

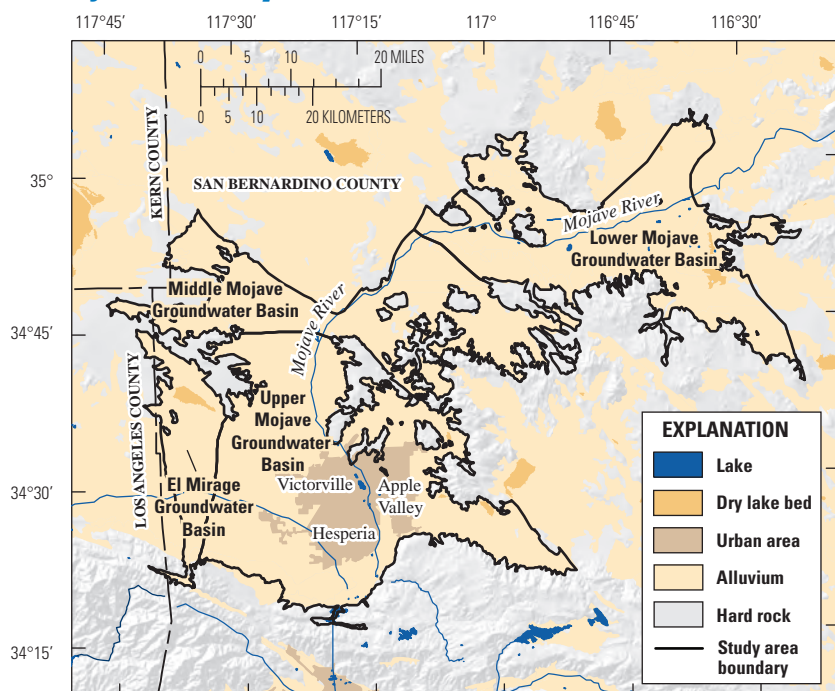
U.S. Geological Survey and the California State Water Resources Control Board

# Groundwater Quality in the Mojave Area, California

Groundwater provides more than 40 percent of California's drinking water. To protect this vital resource, the State of California created 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. Four groundwater basins along the Mojave River make up one of the study areas being evaluated.



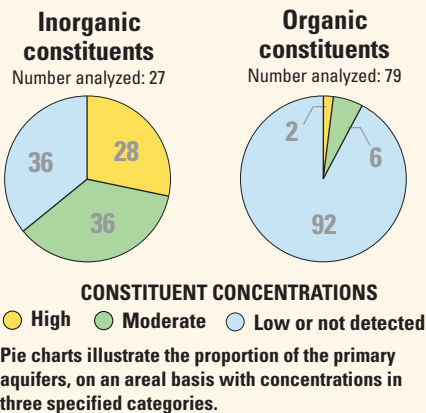
## The Mojave Study Area



The Mojave study area is approximately 1,500 square miles (3,885 square kilometers) and includes four contiguous groundwater basins: Upper, Middle, and Lower Mojave River Groundwater Basins, and the El Mirage Valley (California Department of Water Resources, 2003). The Mojave study area has an arid climate, and is part of the Mojave Desert. Average annual rainfall is about 6 inches (15 centimeters). Land use in the study area is approximately 82 percent (%) natural (mostly shrubland), 4% agricultural, and 14% urban. The primary crops are pasture and hay. The largest urban areas are the cities of Victorville, Hesperia, and Apple Valley (2010 populations of 116,000, 90,000 and 69,000, respectively).

Groundwater in these basins is used for public and domestic water supply and for irrigation. The main water-bearing units are gravel, sand, silt, and clay derived from surrounding mountains. The primary aquifers in the Mojave study area are defined as those parts of the aquifers corresponding to the perforated intervals of wells listed in the California Department of Public Health database. Public-supply wells in the Mojave study area are completed to depths between 200 and 600 feet (18 to 61 meters), consist of solid casing from the land surface to a depth of 130 to 420 feet (40 to 128 meters), and are screened or perforated below the solid casing. Recharge to the groundwater system is primarily runoff from the mountains to the south, mostly through the Mojave River channel. The primary sources of discharge are pumping wells and evapotranspiration.

