of the aquifer corresponding to the perforated intervals of wells listed in the California Department of Public Health database. Public-supply wells in the study unit range in depth from 150 to 1,230 feet, consist of solid casing from the land surface to a depth of about 110 to 350 feet, and are perforated below the solid casing. Water quality in the primary aquifer system can differ from that in the shallower and deeper parts of the aquifer system.

Land use in the study unit is approximately 64-percent urban, 24-percent natural land, and 12-percent agricultural. Small areas of natural land use are intermixed with urban and agricultural land uses. Agricultural land use primarily exists in the eastern part of the study unit and along the outskirts of the western part. Topographically, the study area consists of coastal hills sloping toward the ocean.

The groundwater basins are recharged by percolation of agricultural return and precipitation, infiltration of imported water through canals and aqueducts, and seepage losses from the major rivers and their tributaries. The primary sources of discharge are water pumped for municipal supply, subsurface outflow to other groundwater basins, and evaporation.

Overview of Water Quality



Pie charts illustrate the percentage of the primary aquifer system, on an areal basis, with concentrations in the three specified categories.

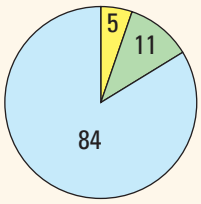
The GAMA's Priority Basin Project evaluates the quality of untreated groundwater. For context, however, benchmarks established for drinking-water quality are used for comparison. Benchmarks and definitions of *high*, *moderate*, and *low* concentrations are discussed in the inset box, "Benchmarks for Evaluating Groundwater Quality," on page 3.

Many inorganic constituents are naturally present in groundwater. The concentrations of the inorganic constituents can be affected by natural processes as well as by human activities. In the Santa Barbara study unit, one or more inorganic constituents with health-based benchmarks were present at high concentrations in about 5 percent of the primary aquifer system and at moderate concentrations in about 32 percent.

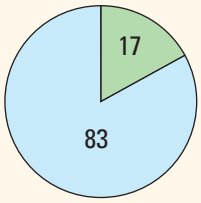
Organic constituents are found in products used in the home, business, industry, and agriculture and can enter the environment through normal usage, spills, or improper disposal. In the Santa Barbara study unit, organic constituents were not present at high concentrations, but were present at moderate concentrations in about 11 percent of the primary aquifer system.

RESULTS: Groundwater Quality in the Santa Barbara Study Unit

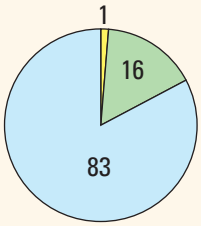
INORGANIC CONSTITUENTS



Trace elements and minor ions



Uranium and radioactive constituents



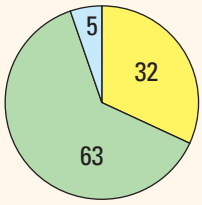
Nutrients

Inorganic Constituents with Human-Health Benchmarks

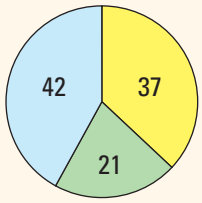
Trace elements and minor ions are naturally present in the minerals in rocks and soils, and in the water that comes into contact with those materials. In the Santa Barbara study unit, trace elements and minor ions were present at high concentrations in about 5 percent of the primary aquifer system and at moderate concentrations in about 11 percent. Boron and fluoride were the trace elements and minor ions that were present at high concentrations.

Radioactivity is the release of energy or energetic particles during spontaneous decay of unstable atoms. Most of the radioactivity in groundwater comes from the decay of naturally present isotopes of uranium and thorium in minerals in the sediments of the aquifer. Radioactive constituents were not detected at high levels, but were present at moderate levels in about 17 percent of the primary aquifer system.

Nutrients, such as nitrogen, are naturally present at low concentrations in groundwater. High and moderate concentrations generally occur as a result of human activities, such as applying fertilizer to crops and landscaping, seepage from septic systems, and human and animal waste. In the Santa Barbara study unit, nitrate was detected at high concentrations in about 1 percent of the primary aquifer system, and was present at moderate concentrations in about 16 percent.



Total dissolved solids



Manganese and/or iron

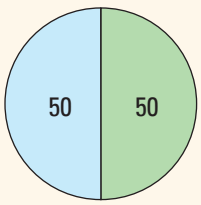
Inorganic Constituents with Non-Health Benchmarks

(Not included in water-quality overview charts shown on the front page.)

Some constituents affect the aesthetic properties of water, such as taste, color, and odor or can create nuisance problems, such as staining and scaling. The State of California has a recommended and upper limit for total dissolved solids (TDS) in drinking water. All water naturally contains these constituents as a result of the weathering and dissolution of minerals in soils. Iron and manganese are naturally present in minerals of rocks and soils. Anoxic conditions in groundwater (low amounts of dissolved oxygen) can result in release of manganese and iron from minerals into groundwater.

In the Santa Barbara study unit, TDS was present at high concentrations (greater than the upper limit) in about 32 percent of the primary aquifer system and at moderate concentrations (between the recommended and upper limit) in about 63 percent. Iron, manganese, or both were present at high concentrations in about 37 percent of the primary aquifer system and at moderate concentrations in about 21 percent.

SPECIAL-INTEREST CONSTITUENT



Perchlorate

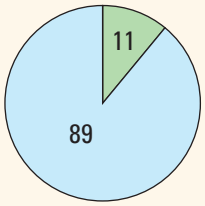
Special-Interest Constituent: Perchlorate

(Not included in water-quality overview charts shown on the front page.)

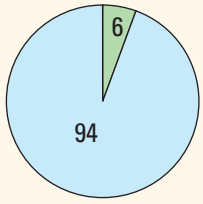
Perchlorate is an inorganic constituent that has been regulated in California drinking water since 2007. It is an ingredient in explosives, rocket fuel, fireworks, and safety flares. Perchlorate is in some fertilizers and can be present at low concentrations in precipitation. In the Santa Barbara study unit, perchlorate was not detected at high concentrations, but was detected at moderate concentrations in 50 percent of the primary aquifer system.

RESULTS: Groundwater Quality in the Santa Barbara Study Unit

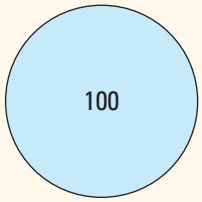
ORGANIC CONSTITUENTS



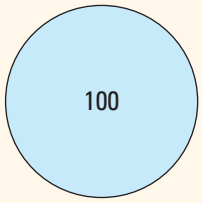
Gasoline components



Solvents



Other VOCs



Pesticides

Organic Constituents

The GAMA Priority Basin Project uses laboratory methods that can detect concentrations of volatile organic compounds (VOCs) and pesticides far below human-health benchmarks. The VOCs and pesticides detected at these very low concentrations can be used to help trace water from the landscape to the aquifer system.

Volatile Organic Compounds with Human-Health Benchmarks

The VOCs are used in many household, commercial, industrial, and agricultural products and are characterized by their tendency to volatilize (evaporate) into the air. In the Santa Barbara study unit, VOCs were not present at high concentrations in the primary aquifer system.

Gasoline components include hydrocarbons and oxygenates, which can be used as additives to increase the efficiency of fuel combustion and improve emissions quality. The gasoline oxygenate methyl-*tert*-butyl-ether (MTBE) was present at moderate concentrations in about 11 percent of the primary aquifer system.

Solvents are used for a number of purposes, including manufacturing and cleaning. The solvents 1,2-dichloroethane and perchloroethene were present at moderate concentrations in 6 percent and 1 percent, respectively, of the primary aquifer system.

Other VOCs include organic compounds such as trihalomethanes, refrigerants, or organic synthesis reagents. Other VOCs were not detected at high or moderate concentrations in the primary aquifer system.

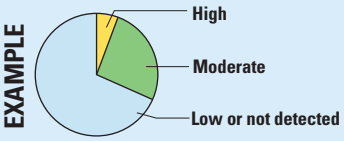
Pesticides with Human-Health Benchmarks

Pesticides, including herbicides, insecticides, fungicides, and fumigants, are applied to crops, gardens, lawns, around buildings and along roads to help control unwanted vegetation (weeds), insects, fungi, and other pests. In the Santa Barbara study unit, pesticides were not detected at high or moderate concentrations in the primary aquifer system. The herbicide simazine was the only pesticide detected.

BENCHMARKS FOR EVALUATING GROUNDWATER QUALITY

The GAMA's Priority Basin Project uses benchmarks established for drinking water to provide context for evaluating the quality of untreated groundwater. After withdrawal, groundwater may be disinfected, filtered, mixed, and exposed to the atmosphere before being delivered to consumers. Federal and California regulatory benchmarks for protecting human health (maximum contaminant level, MCL) are used when available. Otherwise, non-regulatory benchmarks for protecting aesthetic properties, such as taste and odor (secondary maximum contaminant level, SMCL), and non-regulatory benchmarks for protecting human health (notification level, NL; lifetime health advisory, HAL) are used.