## Overview of Water Quality



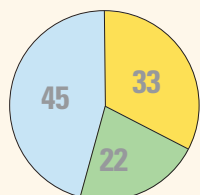
GAMA's Priority Basin Project evaluates the quality of untreated groundwater. However, for context, benchmarks established for drinking-water quality are used for comparison. Benchmarks and definitions of high, moderate, and low concentrations are discussed in the inset box on page 3. The USGS sampled 52 wells for this assessment; data from the California Department of Public Health database were used to supplement USGS data.

Many inorganic constituents occur naturally in groundwater. The concentrations of the inorganic constituents can be affected by natural processes as well as by human activities. In the Mojave study area, one or more inorganic constituents were present at high concentrations in 28% of the primary aquifers and at moderate concentrations in 36%.

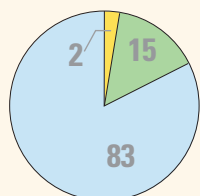
Organic constituents are present in products used in the home, business, industry, and agriculture. Organic constituents can enter the groundwater system through normal usage, spills, or improper disposal. In the Mojave study area, organic constituents were present at high concentrations in 2% of the primary aquifers and at moderate concentrations in 6%.

# RESULTS: Groundwater Quality in the Mojave Study Area

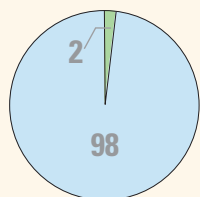
## INORGANIC CONSTITUENTS



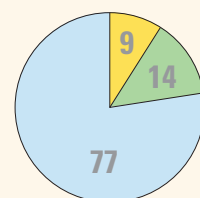
**Trace elements**



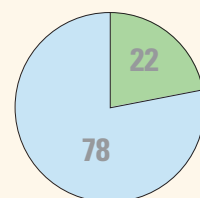
**Radioactive constituents**



**Nutrients**



**Other inorganic constituents**



**Perchlorate**

## Inorganic Constituents with Human-Health Benchmarks

Trace elements are naturally present in the minerals in rocks and soils, and in the water that comes into contact with those materials. In the Mojave study area, trace elements with human-health benchmarks were present at high concentrations in 33% of the primary aquifers on an areal basis, and at moderate concentrations in 22%. Of the 17 trace elements with human-health benchmarks analyzed in this study, 6 were detected at high concentrations: arsenic, boron, fluoride, molybdenum, strontium, and vanadium. Lead was present at moderate concentrations.

Radioactivity is the release of energy or energetic particles during structural changes in the nucleus of an atom. Most of the radioactivity in groundwater comes from decay of naturally occurring isotopes of uranium and thorium that are present in minerals in the aquifer. In the Mojave study area, radioactive constituents were detected at concentrations above benchmarks in 2% of the primary aquifers, and at moderate concentrations in 15%. Six radioactive constituents were analyzed; of these, gross alpha radioactivity was detected at concentrations above benchmarks.

Nutrients, such as nitrate and nitrite, are naturally present at low concentrations in groundwater. High and moderate concentrations generally occur as a result of human activities, such as fertilizer application, livestock waste, or septic-system seepage. Of the three nutrients with health-based benchmarks analyzed, one, nitrate, was detected at concentrations above benchmarks.

## Inorganic Constituents with Non-Health Benchmarks

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

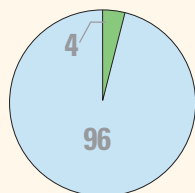
Other inorganic constituents, such as total dissolved solids and manganese, affect the aesthetic properties of water, such as taste, color, or odor. In the Mojave study area, these constituents were present at high concentrations in 9% of the primary aquifers, and at moderate concentrations in 14%. Of the seven constituents with non-health-based benchmarks that were analyzed, five were detected at concentrations above benchmarks: chloride, iron, manganese, sulfate, and total dissolved solids.