CONSTITUENT CONCENTRATIONS



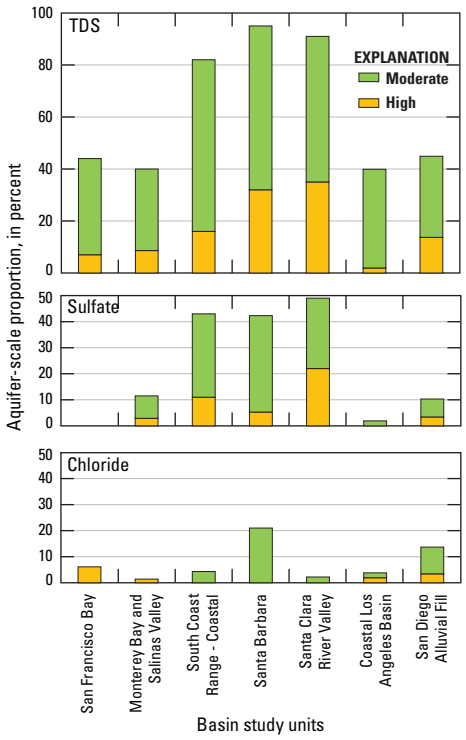
Values are a percentage of the area of the primary aquifers with concentrations in the three specified categories.
[<, less than]

High, moderate, and low concentrations are defined relative to benchmarks

Concentrations are considered *high* if they are greater than a benchmark. For inorganic constituents, concentrations are *moderate* if they are greater than one-half of a benchmark. For organic and special-interest constituents, concentrations are *moderate* if they are greater than one-tenth of a benchmark; this lower threshold was used because organic constituents are generally less prevalent and have smaller concentrations relative to benchmarks than inorganic constituents. *Low* concentrations include non-detections and values less than moderate concentrations. Methods for evaluating water quality are discussed by Davis and Kulongoski (2016).

Factors that Affect Groundwater Quality

Inorganic constituents with health-based benchmarks were not prevalent at high concentrations in the Santa Barbara study unit; however, high concentrations of total dissolved solids (TDS) were present in about 32 percent of the primary aquifer system. Concentrations greater than the upper secondary maximum contaminant level (SMCL) of 1,000 parts per million (ppm) are considered high. The GAMA PBP evaluated seven Central and Southern California coastal basin study units (references below), and the prevalence of high concentrations of TDS in those study units ranged from 2 percent to 35 percent. The Santa Barbara and Santa Clara River Valley study units had the greatest prevalence of high concentrations.



Base derived from U.S. Geological Survey
National Elevation Dataset, 2006, Albers Equal Area Conic Projection
North American Datum of 1983

Groundwater with high concentrations of TDS generally had high or moderate concentrations of sulfate or chloride (upper SMCL benchmark for sulfate and chloride is 500 ppm each). Sulfate was more prevalent at high concentrations than was chloride in five of the seven study units, including in the Santa Barbara study unit. There are many natural and anthropogenic sources and processes that can affect TDS, sulfate, and chloride concentrations in groundwater, including seawater intrusion; upwelling of connate saline waters; water-rock interactions; evaporative concentration of shallow groundwater; and recharge of irrigation return flows, wastewaters, and runoff.

By Tracy A. Davis and Kenneth Belitz

Priority Basin Assessments

The GAMA's Priority Basin Project (PBP) assesses water quality in that part of the aquifer system used for drinking water, primarily public supply. Water quality in shallower and deeper parts can differ from that in the primary aquifers. The GAMA's Domestic Well Project assesses water quality in the shallower parts of the aquifer system. Ongoing assessments are being carried out in more than 120 basins throughout California.

The PBP assessments are based on a comparison of constituent concentrations in untreated groundwater that have benchmarks established for the protection of human health and for aesthetic concerns. The PBP does not evaluate the quality of drinking water delivered to consumers.

The PBP uses two scientific approaches for assessing groundwater quality. The first approach uses a network of wells to statistically assess the status of groundwater quality. The second approach combines water-quality, hydrologic, geographic, and other data to help assess the factors that affect water quality. In the Santa Barbara study unit, data were collected by the PBP in 2011 and retrieved from the CDPH database for 2008–11. The PBP includes chemical analyses not generally available as part of regulatory compliance monitoring, including measurements at concentrations much lower than human-health benchmarks and measurement of constituents that can be used to trace the sources and movement of groundwater.

For more information

Technical reports and hydrologic data collected for the GAMA Program may be obtained from:

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U.S. Geological Survey
California Water Science Center
6000 J Street, Placer Hall
Sacramento, CA 95819-6129
Telephone number: (916) 278-3000
WEB: http://ca.water.usgs.gov/gama

GAMA Program Unit
State Water Resources Control Board
Division of Water Quality
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WEB: http://www.waterboards.ca.gov/gama

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