## Special Interest: Perchlorate

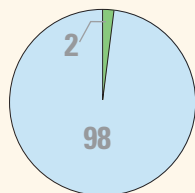
Perchlorate is an inorganic constituent which has been regulated in California drinking water since 2007. It is an ingredient in rocket fuel, fireworks, safety flares, may be present in some fertilizers, and also occurs naturally at low concentrations in groundwater. In the Mojave study area, perchlorate was found at moderate concentrations in 22% of the primary aquifers.

# RESULTS: Groundwater Quality in the Mojave Study Area

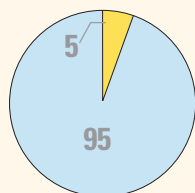
## ORGANIC CONSTITUENTS



**Volatile organic compounds**



**Pesticides**



**NDMA**

## Organic Constituents with Human-Health Benchmarks

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

### Volatile Organic Compounds

VOCs are present in many household, commercial, industrial, and agricultural products and can form during the disinfection of water supplies; they are characterized by their tendency to volatilize into the air. Of 56 VOCs with health-based benchmarks analyzed in the Mojave study area, 3 VOCs (1,2-dichloroethane, tetrachloroethene, and carbon tetrachloride) were detected at moderate concentrations.

### Pesticides

Pesticides are used on lawns, in gardens, around buildings, along roads, and in agriculture to help control unwanted vegetation (weeds), insects, fungi, and other pests. Of the 20 pesticides with health-based benchmarks that were analyzed, one, dieldrin, was detected at a moderate concentration in one well. The use of dieldrin was banned in the United States in 1987.

### Special Interest: *N*-Nitrosodimethylamine (NDMA)

NDMA is an organic constituent that is an industrial and water disinfection byproduct. NDMA was detected at a high concentration in one well, equating to 5% of the primary aquifers in the Mojave study area. Because fewer samples were collected for NDMA than for other organic constituents, the proportion of the primary aquifers with high concentrations of one or more organic constituents (page 1, “Overview of Water Quality”) is less than the proportion for NDMA.

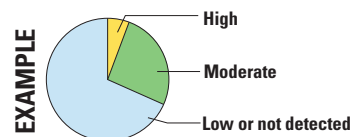
## BENCHMARKS FOR EVALUATING GROUNDWATER QUALITY

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, or 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, nonregulatory benchmarks for protecting human health (Notification Level, NL, and Lifetime Health Advisory, HAL) and nonregulatory benchmarks for protecting aesthetic properties such as taste and odor (Secondary Maximum Contaminant Level, SMCL) are used.

### 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 considered *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 Milby Dawson and Belitz (2012).

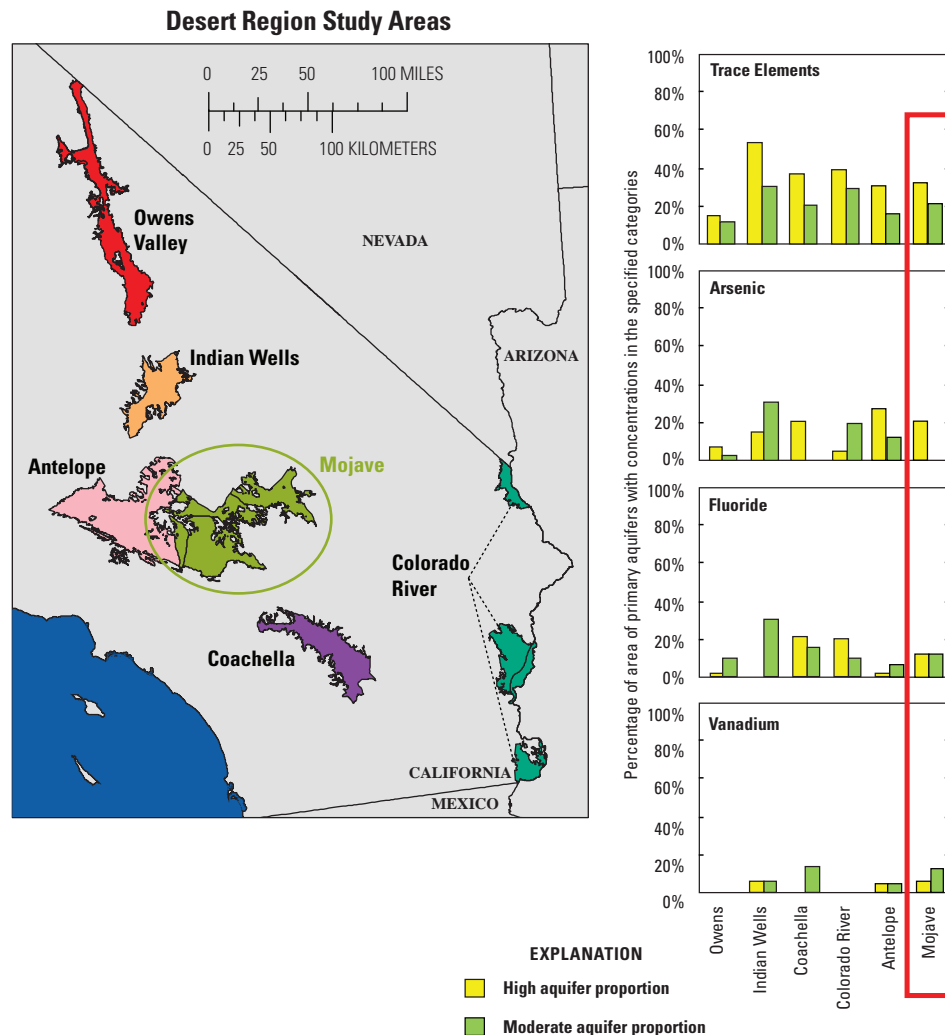
### CONSTITUENT CONCENTRATIONS



Values are a percentage of the area of the primary aquifers with concentrations in the three specified categories.

# Trace Element Concentrations Throughout the California Desert Region

Trace elements were present at high concentrations in all of the Desert Region primary aquifers. In Mojave, they were high in 33% of the primary aquifers, on an areal basis; the range of high trace element percentages in the Desert Region primary aquifers was 15 to 54% (Milby Dawson and Belitz, 2012). The trace elements with the highest percentages in the Mojave study area were arsenic (high concentrations in 21% of the primary aquifers), fluoride (11%), and vanadium (8%). Arsenic was detected at high concentrations in all of the Desert Region primary aquifers. Fluoride was detected at high concentrations in five of the six Desert Region study areas. Vanadium was at detected high concentrations in the Mojave, Antelope, and Indian Wells study areas in the Desert Region.



By Barbara J. Milby Dawson and Kenneth Belitz

## SELECTED REFERENCES

- California Department of Water Resources, 2003, California's groundwater: California Department of Water Resources Bulletin 118, 246 p., available at <http://www.water.ca.gov/groundwater/bulletin118/update2003.cfm>
- Mathany, T.M., and Belitz, K., 2009, Groundwater quality data in the Mojave study unit, 2008—Results from the California GAMA Program: U.S. Geological Survey Data Series 440, 69 p., available at <http://pubs.usgs.gov/ds/440/>
- Milby Dawson, B.J., and Belitz, K., 2012, Status of groundwater quality in the California Desert Region, 2006–2008—California GAMA Program Priority Basin Project: U.S. Geological Survey Scientific Investigations Report 2012-5040, 100 p.

## Priority Basin Assessments

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 may differ from water quality in the primary aquifers. GAMA's Domestic Well Project assesses water quality in the shallower parts of the aquifer system. Ongoing assessments are being conducted in more than 120 basins throughout California.

The PBP assessments are based on a comparison of constituent concentrations in untreated groundwater with 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 approaches for assessing groundwater quality. The first approach uses a network of wells to provide a statistically based assessment of the status of groundwater quality. The second approach uses additional wells to help assess the factors that affect water quality. Both approaches use data routinely collected for regulatory compliance, as well as data collected by the PBP. 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:

### GAMA Program Unit

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